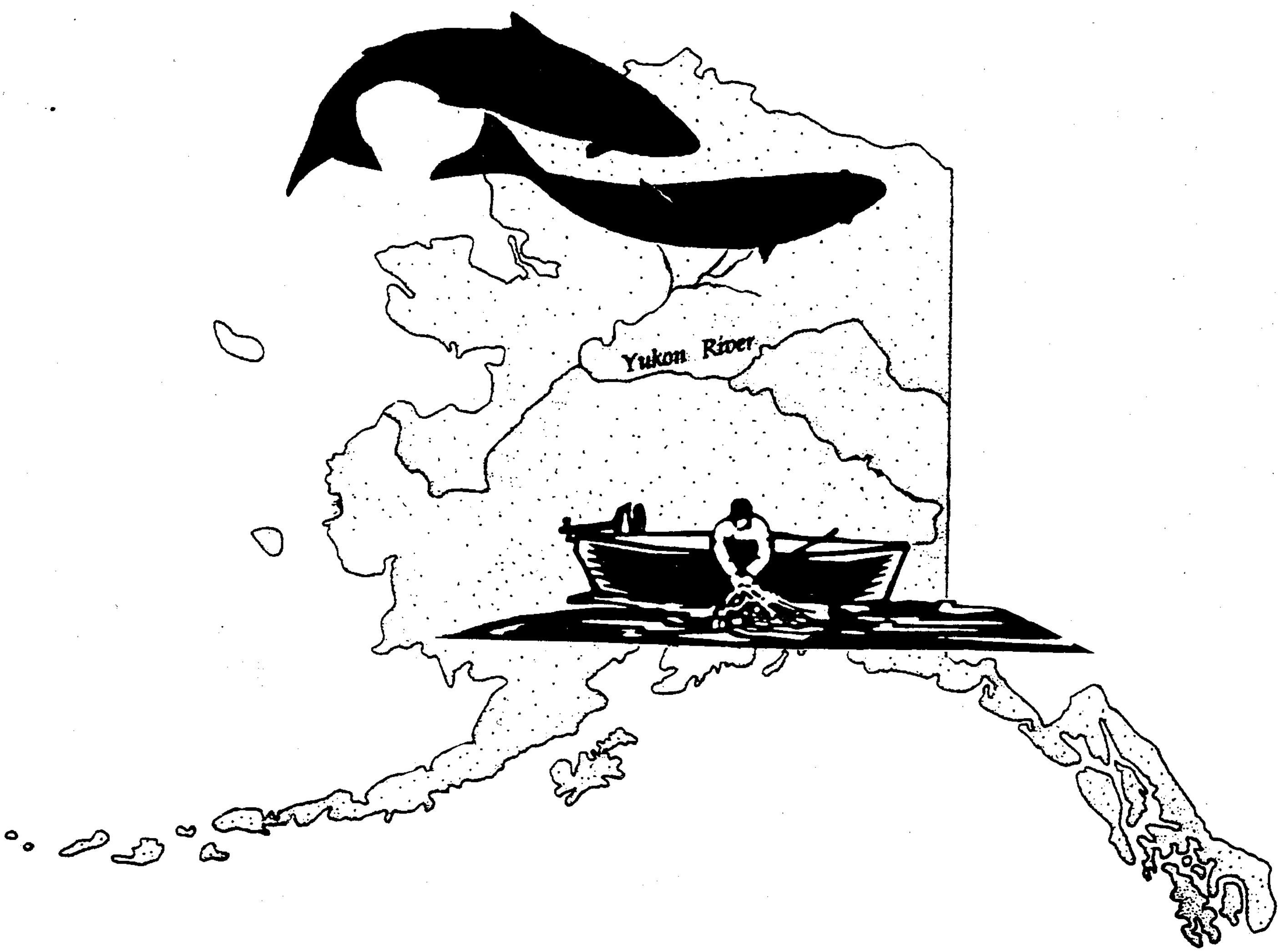
YUKON RIVER
COMPREHENSIVE SALMON PLAN FOR ALASKA

Compiled by
R.R. Holder and D. Senecal-Albrecht for the
Yukon River Regional Planning Team



Frank Rue, Commissioner
Alaska Department of Fish and Game

August 1998

Compilers: Russell R. Holder is the Regional Resource Development Biologist for the Arctic, Yukon, and Kuskokwim Region for the Alaska Department of Fish and Game, Division of Commercial Fisheries, 1300 College Road, Fairbanks, Alaska 99701-1599; Dan Senecal-Albrecht is the Executive Director for the Yukon River Drainage Fisheries Association, 733 West 4th Avenue, #881, Anchorage, Alaska 99501.

STATE OF ALASKA

TONY KNOWLES, GOVERNOR

DEPARTMENT OF FISH AND GAME

OFFICE OF THE COMMISSIONER

P.O. BOX 25526
JUNEAU, ALASKA 99802-5526
PHONE: (907) 465-4100
FACSIMILE: (907) 465-2332

August 7, 1998

Mr. Larry Lujan
Mr. Emmitt Peters
Co-chairmen
Yukon River RPT
Yukon River Drainage Fisheries Association
733 West 4th Avenue #881
Anchorage, AK 99501

Dear Sirs:

This letter is to officially inform you and all members of the Yukon River Regional Planning Team of my approval of the *Yukon River Comprehensive Salmon Plan for Alaska*.

Prior to submittal of the plan for my consideration, I was informed that, in compliance with AS 16.10.375, the Planning Team distributed nearly 100 review draft copies to individuals, organizations, and governmental agencies around the state. The Planning Team also solicited public comments on proposed revisions through published notices in regional newspapers and public service announcements. The plan has undergone complete technical review by staff from the Alaska Department of Fish and Game (i.e., Commercial Fisheries, Sport Fish, Subsistence, and Habitat Divisions), the Bureau of Land Management, and the United States Fish and Wildlife Service. I am confident that the Planning Team and compilers were responsive to the comments and suggestions that resulted from this thorough review process.

Based on the efforts of the Yukon River Regional Planning Team, the two plan compilers in preparing this plan, and on the comments I have received on the quality of those efforts, I believe a viable and responsible document has been produced for maintaining or increasing natural salmon production within the Alaskan portion of the Yukon River drainage. This document emphasizes responsible in-season salmon management, habitat restoration, and investigative studies on Yukon River salmon populations, which I agree are the primary areas for agencies, organizations, and individuals to focus their present and future resources on for maintaining the long-term vitality of Yukon River salmon stocks. Therefore, I offer my congratulations and appreciation to both of you and to all members of the team for your dedication to the planning process.

Sincerely,

Frank Rue
Commissioner

11-K2LH

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Development of a comprehensive salmon plan for the Alaska portion of the Yukon River region was initiated by the Yukon River Drainage Fisheries Association (YRDFA) and Alaska Department of Fish and Game (ADF&G) in spring of 1993 with the signing of a cooperative agreement between YRDFA and ADF&G. This process was initiated in compliance with the commissioner's statutory mandate for salmon planning and in response to interests for restored and expanded salmon production expressed by YRDFA, concerned fishermen, fish and game advisory committees, fishermen's organizations, and delegates to the U.S./Canada Yukon River salmon treaty negotiation process.

Desires and objectives of the fishermen, as expressed by the Yukon River Regional Planning Team (RPT), indicate an emphasis on improving inseason management tools, improving escapement assessments and run size projections, protecting salmon habitat, and restoring habitat of previously productive salmon systems. The RPT sees very little support or desire for large-scale hatchery production, such as that proposed in other regions. There is also a strong recognition of the need to protect the genetic integrity of local stocks and a desire to promote a more comprehensive understanding of local watersheds and their potential for increased salmon production.

Specific actions promoted by this plan include the following:

1. Improve management of existing regional salmon fisheries by:
   (a) increasing monitoring of chinook, chum, and coho salmon escapements in the region;
   (b) maintaining and preserving the health and integrity of salmon spawning grounds, rearing areas, and migration corridors; and
   (c) continuing to identify issues (biology, harvest, management, etc.) which would benefit from further research and understanding.

2. Improve preseason projections of salmon production by:
   (a) conducting comprehensive salmon lifecycle studies of Yukon River index tributaries; and
   (b) encouraging studies of nearshore and marine environments and their productive capacity to support salmon populations.

3. Investigate restoration/rehabilitation opportunities by:
   (a) assessing area watersheds for removal of barriers to fish migration and/or repair of damaged spawning/rearing habitat; and
   (b) evaluating supplemental production potential.

4. Improve public education and involvement in salmon conservation and restoration activities by improving information dissemination to the public

via all media; and promoting joint government-public activities such as field research, conferences, and educational programs.

The RPT realized that relying on supplemental salmon production methods alone to increase harvests would be problematic on the Yukon River. Moreover, the RPT understood that achieving consistently high commercial harvests through expanded run sizes would require expanded spawning escapements. However, to achieve these expanded escapements would require a commensurate reduction in present-day harvests.

Therefore, to establish realistic and sustainable harvest goals, the RPT examined recent historical subsistence and commercial harvests to assess what catches, by salmon species, could be achievable through this Plan. By implementing the activities described above in a manner consistent with the Guiding Principles, it is expected that sustained yield for each salmon species can be maintained, subsistence needs can be met, and commercial harvest opportunities can be maximized.

To assess subsistence needs, care must be used when using past harvest levels to define overall subsistence needs. Harvest anomalies such as regulatory closures, unusually poor runs, and weather events that interrupt harvest should be removed from the equation. Average annual subsistence harvest, by species listed below, represent 15 years of harvest data (1981 through 1995, Yukon River Alaska portion only) with the 5 lowest harvest years removed. The estimated annual subsistence harvest needs by species are as follows:

Chinook	50,000
Summer Chum	234,000
Fall Chum	184,000
Coho	45,000

Note that changes in population or other socioeconomic factors may affect annual subsistence harvest needs.

Commercial harvest opportunities can be maximized in any given year based on the total run size and market demand, provided escapement and subsistence needs are met. Historically, annual commercial harvests in the Yukon are more variable relative to annual subsistence harvests and are occasionally subject to "boom" or "bust" years due to unforeseen swings in productivity and market factors. Therefore, the RPT expects that it is more reasonable to provide a range of achievable commercial harvests based upon the current guideline harvest ranges (GHR) established by the Alaska Board of Fisheries. The RPT expects that harvests between the midpoint and high end of each guideline harvest range are attainable (given adequate market demand) from natural production through actions promoted by this Plan. The estimated annual commercial harvest range expectations are:

GHR	Mid-point		Upper-end
Chinook	97,500	to	128,350
Summer Chum	800,000	to	1,200,000
Fall Chum	196,375	to	320,000

Currently, there are no guideline harvest levels established for coho salmon. Commercial harvests of coho salmon are incidental to the directed fall chum salmon fishery and will vary depending upon coho salmon run size and the harvest effort directed at fall chum salmon.

The RPT hopes this Plan will initiate benefits to all user groups and maintain or increase local salmon production. The RPT realizes that state, federal, and other sources of funding will be needed to obtain and support the programs outlined in this plan, and that while attempting to accomplish these goals acts of nature, including natural productivity cycles, will affect the productivity potential of these stocks.

INTRODUCTION

Acknowledgements

A RPT is structured to bring together biological and technical expertise to review needs and concerns of the user groups in an effort to achieve consensus on the directions of resource development. The Yukon River Regional Planning Team (YRRPT) respectfully acknowledges its members for their contributions in the collective effort of drafting this plan. During development of this plan the participants included;

Regional Planning Team Appointees

Anthony Ulak	Scammon Bay
Larry Lujan, co-chair	Emmonak
Aloysius Unok	Kotlik
Gabe Evan	St. Mary's
Melvin Agwiak, alternate	Emmonak
Harry Wilde, alternate	Mt. Village
Doug Sweat	Kaltag
Philip Titus	Minto
Emmitt Peters, co-chair	Ruby
Paul Williams	Beaver
Clifford Luke, alternate	Ft. Yukon
Richard Burnham, alternate	Kaltag

Alaska Department of Fish and Game

Tom Kron	CFMD, Anchorage
Richard Cannon	CFMD, Anchorage
Fred Andersen	Sport Fish, Fairbanks
Elizabeth Andrews	Subsistence, Fairbanks

Ex-officio Members

Calvin Simeon	AVCP, Bethel
George Yaska	TCC, Fairbanks
Monty Millard	USF&WS, Fairbanks
Peter Stortz	UAF Coop Ext Srvce, Palmer

Project Staff

Dan Senecal-Albrecht	YRDFA Executive Director, Anchorage
Jude Henzler	BSFA Executive Director, Anchorage
Russ Holder	ADF&G CFMD, Fairbanks

We would also like to acknowledge all the public and professional participants, not recognized above, who participated in the planning process by attending one or more of the public meetings, by providing text material for inclusion in this document, or by providing written comments on drafts of this Plan.

Authority for Writing the Plan

The commissioner of the ADF&G, in accordance with Alaska Statutes 16.10.375-470, has designated salmon production regions throughout the state. In each region, the commissioner is responsible for the development and amendment of a comprehensive salmon production plan. The commissioner has placed this responsibility with regional planning teams (RPT) that statutorily consist of representatives from ADF&G and regional aquaculture associations. Although there is no aquaculture association in the case of the Yukon Area, the commissioner has determined that the YRDFA fulfills that role due to its open membership rules, its broad representation through its board and delegation structure and its consensus operating principle. The mission of RPTs is to plan for the long-term future of salmon resources within their regions by initiating and continuing orderly processes that examine the full potential of a region's salmon production capacities.

Background

Similar to other species, salmon numbers fluctuate for a variety of reasons. During the late sixties and early seventies the lack of production from many important salmon fisheries provided cause for alarm. The Alaska legislature responded to this crisis by creating the Fisheries Rehabilitation Enhancement and Development (F.R.E.D.) Division within ADF&G in 1971. One of the responsibilities of this new division was to "develop and continually maintain a comprehensive, coordinated long range rehabilitation, enhancement and development of all aspect of the states fisheries;..." F.R.E.D. Division was responsible for a major expansion in salmon aquaculture research, production, and evaluation. The desire for increased salmon production came at a time when state operating funds were more generous due to the infusion of oil royalties into the state economy. By 1980, hatchery construction and operation in Alaska was becoming fully developed throughout Southeast, Southcentral, and Prince William Sound.

A second response by the Alaska Legislature to sustain the viability of Alaska's commercial fisheries was to pass the Limited Entry Act in 1973. The legislature found that "commercial fishing has reached levels of participation on both a statewide and an area basis that have impaired or threaten to impair the economic welfare of the fisheries of the state, the overall efficiency of the harvest, and the sustained yield management of the fishery resource" (AS16.43.010b). Douglas Pope (1980) compiled a thorough review for the Eleventh Alaska Legislature of the historical relationships of commercial and subsistence Yukon River salmon fisheries in relation to implementation of the Limited Entry Program.

During the expansion of hatchery technology into Southeast, Southcentral and Prince William Sound during the late seventies, some Western Alaska fishermen voiced their desire for increased salmon numbers from hatchery production. Site feasibility investigations were done for Sikusuilaq Hatchery on the Noatak River near Kotzebue in the late seventies. In 1980, the Alaska Legislature requested F.R.E.D. Division to conduct a hatchery site evaluation in the Lower Yukon River (below the village of Tanana). Robert McLean and Jim Raymond investigated the potential of 215 hatchery sites, 101 of which were visited. Because of limited water supplies or access limitations, no sites were identified which could accommodate a production-scale hatchery (greater than ten million egg capacity) with a conventional (non-recirculating) water supply. Volume 1 contains the main results of the survey (McLean and Raymond, 1983). Volume 2 contains water quality analyses, well logs and aquifer tests for many of the sites investigated (McLean and Raymond, 1981).

In 1978, the Lower Yukon/Kuskokwim Aquaculture Association (Yukon River from the village of Grayling to the mouth, and the Kuskokwim River drainage) was formed and received regional aquaculture association status in 1980. In 1982, the association was presented a grant by F.R.E.D. Division to develop a regional salmon fishery overview as a first step for the possible preparation of a Lower Yukon/Kuskokwim Comprehensive Regional Salmon Plan. The Lower Yukon/Kuskokwim regional planning team produced two background documents. The first report was a comprehensive bibliography relating to the Lower Yukon and Kuskokwim salmon fisheries (ADF&G and Lower Yukon Kuskokwim Regional Aquaculture Association, 1983). The second report was a Phase I pre-planning document entitled Lower Yukon/Kuskokwim Regional Salmon Fishery Overview (The Lower Yukon/Kuskokwim Regional Planning Team, 1983). Although the association recommended beginning Phase II, which included development of a Comprehensive Regional Salmon Plan, this second phase was never implemented.

During the mid to late eighties, salmon numbers from both wild and hatchery sources across the state rebounded in response to improved environmental conditions and fishery management actions. General public and political concern about growth in the state operating budget was becoming an issue since funds derived from North Slope oil revenues were declining. With support for state hatcheries declining, the state began to explore the option of private sector operation of fish enhancement programs. Some regional aquaculture associations were eager to take over state hatcheries, believing they could operate them more efficiently. Signaling the end of state funded salmon enhancement, the governor issued an executive order in 1993 which merged F.R.E.D. Division with the Commercial Fisheries Division and created the Commercial Fisheries Management and Development (CFMD) Division.

<u>The main reason for development of this Yukon River plan has been the formation and activities of the Yukon River Drainage Fisheries Association and the cooperative management relationship that has arisen between the YRDFA and the ADF&G</u>. This relationship began to form with the creation of the YRDFA in the winter of 1990/1991 and grew as the YRDFA and the ADF&G attempted to develop consensus approaches to a variety of issues affecting the fishery.

This process of cooperative management has evolved in a dynamic and turbulent time period for the Yukon River salmon fishery. The years 1991, 1992 and 1993 saw below average run strengths for summer chum salmon and 1992 and 1993 had below average returns for fall chum salmon, while some stocks for other species had particularly poor spawning escapements. These low escapement years raised concerns about meeting users needs in the current year while providing for healthy returns in future years.

At the same time, the social and economic needs of the fishermen and villagers continue to grow. Population growth has been steady for more than a decade, but full-time wage jobs continue to be scarce. The importance of subsistence salmon harvests to Yukon River villagers remains as strong as ever with harvest needs remaining stable if not increasing. Concurrent with the variability in chum salmon returns has been a weakening in the economic viability of commercial fishing. Ex-vessel prices have not kept pace with inflation. Yukon River chum salmon, in particular, have lost a considerable market share due, in general, to an inconsistent supply and to increased domestic and international competition.

As described at the beginning of this section, YRDFA and the ADF&G have developed a cooperative working relationship. The two entities have worked together on a number of issues. In the winter of 1992-1993, YRDFA presented the Toklat River Fall Chum Salmon Rebuilding Management Plan to the Board of Fisheries that attempted to rebuild this stock by sharing the conservation burden among all users. The Board of Fisheries adopted this rebuilding plan into regulation. Following the crash of the 1993 summer and fall chum salmon returns, they also worked together to formulate several new chum salmon plans including the 1995-1997 Yukon Area Fall Chum Salmon Management Plan and the Anvik River Summer Chum Management Area. YRDFA also defended the economic and biological rationales behind the middle and upper Yukon River roe fisheries, as well as river fisheries in general, to the Board of Fisheries.

YRDFA has worked through the Alaska Board of Fisheries to update or improve various regulations, often with the support of ADF&G. In response to the arrest and prosecution of one processor and several fishermen in 1992 on the lower Yukon River for illegal sales of chinook salmon, YRDFA worked with lower Yukon River fishermen to have the Board of Fisheries approve several new regulations to impede such illegal sales while protecting subsistence uses. All subsistence-caught chinook salmon must now have the dorsal fin immediately removed. Commercial and subsistence fishing periods are now separated by time, and all vessels used for commercial fishing must be marked with their CFEC permit number or ADF&G vessel identification number. Other regulation changes advanced by YRDFA and approved by the Board of Fisheries include the closure of the lower portion of the Delta River to all fishing to protect salmon spawners and spawning habitat, the legalization of subsistence driftnet fishing in the lower half of Subdistrict 4-A, and the removal of coho salmon from counting against the fall chum salmon guideline harvest in the upper Yukon River.

Since 1985, there have been ongoing negotiations between the U.S. and Canada on developing a treaty for the cooperative conservation and management of Canadian-spawned chinook and fall chum salmon. Despite the absence of any formal Yukon River salmon treaty between the two countries, spawning targets, border passage targets and harvest ranges in Canada, (established with the consent of their advisory delegations of fishermen) were adhered to by the management agencies to help stabilize and increase returns of these important stocks. This was made more formal beginning in February 1995 with the signing of an interim agreement, which implemented the areas of agreement to date while negotiations continued on a long-term agreement. YRDFA, through its publications and village meetings, has also played a key role in disseminating information about the negotiation process as well as being instrumental in forging a unified U.S. position in the negotiations.

The events and activities described above were the backdrop for YRDFA and ADF&G developing a comprehensive restoration and enhancement planning process. Both parties were concerned about stock declines and how to rebuild stocks while allowing continued harvests. Maintaining a healthy fishery while increasing returns to biological maximums was seen as the primary method for meeting the increasing commercial and subsistence needs of villagers throughout the Yukon River region. YRDFA and its members also wanted to learn more about restoration and enhancement techniques which might be deployed in such stock rebuilding efforts. Both parties also wanted documentation that would guide future management efforts; essentially a document that said "where are we now" and "where do we want to be".

Guiding Principles

The statutory mission of the comprehensive salmon plan process is to promote, using sound biological practices, activities which increase salmon production in a regional area for maximal social and economic benefits of the users consistent with the public interest. The Yukon River Plan differs significantly from most other regional salmon plans because the proposed source for increased salmon production is restored or expanded natural stock production rather than large-scale hatchery programs. The guiding principles include the following:

1. Strive to ensure the perpetuation, continual health, and unique characteristics of natural wild stock salmon production in the Yukon River tributary streams.

2. Impacts to subsistence salmon fisheries shall be reviewed in planning restoration and enhancement projects. Attempts should be made to consult with local elders and village residents when restoration and/or enhancement projects are being proposed or planned for salmon stocks.

3. Projects that involve habitat manipulation, supplemental production or other significant impact to salmon productivity shall be carefully planned and proceed in a conservative manner to minimize negative impacts to wild salmon stocks and/or to existing fisheries.

4. Existing habitat must be maintained to ensure protection and productivity of spawning and rearing areas as well as migration routes of Yukon River salmon.

5. Information gaps on salmon stocks must be addressed. More data on total abundance, escapement distribution, return-per-spawner productivity, egg survival, outmigrant survival and

migration timing are needed to provide for sustained yields or optimal yields as established by the Alaska Board of Fisheries.

6. Large-scale enhancement projects (i.e. hatcheries) designed to create new runs of fish are opposed.

7. Habitat or wild stock restoration projects shall have priority over enhancement of habitat or enhancement of wild stocks.

8. Fish mortality shall be minimized as much as possible while conducting salmon studies. Reasonable attempts should be made to donate fish killed to local subsistence users (with elders receiving priority), to charities, and/or have them sold as part of ADF&G's test fishery program.

9. All fisheries harvests (subsistence, commercial, personal use, sport, incidental, bycatch, etc.) within and outside the Yukon River drainage should be monitored for their impacts to Yukon River drainage salmon populations.

10. The strictest genetics and disease policies recommended by reviewing scientists shall apply to projects on the Yukon River. Only eggs, fry, or smolt of Yukon-origin salmon may be released within the Yukon River drainage. Furthermore, the introduction of Yukon River salmon beyond the Yukon River drainage is opposed.

11. The production level goals for restored stocks are to be consistent with natural habitat capacity.

12. The RPT recognizes that factors such as natural fluctuations in fish populations, the mixed-stock nature of the Yukon River fishery, regulatory processes, international agreements, the changing human population, and market conditions will continue to contribute to the difficulty of providing for subsistence needs and commercial harvest desires on a consistent basis. The intent of this plan is to improve the natural productivity of Yukon River salmon stocks so that each year the following goals are achieved: 1) established escapement goals for all salmon species are achieved, 2) drainage-wide subsistence needs are met, and 3) commercial fishing opportunities within sustained yield principles are maximized.

Assumptions

For the purposes of this plan, it is assumed that the following conditions will exist. If some of these conditions change or are proved false, then additional difficulty will be encountered in implementing this plan.

1. It is biologically feasible to bring about a sustained yield increase in harvest of Yukon River salmon to those levels identified if appropriate technology and management practices are utilized;

2. Agencies and individuals will utilize the most current and accurate data available and use the most widely accepted interpretation of those data;

3. Domestic and international market demand will be sufficient to absorb the commercial harvest levels promoted by this plan;

4. Both freshwater and marine habitats will remain favorable for salmon survival;

5. Research programs will be implemented to obtain information needed for optimizing salmon production using the strategies of habitat protection, management, and restoration;

6. Sufficient funding will be provided to achieve the goals identified in this plan;

7. This plan reflects the goals, objectives, principles, assumptions, and activities consistent with the fisheries of the Yukon River drainage at the time of writing.

Phase I--Public Information and Education

Phase I of the agreement began in May 1993 and ended December 31, 1994 and covered the development and implementation of a public information and education program. A 30-minute informational video (released June, 1994) and an eight-page informational newspaper (released February, 1994) were produced by YRDFA and ADF&G. The video was distributed to all RPT members and all Yukon drainage village high schools and village councils. The newspaper was distributed to all Yukon Area CFEC salmon permit holders, over 1,000 subsistence fishing households in the drainage, all village councils, all Yukon salmon processors, state and federal officials, and legislators. These two major media productions adequately covered the topics identified under Section III.3 through III.5 in the original Agreement, namely the regional planning process, supplementary production risks and benefits and how community meetings will gather information useful in the RPT process. Information (tables, charts, etc.) was also distributed at fishermen's meetings and to government agencies.

Phase II--Community Forums

Phase II which began December 1, 1993 and ended June 30, 1995 was focused on organizing and implementing a series of community forums. In early 1994, a 12-member Regional Planning Team was appointed by the Commissioner under the guidelines outlined in amendment #02 to this Agreement. Five Field Agents were also selected to assist the RPT and the ADF&G in the process of holding community forums. Field Agents also serve as alternates to RPT members when necessary. A four-day training session for the Project Field Agents was held in January 1994. User members of the RPT met in their respective downriver and upriver groups for one day seminars in October 1994. Larry Lujan, Sr. of Emmonak and Emmitt Peters of Ruby were selected by the eight user members of the Team as the lower and upper river co-chairs, respectively.

Initial community forums were held in Fairbanks (1/22/94) and Huslia (2/24/94). The Board of Fisheries emergency deliberations on the western Alaska chum salmon crisis in December 1993 and March 1994 and the resulting increase in workload on ADF&G and YRDFA staff and the public prevented the parties from implementing more community forums. However, informational materials on the Plan were distributed at fishermen's meetings in Anvik, Kaltag, Mountain Village, St. Mary's and Tanana in the winter of 1993/94 and limited discussions took place.

Community forums resumed in January 1995 and were completed by May 1995. Forums were held at Ft. Yukon (1/24/95), Scammon Bay (2/14/95), Nenana (4/3/95), Kotlik (5/3/95) and Galena (5/21/95).

As most participants at the community forums were unfamiliar with salmon restoration and enhancement techniques, the basic goal of the forums was to provide a thorough review of these techniques and to review the salmon stock status and run outlook. Since it was important to first develop a general understanding with the public, it was acknowledged by ADF&G and YRDFA staff that it would be inappropriate to prematurely solicit public opinion or consensus on stock conservation or restoration. However, community forums were useful for identifying areas of concern for local residents and fishermen and for acquiring a general sense from their opinions on what strategies the RPT might pursue.

Initially, when the Agreement was developed in the spring of 1993, it was hoped these community forums would assist in achieving the following tasks:

Task 1: develop policies and guidelines for evaluation, prioritization, and implementation of rehabilitation, restoration and enhancement activities in the Alaska portion of the drainage, and;

Task 2: to identify and evaluate potential projects and activities within four major planning areas (One) Districts 1, 2, and 3; (Two) District-4, (Three) District-5, and (Four) District-6, based upon these policies and guidelines.

As mentioned above, however, these forums were primarily informational in nature rather than being working sessions toward accomplishing these two tasks. Specific concerns frequently expressed at all the forums included potential or existing damage to salmon stocks and their habitat from mining, timber harvesting, and offshore fishery interceptions. People were neither adamantly opposed nor overly supportive of the restoration and enhancement techniques described. People seemed impressed with the productive capacity of hatcheries and egg boxes, but noted the high costs of such methods and the potential for disease. The most strongly expressed opinions alleged mismanagement by ADF&G (inaccurate sonar counts, faulty equipment, inadequate fishing time) and the perception that the Alaska Board of Fisheries and the North Pacific Fisheries Management Council policies sanctioned the intercept of Yukon River bound salmon. One key point raised at the Scammon Bay meeting was the need to have reliable data before stating there is a conservation problem. To quote from those minutes:

> *Gilbert Huntington of Galena discussed the issue of deciding when is a salmon stock defined to be "in decline" or "having a conservation problem." Gilbert expressed frustration that the Department comes out to the villages, says there is a problem and then proposes new regulations. However, when you look closer at the facts you see often that the Department is saying that lack of data is equivalent to poor escapements such as "poor or incomplete" aerial surveys on the Andreafsky or Nulato. On the basis of this information the department said that escapements in 1990 and 1991 were poor to the "non-Anvik" systems. However, in 1994, there were several new tower and weir projects put in place and as a result more accurate counts. In 1994, coming off of the 1990 parent year, escapements of these non-Anvik systems were all excellent.*

Gilbert's observation could be the result of better escapements in 1990 than we thought or the result of excellent productivity of those fish which did spawn. Regardless, this excerpt points out a need identified at all of the community forums, namely the need for more comprehensive escapement and management projects. Better information would allow management actions to be directed toward the health of individual stocks in the river so that, it would not be necessary to close the whole river just to protect a few stocks although a large drainage will always have a weak stock management dilemma. Better data will contribute to more accurate preseason run projections as well as inseason assessments of run strength and amounts of allowable harvests. This would in turn increase stability of both the commercial fishing industry and subsistence fishing.

Phase III--Written Report

The comprehensive salmon plan document was the goal of Phase III. Phase III began in July 1995 with the drafting of a written report on Phase I and Phase II. The report included a written narrative of events plus a large appendix of minutes, meeting handouts and other documents associated with Phases I and II. This report was distributed to RPT members, the Board, and Delegates of the YRDFA.

In late November and early December 1995, the lower Yukon and upper Yukon YRDFA members of the RPT met separately to review the proposed chapters of the plan and to discuss stock strategies and habitat issues in their respective planning areas. The members also discussed possible guiding principles for the Plan by examining regional plans from other areas of the state.

In late January 1996, the full RPT, along with its ex-officio members, met in Anchorage for two days. Work continued on formulating specifics and outlining the chapters of the plan. RPT staff was directed to prepare rough working drafts for distribution to the RPT. RPT members wanted increased salmon returns and the rough working draft documented this desire, although the means to obtain the increased returns was not identified.

A very rough first working draft plan was distributed on February 19, 1996 to RPT members, to state and federal agency staff and to the Board members and delegates of the YRDFA. While RPT staff were preparing the first working draft of the Yukon River Comprehensive Salmon Plan it became clear the plan should focus on protecting and maintaining: 1) the wild salmon stocks of the Yukon River, 2) the markets for wild fish, and 3) the subsistence way of life. It was questioned what purpose the Yukon Plan would fulfill, since RPT members were opposed to large-scale enhancement projects, which was the typical approach other Regional Comprehensive Salmon Plans had pursued to obtain increased salmon returns.

RPT staff proposed to RPT members that the Yukon River Comprehensive Salmon Plan could fulfill the following purposes: 1) be a historical resource document for identifying past and current salmon research and assessment projects; 2) be written in a format which would partially fulfill our Interim Agreement with Canada to develop a Yukon River Basin stock rebuilding and restoration plan; 3) identify management or research shortfalls; and 4) be an educational document for individuals desiring to understand the salmon fisheries of the Yukon River. The RPT members endorsed the new purposes for the Yukon River Plan which were to be incorporated into the second working draft.

A second working draft was distributed beginning on October 20, 1997 to all RPT members, Yukon River village councils, to the chairs of Yukon River drainage fish & game advisory committees, to state and federal agency staff and to Board members and delegates of the YRDFA. The table of contents of this second draft identified new sections of the Plan, which may or may not have been written at the time of distribution, but reviewers were able to comment on the new contents, purposes, and direction of the Plan. Formal public notice of the availability of this second draft plan was also made through mailings and advertisements.

In early December 1997 the full RPT along with its ex-officio members met in Fairbanks to review in detail this second draft and craft additions and changes, especially to the Executive Summary, the Guidelines and Principles, and the Assumptions sections. RPT staff explained that increased salmon returns on the Yukon River would have to be cultivated from the wild stocks by foregoing harvest opportunities today, to increase the escapement, for possible increased future harvests. Once RPT members realized the harvest sacrifices which would be necessary to achieve possible increased future harvests, they reevaluated the overall harvests goals, and decided to provide for historical subsistence use levels and commercial harvests in the upper half of the Guideline Harvest Ranges, as established by the Board of Fisheries. The second working draft was also presented and described to state and federal agency staff and to other attendees at the YRDFA Eighth Annual Meeting in Kaltag in mid-February 1998.

Based on the review comments received on the second working draft, a third working draft was finalized for distribution on April 17, 1998. This third working draft was also mailed to all RPT members, Yukon River village councils, to the chairs of Yukon River drainage fish & game advisory committees, to state and federal agency staff, to Board members and delegates of the YRDFA, and to interested groups or individuals who had previously requested earlier drafts. Formal public notice of the availability of this draft plan was also made through newspaper advertisements. Public and agency comments were accepted through May 15, 1998 on the second and third working drafts. The final plan was submitted to the ADF&G Commissioner in July of 1998.

Regional Profile of the Fishery

The Yukon River is the largest river in Alaska, draining approximately 35 percent of the state, and is the fifth largest drainage in North America. The river originates in British Columbia, Canada, within 30 miles of the Gulf of Alaska and flows over 2,300 miles to its mouth on the Bering Sea, draining an area approximately 330,000 square miles (Figure 1). Today, excluding the greater Fairbanks area (population 84,000 in 1996), some 43 villages with a total population of approximately 12,000 people are located within the Alaskan portion of the Yukon River drainage and along the Bering Sea coast (Figure 2). Village populations range from approximately 30 to 800 people, with typical villages having fewer than 300 residents. Nearly all these people are dependent to varying degrees on fish and game resources for their livelihood.

The people of the Yukon River basin have been utilizing salmon since inhabiting this area. Two major ethnic groups historically occupied the Yukon River valley; Yupik Eskimo who lived along the Bering Sea Coast and inland up the river approximately 250 miles, and Athabaskan Indians who occupied the remainder of the Yukon River valley. Prior to European contact, Alaska's aboriginal populations achieved functional adaptations to their respective environments that were central to their economic, social, and value systems. In Alaska Native societies, fishing means more than just food; it is part of a traditional, cultural, and economic system that forms the basis for intrinsic self esteem. The Inupiat of northwest Alaska insist that without traditional fishing and hunting activities, they would disappear as culturally-distinct peoples, possibly transformed into minority enclaves wholly dependent upon welfare and other payments from the dominant Euro-American government (Berger, 1985; Feit, 1983). The harvest, distribution, and use of locally available wild resources and raw materials have continued to provide essential economic, nutritional, cultural, and social benefits to most village households. The economic practices of hunters, gatherers, or fishermen are commonly referred to as "subsistence" today.

After the late 1800s, Europeans and Americans increasingly settled along the Yukon River. Early exploration reports documented the importance of subsistence salmon harvests to people living in the Yukon River drainage (Zagoskin, [1847] 1967; Allen, 1887). Salmon harvests have been cyclic and must be understood in terms of disposition of the catch. Around 1900, harvests for regional commercial sale or barter were high with the increased use of dogs by Euro-Americans entering into the region. Large historical salmon harvests were used not only for human food but also to support dogs used for transportation, packing, and as draft animals for pulling trees out of the forest (Richardson, [1900] 1964; Gilbert and O'Malley, 1921). Around 1930, the airplane began replacing the sled dog as the primary mail and supply carrier, which contributed to a gradual reduction in subsistence salmon harvests. Additionally, the introduction of snow machines during the early to mid-1960s accelerated the decline of sled dog use. Subsistence salmon catches declined through the 1970s as increased transfer payments and employment

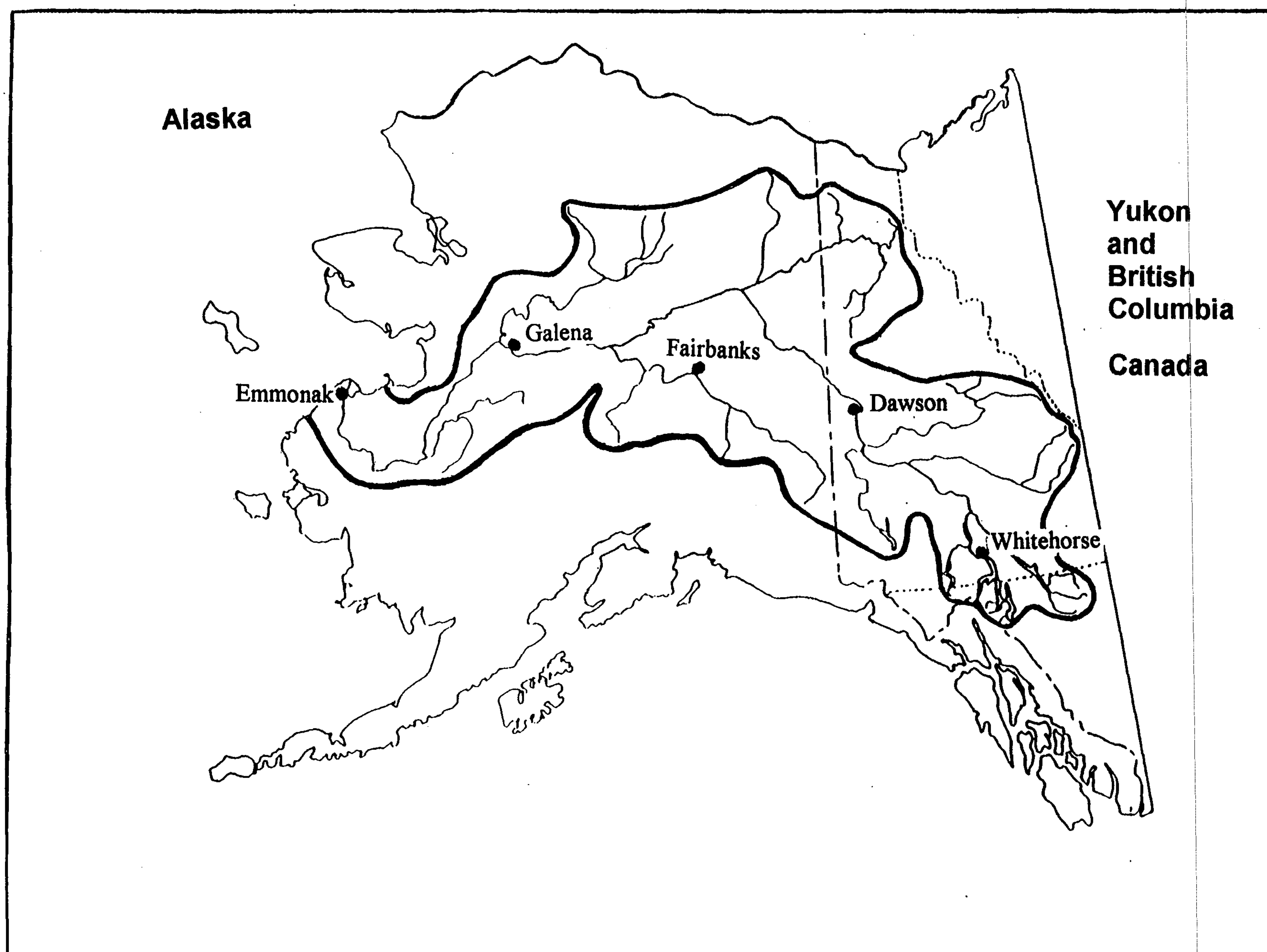


Figure 1. The Yukon River drainage, 330,000 square miles.

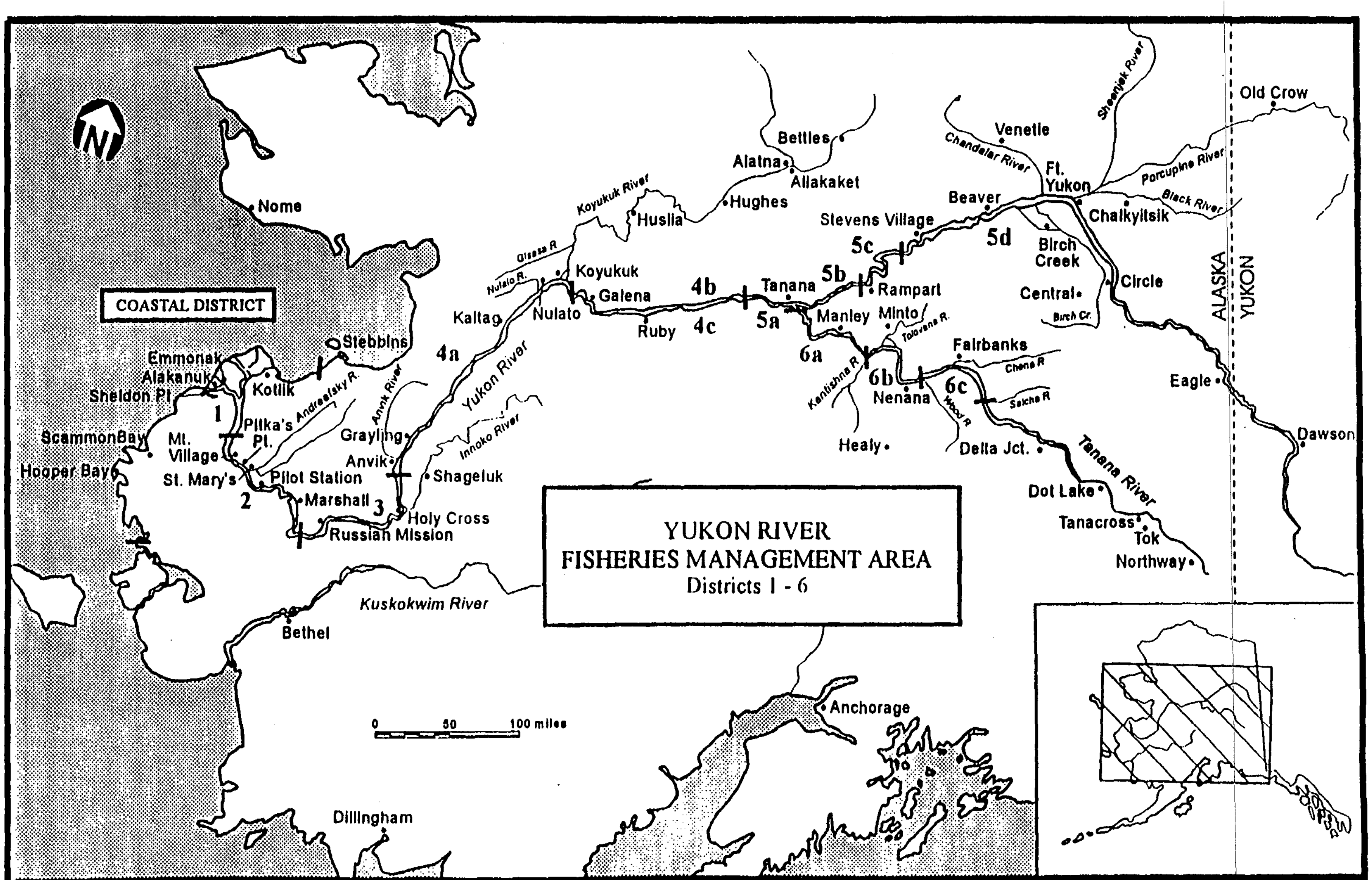


Figure 2. Map of the Alaskan portion of the Yukon River drainage showing communities and fishing districts.

opportunities, including commercial fishing activities, became available to rural residents (ADF&G, 1985). It is likely that the sale of subsistence-caught salmon roe (legal from 1974 through 1977) increased subsistence chum salmon catches in the Upper Yukon Area above normal use levels during the mid-1970s. Beginning in the early 1980s, due in part to a renewed interest in sled dog racing, the number of dogs per family increased in some portions of the drainage with a coincidental increase in the subsistence salmon harvest. In addition, the human population along the river has been increasing, which may also be directly related to increased subsistence salmon harvests.

Today, subsistence salmon fishing occurs throughout most of the Yukon River drainage by approximately 1,400 households. Subsistence use has the highest priority among beneficial uses of the resource. Subsistence salmon fishing is often undertaken by extended family groups of two or more households cooperating to harvest, cut, preserve, and store salmon for subsistence use. Subsistence fishermen use gillnets in main rivers and coastal marine waters. Fish wheels are also used by fishermen primarily in the Upper Yukon River and the Tanana River. The recent 5-year (1992-1996) average subsistence salmon use in the Alaskan portion of the Yukon River drainage was 52,000 chinook, 223,000 summer chum, 125,000 fall chum, and 36,000 coho salmon. Additional Yukon River subsistence fishing information can be found in the Alaska Department of Fish and Game, Wildlife Use Notebook Series, No. 1 through No. 3 (ADF&G, 1987).

Many people who fish for subsistence salmon also fish commercially. The development of the commercial export salmon fishery has enabled many area residents to obtain a cash income. In many cases, the cash income provides a means for fishermen to maintain a subsistence life-style. Income earned from commercial fishing is often used to obtain hunting and fishing gear used for subsistence activities. In many rural Alaskan communities, the "commercial" and "subsistence" sectors of the economy are complimentary and mutually supported (Wolfe, 1981; Ellanna, 1980). Households have been required to convert to a cash oriented economy because payment for mortgages, water, sewer, electric, telephone, and groceries requires cash. Yet, even the most modern villages have remained "subsistence-based" because of the intrinsic value of subsistence activities and because local renewable resources form the most reliable base of the economy from year to year. Village economies typically incorporate both subsistence and commercial activities since neither is sufficient to support the population alone. Comprehensive subsistence salmon surveys to estimate the subsistence salmon harvest in the Alaska portion of the drainage have been conducted by the ADF&G since 1961.

The first recorded commercial salmon harvested for export in the Alaskan portion of the Yukon River drainage occurred in 1918. Relatively large catches of chinook, chum and coho salmon were made during the first four years of this fishery. Because of the existence of a large upriver subsistence fishery, the early commercial fishery met opposition and was closed from 1925 to 1931. Commercial fishing for chinook salmon resumed in 1932 at a reduced harvest level. During the period 1954-1960, a 65,000 chinook salmon quota was in effect for the Yukon River. The present multi-species salmon fishery began development in 1961 and was fully developed by the mid-1970s. Beginning in 1961, with relatively low effort levels, salmon quotas were eliminated and the fishery was regulated by liberal, scheduled, weekly fishing periods. The season was opened and closed by a published regulatory date. As participation and harvests increased, salmon escapements suffered. Following a state referendum and the legislative creation of the Commercial Fisheries Limited Entry Commission (CFEC) program in 1976, a limited entry fishing permit system was implemented on the Yukon River and in other areas of the state. This stabilized the fishing effort in terms of number of participants, but in more recent years, commercial fishing time has been greatly reduced because of increased efficiency of the fleet and conservation concerns for chum salmon. Seeking to establish harvest amounts consistent with inseason run sizes, the Alaska Board of Fisheries enacted guideline harvest range regulations for fall chum in 1979. Chinook salmon guideline harvest ranges were established in 1981, and summer chum salmon guideline harvest ranges were established in 1990. Coho salmon guideline harvest ranges have not yet been established. Table 1 lists the current guideline harvest ranges for chinook, summer chum, and fall chum salmon.

There are two commercial fishing seasons in the Yukon Area: the summer season which targets chinook and summer chum salmon; and the fall season which targets fall chum salmon with an incidental harvest of coho salmon. Legal commercial fishing gear consists of set and drift gillnets in the Lower Yukon Area and fish wheels and set gillnets in the Upper Yukon Area. Important components of management in the Alaskan portion of the drainage include guideline harvest ranges established by the Alaska Board of Fisheries, emergency order authority to open and close seasons, establishment of fishing period frequency and duration, and establishment of mesh size restrictions. Most fishers operate outboard powered skiffs of 18 to 24 feet in length. In most areas, fishers' efficiency has increased due to larger outboard motors, conversion from wood to aluminum hulls, deeper and longer gillnets, VHF radios, fish finders, and small onboard cabins. The history and development of the Yukon River commercial fishery is well documented in the Yukon Area Annual Management Report, 1993 (ADF&G, 1995) in the section entitled "Alaskan Salmon Fishery History and Description" and in the report compiled by Sid Morgan entitled "Socioeconomic Aspects of the Yukon River Salmon Fisheries" (ADF&G, 1985).

Personal use fishing was initially established in the Alaskan portion of the Yukon River drainage in 1988 when regulations went into effect which prohibited non-rural residents from participating in subsistence fishing. In general, harvests were taken under subsistence fishing regulations pre-existing the establishment of personal use regulations. Due to legal and legislative changes, personal use fishing regulations have been off-again, on-again. Since the 1995 fishing season, personal use permits are required for fishing in the Fairbanks Nonsubsistence Area which primarily includes the Fairbanks North Star Borough. Personal use fisheries have a lower priority than subsistence fisheries among beneficial uses of fish resources. Personal use fisheries typically have harvest limits, require more frequent harvest reports, and are restricted sooner, than a subsistence fishery in times of shortage.

In general, sport fish salmon harvests in the Yukon Area are relatively minor compared to commercial and subsistence harvests. Sport fisheries have a lower priority than subsistence fisheries among beneficial uses of fish resources. Approximately ninety percent of all sport fishing effort in the Alaskan portion of the Yukon River drainage occurs in the Tanana River drainage, mostly along the road system. Sport fisheries which target salmon take place on the

Table 1. Guideline harvest ranges and mid-points for commercial harvest of Yukon River chinook, summer chum and fall chum salmon in Alaska, 1997.

Chinook Salmon

District or Subdistrict	Guideline Harvest Range a					
	Lower		Mid-Point		Upper	
	Numbers	Percent	Numbers	Percent	Numbers	Percent
1 and 2	60,000	89.1	90,000	91.6	120,000	92.9
3	1,800	2.7	2,000	2.0	2,200	1.7
4	2,250	3.3	2,550	2.6	2,850	2.2
5A,B,C	2,400	3.6	2,600	2.6	2,800	2.2
5D	300	0.4	400	0.4	500	0.4
6	600	0.9	700	0.7	800	0.6
Total	67,350	100.0	98,250	100.0	129,150	100.0

Summer Chum Salmon

District or Subdistrict	Guideline Harvest Range b					
	Lower		Mid-Point		Upper	
	Numbers	Percent	Numbers	Percent	Numbers	Percent
1 and 2	251,000	62.8	503,000	62.9	755,000	62.9
3	6,000	1.5	12,500	1.6	19,000	1.6
4A c	113,000	28.3	225,500	28.2	338,000	28.2
4B,C	16,000	4.0	31,500	3.9	47,000	3.9
5	1,000	0.3	2,000	0.3	3,000	0.3
6	13,000	3.3	25,500	3.2	38,000	3.2
Total	400,000	100.0	800,000	100.0	1,200,000	100.0

Anvik River Management Area Roe cap of 100,000 pounds d

Fall Chum Salmon

District or Subdistrict	Guideline Harvest Range e					
	Lower		Mid-Point		Upper	
	Numbers	Percent	Numbers	Percent	Numbers	Percent
1, 2, and 3	60,000	82.5	140,000	71.2	220,000	68.6
4B,C	5,000	6.9	22,500	11.4	40,000	12.5
5A,B,C	4,000	5.5	20,000	10.2	36,000	11.2
5D	1,000	1.4	2,500	1.3	4,000	1.2
6	2,750	3.8	11,625	5.9	20,500	6.4
Total	72,750	100.0	196,625	100.0	320,500	100.0

a The chinook salmon guideline harvest ranges have been in effect since 1981.
b Summer chum salmon guideline harvest ranges were established in February 1990 based on the average harvest shares from 1975-1989.
c Or the equivalent roe poundage of 61,000 to 183,000 pounds or some combination of fish and pounds of roe.
d The current Anvik River Management Area roe cap was established in March 1996.
e The current fall chum salmon guideline harvest ranges were established in 1990.

Source: ADF&G 1997b

Salcha, Chena, Chatanika Rivers, and Delta Clearwater River and to a lesser degree on other interior Yukon River tributaries.

Stock Status

Subsistence and commercial harvests are the major factors impacting annual spawning escapement. The Yukon River commercial salmon fishery evolved from being unlimited (early 1900s), progressed to a quota system (1954-1960), developed into a published calendar date and preset time fishery (1961-1979), and is presently managed inseason based on inseason run assessment projects and a combination of guideline harvest ranges and biological escapement goals (BEG).

Although ADF&G uses escapement information to assess the health of salmon stocks, it has also been committed to obtaining an accurate inseason assessment of salmon abundance. The test gill net program at the Yukon River mouth has been the longest running inseason assessor of salmon timing while also providing an index of abundance. The formidable goal of generating inseason abundance estimates by species has been tasked to the Yukon River main river sonar project, at river mile 123.

Apart from fall chum salmon, most escapement goals are based on aerial survey observations. Although aerial surveys continue to be a significant escapement assessment tool, the department supports establishment of weir and tower escapement projects to obtain more complete and accurate inseason counts of spawning populations in key spawning streams. In recent years, several agencies and organizations have contributed to help meet this goal, including ADF&G, USFWS, BLM, BSFA, AVCP, YRDFA, TCC, and other native tribal organizations. Additionally, scale pattern analysis and genetic stock identification (GSI) are being examined as tools for identifying discrete stocks in the mixed stock fisheries. The expectation is that improved stock specific information will translate into an increased ability to maintain healthy salmon stocks throughout the Yukon River drainage in the future.

ADF&G established chinook and summer chum salmon escapement goals in 1984 in the form of either a minimum threshold (point estimate) or ranges to be achieved. These escapement goals were based upon historical information. A summary of the Yukon River escapement goals in effect as of the 1992 fishing season and the historical information based upon which the goals were developed is contained in Buklis, 1993. With the signing of the Departments Escapement Goal Policy in October 1992, all the escapement goals were renamed biological escapement goals (BEG's). The chinook and summer chum salmon BEG's, with the exception of the Anvik River summer chum salmon BEG which is sonar based, are based upon aerial surveys, while those of fall chum salmon are based upon estimates of total spawning abundance. Additional harvest and escapement information can be found in several ADF&G documents: Report to the Alaska Board of Fisheries (ADF&G, 1997c); the United States/Canada Yukon River Joint Technical Committee Report (JTC, 1997); and Annual Management Report, Yukon Area, 1996 (ADF&G, 1997b).

Chinook Salmon

Chinook salmon spawning stocks are widely distributed throughout the Yukon River drainage (Figure 3). Chinook salmon harvests are apportioned post-seasonally to region of origin using a combination of scale pattern analysis, age class composition similarity and geographic location of the harvest. Minimum escapement goals have been established for the East and West Fork Andreafsky, Anvik, North and South Fork Nulato, Gisasa, Chena and Salcha Rivers within the Alaska portion of the Yukon River drainage. In the Canadian portion of the Yukon River drainage, the United States and Canada agreed to a six year stabilization plan (1990 to 1995), of endeavoring to deliver a minimum of 18,000 chinook salmon for Canadian spawning streams. The newly created U.S./Canada Yukon River panel approved a new six-year rebuilding plan for Canadian-spawned chinook salmon at their inaugural meeting in Whitehorse in April, 1996. The 1990 to 1995 border passage target was 34,800 to 37,800, while the new 1996 to 2001 range is 44,800 to 47,800 chinook salmon. The Canadian fisheries on the mainstem Yukon River (all user groups combined) operate within guideline harvest ranges of 16,800 to 19,800 chinook, with the escapement goal minimum being 18,000 chinook for 1990-1995, and 28,000 chinook for 1996-2001.

During the late 1960s, chinook salmon commercial catches increased due to increased fleet efficiency and in some years, benefited from above average run strength. During the period 1971-1976, catches declined, averaging 88,000 fish annually because of below-average runs and regulatory restrictions. Run sizes improved in the late 1970's, and Alaskan chinook salmon commercial catches averaged 139,000 fish during 1981-1985. During this period concern was expressed for possible over-exploitation, based on the observed escapements. Stock identification studies (1982 to 1995) indicate that on average approximately 50% of the Alaskan chinook salmon harvest are spawned in Canada (all documented harvests i.e. subsistence, commercial, etc.). Chinook salmon escapements in Canada were well below desired levels from 1985 through 1987. Efforts to increase escapements to the Canadian mainstem Yukon River resulted in larger spawning escapements during the past ten years (1988-1997).

Aerial survey escapement data indicate that spawning escapement objectives for middle river stocks (primarily Tanana River drainage) were not met during the mid to late-80s. However, escapement objectives for lower river stocks (Yukon River drainage below the Koyukuk River) were generally achieved. Caution must be used when comparing aerial survey results between years because of the variability inherent to this methodology. Table 2 shows the escapement counts for selected Alaskan chinook salmon tributary streams for 1961-1997.

In response to concerns for possible over harvest and inconsistent escapement results, commercial chinook salmon harvests in the Alaskan portion of the Yukon River drainage have been decreased by more conservative management strategies in recent years. The 5-year (1986-1990) average commercial harvest dropped to 107,000 fish with escapements partially responding to conservative management strategies. Escapement goals for lower river stocks were generally achieved during this period, while goals for middle river stocks (primarily Tanana River drainage) were not achieved. The recent 5-year (1992-1996) average harvest of 110,000 chinook salmon, along with general achievement of escapement goals in the Alaskan portion of the

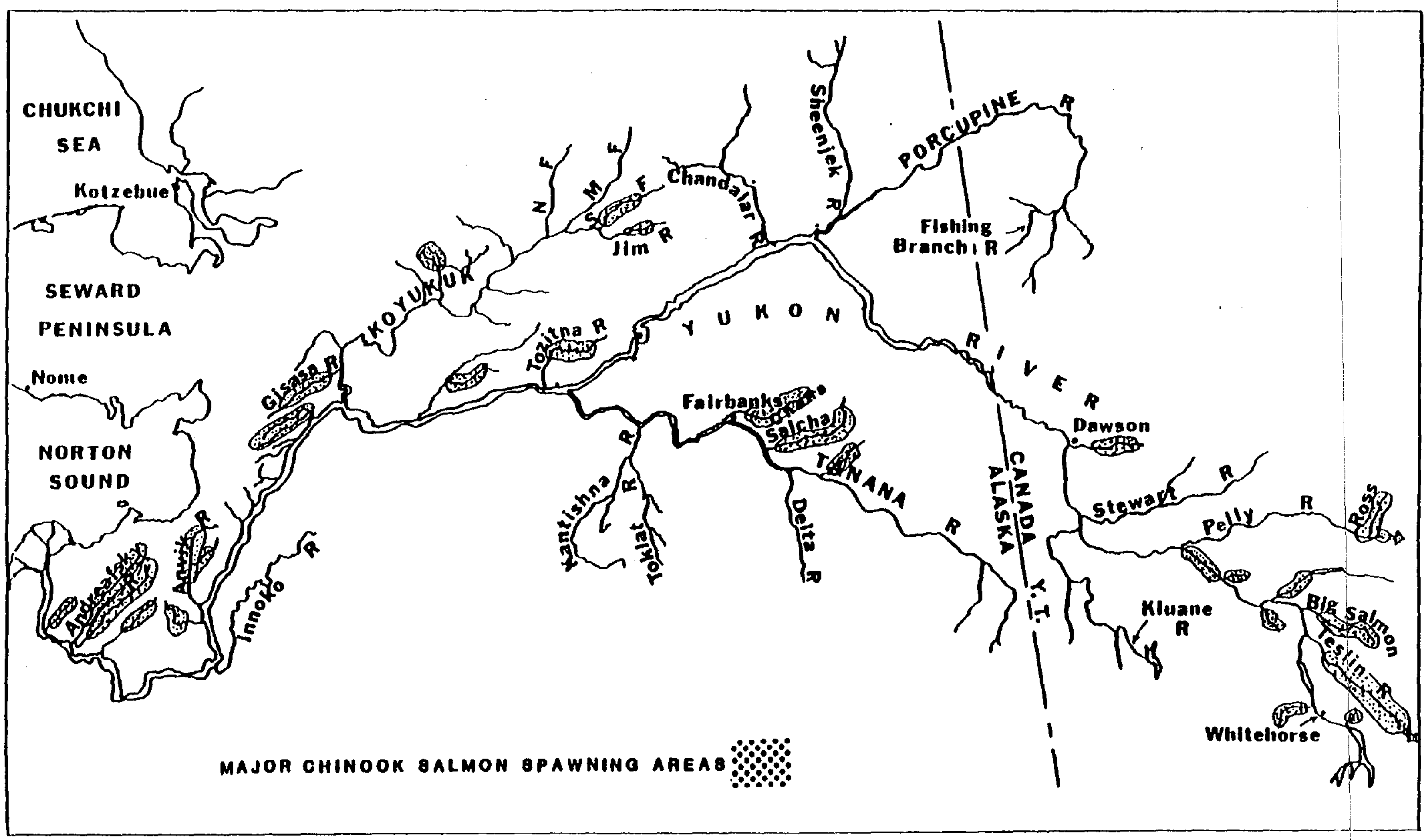


Figure 3. Major chinook salmon spawning locations of the Yukon River drainage.

Table 2. Chinook salmon escapement counts for selected spawning areas in the Alaskan portion of the Yukon River drainage, 1961-1997. [a]

	Andreafsky River			Anvik River		Nulato River			Gisasa River		Chena River			Salcha River		
	East Fork		West Fork	River	Index Area	North Fork	South Fork	Mainstem			River		Index Area	River		Index Area
Year	Aerial	Tower or Weir	Aerial	Aerial [b]	Aerial [b]	Aerial [c]	Aerial	Tower	Aerial	Weir	Population Estimate [m]	Aerial	Aerial [d]	Population Estimate [m]	Aerial	Aerial [f]
1961	1,003			1,226		376	167		266 [g]						2,878	
1962	675 [g]		762 [g]									61 [g,h]			937	
1963												137 [g]				
1964	867		705												450	
1965			344 [g]	650 [g]											408	
1966	361		303	638											800	
1967			276 [g]	336 [g]												
1968	380		383	310 [g]											739	
1969	274 [g]		231 [g]	296 [g]											461 [g]	
1970	665		574 [g]	368								6 [g]			1,882	
1971	1,904		1,682									193 [g,h]			158 [g]	
1972	798		582 [g]	1,198								138 [g,h]			1,193	1,034
1973	825		788	613								21 [g]			391	352 [j]
1974			285	471 [g]		55	23 [g]		161			1,016 [h]	959 [h]		1,857	1,620
1975	993		301	730		123	81		385			316 [h]	262 [h]		1,055	950 [j]
1976	818		643	1,053		471	177		332			531	496		1,641	1,473
1977	2,008		1,499	1,371		286	201		255			563			1,202	1,052
1978	2,487		1,062	1,324		498	422		45 [g]			1,726			3,499	3,258
1979	1,180		1,134	1,484		1,093	414		484			1,159 [g]			4,789	4,310 [j]
1980	958 [g]		1,500	1,330	1,192	954	369 [g]		951			2,541			6,757	6,126
1981	2,146 [g]		231 [g]	807 [g]	577 [g]		791					600 [g]			1,237	1,121
1982	1,274		851						421			2,073			2,534	2,346
1983				653 [g]	376 [g]	526	480		572			2,553	2,336		1,961	1,803
1984	1,573 [g]		1,993	641 [g]	574 [g]							501	494		1,031	906
1985	1,617		2,248	1,051	720	1,600	1,180		735			2,553	2,262		2,035	1,860
1986	1,954	1,530 [k]	3,158	1,118	918	1,452	1,522		1,346		9,065	2,031	1,935		3,368	3,031 [j]
1987	1,608	2,011 [k]	3,281	1,174	879	1,145	493		731		6,404	1,312	1,209	4,771	1,898	1,671
1988	1,020	1,339 [k]	1,448	1,805	1,449	1,061	714		797		3,346	1,966	1,760	4,562	2,761	2,553
1989	1,399		1,089	442 [g]	212 [g]						2,666	1,280	1,185	3,294	2,333	2,136
1990	2,503		1,545	2,347	1,595	568	430 [g,n]		884 [g]		5,603	1,436	1,402	10,728	3,744	3,429
1991	1,938		2,544	875 [g]	625 [g]	767	1,253		1,690		3,025	1,277 [g]	1,277 [g]	5,608	2,212 [g]	1,925 [g]
1992	1,030 [g]		2,002 [g]	1,536	931	348	231		910		5,230	825 [g]	799 [g]	7,862	1,484 [g]	1,436 [g]
1993	5,855		2,765	1,720	1,526	1,844	1,181		1,573		12,241 [k]	2,943	2,660	10,007 [k]	3,636	3,562
1994	300	7,801 [p,r]	213 [g]		913 [g]	843	952	1,795 [r]	2,775	2,888 [r]	11,877 [k]	1,570	1,570	18,399 [k]	11,823	11,189
1995	1,635	5,841 [p]	1,108	1,996	1,147	968	681	1,412	410	4,023	9,680	3,575	3,039	13,643 [k]	3,978	3,734
1996		2,955 [p]	624	839	709		100 [n]	756		1,952	6,833	2,233	2,112	7,958	4,866	4,800
1997 [s]	1,140	3,186 [p]	1,510	3,979	2,690			4,766	144	3,764	13,390 [k]	3,495	3,303	18,396 [k]	3,457 [g]	3,457 [g]
E.O. [t]	>1,500		>1,400	>1,300 [u]	>500 [u]	>800	>500		>600				>1,700			>2,500

continued

[a] Aerial survey counts are peak counts only. Survey rating was fair or good unless otherwise noted.
[b] From 1961-1970, river count data are from aerial surveys of various segments of the mainstem Anvik River. From 1972-1979, counting tower operated; mainstem aerial survey counts below the tower were added to tower counts. From 1980-present, aerial survey counts for the river are best available minimal estimates for the entire Anvik River drainage. Index area counts are from the mainstem Anvik River between the Yellow River and McDonald Creek.
[c] Includes mainstem counts below the confluence of the North and South Forks, unless otherwise noted.
[d] Chena River index area for assessing the escapement objective is from Moose Creek Dam to Middle Fork River.
[f] Salcha River index area for assessing the escapement objective is from the TAPS crossing to Caribou Creek.
[g] Incomplete and/or poor survey conditions resulting in minimal or inaccurate counts.
[h] Boat survey.
[j] Data unavailable for index area. Calculated from historic (1972-91) average ration of index area counts to total river counts (0.90:1.0).
[k] Tower counts.
[m] Mark-recapture population estimate.
[n] Mainstem counts below the confluence of the North and South Forks Nulato River included in the South Fork counts.
[p] Weir counts.
[r] Incomplete count because of late installation and/or early removal of project.
[s] Data are preliminary.
[t] Interim escapement goals. Established March, 1992.
[u] Interim escapement goal for the entire Anvik River drainage is 1,300 salmon. Interim escapement objective for mainstem Anvik River between the Yellow River and McDonald Creek is 500 salmon.

Source: JTC 1997

drainage, demonstrates the value of a conservative management strategy coupled with improved management information. Table 3 documents the Yukon River chinook salmon catch for 1961-1997.

Management of Yukon River chinook salmon is difficult due to the mixed stock nature of the run, broad distribution of the spawning stocks, and relatively compressed entry timing into the river. Commercial fisheries are managed in context with the need to maintain adequate abundance and quality of spawning stock escapements, provide for priority use in subsistence fisheries distributed throughout the 1,200 mile length of the mainstem Yukon River in Alaska and in tributary systems, and provide for passage to the Canadian portion of the drainage at agreed levels. Timely inseason stock assessment in the lower river is technically and logistically difficult given the small run size of chinook salmon, even in a strong year, relative to the overlapping and much larger run of summer chum salmon. Available run assessment methodologies including sonar apportionment sampling and other test fishing have inherent technical limitations which reduce the reliability of evaluations of inseason chinook salmon abundance. For this reason, current management strategy relies heavily on the historic sustainability of chinook stocks within a relatively stable range of harvests.

The weak return in 1998, across multiple age classes, raises serious concerns about upcoming years, and undercuts confidence in forecasting run production. Although the answers are inconclusive at this time, questions about the effect of oceanographic and meteorologic regime shifts as well as fluctuations in fresh water survival of eggs and juvenile salmon have been raised. Future chinook salmon management strategies may need to rely on more conservative commercial harvest levels to provide for escapement and to sustain yields necessary for all user groups. More precise inseason run assessment methods will require significant advancements in sonar technology or application of other methods such as tagging studies which also have limitations in physical environments as challenging as the lower Yukon River.

Summer Chum Salmon

Summer chum salmon primarily spawn in tributaries from the mouth of the Yukon River up to and including the Tanana River drainage (Figure 4). Similar to chinook salmon, minimum escapement goals were established by ADF&G for six Alaskan streams or index areas. Minimum aerial-survey based escapement goals were established in 1984 for the East and West Fork Andreafsky River, Anvik River, North Fork Nulato River, Clear and Caribou Creeks of the Hogatza-Koyukuk River drainage, and the Salcha River. A summer chum salmon escapement goal was established for the Anvik River based upon sonar passage estimates and has replaced the original aerial survey index goal. Aerial survey counts of summer chum salmon appear to be less reliable than counts of chinook salmon for several reasons: summer chum salmon are smaller in size and more numerous, with larger groups requiring greater subjective estimation; their noncontrasting camouflaged spawning colors and their preference for spawning locations off the main channel makes them difficult to see from the air due to increased amount of vegetative interference or nonobservance; they have less stream residence time; their carcasses wash-out faster; and they have a broader stream

Table 3. Alaskan catch of Yukon River chinook salmon, 1961-1997.

Year	Estimated Subsistence Use [a]	Harvest			
		Subsistence [b]	Commercial [c]	Sport [d]	Total
1961	21,488	21,488	119,664		141,152
1962	11,110	11,110	94,734		105,844
1963	24,862	24,862	117,048		141,910
1964	16,231	16,231	93,587		109,818
1965	16,608	16,608	118,098		134,706
1966	11,572	11,572	93,315		104,887
1967	16,448	16,448	129,656		146,104
1968	12,106	12,106	106,526		118,632
1969	14,000	14,000	91,027		105,027
1970	13,874	13,874	79,145		93,019
1971	25,684	25,684	110,507		136,191
1972	20,258	20,258	92,840		113,098
1973	24,317	24,317	75,353		99,670
1974	19,964	19,964	98,089		118,053
1975	13,045	13,045	63,838		76,883
1976	17,806	17,806	87,776		105,582
1977	17,581	17,581	96,757	156	114,494
1978	30,297	30,297	99,168	523	129,988
1979	31,005	31,005	127,673	554	159,232
1980	42,724	42,724	153,985	956	197,665
1981	29,690	29,690	158,018	769	188,477
1982	28,158	28,158	123,644	1,006	152,808
1983	49,478	49,478	147,910	1,048	198,436
1984	42,428	42,428	119,904	351	162,683
1985	39,771	39,771	146,188	1,368	187,327
1986	45,238	45,238	99,970	796	146,004
1987	53,124	53,124	134,760 [f]	502	188,386
1988	46,032	46,032	101,445	944	148,421
1989	51,062	51,062	105,491	1,053	157,606
1990	51,594	51,181	97,708	544	149,433
1991	48,311	46,773	107,105	773	154,651
1992	46,553	45,626	122,134	431	168,191
1993	66,261	65,701	95,682	1,695	163,078
1994	55,266	54,563	115,471	2,281	172,315
1995	50,258	48,934	126,204	2,525	177,663
1996	43,827	43,521	91,890	3,151	138,562
1997 [g]	[h]	[h]	116,401	[h]	116,401
Average					
1961-86	24,452	24,452	109,401	753	134,142
1987-91	50,025	49,634	109,302	763	159,699
1992-96	52,433	51,669	110,276	2,017	163,962

a Includes salmon harvested for subsistence purposes, and an estimate of the number of salmon carcasses harvested for the commercial production of salmon roe and used for subsistence. These data are only available since 1990.

b Includes salmon harvested for subsistence and personal use.

c Includes ADF&G test fish sales, fish sold in the round, and estimated numbers of female salmon commercially harvested for the production of salmon roe (see Bergstrom et al. 1992: 1990 Yukon Area AMR).

d Sport fish harvest for the Alaskan portion of the Yukon River drainage. The majority of this harvest is believed to have been taken within the Tanana River drainage (see Schultz et al. 1993: 1992 Yukon Area AMR).

f Includes 653 and 2,136 chinook salmon illegally sold in District 5 and 6 (Tanana River), respectively.

g Data are preliminary.

h Data are unavailable at this time.

Source: JTC 1997

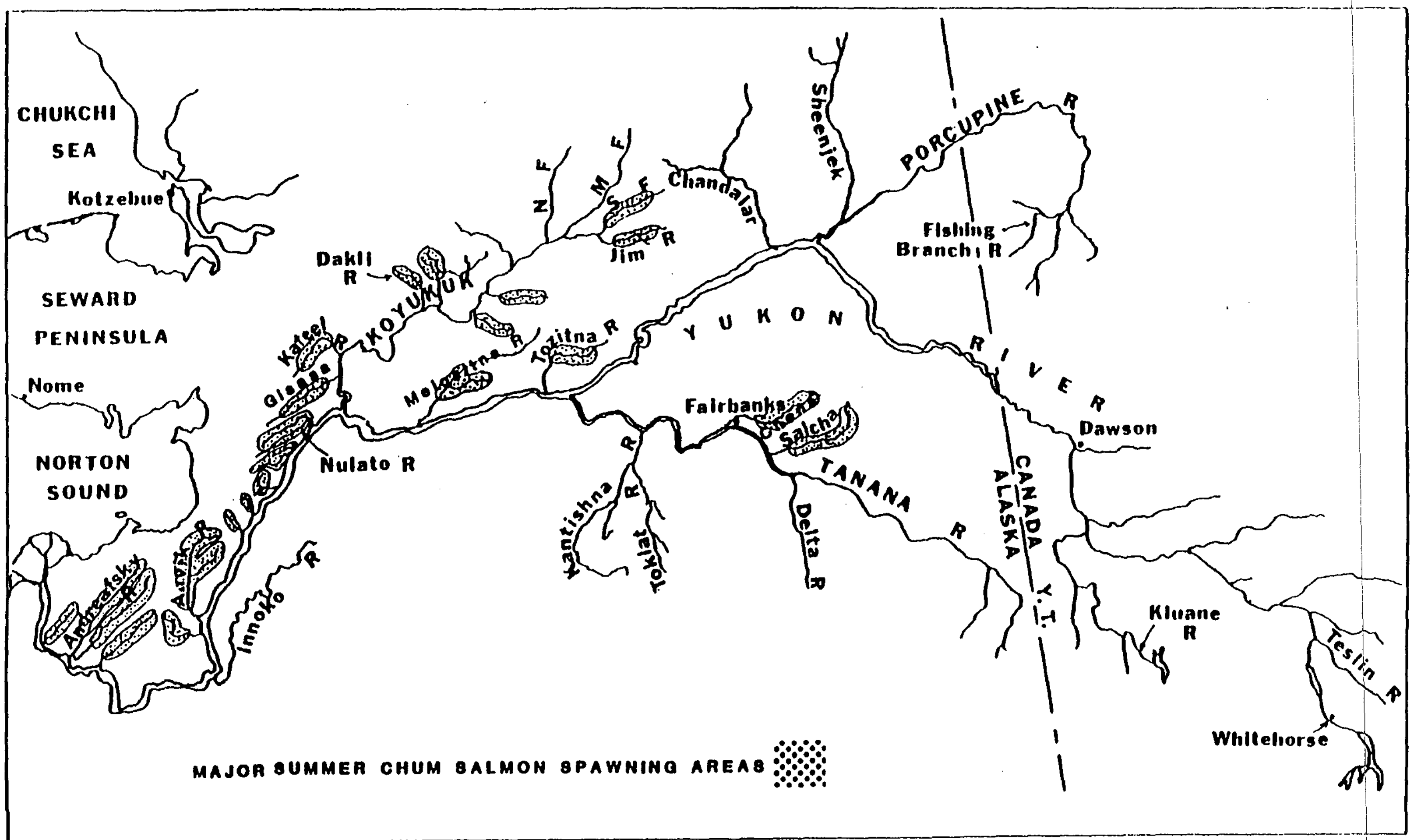


Figure 4. Major summer chum salmon spawning locations of the Yukon River drainage.

entry period, making a one-time aerial estimate a difficult index tool to calibrate. Table 4 lists the summer chum salmon escapement counts for selected spawning areas in the Alaskan portion of the Yukon River drainage for 1973 to 1997.

Due to fishermen concerns over the ADF&G's aerial survey assessment program and conservative chum salmon harvest strategies adopted in 1990, as well as the poor chum salmon returns in 1993, additional tributary escapement monitoring projects have been established. A Kaltag River tower project started in 1991 as a cooperative project between the University of Alaska Extension 4-H educational program and other funding sources employing Kaltag village youth. Unfortunately, funding problems from 1991 to 1993 prevented observations from occurring throughout much (or most of) the chinook and summer chum salmon runs. Entire full summer season tower counts were obtained during 1994, 1995, 1996, and 1997 through increased funding provided by BSFA.

Beginning in 1994, the United States Fish and Wildlife Service (USFWS) funded and operated floating resistance weirs on the Andreafsky and Gisasa Rivers. In the same year, the ADF&G and Tanana Chiefs Conference (TCC) jointly operated the Nulato River tower project which was primarily funded by Bering Sea Fishermen's Association (BSFA). TCC funded and operated the Nulato Tower project themselves in 1995, as well as another tower project on Clear Creek (Hogatza River drainage). Since 1996, the Nulato tower project has been operated cooperatively by the Nulato Tribal Council, BSFA, and ADF&G. USFWS, BLM, TCC, BSFA, and ADF&G all contributed to the counting tower on Clear Creek during 1996, and TCC, BLM, and BSFA worked together to run the project in 1997.

The Sport Fish Division has annually operated counting towers on the Chena and Salcha Rivers since 1993. Although these towers are operated primarily to assess chinook salmon escapement, additional funds were provided by the CFMD to assess summer chum salmon escapement. These two tributaries are very susceptible to rain induced turbidity and high water, but overall these towers have provided important interannual run size comparisons.

The Anvik River is considered the largest single wild stock producer of summer chum salmon in the Yukon River drainage and possibly the world. The ADF&G has monitored the escapement into the Anvik River using a sonar since 1979. A sonar-based escapement goal of 487,000 summer chum salmon was established in 1984 and changed to 500,000 beginning in 1992. Generally, escapements into the Anvik River remained strong even in years when large inriver harvests occurred in the Lower Yukon Area. Unfortunately, summer chum salmon from non-Anvik stocks above the Anvik River appear to have suffered due to the combined harvests in the lower river and Subdistrict 4-A. Concern for over-exploitation on non-Anvik River stocks during the late-1980s prompted the Board of Fisheries in February of 1990 to establish a river-wide guideline harvest range of 400,000 to 1,200,000 summer chum salmon. A trend of declining summer chum salmon harvests occurred from 1990 through 1993, not only as a result of the newly established guideline harvest ranges but also from declining run sizes. While conservative management strategies have resulted in the Anvik River BEG having been met each year since 1991, spawning escapements to other Yukon River tributaries from 1991 to 1993 generally appear to have been below desired levels, based on limited aerial survey information. However, it is believed that escapement

Table 4. Summer chum salmon escapement counts for selected spawning areas in the Alaskan portion of the Yukon River drainage, 1973-1997.[a]

Year	Andreafsky River, East Fork, Aerial	Andreafsky River, East Fork, Sonar, Tower, or Weir Counts	Andreafsky River, West Fork, Aerial	Anvik River, Tower & Aerial[b]	Anvik River, Sonar	Rodo River, Aerial	Kaltag Creek, Tower	Nulato River, South Fork, Aerial	Nulato River, North Fork[c], Aerial	Nulato River, Mainstem, Tower	Gisasa River, Aerial	Gisasa River, Weir	Hogatza River, Clear & Caribou Cr., Aerial	Hogatza River, Clear Creek, Tower	Tozitna River, Aerial	Chena River, Aerial	Chena River, Tower	Salcha River, Aerial	Salcha River, Tower
1973	10,149 [d]		51,835	249,015												79 [d]		290	
1974	3,215 [d]		33,578	411,133		16,137		29,016	29,334		22,022				1,823	4,349		3,510	
1975	223,485		235,954	900,967		25,335		51,215	87,280		56,904		22,355		3,512	1,670		7,573	
1976	105,347		118,420	511,475		38,258		9,230 [d]	30,771		21,342		20,744		725 [d]	685		6,484	
1977	112,722		63,120	358,771		16,118		11,385	58,275		2,204 [d]		10,734		761 [d]	610		677 [d]	
1978	127,050		57,321	307,270		17,845		12,821	41,659		9,280 [d]		5,102		2,262	1,609		5,405	
1979	66,471		43,391		280,537			1,506	35,598		10,962		14,221			1,025 [d]		3,060	
1980	36,823 [d]		114,759		492,676			3,702 [d]	11,244 [d]		10,388		19,786		580	338		4,140	
1981	81,555	147,312 [f]			1,486,182			14,348								3,500		8,500	
1982	7,501 [d]	181,352 [f]	7,267 [d]		444,581						334 [d]		4,984 [d]		874	1,509		3,756	
1983		110,608 [f]			362,912			1,263 [d]	19,749		2,356 [d]		28,141		1,604	1,097		716 [d]	
1984	95,200 [d]	70,125 [f]	238,565		891,028								184 [d]			1,861		9,810	
1985	66,146		52,750		1,080,243	24,576		10,494	19,344		13,232		22,566		1,030	1,005		3,178	
1986	83,931	167,614 [g]	99,373		1,189,602			16,848	47,417		12,114				1,778	1,509		8,028	
1987	6,687 [d]	45,221 [g]	35,535		455,876			4,094	7,163		2,123		5,669 [d]			333		3,657	
1988	43,056	68,937 [g]	45,432		1,125,449	13,872		15,132	26,951		9,284		6,890		2,983	432		2,889 [d]	
1989	21,460 [d]				636,906											714 [d]		1,574 [d]	
1990	11,519 [d]		20,426 [d]		403,627	1,941 [d]		3,196 [d,h]	1,419 [d]		450 [d]		2,177 [d]		36	245 [d]		450 [d]	
1991	31,886		46,657		847,772	3,977		13,150	12,491		7,003		9,947		93	115 [d]		154 [d]	
1992	11,308 [d]		37,808 [d]		775,626	4,465		5,322	12,358		9,300		2,986		794	848 [d]		3,222	
1993	10,935 [d]		9,111 [d]		517,409	7,867		5,486	7,698		1,581				970	168	5,400	212	5,809
1994		200,981 [j,k]			1,124,689		47,295			148,762 [k]	6,827	51,116 [k]	8,247 [m]			1,137	9,984	4,916	39,450
1995		172,148 [j]			1,339,418	12,849	77,193	10,875	29,949	236,890	6,458	136,886		116,735	4,985	185 [d]	3,519 [k]	934 [d]	30,784
1996		108,450 [j]			933,240	4,380	51,269	8,490 [d,h]		129,694		157,589	27,090	100,912	2,310	2,061	12,810 [k]	9,722	74,827 [k]
1997 [q]		51,139 [j]			609,118	2,775 [d]	48,018			157,975	686 [d]	31,800	1,821 [d]	76,454	428 [d]	594 [d]	9,439 [k]	3,968 [d]	35,741 [k]
E.O. [n]	>109,000		>116,000		>500,000				>53,000 [o]				>17,000 [p]					>3,500	

continued

Table 4. (page 2 of 2).

[a] Aerial survey counts are peak counts only, survey rating is fair or good unless otherwise noted.
[b] From 1972-1979 counting tower operated; escapement estimate listed is the tower counts plus expanded aerial survey counts below the tower (see Buklis 1982).
[c] Includes mainstem counts below the confluence of the North and South Forks, unless otherwise noted.
[d] Incomplete survey and/or poor survey timing or conditions resulted in minimal or inaccurate count.
[f] Sonar count.
[g] Tower count.
[h] Mainstem counts below the confluence of the North and South Fords of the Nulato River included in the South Fork counts.
[j] Weir count.
[k] Incomplete count due to late installation and/or early removal of project or high water events.
BLM helicopter survey.
[n] Interim escapement objective.
[o] Interim escapement objective for North Fork Nulato River only.
[p] Consists of Clear and Caribou Creeks interim escapement objectives of 9,000 and 8,000, respectively.
[q] Data are preliminary.

Source: JTC 1997

objectives were achieved throughout the drainage in 1994, 1995 and 1996 based on the results from new projects and aerial surveys, and 1997 spawning escapements were generally adequate.

Summer chum salmon commercial sales averaged 274,000 fish during the 13-year period from 1961 to 1973. Subsequent to 1973, summer chum salmon commercial harvests increased substantially due to a combination of regulation changes (e.g. mesh size specifications and earlier openings of the fishing season), greater availability of processing facilities and tendering, higher prices, development of Japanese frozen fish and roe markets, and the occurrence of several very large runs. For the twelve year period from 1978 to 1989, Yukon River fishermen harvested an average of 1,216,000 summer chum salmon annually. The 1990 to 1997 summer chum salmon harvest has averaged 485,000 fish due to both lower abundance and, more recently, poor flesh markets. Table 5 shows the Alaskan catch of Yukon River summer chum salmon from 1961 to 1997.

Fall Chum Salmon

Major fall chum salmon spawning areas are located in the Chandalar, Tanana, and Porcupine River drainages and within the Canadian portion of the mainstem Yukon River drainage (Figure 5). Table 6 shows the minimum biological escapement goals for the Toklat, Delta, Sheenjek, and Fishing Branch Rivers of 33,000, 11,000, 64,000, and 50,000 fall chum salmon respectively, and their escapement records for 1971 to 1997. Note that the Fishing Branch River is in the Canadian portion of the Porcupine River drainage. Unlike those for chinook and most summer chum salmon stocks, fall chum salmon escapement goals are based on estimates of total abundance. In addition, annual estimates of border passage and spawning escapement are available for the fall chum salmon stock in the Canadian portion of the upper mainstem Yukon River. During U.S/Canada treaty negotiations, a 12-year rebuilding plan, beginning in 1990 and ending in 2001, was developed for Canadian mainstem Yukon River fall chum salmon stocks. The objective of the plan is to rebuild the stock by achieving a spawning escapement of greater than 80,000 fall chum salmon for all primary parent years in the cycle by the year 2001. The plan would include rebuilding the stronger parent years in four years (one life cycle) and the weaker parent years in twelve years (three life cycles), in increments.

Based upon timing of peak spawning, distance of spawning areas from the mouth of the Yukon River, and assumed similar migration rates, the early segment of fall chum salmon is thought to be primarily bound for the Canadian portion of the drainage. The later segment of the fall chum salmon run, although likely mixed with other stocks, is believed to be destined primarily for the Tanana River drainage. Stock identification studies using protein genetics and DNA may improve our understanding of fall chum salmon timing by spawning stock through the various fisheries.

During the 1980s, concern arose over the health of fall chum salmon stocks because of below average spawning escapement levels throughout the early to mid-1980's. Restrictions adopted by the Board of Fisheries in 1983 and 1986 resulted in generally improved spawning escapements during the late 1980s. However, spawning populations in the Toklat River, Fishing Branch River, and the Yukon River mainstem in Canada have shown less improvement than other spawning areas. Fall chum salmon runs in 1992 and 1993 were below average, with spawning escapements below goals in most systems. Based on YRFDA and ADF&G input, the Board of

Table 5. Alaskan catch of Yukon River summer chum salmon, 1961-1997.

Year	Estimated Subsistence Use [a]	Harvest: Subsistence [b]	Commercial [c]	Sport [d]	Total
1961	305,317 f	305,317 f	0		305,317
1962	261,856 f	261,856 f	0		261,856
1963	297,094 f	297,094 f	0		297,094
1964	361,080 f	361,080 f	0		361,080
1965	336,848 f	336,848 f	0		336,848
1966	154,508 f	154,508 f	0		154,508
1967	206,233 f	206,233 f	10,935		217,168
1968	133,880 f	133,880 f	14,470		148,350
1969	156,191 f	156,191 f	61,966		218,157
1970	166,504 f	166,504 f	137,006		303,510
1971	171,487 f	171,487 f	100,090		271,577
1972	108,006 f	108,006 f	135,668		243,674
1973	161,012 f	161,012 f	285,509		446,521
1974	227,811 f	227,811 f	589,892		817,703
1975	211,888 f	211,888 f	710,295		922,183
1976	186,872 f	186,872 f	600,894		787,766
1977	159,502	159,502	534,875	316	694,693
1978	197,144	171,383	1,077,987	451	1,249,821
1979	196,187	155,970	819,533	328	975,831
1980	272,398	167,705	1,067,715	483	1,235,903
1981	208,284	117,629	1,279,701	612	1,397,942
1982	260,969	117,413	717,013	780	835,206
1983	240,386	149,180	995,469	998	1,145,647
1984	230,747	166,630	866,040	585	1,033,255
1985	264,828	157,744	934,013	1,267	1,093,024
1986	290,825	182,337	1,188,850	895	1,372,082
1987	275,914	174,940	622,541	846	798,327
1988	311,724	198,806	1,620,269	1,037	1,820,112
1989	249,582	169,046	1,463,345	2,131	1,634,522
1990	201,839 g	117,436	525,440	472	643,348
1991	275,673 g	118,540	662,036	1,037	781,613
1992	261,448 g	125,497	545,544	1,308	672,349
1993	139,541 g	106,728	141,985	564	249,277
1994	245,973 g	132,510	261,953	350	394,813
1995	221,308 g	119,503	824,487	1,174	945,164
1996	248,856 g	103,408	684,083	1,854	789,345
1997 h	j	j	230,809	j	230,809
Average					
1961-86	221,841	192,003	466,459	672	658,720
1987-91	262,946	155,754	978,726	1,105	1,135,584
1992-96	223,425	117,529	491,610	1,050	610,190

a Includes salmon harvested for subsistence purposes, and an estimate of the number of salmon carcasses harvested for the commercial production of salmon roe and used for subsistence. These data are only available since 1990.

b Includes salmon harvested for subsistence and personal use.

c Includes ADF&G test fish sales, fish sold in the round, and estimated numbers of female salmon commercially harvested for the production of salmon roe (see Bergstrom et al. 1992: 1990 Yukon Area AMR).

d Includes both summer and fall chum salmon sport fish harvest within the Alaskan portion of the Yukon River drainage. The majority of this harvest is believed to have been taken within the Tanana River drainage.

f Catches estimated because catches of species other than chinook salmon were not differentiated.

g Subsistence harvest, summer chum salmon commercially harvested for the production of salmon roe in District 5 and 6, and the estimated subsistence use of commercially-harvested summer chum salmon in District 4.

h Data are preliminary.

j Data are unavailable at this time.

Source: JTC 1997

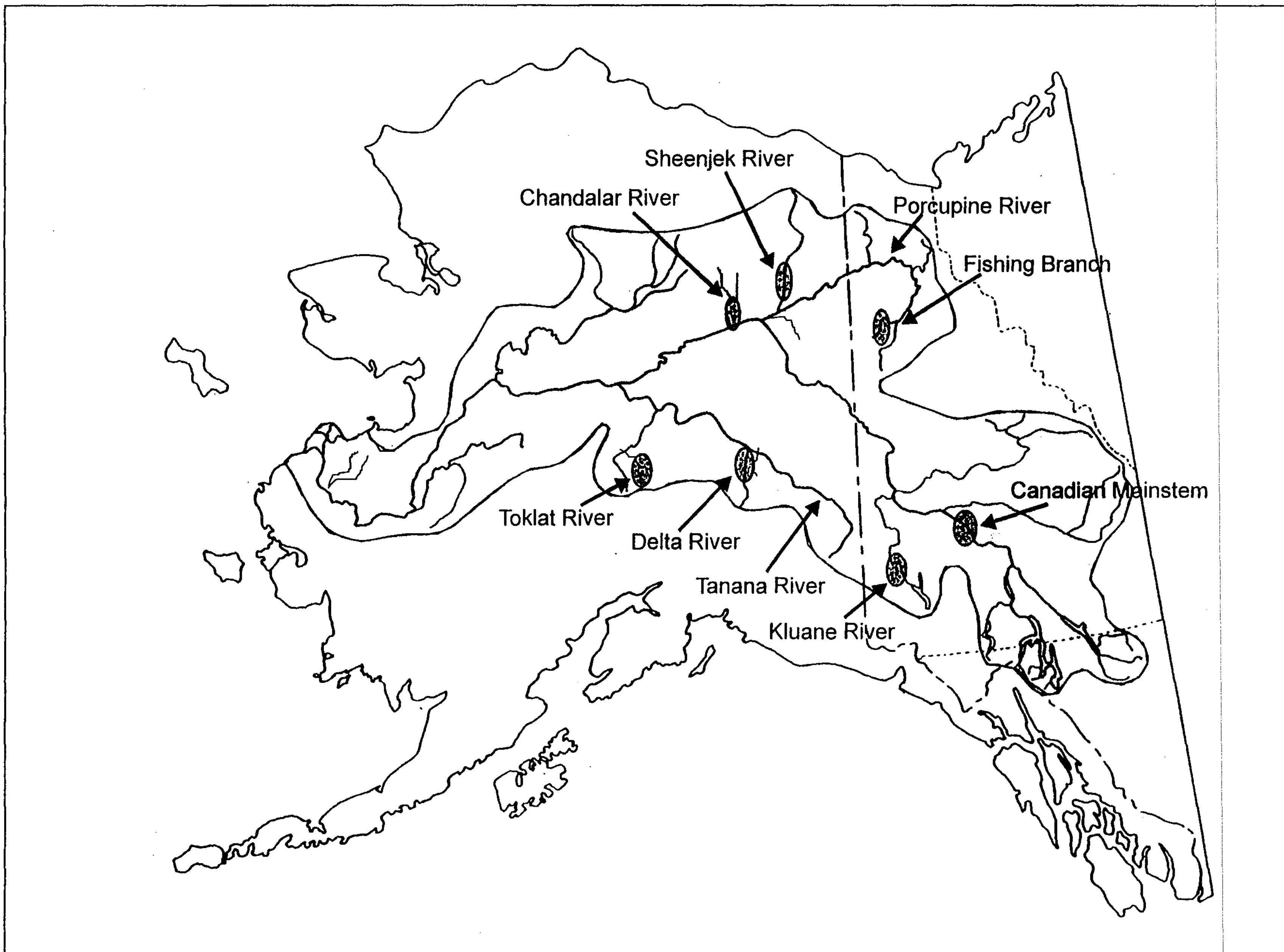


Figure 5. Major fall chum salmon spawning locations of the Yukon River drainage.

Table 6. Fall chum salmon escapement counts for selected spawning areas in Alaskan and Canadian portions of the Yukon River drainage, 1971-1997.

	Alaska				Canada							
										Canadian Mainstem		
Year	Toklat River [b]	Delta River [c]	Chandalar River [d]	Sheenjek River [d]	Fishing Branch River [f,g]	Mainstem Yukon River Index [g,h]	Koidern River [g]	Kluane River [g,j]	Teslin River [g,k]	Border Passage Estimate	Harvest	Spawning Escapement Estimate
1971					312,800							
1972		5,384			35,125 [n]			198 [p,r]				
1973		10,469			15,989 [s]	383		2,500				
1974	41,798	5,915		89,966 [t]	32,525 [s]			400				
1975	92,265	3,734 [v]		173,371 [t]	353,282 [s]	7,671		362 [r]				
1976	52,891	6,312 [v]		26,354 [t]	36,584			20				
1977	34,887	16,876 [v]		45,544 [t]	88,400			3,555				
1978	37,001	11,136		32,449 [t]	40,800			0 [r]				
1979	158,336	8,355		91,372 [t]	119,898			4,640 [r]				
1980 [ah]	26,346	5,137		28,933 [t]	55,268			3,150		39,130	16,218	22,912
1981	15,623	23,508		74,560	57,386 [w]			25,806		66,347	19,281	47,066
1982	3,624	4,235		31,421	15,901	1,020 [x]		5,378		47,049	15,091	31,958
1983	21,869	7,705		49,392	27,200	7,560		8,578 [r]		118,365	27,490	90,875
1984	16,758	12,411		27,130	15,150	2,800 [y]	1,300	7,200	200	81,900	25,267	56,633 [z]
1985	22,750	17,276 [v]		152,768	56,016 [s]	10,760	1,195	7,538	356	99,775	37,765	62,010
1986	17,976	6,703 [v]	59,313	84,207 [aa]	31,723 [s]	825	14	16,686	213	101,826	13,886	87,940
1987	22,117	21,180	52,416	153,267 [aa]	48,956 [s]	6,115	50	12,000		125,121	44,345	80,776
1988	13,436	18,024	33,619	45,206 [aa]	23,597 [s]	1,550	0	6,950	140	69,280	32,494	36,786
1989	30,421	21,342 [v]	69,161	99,116 [aa]	43,834 [s]	5,320	40	3,050	210 [p]	55,861	20,111	35,750
1990	34,739	8,992 [v]	78,631	77,750 [aa]	35,000 [ab]	3,651	1	4,683	739	82,947	31,212	51,735
1991	13,347	32,905 [v]		86,496 [ac]	37,733 [s]	2,426	53	11,675	468	112,303	33,842	78,461
1992	14,070	8,893 [v]		78,808 [ac]	22,517 [s]	4,438	4	3,339	450	67,962	18,880	49,082
1993	27,838	19,857		42,922 [ac]	28,707 [s]	2,620	0	4,610	555	42,165	12,422	29,743
1994	76,057	23,777 [v]		153,000 [ac,ad]	65,247 [s]	1,429 [p]	20 [p]	10,734	209 [p]	133,712	35,354	98,358
1995	54,513 [ah]	20,587	280,999	235,000 [ac,ad]	51,971 [s,aj]	4,701	0	16,456	633	198,203	40,111	158,092
1996	18,264	19,758	208,170	247,965 [ac,ad]	77,278 [s]	4,977		14,431	315	143,758	21,329	122,429
1997 [ad]	14,511	8,000	199,874	80,423	26,959	2,189		3,350	207	94,725	9,090	85,635
E.O. [af]	>33,000	>11,000		>64,000	50,000-120,000							>80,000

continued

Table 6. (page 2 of 2).

[a] Latest table revision November 3, 1997.

[b] Expanded total abundance estimates for upper Toklat River index area using stream life curve (SLC) developed with 1987-1993 data. Index area includes Geiger Creek, Sushana River, and mainstem floodplain sloughs from approximately 0.25 mile upstream of roadhouse to approximately 1.25 miles downstream of roadhouse.

[c] Estimates are a total spawner abundance, generally from using spawner abudance curves and streamlife data.

[d] Side-scan sonar estimate 1986-1990, split beam sonar estimate 1995-1996.

[f] Located within the Canadian portion of the Porcupine River drainage. Total escapement estimated using weir to aerial survey expansion factor of 2.72, unless otherwise indicated.

[g] Aerial survey count unless otherwise indicated.

[h] Tatchun Creek to Fort Selkirk.

[j] Duke River to end of spawning sloughs below Swede Johnston Creek.

[k] Boswell Creek area (5 km below to 5 km above confluence).

[m] Excludes Fishing Branch River escapement (estimated border passage minus Canadian removal).

[n] Weir installed on September 22. Estimate consists of a weir count of 17,190 after September 22, and a tagging passage estimate of 17,935 prior to weir installation.

[p] Incomplete and/or poor survey conditions resulting in minimal or inaccurate counts.

[r] Foot survey.

[s] Weir count.

[t] Total escapement estimate using sonar to aerial survey expansion factor of 2.22.

[v] Population estimate from replicate foot surveys and stream life data.

[w] 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.

[x] Boat survey.

[y] Total index area not surveyed. Survey included the mainstem Yukon River between Yukon Crossing to 30 km below Fort Selkirk.

[z] Escapement estimate based on mark-recapture program unavailable. Estimate based on assumed average exploitation rate.

[aa] Expanded estimates for period approximateing second week August through middle fourth week September, using Chandalar River run timing data.

[ab] Weir was not operated. Although only 7,541 chum salmon were counted on a single survey flown October 26, a population estimate of approximately 27,000 fish was made through date of survey, based upon historic average aerial-to-weir expansion of 28%. Actual population of spawners was reported by DFO as between 30,000-40,000 fish considering aerial survey timing.

[ac] Total abundance estimate are for the period approximating second week August through middle fourth week of September. Comparative escapement estimates prior to 1986 are considered more conservative; approximating the period of end of August through middle week of September.

[ad] Data are preliminary.

[af] Interim escapement objective.

[ag] Based on escapement estimates for years 1974-1990.

[ah] Minimal estimate because of late timing of ground surveys with respect to peak of spawning.

[aj] Incomplete count due to late installation and/or early removal of project or high water events.

Source: JTC 1997

Fisheries established the Toklat River Fall Chum Salmon Rebuilding Management Plan prior to the 1993 season. The Yukon River Fall Chum Salmon Management Plan was adopted by the Board of Fisheries prior to the 1994 season. The Yukon River Fall Chum Salmon Management Plan contained the important element of an escapement-based management approach. Fall chum salmon abundance and subsequent escapements were much greater from 1994 through 1997 when most fall chum salmon spawning escapement objectives were achieved.

Table 7 shows the Alaskan catch of Yukon River fall chum salmon for 1961 to 1997.

Coho Salmon

Coho salmon returns to the Yukon River are of a lesser magnitude than fall chum salmon and are taken incidentally to the fall chum salmon commercial fishery. Coho salmon spawning escapement assessment within the Yukon River drainage is limited because of funding and survey conditions in late fall (Table 8). ADF&G collected basic coho salmon presence or absence information from households interviewed in the 1992 and 1993 Yukon Area subsistence salmon surveys. Coho salmon were observed spawning from the coastal rivers, through the lower and middle Yukon River tributaries, and throughout most of the Tanana River drainage. Currently, a BEG has been established for only one coho spawning stream within the Yukon River drainage, a minimum of 9,000 coho salmon for the Delta Clearwater River.

Commercial coho salmon harvests in the Alaskan portion of the Yukon River drainage have shown a decreasing trend (Table 9). Reductions in coho salmon harvests have resulted from commercial fall season fishery closures and restrictions in recent years. The department has resisted requests from fishermen to commercially target coho salmon as they migrate with fall chum salmon. The escapement database is inadequate and there is no had a coho salmon management plan in place. The Alaska Board of Fisheries charged the Yukon River Drainage Fisheries Association in March of 1994 to develop a coho salmon management plan for the Yukon River drainage. Extending current fall chum salmon assessment programs (such as the lower Yukon test fishery and Pilot Station Sonar) through the majority of the coho salmon migration would be an important element for assessing the coho salmon return. Extending projects will be a great challenge due to budgetary and personnel constraints. Due to funding support in 1995, 1996, and 1997 from BSFA, the USFWS extended their operation of the Andreafsky River weir project to include a portion of the coho salmon return. From August 1 through September 12, a total of 10,901 coho salmon were counted in 1995, in 1996 from July 23 through September 16 a total of 8,075 coho salmon were counted, and in 1997 from July 23 through September 13 a total of 9,472 coho were counted.

Table 7. Alaskan catch of Yukon River fall chum salmon, 1961-1997.

Year	Estimated Subsistence Use [a]	Harvest: Subsistence [b]	Harvest: Commercial [c]	Harvest: Total [d]
1961	101,772 [f,g]	101,772 [f]	42,461	144,233
1962	87,285 [f,g]	87,285 [f]	53,116	140,401
1963	99,031 [f,g]	99,031 [f]	0	99,031
1964	120,360 [f,g]	120,360 [f]	8,347	128,707
1965	112,283 [f,g]	112,283 [f]	23,317	135,600
1966	51,503 [f,g]	51,503 [f]	71,045	122,548
1967	68,744 [f,g]	68,744 [f]	38,274	107,018
1968	44,627 [f,g]	44,627 [f]	52,925	97,552
1969	52,063 [f,g]	52,063 [f]	131,310	183,373
1970	55,501 [f,g]	55,501 [f]	209,595	265,096
1971	57,162 [f,g]	57,162 [f]	189,594	246,756
1972	36,002 [f,g]	36,002 [f]	152,176	188,178
1973	53,670 [f,g]	53,670 [f]	232,090	285,760
1974	93,776 [f,g]	93,776 [f]	289,776	383,552
1975	86,591 [f,g]	86,591 [f]	275,009	361,600
1976	72,327 [f,g]	72,327 [f]	156,390	228,717
1977	82,771 [g]	82,771 [g]	257,986	340,757
1978	94,867 [g]	84,239 [g]	247,011	331,250
1979	233,347	214,881	378,412	593,293
1980	172,657	167,637	298,450	466,087
1981	188,525	177,240	477,736	654,976
1982	132,897	132,092	224,992	357,084
1983	192,928	187,864	307,662	495,526
1984	174,823	172,495	210,560	383,055
1985	206,472	203,947	270,269	474,216
1986	164,043	163,466	140,019	303,485
1987	361,663	361,663 [h]	0	361,663
1988	158,694	155,467	164,210	319,677
1989	230,978	216,229	301,928	518,157
1990	185,244	173,076	143,402	316,478
1991	168,890	145,524	258,154	403,678
1992	110,903	107,602	20,429 [k]	128,031
1993	76,925	76,925	0	76,925
1994	127,586	123,218	7,999	131,217
1995	163,693	131,369	284,178	415,547
1996	146,154	129,251	109,435	238,686
1997 [j]	[m]	[m]	58,187	58,187
Average				
1961-86	109,078	106,897	182,251	289,148
1987-91	221,094	210,392	173,539	383,931
1992-96	125,052	113,673	84,408	198,081

a Includes salmon harvested for subsistence purposes, and an estimate of the number of salmon carcasses harvested for the commercial production of salmon roe and used for subsistence. These data are only available since 1990.

b Includes salmon harvested for subsistence and personal use.

c Includes ADF&G test fish sales, fish sold in the round, and estimated numbers of female salmon commercially harvested for production of salmon roe (see Bergstrom et al. 1992: 1990 Yukon Area AMR).

d Does not include sport-fish harvest. The majority of the sport-fish harvest is believed to be taken in the Tanana River drainage. Sport fish division does not differentiate between the two races of chum salmon. However, the majority of this harvest is believed to be summer chum salmon.

f Catches estimated because catches of species other than chinook salmon were not differentiated.

g Minimum estimates because surveys were conducted prior to the end of the fishing season.

h Includes an estimated 95,768 and 119,168 fall chum salmon illegally sold in Districts 5 and 6 (Tanana River), respectively.

j Data are preliminary.

k Commercial fishery operated only in District 6, the Tanana River.

m Data are unavailable at this time.

Source: JTC 1997

Table 8. Coho salmon escapement counts for selected spawning areas in the Alaskan portion of the Yukon River drainage, 1972-1997. [a]

	Andreafsky River			Kantishna River		Nenana River						
Year	East Fork	West Fork	Anvik River	Geiger Creek [b]	Barton Creek	Lost Slough	Nenana Mainstem [c]	Wood Creek [d]	Seventeen Slough	Delta Clearwater River [f,g]	Clearwater Lake and Outlet	Richardson Clearwater River
1972										630	417	454 [k]
1973										3,322	551 [f]	375 [f]
1974						1,388			27	3,954 [j]	560	652 [f]
1975						943			956	5,100	1,575 [f, h]	4 [k]
1976			467 [k]	25 [j]		118			281	1,920	1,500 [f, h]	80 [k]
1977			81 [k]	60		524 [k]		310 [b]	1,167	4,793	730 [f, h]	327
1978						350		300 [b]	466	4,798	570 [f, h]	
1979						227			1,987	8,970	1,015 [f, h]	372
1980				3 [j]		499 [k]		1,603 [b]	592	3,946	1,545 [f, h]	611
1981	1,657 [k]					274		849 [n,r]	1,005	8,563 [p]	459 [k]	550
1982				81				1,436 [n,r]		8,365 [p]		
1983				42		766		1,042 [n]	103	8,019 [p]	253	88
1984				20 [j]		2,677		8,826 [n]		11,061	1,368	428
1985				42 [j]		1,584		4,470 [n]	2,081	5,358	750	
1986				5	496	794		1,664 [n]	218 [d,h]	10,857	3,577	146 [k]
1987				1,175		2,511		2,387 [n]	3,802	22,300	4,225 [f, h]	
1988	1,913	830	1,203	159	437	348		2,046 [n]		21,600	825 [f, h]	
1989				155	12 [k]			412 [n]	824 [k]	11,000	1,600 [f, h]	483
1990				211		688	1,308		15 [k]	8,325	2,375 [f, h]	
1991				427	467 [k]	564	447		52	23,900	3,150 [f, h]	
1992				77	55 [k]	372			490	3,963	229 [f, h]	500 [f]
1993				138	141	484	419	666 [n,s]	581	10,875	3,525 [f, h]	
1994				410	2,000 [n,s]	944	1,648	1,317 [n,s]	2,909	62,675 [w]	3,425 [f, h]	5,800 [f]
1995	10,901 [n]			142	192 [n,s]	4,169	2,218	500 [n]	2,972 [k]	20,100	3,625 [f, h]	
1996	8,037 [n]			233	0 [n]	2,040	2,171	2,416 [j]	3,668 [d,h]	14,075 [x]	1,125 [f, y]	
1997 [t]	9,462 [n]			274		1,524 [aa]	1,446	1,464 [j,ab]	1,996 [d,h]	11,525	2,775 [f, h]	
E.O.										>9,000 [u]		

continued

Table 8. (page 2 of 2).

[a] Aerial surveys unless otherwise noted. Only peak counts presented. Survey rating is fair to good, unless otherwise noted.
[b] Foot survey.
[c] Mainstem Nenana River between confluences of Lost Slough and Teklanika River.
[d] Surveyed by F.R.E.D.
[f] Surveyed by Sport Fish division.
[g] Boat survey counts in the lower 17.5 river miles, unless otherwise indicated.
[h] Boat survey.
[k] Poor survey.
[n] Weir count.
[p] Expanded estimate based on partial survey counts and historic distribution of spawners from 1977-1980.
[r] Coho weir was operated at the mough of Clear Creek (Shores Landing).
[s] Incomplete count because of late installation and/or early removal of project.
[t] Data are preliminary.
[u] Interim escapement objective established March, 1993, based on boat survey counts of coho salmon in the lower 17.5 river miles during the period October 21-27.
[w] An additional 17,565 coho salmon were counted by helicopter in the Delta Clearwater outside of the normal mainstem index area.
[x] An additional 3,300 coho salmon were counted by helicopter in the Delta Clearwater outside of the normal mainstem index area.
[y] An additional 350 coho salmon were counted in Clearwater Lake Inlet.
[aa] Survey of western floodplain sloughs only.
[ab] Beginning at confluence of Clear Creek, the survey includes counts of Glacier and Wood Creeks up to their headwaters.

Source: JTC 1997

Table 9. Alaskan catch of Yukon River coho salmon, 1961-1997.

Year	Estimated Subsistence Use [a]	Harvest Subsistence [b]	Commercial [c]	Sport [d]	Total
1961	9,192 f,g	9,192 f,g	2,855		12,047
1962	9,480 f,g	9,480 f,g	22,926		32,406
1963	27,699 f,g	27,699 f,g	5,572		33,271
1964	12,187 f,g	12,187 f,g	2,446		14,633
1965	11,789 f,g	11,789 f,g	350		12,139
1966	13,192 f,g	13,192 f,g	19,254		32,446
1967	17,164 f,g	17,164 f,g	11,047		28,211
1968	11,613 f,g	11,613 f,g	13,303		24,916
1969	7,776 f,g	7,776 f,g	15,093		22,869
1970	3,966 f,g	3,966 f,g	13,188		17,154
1971	16,912 f,g	16,912 f,g	12,203		29,115
1972	7,532 f,g	7,532 f,g	22,233		29,765
1973	10,236 f,g	10,236 f,g	36,641		46,877
1974	11,646 f,g	11,646 f,g	16,777		28,423
1975	20,708 f,g	20,708 f,g	2,546		23,254
1976	5,241 f,g	5,241 f,g	5,184		10,425
1977	16,333 g	16,333 g	38,863	112	55,308
1978	7,787 g	7,787 g	26,152	302	34,241
1979	9,794	9,794	17,165	50	27,009
1980	20,158	20,158	8,745	67	28,970
1981	21,228	21,228	23,680	45	44,953
1982	35,894	35,894	37,176	97	73,167
1983	23,905	23,905	13,320	199	37,424
1984	49,020	49,020	81,940	831	131,791
1985	32,264	32,264	57,672	808	90,744
1986	34,468	34,468	47,255	1,535	83,258
1987	84,894	84,894 h	0	1,292	86,186
1988	69,080	69,080	99,907	2,420	171,407
1989	41,583	41,583	85,493	1,811	128,887
1990	47,896	44,641	46,937	1,947	93,525
1991	40,894	37,388	109,657	2,775	149,820
1992	53,344	51,921	9,608 k	1,666	63,195
1993	15,772	15,772	0	897	16,669
1994	48,926	44,594	4,452	2,174	51,220
1995	29,716	28,642	47,206	1,278	77,126
1996	33,651	30,510	57,352	1,588	89,450
1997 j	m	m	35,320	m	35,320
Average					
1961-86	17,199	17,199	21,292	405	38,647
1987-91	56,869	55,517	68,399	2,049	125,965
1992-96	36,282	34,288	23,724	1,521	59,532

a Includes salmon harvested for subsistence purposes, and an estimate of the number of salmon carcasses harvested for the commercial production of salmon roe and used for subsistence. These data are only available since 1990.
b Includes salmon harvested for subsistence and personal use.
c Includes ADF&G test fish sales, fish sold in the round, and estimated numbers of female salmon commercially harvested for the production of salmon roe (see Bergstrom et al. 1992: 1990 Yukon Area AMR).
d Sport fish harvest for the Alaskan portion of the Yukon River drainage. The majority of this harvest is believed to have been taken within the Tanana River drainage (see Schultz et al. 1993: 1992 Yukon Area AMR).
f Catches estimated because catches of species other than chinook were not differentiated.
g Minimum estimates because surveys were conducted prior to the end of the fishing season.
h Includes an estimated 5,015 and 31,276 coho salmon illegally sold in Districts 5 and 6 (Tanana River), respectively.
j Data are preliminary.
k Commercial fishery operated only in District 6, the Tanana River.
m Data are unavailable at this time.

Source: JTC 1997

Habitat Status

Yukon River salmon stocks have generally remained healthy due primarily to undisturbed spawning, rearing, and migration habitat. The first salmon habitat threats caused by human presence in the Yukon River drainage began in the early 1900s with mining exploration. Mining activity was, and remains, an important economic industry within the drainage. Fortunately, most historical mining activity occurred on localized, discrete, headwater streams using manual labor which helped to minimize impacts on salmon spawning habitat. A very thorough reference of mining activity in the Yukon River Area and salmon presence is contained in "A History of Mining in the Yukon River Basin of Alaska" (Higgs, 1995). This report notes major mining activity has occurred on the following tributaries: the Iditarod and Innoko River drainages in the Lower Yukon; American Creek, Eureka Creek, Minook Creek, and upper Sulatna River in the Middle Yukon; Birch Creek, Woodchopper Creek, Coal Creek, Nome Creek, Beaver Creek and the Fortymile River in the Upper Yukon; Middle and South Forks of the Koyukuk River and Hogatza River in the Koyukuk River drainage; and Goldstream Creek, Chatanika River, Chena River, Livengood Creek in the Tanana River drainage. Northern mining operations had to cope with short operating seasons, difficult transportation conditions, and high freight and labor costs. Both small and large mining operations exist today. However, more rigid enforcement of environmental regulations since the mid-1980s, has resulted in mining operations which are less detrimental to fisheries habitat than in the past. Today, all mining operations must obtain numerous environmental permits prior to initiating or continuing mining activity. Currently, two large hard-rock mines are operating; the Illinois Creek mine in the Upper Innoko drainage and the Fort Knox mine near Fairbanks with a third being assessed for development near Pogo Creek of the Goodpaster River near Delta.

In the late 1950s and early 1960s, the Yukon River likely faced its largest habitat threat with proposed construction of a hydroelectric dam at Rampart Canyon near the village of Rampart. The dam, which would have inundated 10,500 square miles (larger than the state of Maryland), was proposed as a cheap source of power to stimulate an industrial economy in Alaska. Fortunately, this dam was not built.

Logging has become a potential threat to fisheries habitat in the Tanana River drainage. With the transfer of large tracts of federal land into private corporation and state ownership, logging activity is increasing to meet both local and export timber demands. Current concerns relate to insufficient buffer or setback zones to protect tributaries from increased runoff, increased temperature fluctuations, loss of spawning and rearing habitat, increased siltation and turbidity, and other effects which can all be stabilized or moderated with sufficient streamside vegetation.

SOCIOECONOMIC OVERVIEW

In order to give context to the guidelines and principles of this Plan, the following chapter notes some of the key socioeconomic characteristics of the region. Compared to many other regions of Alaska, the Yukon River drainage is highly dependent upon the subsistence lifestyle and is cash-poor. Commercial and subsistence fishing are central to the economy of the region.

Population and Income

The total population of the U.S. portion of the Yukon River drainage in 1995 was estimated at 95,500. However, excluding residents of the Fairbanks area, the rural population of the drainage is approximately 10,000-15,000 (ADF&G, 1997a). This rural population is distributed amongst villages stretching from the Bering Sea coast up to the Canadian border and encompasses the major tributaries of the Koyukuk and Tanana Rivers. The population of these villages ranges from 30 to 800 with an average population of 270.

The majority of the rural population in Alaska are Natives. According to the 1990 U.S. census, the percentage of Alaska Natives in a village's population increases as one moves away from Fairbanks. In the lower Tanana River communities of Minto, Nenana and Manley, Alaska Natives comprise 60.3% of the population. Along the middle and upper Yukon, this percentage increases to 80 percent or more, while in the Yup'ik communities of the lower Yukon and the Yukon River Delta, including the Coastal District, Alaska Natives comprise over 90 percent of the population.

The rural portion of the drainage is also characterized by a low per capita income (U.S. Census, 1990). In 1989, per capita income for the communities of the Coastal District, the lower, middle and upper Yukon and the Koyukuk River ranged from about $5,000 to $8,000. This compares to 1989 per capita income averages of $10,358 for residents of the Tanana River and $16,092 for Fairbanks area residents. Consequently, the number of persons living below the poverty line in the rural Yukon River drainage is high relative to urban areas of Alaska. In 1995 the percentage of persons with incomes below the poverty line for the communities of the Coastal District, the lower, middle and upper Yukon and Koyukuk Rivers, averaged from 37.2 to 53.2 percent. For the three lower Tanana River communities this percentage dropped to 26.4 percent, while the Fairbanks area had only 11.6 percent of its population living below the poverty line.

Salmon fishing has been and continues to be central to the annual economic cycle of families and villages in the region. As described in earlier chapters, commercial salmon fishing in today's cash market is a prime contributor to the survival of the mixed subsistence-market economy (Wolfe, 1984; Wolfe and Walker, 1987). Commercial fishing plays a critical role in this economy since it is the largest single source of private sector income and is compatible with the traditional patterns of subsistence hunting, fishing and gathering. Commercial fishing income generated from working as a permit holder, crew member, tender operator, plant laborer, etc., enables village residents to purchase non-perishable food items (rice, canned and boxed goods, etc.) to supplement their harvests of wild food (fish, moose, caribou, seals, snowshoe hares, etc.). The cash also allows for purchase of the equipment and supplies (rifles, nets, traps, boats, outboards, snowmachines, four-wheel ATV, etc.) which assist in subsistence activities. There are other sources of cash income, but these are generally short-term and infrequent. These include summer wage labor on construction or renovation projects of village facilities such as schools, laundromats, city buildings and airports, and summer fire-fighting or National Guard participation. Only a few local year-round jobs are available with the local school or city and village governments. Other income sources include transfer payments such as Aid to Families with Dependent Children (AFDC), Longevity Bonus, and Permanent Fund Dividends. The Regional Native Corporations for the Yukon area (Calista and Doyon) established by the Alaska Native Claims Settlement Act are significantly less profitable than some of their better-known counterparts such as Cook Inlet Region, Inc. or Sealaska. This is primarily due to a lack of readily developable natural resources on their land holdings. Doyon does offer some job opportunities and the occasional dividend. Calista Corporation is one of the least successful corporations. It has never issued a dividend to any of its numerous shareholders and only has limited work opportunities. Interestingly, neither Calista or Doyon have made any significant investments in the local fishing industry.

Compared to other areas in Alaska, however, the subsistence economy of the Yukon River drainage has been supported by the commercial salmon fishery rather than displaced (Wolfe, 1984; Wolfe and Walker, 1987; Andrews and Pete, 1991; Andrews and Albrecht, 1992). Regulations and policy advocated by Yukon fishermen and approved by the Board of Fisheries provide for the subsistence priority and adequate subsistence fishing opportunity. ADF&G's conservative management approach has also prevented overexploitation of stocks and the state subsistence priority has minimized disruptions to traditional harvests and fishing practices even in years of poor returns. Overexploitation of stocks has not persisted due to the implementation of realistic commercial harvest allocations by the Alaska Board of Fisheries and the higher costs of shipping and fish processing infrastructure from villages along the river. Although commercial salmon fishing permits for the Yukon River drainage can be bought and sold on the open market, there is not enough potential income from commercial fishing on the Yukon River (at present) to attract significant non-local or out of state participation.

Yukon Area Commercial Fishing Permits

The State of Alaska, Commercial Fishing Entry Commission re-issues approximately 940 limited entry salmon permits annually which allow commercial salmon fishing in the U.S. portion of the Yukon and Tanana River mainstem (Table 10). The limited entry permits are divided into three fishery permit code categories depending upon the area and gear type to be fished: the Lower Yukon Area gillnet fishery--S04Y, the Upper Yukon Area set gillnet fishery--S04P, and the Upper Yukon Area fish wheel fishery--S08P.

Unlike other fisheries in Alaska, Yukon River permit holders are primarily local residents of Yukon River drainage rural villages or the greater Fairbanks area (CFEC, 1997). In 1994, 91% of the Upper Yukon Area fish wheel permits were locally owned, followed by 86% of the Lower Yukon Area gillnet permits, and lastly, 79% of the Upper Yukon Area set gillnet permits were locally owned. Permit holders who live in villages or towns outside the Yukon River drainage often are former residents of the drainage. However, permit ownership by non-Alaskan residents in 1995 was negligible. Eight Lower Yukon Area gillnet permits, 4 Upper Yukon Area fish wheel permits, and 3 Upper Yukon Area gillnet fish wheel permits were owned by nonresidents.

Lower Yukon Gillnet Permits

On an annual basis, CFEC issues approximately 707 limited entry Lower Yukon Area salmon gillnet permits authorizing commercial salmon fishing in the Lower Yukon Area (Table 11). The Lower Yukon Area stretches from the Yukon River delta to a boundary marker 301 river miles upstream, near the village of Holy Cross. The Lower Yukon Area is further subdivided into Districts 1, 2 and 3. Either set net or drift net gear may be used by a Lower Yukon Area permit holder although most fishermen operate drift gear. Between 650 and 690 of the permits are actually used during each fishing season, with effort levels varying depending upon salmon abundance and market conditions.

The chinook salmon fishery is the primary motivation for participation since Yukon River king salmon (as they are commonly known) command one of the highest ex-vessel prices in the state (around $2.00/lb. in the mid-1990s) and usually contribute to more than 90% of a fisherman's income. During the chinook and summer chum salmon season from early June to early July the majority of the effort is concentrated in District 1 with about 400 permits fished per period, while about 200 permits are fished per period in District 2. During the less lucrative fall chum and coho salmon fishing season in late July through mid to late August, effort drops significantly.

District 3 at the upper end of the Lower Yukon Area is significantly smaller than Districts 1 and 2 in terms of both area and fishing effort. Historically, only about 15 permits per year were fished in District 3, mostly during the chinook salmon fishery. However, due to lack of chinook salmon buyer interest, no commercial fishing occurred in District 3 in 1995 and 1997. In 1996 only two short summer chum salmon fishing periods occurred in July to test salmon roe harvest feasibility.

Table 10. Estimated value[1] and fishermen's participation in the Yukon Area commercial salmon fishery, 1977-1997.

Year	Ex-vessel value	Total permits issued	Total permits fished
1977	4,090,893	929	783
1978	5,102,046	928	834
1979	7,308,313	943	840
1980	5,899,260	943	834
1981	9,332,487	943	836
1982	6,229,804	952	820
1983	5,376,407	945	810
1984	5,738,558	940	812
1985	6,958,372	938	817
1986	6,362,138	939	801
1987	7,212,937	938	797
1988	13,446,256	938	844
1989	10,375,947	937	851
1990	6,561,209	936	826
1991	9,596,884	935	826
1992	11,443,933	943	821
1993	5,698,504	945	805
1994	4,996,425	944	762
1995	7,238,761	946	805
1996	4,496,582	944	763
1997	5,889,300	940	725
15 -year average (1983-1997)	**7,426,147**	**940**	**804**

[1] Data provided by Commercial Fisheries Entry Commission and includes only commercial catch landed on valid permits. Data associated with test fishing, illegal landings, derbies, educational permits, or unmatchable permits are excluded.

Table 11. Commercial Fisheries Entry Commission salmon gear permits issued by residence for the Lower Yukon Area, 1997. [a]

District	Residence	GillNet Permits (S04Y)
1, 2, and 3	Alakanuk	73
	Aleknagik	1
	Anchorage	27
	Aniak	1
	Belens Creek, NC	1
	Bethel	16
	Big Lake	1
	Cameron Mills, NY	1
	Chevak	2
	Chuathbaluk	1
	Cooper Landing	1
	Dillion, MT	1
	Eek	1
	Elim	1
	Emmonak	100
	Everett, WA	1
	Fairbanks	14
	Glennallen	1
	Holy Cross	7
	Hooper Bay	2
	Iliamna	1
	Kalskag	1
	Koliganek	1
	Kotlik	76
	Lower Kalskag	1
	Manley Hot Springs	2
	Marshall	38
	Mountain Village	88
	Newtok	1
	Nome	2
	Palmer	1
	Pilot Station	52
	Pitkas Point	2
	Rock Hill, SC	1
	Russian Mission	10
	Sand Point	1
	Scammon Bay	42
	Seattle, WA	1
	Shaktoolik	1
	Sheldon Point	27
	Sitka	1
	St. Marys	70
	Stanwood, WA	1
	Stebbins	12
	Sutton	1
	Talkeetna	4
	Tok	1
	Twisp, WA	1
	Unalakleet	4
	Wasilla	7
	Whittier	1
Total Lower Yukon		705

[a] Counts are for initial issues only and do not include transfers. Counts include interim use permits.

Source: ADF&G In Prep.

Average gross earnings and annual incomes vary considerably depending upon permit type (CFEC, 1997). Gross earnings and annual per permit incomes are highest in the Lower Yukon Area gillnet fishery. The total gross annual earnings for the Lower Yukon Area fishery from 1977 to 1995 averaged $6,434,000 (Table 12).

Gross earnings per permit have ranged from a low of $5,900 in 1977 to a high of $17,500 in 1988, with an annual average gross income per permit of $9,600 from 1977 to 1995. Lower Yukon permits are the most valuable of the Yukon CFEC permits. Open market values for these permits ranged between $21,000 and $31,000 from 1987 through 1996. From 1989-1994, 7 to 12 permits per year were sold or transferred.

Upper Yukon Fish Wheel and Set Gillnet Permits

The Upper Yukon Area fishery includes the mainstem Yukon River from river mile 301 (near the village of Holy Cross), up to the Canadian border (river mile 1,224) and the Tanana River from its confluence with the Yukon River, up to the downstream edge of the Chena River mouth, near Fairbanks (river mile 920). The Upper Yukon Area is divided into Districts 4, 5 and 6. District 4 stretches from river mile 301 up to river mile 664 (Illinois Creek), downstream of the village of Tanana. The Anvik River, in the lower portion of District 4, has recently developed a summer chum salmon terminal fishery which began in 1994, with the commercial product being salmon roe. District 5 extends from Illinois Creek to river mile 1,224, the Canadian border. Commercial fishing within District 6 of the Tanana River occurs in the lower 225 river miles, from its confluence with the Yukon River, upstream, to the Chena River.

CFEC issues approximately 72 set gillnet permits (S04P) and 166 fish wheel permits (S08P) each year, although in recent years, only about 50% of the licensed permittees actively participated in the fishery (Table 13). Both of these gear types are stationary or fixed and because of this a permit holder must have access to a good fishing site, unlike drift gear which is mobile. With the exception of chum salmon roe, both the relative volume and value of the Upper Yukon Area harvest is lower than the Lower Yukon Area fishery. Although flesh quality of some Upper Yukon Area king and fall chum salmon may be good, the skin is watermarked and hence difficult to sell in today's competitive market conditions. Summer chum salmon are usually heavily watermarked, but their roe is very mature and suitable for making single egg roe caviar known as "ikura" which commands a higher price than the roe skein caviar known as "sujiko". Only half of the issued Upper Yukon Area permits are fished because of the lower volume of harvest, decreased value, as well as the necessity to access fishing sites. About 80 to 100 of the 165 fish wheel permits are being fished each year. Use of set gillnet permits is lower than fish wheel permits because they generally are less efficient and require more labor during heavy debris times. Only 30 to 35 of the 72 issued set gillnet permits are being fished each year.

Table 14 shows the value by species of the Upper Yukon Area fishery for 1977-1997. Gross earnings and annual per permit incomes are higher for fish wheel permits than set gillnet permits. Annual total gross earnings for the fish wheel and set gillnet fishery averaged $704,000 and

Table 12. Estimated exvessel value of commercial salmon fishery to Lower Yukon Area fishermen, 1977-1997.

	Chinook		Summer Chum				Fall Chum		Coho			
Year	$/lb.	Dollars	$/lb.	$/Roe	Dollars	Subtotal Value	$/lb.	Dollars	$/lb.	Dollars	Subtotal Value	Total Value
1977	0.85	1,841,033	0.40		1,007,280	2,848,313	0.45	718,571	0.50	140,914	859,485	3,707,798
1978	0.90	2,048,674	0.45		2,071,434	4,120,108	0.47	691,854	0.60	96,823	788,677	4,908,785
1979	1.09	2,763,433	0.52		2,242,564	5,005,997	0.68	1,158,485	0.80	83,466	1,241,951	6,247,948
1980	1.04	3,409,105	0.20		1,027,738	4,436,843	0.28	394,162	0.36	17,374	411,536	4,848,379
1981	1.20	4,420,669	0.40		2,741,178	7,161,847	0.55	1,503,744	0.60	87,385	1,591,129	8,752,976
1982	1.41	3,768,107	0.40		1,237,735	5,005,842	0.55	846,492	0.69	135,828	982,320	5,988,162
1983	1.40	4,093,562	0.34		1,734,270	5,827,832	0.34	591,011	0.35	17,497	608,508	6,436,340
1984	1.50	3,510,923	0.26		926,922	4,437,845	0.32	374,359	0.50	256,050	630,409	5,068,254
1985	1.50	4,294,432	0.35		1,032,700	5,327,132	0.47	634,616	0.53	176,254	810,870	6,138,002
1986	1.63	3,165,078	0.38		1,746,455	4,911,533	0.49	399,321	0.71	211,942	611,263	5,522,796
1987	1.98	5,428,933	0.48		1,313,618	6,742,551	-	0	-	0	0	6,742,551
1988	2.97	5,463,800	0.66		5,001,100	10,464,900	1.01	638,700	1.38	734,400	1,373,100	11,838,000
1989	2.77	5,181,700	0.34		2,217,700	7,399,400	0.50	713,400	0.66	323,300	1,036,700	8,436,100
1990	2.84	4,820,859	0.24		497,571	5,318,430	0.45	238,165	0.66	137,302	375,467	5,693,897
1991	3.70	7,128,300	0.36		782,300	7,910,600	0.34	438,310	0.44	300,182	738,492	8,649,092
1992	4.12	9,957,002	0.27		606,976	10,563,978	-	0	-	0	0	10,563,978
1993	2.70	4,884,044	0.37		226,772	5,110,815	-	0	-	0	0	5,110,815
1994	2.07	4,169,270	0.21		79,206	4,248,476	-	0	-	0	0	4,248,476
1995	2.09	5,317,821	0.16		244,304	5,562,125	0.15	185,036	0.29	80,019	265,055	5,827,180
1996	1.95	3,491,582	0.09	2.96	89,020	3,580,602	0.10	48,579	0.26	96,795	145,374	3,725,976
1997	2.46	5,450,433	0.10		56,535	5,506,968	0.22	86,526	0.32	79,973	166,499	5,673,467
5 Yr Ave 1992-1996	2.59	5,563,944	0.22	-	249,256	5,813,199	-	46,723	-	35,363	82,086	5,895,285

Source: ADF&G 1997c.

Table 13. Commercial Fisheries Entry Commission salmon gear permits issued by residence for the Upper Yukon Area, 1997. [a]

District	Residence	GillNet Permits (S04P)	Fish Wheel Permits (S08P)	Total
4, 5, and 6	Anchorage	4	2	6
	Anchor Pt.	0	2	2
	Aniak	1	0	1
	Anvik	5	9	14
	Barrow	0	1	1
	Cantwell	1	0	1
	Circle City	0	1	1
	Dot Lake	0	1	1
	Eagle River	0	1	1
	Fairbanks	23	22	45
	Ft. Yukon	0	1	1
	Gakona	1	0	1
	Galena	4	26	30
	Grayling	5	4	9
	Healy	1	0	1
	Holy Cross	1	0	1
	Huslia	0	1	1
	Kaltag	3	15	18
	Koyukuk	0	2	2
	Manley Hot Springs	2	4	6
	Minto	0	1	1
	Nenana	6	21	27
	New York, NY	0	1	1
	Nome	1	0	1
	North Pole	0	2	2
	Nulato	0	15	15
	Palm Desert, CA	1	0	1
	Palmer	1	0	1
	Portland, OR	0	1	1
	Rampart	4	2	6
	Ruby	2	8	10
	Salcha	1	0	1
	Soldotna	1	0	1
	Stevens Village	1	3	4
	Tanana	3	15	18
	Wasilla	0	2	2
Total Upper Yukon		72	163	235

[a] Counts are for initial issues only and do not include transfers. Counts include interim use permits.

Source: ADF&G In Prep.

Table 14. Value of commercial salmon fishery to Upper Yukon Area fishermen, 1977-1997.

	Chinook			Summer Chum			Fall Chum			Coho			
Year	$/lb	$/lb Roe	Value	$/lb	$/lb Roe	Value	$/lb	$/lb Roe	Value	$/lb	$/lb Roe	Value	Total Value
1977	1.37		148,766	0.27	2.66	306,481	0.22		102,170	0.27		2,251	559,668
1978	0.87		66,472	0.24	N/A	655,738	0.25		103,091	0.24		6,105	831,406
1979	1.00		124,230	0.25	3.00	444,924	0.29		347,814	0.25		6,599	923,567
1980	0.85		113,662	0.23	2.50	627,249	0.27		198,088	0.29		2,374	941,373
1981	1.00		206,380	0.20	3.00	699,876	0.35		356,805	0.35		4,568	1,267,629
1982	1.02		162,699	0.18	2.75	452,837	0.28		53,258	0.37		18,786	687,580
1983	1.08		105,584	0.16	1.66	281,883	0.19		128,950	0.31		11,472	527,889
1984	0.95		102,354	0.23	1.78	382,776	0.26		103,417	0.24		12,823	601,370
1985	0.86		82,644	0.23	1.94	593,801	0.25		178,125	0.33		26,797	881,367
1986	0.89		73,363	0.22	2.08	634,091	0.14		30,309	0.21		556	738,319
1987	0.79		136,196	0.19	2.22	323,611	-		0	-		0	459,807
1988	1.04		142,284	0.23	4.33	1,213,991	0.32		151,300	0.37		34,116	1,541,691
1989	0.84		108,178	0.24	4.41	1,377,117	0.28		223,996	0.35		33,959	1,743,250
1990	0.72		105,295	0.11	4.41	506,611	0.34		174,965	0.34		37,026	823,897
1991	0.70	2.92	97,140	0.18	4.21	627,177	0.23	3.56	157,831	0.30	2.50	21,556	903,704
1992	0.91	2.82	168,999	0.30	4.53	525,204	0.39	4.50	54,161	0.39	2.18	19,529	767,893
1993	1.06	5.52	113,217	0.35	8.53	203,762	-	-	0	-	-	0	316,979
1994	0.92	3.11	124,270	0.20	3.77	396,685	0.16	1.50	8,517	0.48	1.50	8,739	538,211
1995	0.77	2.64	87,059	0.13	3.57	1,060,322	0.13	2.96	167,571	0.14	2.51	11,292	1,326,244
1996	0.95	2.57	47,282	0.07	3.05	966,277	0.13	1.71	45,438	0.09	2.16	13,020	1,072,017
1997	0.97	1.62	110,713	0.07	1.36	96,806	0.17	1.75	7,252	0.20	0.00	1,062	215,833
5 Year Ave. 1992-1996	0.92	3.33	108,165	0.21	4.69	630,450	0.20 a	2.67 a	55,137	0.28 a	2.09 a	10,516	804,269

a Four year average for the years of 1991, 1992, 1994, and 1995.

Source: ADF&G 1997c.

$176,000, respectively, for the period from 1977 to 1995. From 1977 to 1995, gross earnings per fish wheel permit averaged $6,200 with a low of $2,600 in 1992 to a high of $12,000 in 1989. For set gillnet permits from 1977 to 1995 gross earnings per permit averaged $4,400 with a low of $2,200 in 1987 and a high of $7,500 in 1979.

Open market values for Upper Yukon Area fish wheel permits and set gillnet permits are harder to determine as only a few are transferred each year and thus value data for some years is unavailable due to confidentiality requirements. Fish wheel permits have ranged in value between $8,000 to $12,000, while set gillnet permits sold for an average price of $9,875 in 1989 and $11,250 in 1990. From 1989-1994, 3 to 7 fish wheel permits per year have been sold or transferred, while only 1 to 4 set gillnet permits per year changed ownership during the same time period.

Participation rates are very stable in all three commercial fisheries of the Yukon Area. Essentially the same fishermen renew their permits each year with only a handful of permits changing hands each year. As fishermen age they usually transfer the permits to an immediate family member or another relative.

Processing Industry

Because of the large distances to domestic and international markets, fishermen are primarily dependent on the processing industry for tendering, packing, transporting, and marketing of salmon. Most of the dozen or so processors operating within the Yukon River drainage are small by Alaskan standards and generally consist of companies who have operated in the Yukon River drainage for more than 10 years, although the company name may have changed more than once. The following paragraphs list the companies which have recently operated in the Yukon River employing "slime-line" workers, freezer workers, tender skippers, tender crews, foremen, laborers, office personnel and equipment maintenance personnel (Table 15). The following Yukon River processing industry information has been summarized from ADF&G Annual Management Report for 1996 and personal communication with identified processors.

Headquartered in Emmonak, the Yukon Delta Fish Marketing Cooperative (YDFMC) has operated a processing and freezing plant on a barge moored to the dock in Emmonak since 1965 (Pio Park, Executive Director, Emmonak, personal communication). Almost all of its employees are local residents. The company sells essentially all of its king salmon to Nichiro Corporation of Japan. The Cooperative sells summer chum salmon and a handful of kings to domestic markets. YDFMC is actively searching for new markets for fresh chum salmon.

Bering Sea Fisheries of Everett, Washington has operated a processing and freezing plant on a barge operation in Sunshine Bay in the middle of District 1 since 1965 (Bill Bodey President, Everett, Washington, personal communication). The company sells essentially all the king salmon and most of the fall chum and coho salmon it purchases to Marubeni Corporation of

Table 15. Yukon Area salmon processors and buyers, and associated data for those referenced in the text.

Commercial operation (Processing location/ buying station)	Product	Commercial operation (Processing location/ buying station)	Product
Yukon Delta Fish Marketing CO-OP, Inc. P.O. Box 169 Emmonak, AK 99581 (Emmonak) DISTRICTS 1 and 2	Frozen Salmon Fresh Salmon Chinook Chum Salmon Roe	Sea Crest Inc. 6240 Rockhill Circle Anchorage, AK 99516 (Anvik, Galena, Ruby) DISTRICTS 3 and 4	Frozen Salmon Fresh Salmon Chinook, Chum, Coho Salmon Roe
Bering Sea Fisheries, Inc. 4413 83rd Ave. SE Everett, WA 98205 (Lamont Slough) DISTRICTS 1 and 2	Frozen Salmon Chinook Chum Salmon Roe	Interior Alaska Fish Processors 2400 Davis Road Fairbanks, AK 99701 (Fairbanks, Kaltag, Nenana, North Pole) DISTRICTS 4, 5, and 6	Frozen Salmon Chinook, Chum, Coho Salmon Roe
Boreal Fisheries P.O. Box 561 Graham, WA 98338 (Old Andreafsky) DISTRICTS 1 and 2	Fresh Salmon Chinook Chum Salmon Roe	Dainty Island Fisheries P.O. Box 49 Galena, AK 99741 (Galena) DISTRICT 4	Smoked Salmon Chinook Chum
Great Pacific Seafood's, Inc. Box 81165 Seattle, WA 98108 (Emmonak) DISTRICT 2	Fresh Salmon Chinook Chum Salmon Roe	Yutana Fisheries P.O. Box 83809 Fairbanks, AK 99701 (Kaltag, Manley, Nenana) DISTRICTS 4, 5, and 6	Frozen Salmon Fresh Salmon Chinook, Chum, Coho Salmon Roe
Maserculiq Fish Processors P.O. Box 118535 Marshall, AK 99585 (Marshall) DISTRICT 2	Fresh Salmon Chinook Chum Salmon Roe	Steven's Fisheries. P.O. Box 38 Nenana, AK 99760 (Nenana) DISTRICT 6	Frozen Salmon Fresh Salmon Chinook, Chum, Coho Salmon Roe
Trans-Ocean Seafood Sales P.O. Box 64 Aniak, AK 99557 (Aniak, Anvik, Grayling) DISTRICTS 3 and 4	Frozen Salmon Chinook Chum Salmon Roe	Arctic Circle Seafood's P.O. Box 18 Circle, AK 99733 (Circle) DISTRICT 5	Frozen Salmon Chinook Chum Salmon Roe
Great Northern Seafood's, Inc. Box 240365 Anchorage, AK 99524 (Galena) DISTRICT 4	Frozen Salmon Chinook Chum Salmon Roe		

Source: ADF&G 1997b

Japan while its summer chum salmon go to domestic markets. Bering Sea Fisheries employs both out-of-state and local residents.

Boreal Fisheries of Graham, Washington is a family business that has operated a salmon buying station since 1974, headquartered near the mouth of the Andreafsky River near Pitka's Point in the heart of District 2 (Randy Crawford, Owner, Graham, Washington, personal communication). It employs both local and out-of-state residents. As an independent buying station it acts as a subcontractor to fill orders for a larger company. For the last few years it has bought salmon for Inlet Salmon and weighs, ices, and packs the fish for air shipment to one of Inlet Salmon's processing plants. Inlet Salmon operates processing plants in Naknek, Bethel, and Kenai (Stuart Currie, Operations, Seattle, Washington, personal communication). Inlet sells most of its king, fall chum, and coho salmon to one large Japanese trading company, while summer chum and a few hundred king salmon are sold domestically. Fall chum and coho salmon go primarily to the Japanese market.

Great Pacific Seafoods of Seattle, Washington first operated in the Yukon Area in 1996. The primary base for this company is Prince William Sound (Roger Stiles, Operations, Seattle, Washington, personal communication). Great Pacific uses a small buying station in Emmonak. Its limited crew consists of both locals and non-locals. After weighing, icing and packing the fish into aircraft totes, Great Pacific's production is flown out by cargo plane and processed at their Anchorage plant. Most all of their king and fall chum salmon production is sold to Japan, while their summer chum salmon and a few thousand pounds of kings are sold fresh or frozen to domestic markets. Fall chum and coho salmon go to both domestic and foreign markets.

Maserculiq Fish Processors (MFP) of Marshall, Alaska are a subsidiary of Maserculiq, Inc., the village corporation of Marshall (Lloyd Stiassny, Manager, Anchorage, personal communication). Employing local residents, it operates a buying station at an older processing facility in the village, then ices and tenders the fish down to St. Mary's for air shipment to Kenai or Anchorage. The Corporation does not currently operate a processing or freezing plant but must have its production custom processed in Anchorage or Kenai. Unlike the other lower Yukon River buyers, Maserculiq does not have a large Japanese corporation as its backer but instead sells most of its chinook salmon production to a Japanese broker. Maserculiq also markets a significant percentage of its chinook salmon product to domestic restaurant markets on the U.S. west coast.

The Subdistrict 4-A summer chum salmon roe fishery attracts the next highest level of buyer interest according to the 1996 Commercial Fisheries Management and Development Division Annual Management Report for the Yukon Area (ADF&G, 1997b). Each individual fisherman cuts and hangs the carcasses for later subsistence use while removing the salmon roe for sale. The salmon roe is usually sold in five gallon buckets or coolers to the processing company. Fishermen either deliver their salmon roe directly to the processors' facilities at various villages or the salmon roe is picked up by small tender boats or float planes employed by the processors. Processing facilities generally consist of small buildings with chilling capabilities, a roe agitator and packing equipment. Essentially all of the salmon roe is processed into *ikura* caviar and sold to a variety of individual brokers and distributors for sale to the Japanese market. A very small percentage is sold to ethnic Eastern European markets in the lower 48 states. The companies usually employ a handful of Alaska residents as laborers and tender crew.

Trans-Ocean Seafood Sales purchases salmon roe from fishermen near the villages of Anvik and Grayling but flies the salmon roe to Aniak on the Kuskokwim River for processing (ADF&G 1997b). Sea Crest of Anchorage, Alaska runs small salmon roe processing facilities in Anvik, Nulato, and Galena (Terry Reeve, Owner, Anchorage, personal communication). Sea Crest also purchases chinook, summer chum, and fall chum salmon from fishermen in Subdistricts 4-B and 4-C. Great Northern Seafood Products of Anchorage, Alaska operates a small roe processing facility in Galena and a larger plant in Anchorage. They purchase roe in Anvik and throughout Subdistrict 4-A via floatplane and fly it to their plants for processing (Jack McMahon, General Manager, Anchorage, personal communication). Dainty Island Fisheries of Galena, Alaska is owned and operated by an Alaska Native who processes fish caught by family fishermen and other locals in District 4 for production into traditional, "Native-style" smoked salmon strips which are sold primarily to retail markets in Alaska (Sidney Huntington, Owner, Galena, personal communication).

The other major processing industry effort in the upper Yukon Area is centered around buying stations connected by road to the fishing grounds at Manley, Nenana, and the Yukon River bridge of the North Slope haul road. Processors also utilize tenders based from these buying stations particularly to service fishermen near the villages of Tanana and Rampart. Operating in the Yukon since 1984, Interior Alaska Fish Processors, Inc. of Fairbanks primarily purchases salmon and salmon roe in Districts 5 and 6. In recent years, the company has also purchased salmon roe from a small buying station near Kaltag and also buys roe from fishermen in Subdistricts 4-B and 4-C who sends it in via airplane. Although most of Interior Alaska Fish Processors roe production from Districts 4, 5, and 6 is sold to wholesale brokers, most of the salmon flesh is used to make a variety of smoked and value-added salmon products which are sold by retail and mail order under the “Santa’s Smokehouse” label. Salmon roe processing occurs at a small facility at a mid-Subdistrict 4-A fish camp and also at its Fairbanks processing facility, with most of its product flown in from the village of Kaltag. The company also custom processes sport-caught fish for individuals and small lots of commercially-caught salmon for other processors (Virgil Umphenour, CEO, Fairbanks, personal communication).

Yutana Fisheries, a Native-owned business, has operated a small processing plant at Manley for more than 20 years and buys salmon mostly from Districts 5 and 6. Since 1994 they have operated a small roe buying station at Kaltag (Jim Friedman, Sales Agent, Manley, personal communication). Steven's Fisheries of Nenana has operated since approximately 1979, running a small processing plant and roe facility and purchasing salmon and roe exclusively from District 6 fishermen (Gayle Stevens, Owner, Nenana, personal communication). The salmon and roe production of both Yutana Fisheries and Stevens Fisheries are sold primarily to wholesale buyers.

Due to the limited markets for Upper Yukon salmon products, especially in recent years, many individual fishermen in this area also register as catcher-sellers with the ADF&G (Keith Schultz, ADF&G, Fairbanks, personal communication). This designation enables them to sell all or a portion of their catch direct to consumers such as a local dog musher or to a restaurant. One fisherman in Circle, operating as Arctic Circle Seafoods, processes and freezes his catch for sale from his commercial fishwheel (ADF&G 1997b).

Recent Market Trends

Salmon markets on the Yukon River have exhibited a great deal of volatility in recent years. The following section provides the reader with information by species for harvests, processor participation, landed and wholesale prices, market products, and other relevant information.

Chinook Salmon

Essentially all of the chinook salmon harvested in the Lower Yukon Area are sold to four Japanese trading companies; Nichiro, Marubeni, Kyokuyo and Mitsubishi (personal communication with Ken Halvorsen, Vice President-Sales, Whitney Foods, Seattle, Washington; and Lloyd Stiassny, Manager-MFP, Anchorage). These Japanese traders then sell them to reprocessors who make either an expensive flaked product for sale in individual jars or process them into *tai-en* fillets, *sashimi* portions or smoked product. As a result, Yukon chinook salmon command a very high ex-vessel price and, depending upon annual market conditions, share the distinction with Copper River chinook salmon of having the highest ex-vessel price in the state, usually around $2.00 per pound. Depressed economic conditions in Japan and Asia in the late 1990's have made seafood products from Alaska more costly for these international consumers (Knapp, 1998). Japanese trading companies prefer the highest oil content chinook salmon they can obtain and have put their fish buyers on the lower Yukon River on strict quotas of the amount of chinook salmon they will purchase. Based upon their pre-season contracts with the fish buying companies, it is evident that at the present, Japanese trading companies would prefer harvests of around 90,000 to 100,000 chinook salmon annually from as close to the mouth of the Yukon River as possible, which typically includes District 1 and the lower half of District 2 below Pilot Station (Dan Bergstrom, ADF&G, Anchorage, personal communication). As a result, District 2 processor participation has decreased in several recent years (Dan Bergstrom, ADF&G, Anchorage, personal communication). In 1995, 1996, and 1997 for the first time ever, there were no openings in District 3 for chinook salmon due to a lack of market (ADF&G 1996, 1997a, 1997b).

In the Upper Yukon Area there are generally small but steady harvests of a few thousand chinook salmon in Subdistricts 4-B & 4-C and Districts 5 and 6. Although chinook salmon sales were allowed in Subdistrict 4-A, buyers were interested only in chum salmon roe there and incidental chinook salmon catches were retained for subsistence use. The Alaska Board of Fisheries adopted a regulation in December of 1997, proposed by local Subdistrict 4-A fishermen, which made the sale of roe from chinook salmon in Subdistrict 4-A illegal. The Upper Yukon Area market for chinook salmon flesh seems stable at present with prices usually around $0.75 to

$1.00 per pound. Only in District 6, the Tanana River, are the kings mature enough for their roe to be *ikura* grade caviar. Upper Yukon Area chinook salmon are primarily sold to local Fairbanks food service operators or sold to custom packers for processing into steaks, fillets or smoked products (Virgil Umphenour, Interior Alaska Fish Processors, Fairbanks, personal communication). If market conditions are poor, however, some commercial fishermen retain their chinook salmon for subsistence use (Keith Schultz, ADF&G, Fairbanks, personal communication).

Summer Chum Salmon

Since 1990, harvests of summer chum salmon in the lower Yukon River have been near the low end of the guideline, due initially to low run sizes and then most recently, plummeting wholesale prices for chum salmon flesh. In years prior to 1990, the lower Yukon River commercial fishery would last until mid-July. Yukon River summer chum salmon (as well as Kuskokwim River summer chum salmon) were once a big seller for a fresh market for Fourth of July promotions in the U.S. and frozen chums were exported to Japan and Europe (personal communications with Ken Halvorsen, Whitney Foods; Jack Schultheis, North Alaska Fisheries; Jim Gonzales, Inlet Salmon; and Paul Packer, Distributor, Northeast Seafoods, Denver, Colorado).

For 1998 and the near future, the lower Yukon River summer chum salmon flesh market outlook is grim. Chum salmon caught incidental to the Lower Yukon chinook salmon commercial fishery, and in perhaps a few directed openings prior to the 25th of June, could still be sold in the fresh market. If there is buyer interest after that date, purchases of a few thousand fish may continue for another week. However, it is likely that for the next few years the annual commercial harvest in the lower Yukon River will range between 100,000 and 300,000 chum salmon regardless of run size due to the depressed market situation. As a result, some Yukon River stocks such as the Anvik River will likely be underexploited. At the request of YRDFA, BSFA, and other western Alaska fishermen's groups, Governor Knowles initiated an AYK chum salmon marketing initiative administered by the Alaska Fisheries Development Foundation beginning in late 1996. It is hoped that through this program development of a niche market for "Arctic Keta" will help the market situation of AYK chum salmon.

In the Upper Yukon Area strong chum salmon returns (coupled with the lack of chum salmon fishing in the lower Yukon River) from 1994 through 1996 have lead to rebounding strong harvests in the Upper Yukon Area, particularly in Subdistrict 4-A and the Anvik River roe fisheries. However, in 1997, despite good chum salmon availability roe harvests dropped dramatically due to a 60% drop in the wholesale and exvessel price. The market for Upper Yukon Area summer chum salmon in-the-round sales, although never a large market, is now practically non-existent with the exception of District 6 fish which are cheaper to transport.

Fall Chum Salmon

The fall chum salmon commercial fishery in the Lower Yukon Area was closed in 1987 and in 1992-1994 due to conservation concerns (ADF&G 1993, 1995, 1996). Run assessment difficulties in 1994 resulted in commercial harvest opportunities being missed (ADF&G 1996). These closures strained the relationships Yukon River processors had with Japanese brokers (Ken Halvorsen, Whitney Foods, Seattle, Washington, personal communication). Japan is the primary purchaser of lower Yukon River fall chum salmon. The lack of reliable production occurred at the same time production of other red-meated, low cost fish such as Chilean farmed coho salmon and Japanese hatchery fall chum salmon was increasing. In spite of this, Yukon River fall chum salmon still retain Japanese market interest since they become available in late July and August and are considered a higher quality fish due to their oil content of 10% to 12%(Crapo, 1997 and Medallion Laboratories, 1996). The Japanese hatchery chum salmon do not become available until mid to late October and have a lower oil content of around 4% (Ando, 1986). In 1995-1997, the Yukon River had a more normal return of fall chum salmon, which revitalized the lower Yukon River commercial fishery (Keith Schultz, ADF&G, Fairbanks, personal communication). Both processor and fishermen participation was down dramatically in these three recent years compared to the 1980s due to extremely low ex-vessel and wholesale prices. However, harvests have resumed and market relationships are being reestablished but it is anticipated that marketing of fall chum salmon will continue to be difficult due to the competitive international marketplace, in spite of their high fat content and good flesh quality.

In the Upper Yukon Area, some of the same factors are in effect. Stronger fall chum salmon returns in 1995 and 1996 led to good harvests in the upper Yukon River, particularly in District 6. Most sales in Subdistricts 4-B & 4-C and District 5 were primarily salmon roe since transportation costs and depressed wholesale prices made flesh market participation prohibitive. Unlike Yukon River summer chum salmon which are harvested earlier in the market cycle and in greater volumes, upper Yukon River fall chum salmon are harvested in late August and September, slightly later than the lower Yukon River harvests. Factors which enable limited sales of District 5 and District 6 fall chum salmon include; access to transportation, greater volume due to higher guideline harvest ranges, good flesh quality, and the roe value.

Coho Salmon

There was no incidental commercial harvest of coho salmon in the lower Yukon River from 1992 through 1994 due to the fall chum salmon commercial fishery closure. Although coho salmon in recent years command a higher exvessel price than fall chum salmon, they return somewhat later and are less abundant than fall chum salmon. Even an above average harvest of lower Yukon coho salmon of about 100,000 fish is significantly less than an average 150,000 fish harvest of fall chum salmon (Keith Schultz, ADF&G, Fairbanks, personal communication). In the Upper Yukon Area, the only significant commercial harvest of coho salmon occurs in District 6, as incidental catch to the fall chum salmon directed fishery. Flesh markets for coho salmon are slightly better than for fall chum salmon, but the salmon roe also provides a significant source of value (Virgil Umphenour, Interior Alaska Fish Processors, Fairbanks, personal communication). Fishermen throughout the Alaskan portion of the Yukon River drainage have advocated for a directed coho salmon commercial fishery, due in part to declining fall chum salmon prices in recent years (Keith Schultz, ADF&G, Fairbanks, personal communication). Concerns for chum salmon which are intermixed with the coho salmon, allocation conflicts and the lack of information on overall stock status have thus far prevented approval of a targeted fishery by the Alaska Board of Fisheries. In November 1998, the Board is scheduled to deliberate on a proposed coho fishery management plan drafted by the YRFDA.

It is speculated that the near future market outlook for coho salmon is not promising. Production of competing fish such as Bristol Bay sockeye and Chilean farmed coho will likely remain at high levels for the foreseeable future. The one bright spot may be a rebound or expansion of the Asian market some time in the future. In years when the fall chum salmon run is low, lower Yukon processors must weigh the overhead costs of operating in the bush longer (labor, utilities, etc.) against the benefits of perhaps processing more coho salmon.

PROJECTS, DATA NEEDS, AND RESTORATION PROJECTS FOR YUKON RIVER SALMON STOCKS

The vast size of the Yukon River drainage, the broad spawner distribution, the mixed stock nature of the fishery and the overlapping migratory timing, all complicate assessment of salmon run abundance and the harvest and escapement within the Yukon River. Effective planning for the long-term future of the salmon resources of the Yukon River includes: 1) identification of those programs which are essential or of high priority and need to be maintained or expanded to ensure management decisions adequately provide for user allocations (established by the Board of Fisheries) and escapement goals (established by ADF&G); 2) identification of data gaps or program deficiencies, which if filled, would improve inseason run timing and/or abundance assessments; and 3) identifying restoration projects or issues of concern which, if addressed, might improve the long-term health (abundance) of Yukon River salmon stocks. Table 16 provides a summary of the life cycles of the economically or numerically important salmon species of the Yukon River and gives a brief look at the complexity of Yukon River salmon management and the associated environmental relationships.

<u>NOTE TO READER</u>: Throughout the remainder of this report, all literature cited within the body of the text will have the full reference provided at the end of each heading section unless the citation is already provided in the Literature Cited section of this report. Some sections of the report may contain references at the end of the section which are not cited in text section, these references are intended to provide additional resource material relating to the section heading.

Conservation Strategies

Strategies for conserving Yukon River salmon have evolved over time and will continue to develop in response to new information. Two areas of any salmon run must be evaluated to obtain a complete picture of run strength; harvest and escapement.

Yukon River salmon harvests are comprised predominantly of commercial and subsistence components, both of which are extremely important to fishermen. The Yukon River commercial fishery is somewhat unique in that the income realized from the commercial fishery assists Yukon River fishing households in their subsistence lifestyle. The commercial fishing harvest is well documented by fish tickets which are generated by buyers and provided as a receipt upon the sale of the harvest, to the fisherman and ADF&G. The current conservation strategy for the subsistence and commercial fishery is to accurately assess run strength as early as possible, determine the harvestable surplus, and provide time and opportunity for fishermen to harvest the surplus. Estimates of the subsistence and personal use harvest are generated from either permits

Table 16. Life cycles of Yukon River drainage salmon.

Lifestage	Activity	Chinook	Summer Chum	Fall Chum	Coho	Pink
Egg	Incubation location	Clean gravel, riffle areas	gravel, lower stream, sloughs	gravel with upwelling water	Small streams; clean gravel	gravel, intertidal, lower streams
Alevin	Hatching (remain in gravel)	Midwinter	Midwinter	Midwinter	Late winter	Midwinter
	Emergence (swim-up)	April-May	April-May	April-May	May-June	April-May
Fry	Rearing location	Stream, river edges	Stream, river edges, nearshore, marine	Stream, river edges, nearshore, marine	Lakes, streams, ponds, sloughs	Nearshore, estuary, marine
	Time in fresh water	1 year	less than six months	less than six months	1-3 years	less than six months
	Food	Aquatic insects	Plankton	Plankton	Aquatic insects	Plankton
Smolt	Migration	May-June	May-June (as fry)	May-June (as fry)	June-July	May-June (as fry)
	Age	1 year	1-6 weeks	1-6 weeks	2 years	1-3 weeks
Ocean rearing and development	Food	Fish/other	Fish/other	Fish/other	Fish/other	Fish/other
	Time in ocean	3-6 years	3-4 years	3-4 years	1 year	1 year
Homing migration	Timing (at Yukon River mouth)	June-July	June-July	July-August	August-October	June-July
	Size	15-70+ lb	5-10 lb	5-15 lb	5-15+ lb	3-6 lb
Spawning	Timing	July-August	July-August	August-October	September-December	July-August
	Age	5-7 years	4-5 years	4-5 years	4 years	2 years
	Location	Streams, rivers	streams, sloughs	upwelling ground water streams	Streams, sloughs	Intertidal; lower streams

or a post-season stratified random sampling program comprised of personal interviews, telephone interviews, and returned harvest calendars.

The second component of run evaluation is the escapement. The Department is in the process of evolving to an escapement based management system. The current management strategy for adequately assessing the escapement is to establish and maintain a minimum of two strong stock status evaluation projects within each of the five sub-basins defined by this report. An exception is sub-basin 2 for which three summer season assessment projects are considered the minimum (2 in Subdistrict 4-A and 1 in Subdistricts 4-B and C).

Yukon River (Alaskan) Drainage Basin (Components Common to all Sub-Basins)

Figure 6 shows the Alaskan portion of the Yukon River drainage and the five sub-basins which are described and discussed in the remainder of this report.

Projects and Programs

ADF&G and YRDFA Teleconferences.
Beginning in the summer of 1993, management teleconferences have been held between ADF&G Yukon Area staff and members of the YRDFA. The primary purpose of these teleconferences is to share both biological information and local knowledge about the progress of the different salmon returns and for the ADF&G to describe and explain its management strategy. Fishermen provide feedback on the ADF&G's strategy as well as report on local commercial and subsistence catch rates. Representatives of the processing industry also participate to provide information on current market conditions, processing and airfreight capabilities and when the optimal time would be for commercial openings. This pooling of knowledge improves the overall management of the fishery. The teleconferences have proven very useful from an ADF&G perspective as they have been a good mechanism to exchange information. They have reduced public confusion over the management strategy and give fishermen a greater appreciation of the complexity of the management task and the need to satisfy the commercial and subsistence needs of both downriver and upriver users. The teleconferences are valuable to the YRDFA because fishermen's knowledge and experience serves as a cross-check on management tools such as test fisheries and the Pilot Station sonar. For example, during teleconferences in August 1994, fishermen's reports of good fall chum salmon catch rates helped persuade ADF&G staff to double-check the low fish counts reported by the Pilot Station sonar and resulted in the discovery that the sonar was seriously undercounting the return.

Commercial Fishery Catch-per-unit-effort Information.
Catch-per-unit-effort (CPUE) is a statistic used to evaluate fishery performance. CPUE is computed by dividing the catch in a fishery by a measure of the effort used to obtain the catch. Effort is a standardized measure that reflects the fishing power or efficiency of the fleet. In other words, CPUE attempts to express the size of harvests as a function of the effort used to obtain the catch. In theory, if effort accurately reflects the efficiency of the fleet, changes in CPUE should

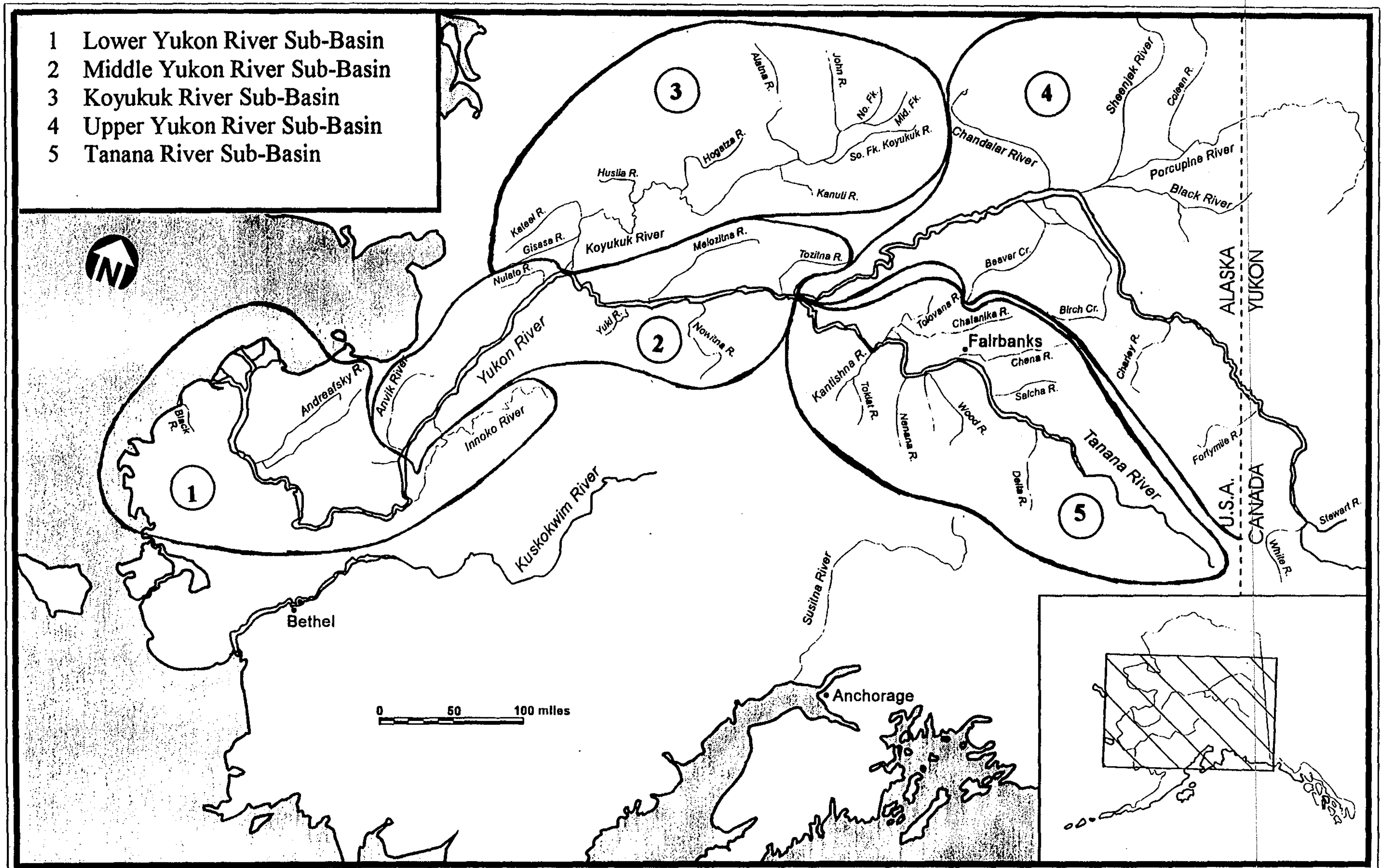


Figure 6. Five Yukon River sub-basins which make up the Alaskan portion of the Yukon River drainage basin.

reflect changes in abundance. However, effort may not always accurately reflect the fishing efficiency of the fleet because of changes in environmental conditions and characteristics of the fishery (see the Catch-per-unit-effort section within the Fish Management and Research Methods section).

Within the Yukon River, catch is usually expressed in numbers of fish. Effort is usually taken to be the number of fishermen participating in a fishing period multiplied by the length of the period in hours. As a result, CPUE within the Yukon River usually reflects the average number of fish caught per fisherman per hour. Managers compare CPUE statistics between periods within a year and between years in an attempt to make judgements about the size and timing of a run. This information factors into assessment of management strategies in-season to provide for adequate escapements while harvesting the available surplus. CPUE is the run strength indicator available to managers from the ADF&G's test fisheries, commercial fishing periods, and in-season subsistence reports.

Inseason Subsistence Harvests Reports.

Since subsistence fishermen typically fish in a traditional location, using similar gear, at a similar time of year, their catch-per-unit-effort can be reflective of salmon run strength. Managers usually try to develop a list of subsistence fishermen contacts in each village who are willing to relay their harvest information or identify a village resident who is knowledgeable of others' subsistence harvests. Although this information may be sketchy and incomplete, it can be used in assessing run timing, tracking pulses of fish as they move up the river, or verifying other run indicators.

With the vast size of the drainage, it is very difficult to assess run strength and migration patterns in all the various Subdistricts, let alone all the tributaries. However, with more than 1,400 active subsistence and commercial fishing households spread throughout the drainage, their direct experience and knowledge from being out on the river on a day-to-day basis is valuable in evaluating the timing and strength of salmon runs.

Age, Sex, and Length Data.

Samples of age, sex, and length of Yukon River salmon have been obtained by the department since 1961. Age, sex, and length information contribute primary biological information necessary to manage Yukon River salmon fishery harvests and monitor the status of spawning stocks and is used for: 1) examining drainage or tributary productivity; 2) salmon growth analysis; 3) catch apportionment based on age composition and/or scale pattern analysis (SPA); 4) in-season run strength estimation; 5) developing run strength outlooks; 6) setting escapement goals; and 7) to gain a better understanding of salmon stock biology.

From 1961 through 1968, the Yukon River salmon age, sex, and length information was reported in the ADF&G Arctic-Yukon-Kuskokwim Area Annual Management Reports. From 1969 to 1981, the Yukon River salmon age, sex, and length data was reported in the ADF&G Arctic-

Yukon-Kuskokwim Region Age, Sex, and Size Composition of Salmon Report Series. Since 1982 the age, sex, and length information has been reported in annual department reports entitled, Age, Sex, and Length of Yukon River Salmon Catches and Escapements. The literature cited section of Menard, 1996 contains a complete listing for the 1982 to 1993 reports.

Reference:
Menard, J. 1996. Age, Sex, and Length of Yukon River Salmon Catches and Escapements, 1994. Regional Information Report No. 3A96-16. Alaska Department of Fish and Game, Division of Commercial Fish, Anchorage Alaska.

Aerial Surveys.
Accurate salmon escapement counts on Yukon River tributaries are important for regulating fishery harvests, evaluating escapement objectives, evaluating the effectiveness of management programs, and providing information for use in projecting subsequent returns. However, because of the vast size of the Yukon River drainage enumerating escapements to more than a few tributaries is limited by fiscal resources. Consequently, escapements have been more commonly indexed by low-level aerial surveys from single-engine, fixed-wing aircraft. Aerial surveys were initiated in 1960 for assessing salmon spawning distribution and relative magnitude. The primary objective is to provide an index of escapement abundance which could be compared between years and among tributaries to obtain a qualitative assessment of the magnitude of the escapement in any given year. These surveys are subject to counting errors and year-to-year variability associated with weather, stream conditions, timing of the survey relative to spawning stage, and observer/pilot subjectivity and experience. Although aerial escapement information is not useful for direct in-season management in most cases, monitoring escapements is the basis for adjusting regulatory and management strategies on a post-season basis. Attempts to standardize the conditions under which these indices are conducted, improves their usefulness.

Because it is cost prohibitive to fly all the tributaries within the drainage, key salmon escapement tributaries thought to be representative of similar streams in that vicinity, were identified as aerial survey index streams. These index streams are identified by survey target dates, salmon species, and stream priority relative to other index streams.

Yukon Area aerial survey techniques are documented in the Yukon Area Escapement Aerial Survey Manual (Barton, ADF&G, unpublished report, March 1987).

References:
Barton, L.H. 1987. Yukon Area Salmon Escapement Aerial Survey Manual. Alaska Department of Fish and Game. Division of Commercial Fisheries. Fairbanks, Alaska. 14p.

Barton, L.H. 1984. A catalog of Yukon River salmon spawning escapement surveys. ADF&G Technical Data Report No. 121. 472pp.

Salmon Stock Identification.

It was recognized as early as 1964 that the department needed to determine some way of identifying salmon stocks to improve fisheries management and also to determine the effects of the proposed Rampart Dam. Even though salmon age information from scales had been documented since 1961, the Department first began using scale growth patterns of chinook salmon in 1980 on an experimental basis to identify the region of origin within the Yukon River. Scale growth patterns of chum salmon were not unique enough to be useful for stock identification information. The U.S. and Canada began negotiations on Yukon River salmon in 1985, and salmon stock of origin information has become increasingly more important as the negotiations have developed.

Analysis of scale patterns, age composition estimates, and geographic distribution of catches is used by ADF&G on an annual basis to estimate the stock composition of chinook salmon in Yukon River commercial fishery harvests. Three region-of-origin groupings of chinook salmon, or runs, have been identified within the Yukon River drainage. The lower and middle run stocks spawn in the Alaska portion of the drainage, and the upper run stock spawns in Canada. Since 1982, the average contribution to the total Alaskan and Canadian harvest by region of origin was similar for the lower and middle run stocks, and over 50% for the upper run stocks. The scale pattern analysis data processing methodology is being improved, and historic data will be reanalyzed using the improved system.

In 1984, a study was initiated by the Canadian Department of Fisheries and Oceans (CDFO) to assess the feasibility of using genetic stock identification (GSI) allozyme markers to identify the region of origin, or stock for chum salmon. In 1987, this research was taken up by the USFWS and expanded to include chinook salmon, with ADF&G providing support for field sampling. In recent years this research has been conducted by both the USFWS and ADF&G and further expanded to include coho salmon.

Because the genetic discrimination among some U.S. and Canada fall chum salmon stocks has not been satisfactory using protein-based genetic information, the United States Geological Survey Biological Resources Division (BRD), USFWS, and ADF&G are testing the use of various molecular genetic markers to discriminate among those stocks; microsatellite regions of nuclear DNA, nuclear DNA introns, and mitochondrial DNA.

Reference:

Wilmont, R.L., R. Everett, W.J. Spearman, R. Baccus. 1992. Genetic Stock identification of Yukon River chum and chinook salmon, 1987 to 1990. Progress Report. U.S. Fish and Wildlife Service, 1011 East Tudor Road, Anchorage, Alaska.

Postseason Yukon River Subsistence Survey and Permits.

Estimates of subsistence salmon harvests in the Alaska portion of the Yukon River drainage have been documented by ADF&G since 1961. The majority of households in the Yukon River drainage reside in villages in which there are no regulatory requirements for the reporting of subsistence salmon harvests. Successful management of the Yukon River fishery resources depends upon accurate estimates of subsistence harvests.

Survey methods, harvest reporting, and data expansion formulas have varied. The usual survey methods of household interviews, catch calendars, and mail-out questionnaires have been used annually but to varying degrees, depending upon funding. Surveys prior to 1988 typically targeted the fishing families or used a village census approach. In 1988, a new approach was implemented which created a complete list of village households and stratified them by "usually fished" or "do not usually fish." This stratified random sample was further refined in 1990 by classifying households into one of five categories based upon their historic level of reported subsistence catches. Assuming that households tend to harvest the same number of fish in the current year as they have historically, this stratification system allows the households with the heaviest use of the resource to be sampled more intensively. This produced a reduction in the variance of the estimates in comparison to past surveys.

In areas where subsistence salmon fishing permits are required, the department depends on the returned permits and reported harvest for subsistence or personal use fish harvest information. Subsistence fishing permits have been required in three sections of the Upper Yukon Area since the early 1970s: (1) the Yukon River near the Yukon River bridge between Hess Creek and the Dall River; (2) the upper portion of District 5 between the upstream mouth of Twenty-Two Mile Slough and the U.S./Canada border; and (3) the Tanana River near Fairbanks. Beginning in 1988, subsistence (or personal use) permits have been required for the entire Tanana River drainage.

A comprehensive list of subsistence references is listed in the literature cited section of Borba and Hamner, 1998.

Reference:

Borba, B. M. and H. H. Hamner. 1998. Subsistence and Personal Use Salmon Harvest Estimates, Yukon Area, 1997. Regional Information Report 3A98-23. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Anchorage.

Alaska 4-H Fisheries, Natural Resource and Youth Development Program.

This program started in 1991 in ten Yukon River villages. The purpose is to provide hands-on science, math, and statistical skills to village students. The program has primarily focused on learning opportunities associated with incubating salmon eggs in special classroom incubator aquariums. Salmon eggs have been collected either during field trips or received from a hatchery. School teachers participating in this program have annually been offered the opportunity to participate in a teacher training session which provides teachers with necessary training in aquarium maintenance and related educational materials. Suggestions for teaching math, statistical methods, and chemistry through fish counts, survival calculations, temperature monitoring, and water quality testing are provided.

The program has survived and expanded through partnerships with school districts, local communities, agencies, and corporate or independent businesses. Nearly 25 schools in the Yukon River drainage are currently participating in this program along with over 50 schools statewide. All the schools recently became linked by computer internet. Not only are students exposed to fish biology, genetics, management and aquaculture concepts, but they also learn about watershed management, aquatic ecology, and resource allocation issues. Additionally, the program helps to train youth for summer employment at the Kaltag Creek salmon counting tower funded by BSFA and run by the Kaltag City office.

Data and Project Needs

Salmon Stock Identification.

Fisheries managers have been searching for an inexpensive, timely, and accurate method for identifying stocks harvested in mixed stock fisheries. Currently, both scale pattern analysis and genetic stock identification are post-season assessments of geographical fish groupings, and costs vary from moderate to high based on the method and level of coverage intended by the sampling program. Development of an inexpensive, accurate, inseason method of identifying stocks could improve management of weak stocks in mixed stock fisheries.

Basic Salmon Life History Information.

Because of the vast size of the Yukon River drainage, the remote spawning locations, environmental challenges, and higher priorities, basic salmon life history information for Yukon River salmon stocks has not been well documented. This basic research could improve salmon management decisions for Yukon River salmon stocks because much, if not all, quantitative salmon escapement information is interpreted based on understanding basic salmon life history.

Environmental Influences.

It is fairly easy to observe, and in some cases document, abnormal environmental conditions, but the actual detrimental effects on salmon stocks can only be postulated since quantitative measurements are extremely difficult to obtain. Events like; 1) the "Omega block" winter of 1988-89, which had below normal cold temperatures, 2) the Koyukuk River flood during August of 1994, 3) the low snow cover and cold temperatures during the winter of 1995/1996, 4) the low tributary water flows during the summer of 1997 and, 5) shifting of ocean water temperatures commonly known as El Nino, are all suspected of having detrimental impacts on salmon stocks. However, no quantitative assessments can be made since adult escapement estimates are currently the only time in the fishes life the department is able to obtain a quantitative measurement. Extrapolating escapement for the next generation based on an estimate of parent year numbers is difficult because of all the potential causes of mortality encountered between the time eggs are laid and the subsequent return as adult salmon.

Reconnaissance of Small Tributaries Throughout the Basin.

Due to the vast size and remoteness of the Yukon River drainage, the department has historically primarily assessed salmon stocks on the basis of aerial survey index tributaries thought to be representative of the salmon escapements within a geographic area. A large number of streams too small to aerial survey support salmon spawning, and in aggregate, are thought to represent an important component of the chinook, chum and coho salmon production. Documenting use in these smaller tributaries by both juvenile and adult salmon is extremely important for protecting these habitats for future salmon use and assessing their contribution to overall salmon production.

Restoration Projects or Issues of Concern

Water Quality (Pollution).

There is a growing awareness and concern for the impact decreasing water quality, specifically pollution, could have on Yukon River salmon stocks. Sources of pollution that Regional Planning Team members identified included waste water, village garbage dumps, and petroleum spills or leakage. Turbidity and excessive sediment in the discharge from mining operations degrades water quality and spawning habitat. Additionally, fuel spills, other hazardous materials, and sewage problems associated with mining can contribute to poor water quality. Members felt that proactive actions should be taken to prevent human waste water from entering the river, protecting and relocating garbage dumps so that high river water does not flood garbage areas, and educating people on the lethal effects of fuel spills and methods of prevention and containment. It was suggested that the RPT investigate obtaining water rights for important spawning streams in order to make progress in "maintaining and preserving the health and integrity of salmonid spawning grounds, rearing areas, and migration corridors".

On a regional basis, RPT members noted that the aging trans-Alaska oil pipeline which crosses both the main stem Yukon and Tanana rivers as well as numerous salmon spawning tributaries, and river barges which annually carry millions of gallons of fuel to river communities, represent a significant pollution threat within the Yukon drainage.

In a more global perspective, although not specifically discussed by the RPT, environmental contaminants associated with aquatic ecosystems and consequently their potential effect on salmon and bioaccumulation in people and other animals who consume salmon is starting to become more of a concern. The following information is intended to inform and encourage dialogue which will hopefully set direction for needed monitoring and research. These concerns are not limited to Yukon River salmon, but represent a set of emerging environmental questions that may effect the entire human food chain.

The global distribution of environmental contaminants including heavy metals and industrial, herbicide and pesticide residues is a growing concern among scientists, regulatory agencies, industry and the general public. Although there is much debate and many unanswered questions about the mechanisms by which these substances contaminate animal and human populations and their effect, there is sufficient information and concern to cause regulatory agencies to expand research and monitoring of these potentially toxic substances in air, water and food sources. The potential for contamination through food sources and bioaccumulation through wild and domestic food chains has raised particular concern for foods with a high lipid content including eggs, meats, dairy and fish. Federal and state agencies are increasing monitoring efforts associated with sources of these foods and the number of regulatory actions and consumer warnings have also increased (U.S. Dept. of Health and Human Service 1993).

Very limited monitoring of these environmental contaminants in food sources has been conducted in Alaska. In a recently published survey of available information prepared by Department of Health and Social Services (Egeland et al. 1998) uses of traditional foods (fish, wildlife and indigenous plants) in a healthful diet and the risk of contamination from these sources was evaluated. The primary conclusions this assessment provided were that wild foods traditionally used in Alaskan diets are very nutritious and healthy and that based on information currently available, people should continue to eat them. However, the report also stressed that limited and very incomplete monitoring of environmental contaminants is available for wild foods in Alaska. Based on limited assessments in Alaska and other high latitude areas, some level of environmental food contamination could exist due to natural processes, toxic waste sites and atmospheric transport and subsequent bioaccumulation of contaminants into Alaskan wild food products. More research and monitoring of levels of contamination and their effects on human health were recommended.

Some contaminants, such as mercury and organochlorines, are found in low levels in air and water but build up to higher concentrations in aquatic food chains. These contaminants accumulate in certain tissues or organs of fish and affect the health of the fish or of people or other animals who eat the fish. Mercury and other metals are stored by special proteins in fish that can build up to high levels in muscle or liver tissue. Organochlorines are stored in fish fat. Experiments have shown that contaminants even at very low concentrations stored in fish tissues can affect reproduction, growth or resistance to disease. These effects are often difficult to detect in wild fish populations because so many other factors influence their health. Long-lived freshwater fish (e.g. pike, whitefish) are more likely to concentrate such low level contaminants.

A recent study by Ewald et al. (1998) of two interior Alaskan lake systems in the Copper River drainage found surprising high levels of PCB and DDT in salmon tissues. The authors proposed that migrating salmon populations provided a biotransport mechanism for moving and concentrating these contaminants in fresh water lake food chains. Arctic grayling feeding on salmon eggs and carcasses accumulated organochlorine residues at levels many times higher than in grayling in an adjacent lake which did not support a salmon run. Levels of contaminants increased in salmon tissue samples with maturity of the fish. PCB levels as high as nine parts per million (ppm) and DDT as high as 5.5 ppm were observed in salmon tissue.

References:
Ewald, G., Larsson, P., Linge, H., Okla, L., and Szarzi, N. 1998. Biotransport of organic pollutants to an inland Alaska lake by migrating sockeye salmon (Oncorhynchus nerka). Arctic 51(1): 40-47.

Egeland, G., Feyk, L. and Middaugh, J. 1998. The use of traditional foods in a healthy diet in Alaska: risks in perspective. Bulletin. Alaska Division of Public Health, Department of Health and Social Services.

U.S. Dept. of Health and Human Service. 1993. Proceedings of the expert panel workshop to evaluate the public health implications for the treatment and disposal of polychlorinated biphenyls contaminated waste.

Marine Interceptions.

Salmon from North America and Asia migrate into the North Pacific Ocean as juveniles and return as adults to their natal streams to spawn. Salmon form groups of numerous stocks and species during their ocean residency and freshwater migrations. Identification of composite stocks in mixtures of salmon caught in international waters, the U.S. Exclusive Economic Zone, and in the major river systems leading to spawning tributaries has been an ongoing challenge for fisheries biologists and management agencies throughout the Pacific Rim. Evidence from tagging studies and scale pattern analysis indicate Yukon River salmon spread throughout the Bering Sea, south of the Aleutian Island chain into the Gulf of Alaska and North Pacific Ocean (Groot and Margolis, 1991).

While in the ocean, some of these salmon are caught by marine commercial fisheries. Until 1992, five large commercial fisheries in the ocean caught large numbers of salmon, some of which were likely Yukon River Salmon (JTC, 1993). However, under international agreements, those fisheries no longer operate. They were (in order of decreasing salmon harvest): 1) the Japanese high-seas mothership and land-based salmon gill net fisheries; 2) the high-seas squid gill net fisheries in the North Pacific Ocean of Japan, the Republic of Korea, and the Republic of China (Taiwan); 3) the foreign groundfish fisheries of the Bering Sea and Gulf of Alaska; 4) the joint-venture groundfish fisheries of the Bering Sea and the Gulf of Alaska; and 5) the groundfish trawl fishery by many nations in the international waters of the Bering Sea (the "Doughnut Hole").

Other marine commercial fisheries which operate in the Bering Sea and Gulf of Alaska where Yukon River salmon occur, but which catch few, if any salmon include: 1) the U.S. longline fisheries for Pacific halibut, Pacific cod, and other groundfish; 2) the U.S. pot fisheries for Pacific cod and other groundfish, and Dungeness, king, and Tanner crab; and 3) the U.S. purse seine and gillnet fisheries for Pacific herring (JTC, 1993). Currently, marine commercial fisheries with a salmon bycatch which includes Yukon River salmon include: 1) the purse seine and gill net salmon fishery in the South Alaska Peninsula; and 2) the U.S. groundfish trawl fisheries in the Bering Sea-Aleutian Islands Area and in the Gulf of Alaska.

Numerous tagging studies (Gilbert and Rich, 1925; Aro et al., 1971; Aro, 1972; Myers, 1983; and Eggers et al., 1991) have shown that Western Alaska chum salmon are present in the June sockeye fisheries in the South Alaska Peninsula (South Unimak Island and Shumagin Islands, known as Area M). Chum salmon catches in the Area M fishery increased in the 1980s coincidental to the increasing importance of chum salmon to the developing AYK chum salmon fisheries, causing considerable controversy between Western Alaska and Area M fishermen. This controversy was exacerbated by the low returns of chum salmon to Western Alaskan spawning streams in the early 1990's. Unfortunately, potential impacts of the Area M fishery on specific

Western Alaskan chum salmon spawning populations cannot adequately be determined because of the lack of geographic-specific stock composition data on incidentally harvested chum salmon.

Typically, mixed stock tagging studies are unable to apply sufficient tag numbers for estimating individual stock composition or fishery contribution. However, when used in conjunction with run timing data they can lend support for the presence/absence and relative vulnerability conclusions. In the 1987 Area M tagging study (Eggers et al., 1991) it appeared Kuskokwim River, Bristol Bay, and (based on less information) Norton Sound, summer chum salmon stocks are vulnerable to interception in the Area M June commercial sockeye fishery. Most Yukon River summer chum salmon stocks (with the exception of lower river stocks such as the Andreafsky and Anvik River) probably pass through Area M in late May and early June. The Department initiated a genetic stock identification program to gain a better understanding of the stock harvest composition of the Area M fishery (Seeb et al., 1995). Genetic stock identification studies provide a much more accurate picture of stock composition although stocks from different streams must often be pooled together due to their genetic similarity. GSI analysis of the chum salmon bycatch from the 1993 to 1996 June Area M commercial fishery showed remarkable consistency from year to year in stock composition. The Northwest Alaska summer region grouping was predominate and was estimated to annually contribute from 38% to 60% in the Shumigan Islands and South Unimak fisheries combined (Seeb et al, 1997). The Northwest Alaska summer region stock grouping consisted of chum salmon from Kotzebue Sound, Norton Sound, Yukon River summer, Kuskokwim River, Bristol Bay, and North Alaska Peninsula. The Yukon River fall chum salmon stock complex comprised a small component or were absent in the chum salmon catch samples collected from the Area M June fishery.

Yukon River fall chum salmon stocks could be vulnerable to the Area M fisheries conducted under the "Post-June Salmon Management Plan," based on assumptions about ocean migration routes and plausible travel times. The Department has collected tissue samples from chum salmon caught in Area M during July for the 1996 and 1997 seasons to test this hypothesis. Although unanalyzed at present, these samples will provide the first genetic estimates of chum salmon harvest stock composition within the Post-June fishery, including the Yukon River fall chum salmon contribution (Lisa Seeb, ADF&G, Anchorage, personal communication). A report on this work is scheduled for release during the winter of 1998-1999.

Another longstanding concern has been the interception of Western Alaskan juvenile chinook and chum salmon stocks in the Bering Sea and Aleutian Islands trawl fisheries. These stocks are taken as bycatch in bottom-trawl and midwater-trawl fisheries primarily targeting pollock and cod. Scale-pattern analysis of chinook salmon bycatch during the 1979, 1981 and 1982 trawl fisheries identified that Western Alaska stocks (Bristol Bay, Kuskokwim, and Yukon) consistently comprised about 60% of the total bycatch (Myers and Rogers, 1988). Three other regional groupings (Central Alaska, Southeast Alaska/British Columbia, and Asia) comprised the remaining 40%. About 17% of the samples on average during each of the three years could reasonably be assigned as Yukon River origin chinook salmon.

Current estimates of salmon bycatch are calculated by the National Marine Fisheries Service (NMFS) through partial-haul and whole-haul sampling conducted on board factory trawlers and on motherships and shore plants receiving deliveries from smaller trawlers called catcher boats. There is considerable debate between NMFS and the trawl industry over the accuracy of these estimates. Minimally, however, it must be noted that the number of actual observed bycaught chinook salmon is at least 31% to 44% of the total final estimated catch. Since 1994 regulations have prohibited the discard of salmon taken as bycatch in the Bering Sea & Aleutian Islands groundfish trawl fisheries until the number of salmon has been certified by a NMFS certified observer. Estimates of salmon bycatch in the Bering Sea & Aleutian Island trawl fisheries for the period, 1989-1994 are reported in NPFMC, 1994 and for 1995-1997 are on the NOAA web page. The estimates (which are subject to change as updates are made) are as follows:

Year	Chinook Salmon	Other Salmon
1989	40,354	5,545
1990	13,990	16,661
1991	35,766	31,987
1992	37,372	38,919
1993	45,964	243,246
1994	43,636	94,508
1995	23,079	21,780
1996	63,179	77,926
1997	50,218	67,536
Average	39,284	66,456

(Note: More than 95% of the "other salmon" are chum salmon.)

Most chinook salmon bycatch occurs in the pollock "A" season fishery from mid-January to mid-April, although high bycatch can also occur if pollock fishing during the "B" season which starts September 1st extends into October or November. Unfortunately, no new information has been collected concerning the river of origin or even the continent of origin of these chinook salmon since the early 1980s research identified above.

Yukon River chinook stocks are definitely still known to be present in the bycatch because of the recovery of four coded-wire-tagged juvenile salmon that were reared and tagged at the Whitehorse hatchery (Dalberg et. al. 1993, Dalberg et al. 1995, and Dalberg et al. 1996). Release and recovery information for these four juvenile chinook salmon are as follows:

Brood Year	Release Date	Recovery Date	Latitude	Longitude	Length (inches)	Weight (lbs.)
1988	6/89	3/25/92	56.44N	173.15W	24.41	6.34
1990	6/91	3/14/94	60.06N	178.58W	27.05	N/A
1991	6/92	2/24/95	55.19N	164.43W	N/A	3.94
1992	6/93	12/6/94	56.52W	171.18W	15.75	2.19

Three of these fish were females with the exception of the 12/6/94 recovery.

Predictably, these recoveries were along the 200-meter depth contour line of the outer continental shelf and just north of Unimak Island. These areas are where many fish species concentrate including pollock, cod and juvenile salmon due to the abundance of various prey species brought in by ocean currents.

Chum salmon bycatch occurs primarily in the pollock "B" season fishery from late August into November. More recent and exact information is available on the origin of this chum salmon bycatch from genetic stock identification studies conducted on the 1994, 1995 and 1996 bycatch. This research was funded in part through donations by Unisea, which owns large shoreside processing operations at Dutch Harbor, and by United Catcher Boats, a trade group representing many vessels that participate in the pollock "B" season fishery.

Preliminary analysis of 457 samples collected (out of a total bycatch of close to 90,000) during the 1994 B season fishery (Wilmot et al., 1995) indicated a composition of approximately 22 percent Western Alaska summer chum run stocks (Kotzebue, Norton Sound, Yukon River, Bristol Bay) and approximately 4 percent Yukon River fall chum. However, sampling procedures in 1994 were not designed to obtain representative collections of the commercial fishery bycatch and thus the results may not accurately reflect the true stock contributions to the total bycatch.

In 1995 not only were samples collected proportional to the total bycatch but the total number of samples collected compared to the total bycatch was excellent for accurate estimates of bycatch by stock region. 1,853 samples were collected out of a total pollock "B" season bycatch of 17,039 (Wilmot et al., 1996). Analysis of the 1995 samples indicated a composition of 31 percent Western Alaska summer chum run stocks (Kotzebue, Norton Sound, Yukon River, Bristol Bay) and 8 percent Yukon River fall chum salmon. Results from the analysis of samples collected in the 1996 fishery are expected to be published in 1998.

References:

Aro, K.V. 1972. Recoveries of salmon tagged offshore in the North Pacific Ocean by Japan and the United States in 1970 and 1971, and additional recoveries from earlier taggings by Canada, Japan, and the United States. Fisheries Research Board of Canada, Manuscript Report 1186.

Aro, K.V., J.A. Thomson and D.P. Giovando. 1971. Recoveries of salmon tagged offshore in the North Pacific Ocean by Japan and the United States, 1956-1969. Fisheries Research Board of Canada, Manuscript Report 1147.

Dahlberg, M., S. Fowler, N. Maloney and R. Heintz. 1992 Incidence of coded-wire tagged salmonids in commercial and research catches in the North Pacific Ocean and Bering Sea, 1991-1992. (International North Pacific Fisheries Commission Document) Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626. 12 pp.

Dahlberg, M., S. Fowler, N. Maloney and R. Heintz. 1993. Incidence of coded-wire tagged salmonids in commercial and research catches in the North Pacific Ocean and Bering Sea, 1992-

1993. (NPAFC Doc.34) Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626. 15 pp.

Dahlberg, M., S. Fowler, N. Maloney and R. Heintz. 1994. Incidence of coded-wire tagged salmonids in commercial and research catches in the North Pacific Ocean and Bering Sea, 1993-1994. (NPAFC Doc.) Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626. 16 pp.

Dahlberg, M., S. Fowler, N. Maloney and R. Heintz. 1995. Incidence of coded-wire tagged salmonids in commercial and research catches in the North Pacific Ocean and Bering Sea, 1994-1995. (NPAFC Doc.153) Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626. 14 pp.

Dahlberg, M., S. Fowler, N. Maloney and R. Heintz. 1996. Incidence of coded-wire tagged salmonids in commercial and research catches in the North Pacific Ocean and Bering Sea, 1993-1994. (NPAFC Doc.220) Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626. 11 pp.

Eggers, D.M. 1992. South Peninsula tagging study (Review and Revisions). Report to the Alaska Board of Fisheries, March 3, 1992. Alaska Department of Fish & Game, Division of Commercial Fisheries, Juneau, AK.

Eggers, D.M., K. Rowell and B. Barrett. 1991. Stock composition of sockeye and chum salmon catches in southern Alaska Peninsula fisheries in June. Fishery Research Bulletin No. 91-01, Division of Commercial Fisheries, Juneau, AK.

Gilbert, C.H. and W.H. Rich. 1925. Second tagging experiment in tagging salmon in the Alaska Peninsula Fisheries Reservation, summer of 1923. U.S. Bureau of Fisheries, Fisheries Bulletin 42:27-75.

Groot, C. and L. Margolis (Editors). 1991. Pacific Salmon Life Histories. University of British Columbia Press, Vancouver, B.C.

Myers, K.W. 1983. Recoveries of salmon tagged offshore in the North Pacific Ocean by Japan and the United States in 1980, 1981, 1982, and additional recoveries from earlier taggings by Canada, Japan, and the United States. Fisheries Research Institute, University of Washington, Seattle, FRI Circular 83-1.

Myers, K.W. and D.E. Rogers. 1988. Stock origins of chinook salmon in incidental catches by groundfish fisheries in the eastern Bering Sea. North American Journal of Fisheries Management Vol. 8: 162-171.

NOAA web site: http://www.fakr.noaa.gov

NPFMC (North Pacific Fishery Management Council). 1994. Environmental Assessment/Regulatory Impact Review for Amendment 21b to the Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands.

Seeb, L.W., P.A. Crane and R.B.Gates. 1995. Progress report of genetic studies of Pacific Rim chum salmon and preliminary analysis of the 1993 and 1994 South Unimak June Fisheries. Regional Information Report No. 5J95-07, Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Anchorage, Alaska.

Seeb, L.W., P.A. Crane and E.B. Debevec. 1997. Genetic analysis of chum salmon harvested in the South Unimak and Shumagin Islands June fisheries, 1993-1996. Regional Information Report No.5J97-17, Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Anchorage, Alaska.

Wilmot, R.L., C.M. Kondzela, C.M. Guthrie and M.S. Masuda. 1995. Preliminary results on the origin of chum salmon harvested incidentally in the 1994 Bering Sea trawl fishery determined by genetic stock identification. (North Pacific Anadramous Fish Commission Doc. 132) 22 pp. Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801 U.S.A.

Wilmot, R.L., C.M. Kondzela, C.M. Guthrie and M.S. Masuda. 1996. Genetic stock identification of chum salmon harvested incidentally in the 1994 and 1995 Bering Sea trawl fishery. (North Pacific Anadramous Fish Commission Doc. 244) 22 pp. Auke Bay Laboratory, Alaska Fisheries Science Center, National Marine Fisheries Service, NOAA, 11305 Glacier Highway, Juneau, AK 99801-8626 U.S.A.

Yukon River Joint Technical Committee, Subcommittee on Stock Identification. 1997. Review of Stock Identification Studies on the Yukon River. November, 1997.

Feeding of Salmon to Dog Teams.

In Alaska, the history of dog team use and of feeding fish to dogs can be traced beyond the contact period 150 years ago. Ethnographic and historic accounts for the 100-year period from 1850 to 1950 show that dogs were traditionally used to support a variety of activities including trapping, exploration, commercial freighting, individual and family transportation, racing, and even military applications. Throughout this period, fish, primarily dried salmon, was the standard diet for working dogs and became a commodity of trade and currency along the Yukon River and elsewhere (Andersen, 1992).

Dog teams are maintained today in most Yukon River drainage communities, even with the dominant use of snow machines for transportation, to support activities such as general transportation, trapping, wood and water hauling, and racing. In recent years, estimates of dog populations in 32 rural Yukon River Drainage villages has averaged about 5,000 dogs. Regional differences between the lower and upper Yukon Areas are noted by the size of teams, how dogs are used, and kinds of fish fed to dogs. Lower Yukon Area kennels typically averaged 11 dogs, approximately 14 percent of the teams are used for trapping, and non-salmon fish species numerically comprise most of the fish fed to dogs. Upper Yukon Area kennels typically average 17 dogs, approximately 52 percent of the teams are used for trapping, and salmon is the most common fish fed to dogs.

When salmon resources are abundant, most people do not voice opposition to the accepted subsistence use of feeding salmon to dogs. During those years in which salmon supplies provide for only a limited commercial fishery or are inadequate for all subsistence uses, people have voiced opposition to the feeding of salmon to dogs, saying that human subsistence needs should be met before salmon are fed to dogs. The Alaska Board of Fisheries addressed this issue in March 1991, as result of a petition submitted in late 1990, and declined to place any restrictions on subsistence uses of salmon.

Reference:
Andersen, D. B. 1992. The use of dog teams and the use of subsistence-caught fish for feeding sled dogs in the Yukon River drainage, Alaska. Alaska Department of Fish and Game, Division of Subsistence. Technical Paper No. 210. Juneau.

Illegal Activities.
Although it is recognized that there is generally good compliance with most commercial and subsistence regulations and fishermen realize the impact illegal activities can have on future salmon stocks, there are still individuals who disregard regulations. Violations dealing with the sale of subsistence-caught salmon and salmon roe are difficult to prosecute since the line defining "limited amounts of cash", as allowed by the subsistence regulations, is not an exact dollar amount and is subject to interpretation. In addition, possible wastage of commercially caught salmon flesh in those areas where markets only exist for the roe continues to be a concern. Three significant prosecutions which have occurred in recent times were: the 1987 sale of illegal harvest of significant numbers of fall chum and coho salmon taken from Districts 5 and 6 during commercial fishing closures; the 1992 prosecution of Mr. L. George Schenk for unlawfully purchasing salmon on the Lower Yukon River in 1991 and 1992; and the 1995 prosecution of Mr. George Attla for the interstate sale and transport of illegally taken fall chum salmon roe in 1990 from District 5. Although illegal activities along the Yukon River have occurred in the past, and may in the future, it is hoped that a visible management presence, regular enforcement, and fishermen education will deter fishermen from hurting other shareholders and the resource. The Alaska Department of Public Safety has Fish and Wildlife Protection officers in Fairbanks, Bethel, Aniak, McGrath and Nome, and at times all of these officers and more from other areas of the state are present for short periods during the salmon fishing season on the Yukon River.

Non-Local Use.
RPT members identified two areas in which harvests by non-local users was perceived as impacting the harvest of the local residents. These two areas are 1) the Dall River in the upper Yukon River sub-basin, and 2) the Koyukuk River in the Koyukuk River sub-basin. The Dall River issue is the sport harvest of pike by non-local persons (Burr and James, 1996) and to a

lesser degree big game hunting (black bear and moose). The Koyukuk River issue was the increased fall use of moose and bear by groups of hunters floating the Koyukuk River. Although the voiced concerns are not explicit salmon issues, the underlying principle is at the heart of many salmon disputes. Local residents feel disadvantaged by having to compete with other people for finite salmon resources.

Reference:
Burr, J.M. and D. James. 1996. Dall River Cooperative Research Project, 1995. Alaska Department of Fish and Game, Division of Sport Fish. Fishery Data Series No. 96-34.

International Issues (U.S./Canada).
Negotiations were initiated in 1985 between the U.S. and Canada regarding a Yukon River salmon treaty. The purpose of these negotiations is to develop coordinated conservation and management between the U.S. and Canada for the salmon stocks that spawn in the Canadian portion of the Yukon River drainage.

In the mid-1990s, the realization was that, while reaching a comprehensive long term agreement remained a formidable challenge given some of the key unresolved issues, there would be benefits that could be realized by more formally implementing the areas of agreement to date. In February 1995, an interim Yukon River Salmon Agreement (Agreement) went into effect through an exchange of diplomatic notes. A U.S./Canada Yukon River Panel (Panel) was formed to implement the Agreement. The Panel consists of six United States members and six Canadian members. The Panel also administers a Yukon River Salmon Restoration and Enhancement Fund (Fund). Both sides have to agree on an item before an action can be taken by the Panel. The U.S. side of the Panel consists of four Alaskan Yukon River drainage fishers, one Alaska state government official, and one U.S. federal government official. Each Panel member on the U.S. side has an alternate. An advisory group of Alaska Yukon River drainage fishers providing input to the U.S. side. A Joint Technical Committee (JTC) provides technical support to the Panel. The focus of the Panel is on salmon stocks that spawn in the Canadian portion of the Yukon River drainage. The Panel makes recommendations to management agencies in Alaska and Canada.

The Agreement was put in place through 1997, with an option to extend if both sides concur. There are a number of issues that remain to be resolved, and negotiations resumed in October 1997, followed by another session in March, 1998. The goal of the negotiations will be to reach a long-term agreement on the remaining issues and to incorporate the relevant elements of the Agreement. The interim Agreement was extended through March 1998. However, at the time of this writing, further extension of the interim Agreement had been declined by Canada.

The Panel held its inaugural meeting in Whitehorse, Yukon Territory, in April 1996. The Panel addressed the work of jointly improving salmon stocks of common concern on the Yukon River. The Panel agreed to the first six years of a rebuilding plan for Canadian mainstem chinook salmon stocks. Recognizing the desirability of rebuilding stocks, the Panel agreed to an interim, minimum spawning escapement objective for Canadian mainstem Yukon River chinook salmon of 28,000 fish for six years beginning in 1996. The U.S. contribution to this effort is to endeavor to deliver 44,800 to 47,800 chinook salmon to the Canadian mainstem Yukon River. The

Canadian contribution to this effort is to endeavor to manage the harvest of chinook salmon in the mainstem Yukon River drainage in Canada by all user groups combined within a guideline harvest range of 16,800 to 19,800 chinook salmon. The long term goal of the rebuilding program is to achieve escapements of 33,000 to 43,000 chinook in the mainstem Yukon River in Canada.

During the negotiation process, a 12-year rebuilding plan was agreed upon for Canadian Yukon River mainstem fall chum salmon beginning with the 1990 season. The objective of this plan is to rebuild the stock by achieving a spawning escapement of 80,000 or more fall chum salmon for all brood years in the cycle by the year 2001. The U.S. contribution to this effort is to endeavor to deliver to the Canadian border on the mainstem Yukon River an agreed to number of fall chum salmon, which varies by year based upon the rebuilding schedule. The Canadian contribution to this effort is to endeavor to manage the harvest of fall chum salmon in the mainstem Yukon River drainage in Canada by all user groups combined within a guideline harvest range of 23,600 to 32,600 fall chum salmon.

Given the prospect of a poor 1997 fall chum salmon return, the Panel began discussions on how to deal with this challenge at its November 1996 meeting in Anchorage. At the March 1997 meeting in Whitehorse, the Panel agreed to a rebuilding step spawning escapement goal of 55,000 fall chum salmon for the Canadian mainstem Yukon River for 1997. This goal was met with a total escapement of 85,635 in 1997.

A key component of the Agreement is administration of the Fund by the Panel to address the restoration and enhancement of Canadian origin salmon stocks. The U.S. contributes $400,000 per year into the Fund. The Panel administers a call for proposals and a review and decision-making process. In April 1996, the Panel funded several initial projects with $140,000 "seed-money". In March 1997, the Panel agreed to fund 17 projects with a total cost of $480,000. A call for proposals for 1998 projects resulted in 37 proposal applications. The Panel agreed to fund 29 proposals for the 1998 field season at a total cost of $677,200 at the March 1998 meeting in Teslin, Canada.

Salmon Markets.

A basic knowledge of the relationship between demand and supply is essential to understanding what drives short term and long term prices of Yukon River salmon products in domestic and international markets. It is also critical to understanding why reliable econometric models of chum markets do not exist at this time, and why it is so difficult to test any theory that attempts to explain what has caused prices to have gone up or down. Most of the variables that determine market prices are of two major types. Variables can either shift demand inward or outward or move it to a new point along a demand curve. Some of the major variables that impact market prices are: production or output, financial factors, product quality, food preferences, and prices of substitutes.

It is commonly thought that production or output changes demand for a product—it does not. Production of a given product (such as tons of frozen chum fillets) does not change the basic demand for that product. Demand is determined by other factors. However, changes in production can lead to a different price paid to fishermen, processors, shippers, brokers and finally to the consumer. The production variable only changes the prices by moving the supply line to a new point along the demand curve, as shown in Figure 7, Diagram A. For example an increase of 10 million pounds of Atlantic salmon fresh fillets imported into U.S. markets resulted in prices falling by 17% from $6./lbs to $5/lbs. The supply line is shown to move to the right reducing the price. In this example the demand for Atlantic salmon fillets remains constant.

Many factors impact the overall demand for salmon products by shifting demand inward or outward on the graph. Two of the most important financial variables capable of shifting demand are interest rates and exchange rates. A good example of a financial variable that causes a shift in demand for Alaskan salmon is the Japan/U.S. exchange rate. A decline in the strength of the currency in an importing country causes the prices they are willing to pay (in U.S. dollars) to immediately decline (Figure 7, Diagram B) unless there is some counteracting increase in demand from the market.

Changes in product quality will also shift demand. Quality variables include freshness, color, odor, appearance, shelf life, and attractiveness of packaging. The product that makes it to the shelf with an inferior quality will usually sell at a lower price.

People's preferences for foods also shift demand. The problem for food manufacturers is that cultural preferences for food products may change from year to year and decade to decade. A segment of a population may simply decide that they would like to eat other types of foods more frequently (Wessels and Wilen 1993). In Japan, preferences for western food products are on the rise. Correspondingly, their preferences for some traditional seafood products is declining.

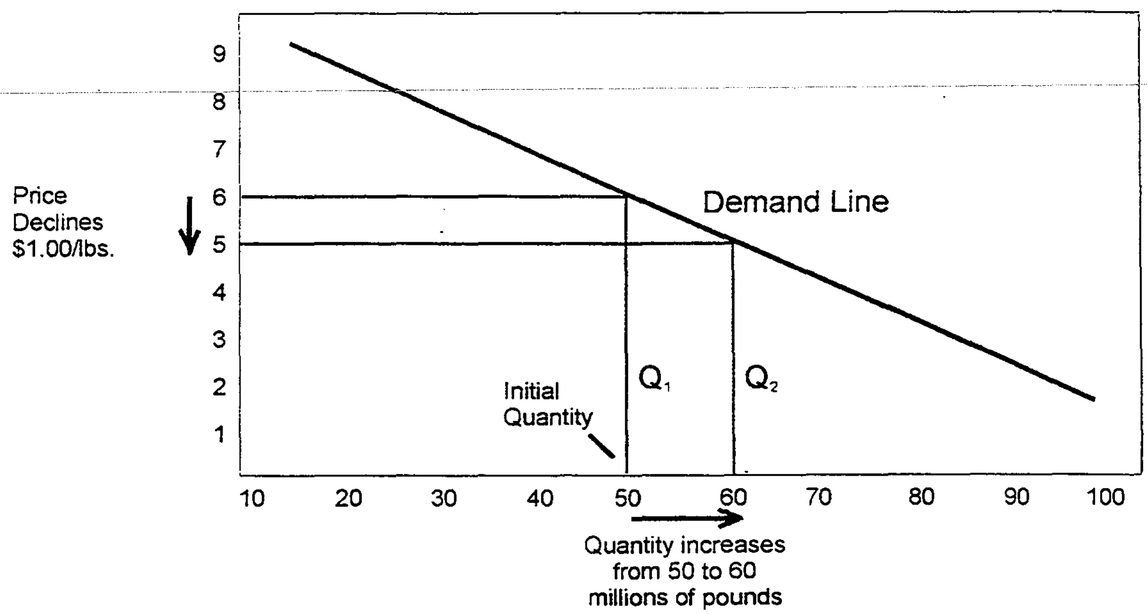
Prices of substitute products can shift demand. Common substitutes for many Alaska salmon products include farmed salmon, other fish products, and other meat products. Lower prices for any of these products in the market place can shift demand inward.

How does the above explanation of shifts in market variables or changes in demand relate to the Yukon River salmon markets? Ideally, a model of the Yukon salmon market should be constructed with excellent data which is consistent with economic theory. Such a model could be used to produce highly precise regression statistics that would explain what forces (variables) drive markets for Alaskan chum salmon. Unfortunately, there are three primary reasons why such a model does not exist at this time for addressing many of the fishery policy and management questions facing Yukon River fishermen.

First, in the last several years there has been a considerable shift and growth in the number of chum salmon product forms and grades of salmon products now in the market place, thus complicating our ability to use traditional econometric models. A typical econometric model requires a long time series of at least 20 observations (months, quarters, years, etc.) to allow adequate calibration.

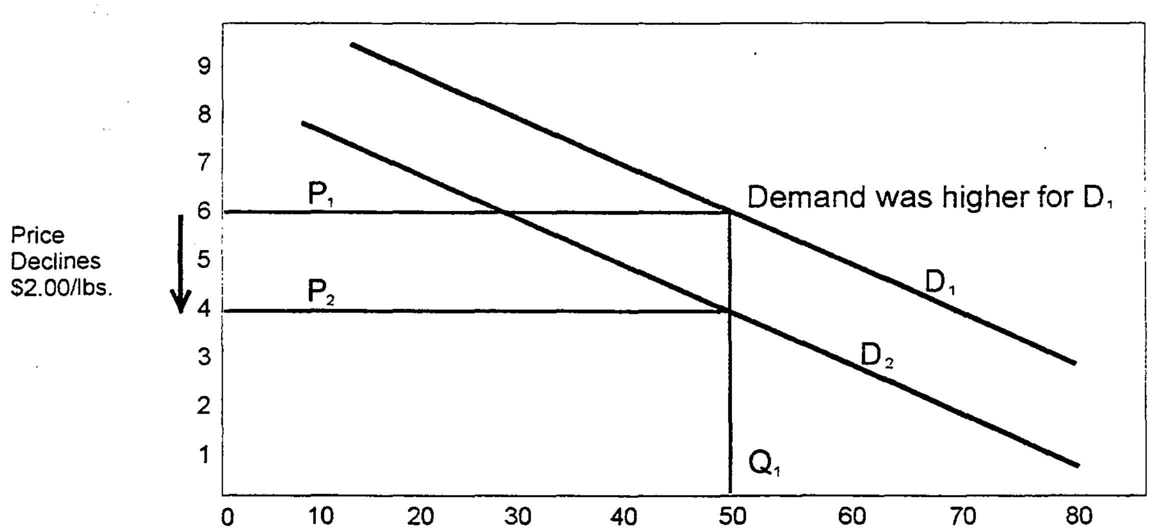
Second, the market dynamics of most salmon markets are complex. For example, harvesting may occur in semi-predictable pulses, but some Yukon salmon products are stored for prolonged periods. The timing of putting this inventory on the market can be subject to many economic

Diagram A



In (A) a $1.00 decline in price is caused by increased imports, and a movement down the demand curve. In (B) a $2.00 decline in price is caused by falling value of the Yen against the U.S. Dollar as the whole demand curve shifts inward.

Diagram B



Note: In B. quantity of product does not change, but price declines $2.00/lbs. from P_1 to P_2

Figure 7. Mechanics of a decline in salmon price. Diagram A illustrates a decline in salmon price due to an increase in quantity of salmon. Diagram B illustrates a decline in salmon price due to a decline in the Japanese Yen.

factors. How fast the inventory is dissipated may depend on the expectation of prices of other products.

Third, it is extremely difficult to measure prices and quantities of products and their substitutes in a consistent manner for international salmon markets. A supply function for explaining the behavior of intermediate markets may critically depend on understanding how the costs of production vary in different areas of the state. In Alaska, costs of transportation and labor vary dramatically from one major production location to the next.

Particularly in the fisheries markets of Japan, the number of grades that salmon may be divided into are considerable. An econometric model would require consistent prices and grading to be able to incorporate these quality variables. Even when prices and grades can be stratified, it is often difficult to determine the corresponding quantity of product (at a given grade) that was sold in the market. Trade literature is particularly poor at tracking all these variables simultaneously. Finally, information on quality and product forms in final markets can not be easily linked to a given increment of production from ADF&G production data. The flow and stratification of price and quantity data into the final market is simply not recorded for any given increment of Alaskan salmon.

Considering some of the previously mentioned modeling problems, even if a creative approach was developed to generate a Yukon River salmon econometric analysis, it might be useful for analysis of academic market questions, but not sufficient for addressing applied Yukon River salmon management questions. The value of investing in rigorous econometric models that are capable of addressing Yukon fisheries issues must be weighed against the cost of obtaining data and developing the models, compared to the anticipated performance of the models.

While little published information exists on Yukon salmon markets, it is none-the-less one of the more pressing issues of recent concern to Yukon River commercial fishermen and processors. It would be difficult to address all of the potential factors that could impact the chum salmon market for whole fish, flesh products, and roe. The following list includes some of the variables that have been evaluated in previous studies and two additional variables (9,10) which should be included in future studies.

(1) Production numbers, quality FOB Alaska and consistency of production of Yukon River Salmon products (Holms 1997) (Note: this is from The Arctic Sun, a Report of the AYK Salmon Market Development Project)
(2) Production and prices of other salmon from Alaska (Herrmann and Greenberg 1993)
(3) Production and prices of other salmon in Japan, (Boyce 1990; Herrmann 1993)
(4) Production and prices of farmed Atlantic salmon (Herrmann and Greenberg 1993)
(5) Production and prices of substitute products other than salmon (Wessels and Anderson 1992)
(6) Japan Yen against the U.S. dollar exchange rate (Muse, 1984; Herrmann and Greenberg 1993).
(7) Japanese prime interest rate (Muse 1984)
(8) Shifts in preferences for fresh frozen salmon and roe products (Wessels and Anderson 1992).

(9) Existence of new product forms (Gunnar Knapp personal communication with Jeff Hartman 6-25-98).

(10) The supply costs and particularly the transportation costs of Yukon River products (Gunnar Knapp personal communication with Jeff Hartman 6-25-98).

Wild, ranched, and farmed Pacific salmon production has increased dramatically in recent years. Wild or ranched chum salmon are produced by Alaska, British Columbia, Washington State, Japan, and Russia. In addition, during the 1980s, international salmon farming in Norway, Chile, Canada, and Russia began to compete with some wild stock markets and by 1991 accounted for nearly 30 percent of the world's total salmon production (Herrmann 1993). In 1997, pen-raised salmon and trout exceeded the total world wild salmon production for the first time (Knapp, 1998). Of several parameters that may impact chum salmon prices, production of quantities of fish from Alaska and Japan, is the most readily available to review.

Alaskan wild salmon stocks experienced sharp declines in the 1970's. However, market prices remained relatively high during this period (Herrmann 1993). These conditions, and the expectation that the runs might stay low for a prolonged period of time prompted the Alaska State Legislature to request funding and develop voter approved General Obligation Bonds for a large scale investment in State funded salmon hatcheries (Kramer et al. 1975). Estimates of Alaska catches in the common property fisheries are include in the Alaska Department of Fish and Game Annual Reports on the salmon enhancement program (McNair 1998).

During the 1980s, most of Alaska's chum salmon harvests originated from wild stocks. These commercial harvests generally ranged between 8 million and 11 million fish, although a peak harvest of 12.8 million fish was achieved in 1988 (Knapp, 1996—Chart 2). Hatchery contributions (both common-property harvest and hatchery cost recovery) to total chum harvests during the period 1986-1989 ranged between 889,000 fish and 2,110,000 fish and contributed between 12 and 15 percent of the total Alaska chum harvest (Knapp, 1996—Chart 2).

Beginning in 1992, harvests of chum salmon from Alaskan hatchery production grew dramatically in both the common-property fisheries and in cost-recovery harvests for the hatcheries themselves. Hatchery-produced harvests (common-property and cost-recovery) grew as follows (Knapp 1996—Chart 2; McNair 1998):

1991-1.59 million chum salmon
1992-2.46 million chum salmon
1993-5.90 million chum salmon
1994-7.84 million chum salmon
1995-8.42 million chum salmon
1996-13.36 million chum salmon
1997-11.75 million chum salmon

Hatchery-produced chum salmon (common-property and cost-recovery) now dominate Alaska's total commercial chum salmon harvests. Between 1993 and 1995 the hatchery-produced share ranged between 44 and 52 percent, grew to 63 percent in 1996 and reached 75 percent in 1997(Knapp, 1996—Chart 2, McNair, 1998). Additionally, cost-recovery harvests for the hatcheries themselves reached 21 percent and 29 percent of the total Alaska chum salmon harvest in 1996 and 1997, respectively (Knapp, 1996—Chart 2, McNair, 1998).

Chum salmon produced from salmon ranching has also experienced rapid growth in Japan in recent years. The following list (Rogers and Ramstad, 1997) shows that Japanese adult chum salmon returns (catch and escapement) have grown dramatically from 1965 to the present. This increase contributed to a loss of frozen Yukon chum salmon sales to Japan except for fall chum salmon at reduced prices.

1965 to 1973	below 10 million fish
1974 to 1978	10 million to 18 million fish
1979 to 1982	22 million to 30 million fish
1983 to 1987	34 million to 50 million fish
1988 to 1994	51 million to 69 million fish
1995	78 million
1996	87 million
1997	85 million

During this period of rapidly growing worldwide chum salmon production, explosive growth in farmed salmon production, and more recently the troubled Asian economies are expected to have influenced Yukon chum prices and market prices of other species. Yukon River chum salmon have experienced significant declines in landed prices. The Salmon Market Information Service (Knapp, 1996 and Knapp 1997) has identified hatchery production of chum salmon as one variable among many that contributed to low chum salmon prices in the 1990's. For example, during the summers of 1991 and 1992, fresh gillnet chum wholesale (low list) prices ranged between $1.00/lb. to $1.50/lb. and $1.20 to $2.05/lb., respectively. However, from 1993 through 1997, fresh gillnet chum wholesale (low list) prices generally ranged only between $0.50/lb. and $1.00/lb. and only once went above $1.00/lb. (to $1.10/lb.) in 1994. Wholesale prices (low list) for frozen semi-bright chum during this same time period (1991-1997) dropped as well. These prices (per lb.) fell as follows: 1991-$1.40, 1992-$1.65, 1993-$1.40, 1994-$1.25-$0.95, 1995-$0.70, 1996-$0.45 and 1997-$0.70. (Knapp, 1996; Knapp, 1997; Jack Schultheis, North Alaska Fisheries, personal communication; Jim Gonzales, Inlet Salmon, personal communication).

Alaska ex-vessel prices, both statewide and in specific fisheries have also fallen. For example, statewide average chum prices were $0.38/lb. in 1990, $0.27/lb. in 1991, then back up to $0.37/lb. in both 1992 and 1993 (Knapp, 1996—Chart 1). However, with increased U.S. and Japan production as well as rapid growth in farmed salmon and other factors, in 1994, 1995 and 1996, statewide average chum prices were $0.26/lb., $0.28/lb. and $0.17/lb., respectively (Knapp, 1996—Chart 1). On the Yukon River, the ex-vessel price drop has been proportionally greater. Yukon ex-vessel prices between 1990 and 1993 ranged between a low of $0.28/lb. and a high of $0.38/lb (Knapp, 1996—Chart 1). In 1994, 1995 and 1996 ex-vessel prices dropped to $0.19/lb., $0.17/lb. and $0.09/lb., respectively (Knapp, 1996—Chart 1).

While the problems associated with developing appropriate econometric models for Yukon salmon markets are significant, the alternative of relying on market testimonials from industry sources also has considerable drawbacks. The first major problem with relying on unstructured industry testimony is that it is very difficult to determine if the contacts are representative of the entire industry. More formal market survey techniques concentrate on a statistical sample of buyers at a given market level. It is also difficult to structure questions on a particular parameter so that the analyst can evaluate only the impact of that variable independently of other variables that might be influencing the market. Finally, there is the considerable issue of strategic bias. Since analysts often probe for answers to controversial policy questions, and the respondants know that the answers to these questions may impact government investment and decision making, it may be in their interest to bias answers in favor of a desired result.

These complicating factors place a great deal of responsibility on the interviewer to (1) understand and apply consistent and meaningful survey questions, (2) be able to search for and report potential strategic responses, and (3) to filter responses dealing with markets through a well informed understanding of how markets work in theory and practice.

The testimony offered in the following sections was not obtained under a formal and controlled survey approach. However, at this time, this is the only accumulation of market insight that is available to the Yukon River Comprehensive Plan. The reader should regard these statements with some caution. They are divided into 4 major groups: comments on production related variables, financial market variables, quantity and prices of substitutes, and preferences.

Testimony From Processors, Distributors and Marketers regarding Production variables

1. *Summarized from Fitzgerald, 1995.* Processors have complained that the market for Yukon Area chum salmon in-the-round sales continues to erode due to competition from farmed Chilean coho salmon and expanded chum salmon hatchery production from Japan, southeast Alaska and Prince William Sound. Erosion of roe prices are attributed to expanded chum salmon production from southeast Alaska, Prince William Sound, and northern Japan hatcheries. Many Yukon River processors attribute chum exvessel and wholesale market price declines in whole or in part to the increase in recent years of the production of chum salmon in hatcheries both in Japan and Alaska.

2. Hatchery production has caused a significant increase in the total numbers of chum salmon (wild and hatchery) harvested on an annual basis (Knapp, 1996—Chart 2; Rogers and Ramstad, 1997).

3. *Personal communication with Dan Senecal-Albrecht; Ken Halvorsen, Whitney Foods, Jack Schultheis, North Alaska Fisheries, Jim Gonzales, Inlet Salmon, and Paul Packer, Distributor, Northeast Seafood's, Denver, Colorado.* Certain portions of the chum salmon whole fish market may be directly competing at the retail level. For example the increase in total chum production has contributed towards the overall

drop in wholesale and ex-vessel values of fresh and frozen head and gutted (H&G) chum salmon and *sujiko* and *ikura* roe

4. *Personal communication with Dan Senecal-Albrecht; Virgil Umphenour, CEO Interior Alaska Fish Processors, Fairbanks, Alaska; Jim Friedman, Sales Yutana Fisheries, Manley; and Gayle Stevens, Owner Stevens Fisheries, Nenana.* A more direct impact of the increase in chum roe production from Alaskan hatcheries is incurred by Middle Yukon River and Upper Yukon River fishermen harvesting ikura grade roe from mature summer chum salmon in late June and July and mature fall chum salmon in September. Like the growth in H & G chum salmon produced by Alaskan hatcheries since the 1990s, there has been a parallel increase in ikura production. Ikura from these hatchery chum salmon are produced by three different entities: by processors buying chum salmon from common-property harvests by individual fishermen; by hatcheries that contract with processors to process roe from chum salmon harvested for cost-recovery; and by sales from individual fishermen who operate as catcher-processors and sell the roe directly to brokers. Most of this ikura production comes from harvests in July and August. Ikura caviar from fall chum salmon production from Japan's Hokkaiddo area facilities has also grown significantly although this production comes later, primarily in October and November. Ikura caviar is also imported to Japan from Russian, Canadian, and Washington hatchery chum fisheries which also take place in the fall.

Testimony from processors, distributors and marketers regarding substitutes for Yukon River chum salmon and preference variables for chum salmon.

1. *Personal communication with Dan Senecal-Albrecht; Knut Nordess, Marketing Consultant, The Alliance Group, Seattle Washington, and Chris Mitchell, Executive Director, Alaska Fisheries Development Foundation, Anchorage.* Farmed salmon are primarily sold fresh to retail and food service operations in fillet or portion-controlled forms, often with pinbones removed and the skin removed (skin-off) and thus may not directly compete with Alaska fresh or frozen chum salmon.

2. *Personal communication with Dan Senecal-Albrecht; Knut Nordess, Marketing Consultant, The Alliance Group, Seattle Washington; and Chris Mitchell, Executive Director, Alaska Fisheries Development Foundation, Anchorage.* The main reasons for farmed salmon's popularity are that they can be ordered fresh year-round in any size, in any quantity and in excellent condition. Price is not their major selling point; excellent quality and convenience are. These filet portions are sold at retail for prices between $4/lb. and $7/lb .

3. *Personal communication with Dan Senecal-Albrecht; Knut Nordess, Marketing Consultant, The Alliance Group, Seattle Washington, personal communication; and Chris Mitchell, Executive Director, Alaska Fisheries Development Foundation, Anchorage.* Certain portions of the chum salmon whole fish market may be not be directly competing at the retail level. For example much of the farmed salmon production from Chile and

Norway, is sold primarily as a fresh portioned product, whereas chum salmon are sold at both the wholesale and retail level as a basic headed and gutted product.

4. *Personal communication with Dan Senecal-Albrecht; Al Shelly, Vice President Sales, Great Pacific Seafood's, Seattle, Washington; Jack Schultheis, Owner, North Alaska Fisheries, Anchorage; Jim Gonzales, Sales, Inlet Salmon, Bothell, Washington; and Paul Packer, Distributor, Northeast Seafood's, Denver, Colorado.* Chum salmon sold in the domestic market are traditionally used for summertime fresh salmon promotions in lower-tier and middle-class grocery stores, fish markets and supermarkets such as Safeway, Krogers, Winn-Dixie, and King Sooper. These retail sales highlighting "Fresh Alaska Salmon" (at prices between $0.99/lb. and $1.99/lb.) are often "loss leaders" or "break evens" for the stores and are designed to generate customer interest and excitement and get people into the store. Chum salmon are also sold frozen to these same retail customers and to distributors for "Lent" promotions and for freezer case sales and thawed product sales. The other element of domestic chum salmon sales is frozen sales to reprocessors and smokers, although many smokers have switched over to buying farmed salmon.

Comments and observations regarding financial market variables.

1. *Summarized from Bill Atkinson News Reports, 1997 and Knapp, 1996-Chart 1).* The increase in ikura production coupled with the decline in the Japanese economy has eroded the wholesale price of Alaska chum ikura. In 1992, Japanese wholesale prices were 5000-6000 yen/ kilo and in 1993 spiked dramatically up to 9000 yen/ kilo due to a perceived market shortage. Prices began to slip in 1994 to the 3300-4200 yen/ kilo range, the 3000-4200 yen/ kilo range in 1995 and the 2500-3300 yen/ kilo range in 1996. In 1997, prices were at their lowest in recent memory at a range of 2000-2500 yen/ kilo. Prices as of early 1998 have rebounded above the 3000 yen/kilo, but the ex-vessel and wholesale outlook remains bleak due to the broad slowdown in the Japanese economy and the weakness of the Japanese yen relative to the U.S. dollar.

The remainder of this section identifies projects and proposals intended to improve the marketing and production of Yukon River salmon.

Salmon have long been acknowledged as both economically and culturally vital to the well-being of local residents (The Arctic Sun, November, 1996). Recognizing that the salmon markets have dramatically changed within the State of Alaska, fishermen's organization requested State assistance in marketing of AYK salmon. Fishermen are also asking what information is lacking to develop an economic model which would help fishermen and managers understand how market variables effect marketing of AYK salmon.

The governor of Alaska initiated the Arctic-Yukon-Kuskokwim Salmon Market Development Project in 1996 due to concerns over the declining value of the region's salmon fisheries. The goals of the project were to: (1) develop new markets for AYK chum salmon; (2) establish a unique identity for chum salmon from the AYK region, including quality standards and exclusive labeling; and (3) generate demand among targeted buyers in the U.S. for the unique qualities of AYK chum salmon (e.g., higher oil content), similar to the market reputation enjoyed by sockeye salmon from the Copper River. It is hoped that through improving quality, educating buyers and finding new customers, the demand for AYK chum salmon will be increased, thus raising prices paid to local fishermen (The Arctic Sun, May, 1997).

Most of the chum salmon produced from the AYK region have been shipped as frozen, headed and gutted product (The Arctic Sun, November, 1996). The AYK Salmon Market Development Project concentrated its efforts on market development for simple, value-added products such as skinless-boneless fillet portions, or pin-bone removed fillets. In addition to initial funding from various sources in the State of Alaska (total of approximately $260,000), the project received approximately $950,000 in federal funds through the U.S. Department of Agriculture FY 98 budget (The Arctic Sun, May, 1997; December 1997).

After the first year of the project, initial marketing efforts showed promise; however, efforts to improve the quality of the product need to be increased (The Arctic Sun, December, 1997). In order to compete with the new standard in the salmon business, farmed salmon, the AYK region needs to commit to a long-term effort to improve the quality of fish delivered by fishermen to processors as well as the quality of the final product that comes off the processing line. Fishermen cannot wait for higher prices before they ice their catch. When not iced, fish go into rigor at too high a temperature, and this causes the muscle tissue to contract and separate, leaving unacceptable gaps in the flesh (The Arctic Sun, December, 1997). Once on the processing line, handling needs to be reduced to a minimum in the filleting and skinning processes and the core temperature of the fillets needs to be kept as low as possible. Detailed product specifications need to be developed that both producers and buyers can agree to. Good, tight product specifications should list the number of bones allowed, the amount of skin and bruising that is acceptable, and the approximate color and texture of specific products (The Arctic Sun, December, 1997). The changes necessary in the harvesting and processing industry in the AYK region to result in a consistently high quality final product are relatively simple, but will require a concerted effort and commitment on the part of all participants to implement (The Arctic Sun, December, 1997).

Given the difficulty using existing market information in a formal and traditional econometric model for forecasting market prices of Yukon salmon, additional information is needed for policy analysis. Three approaches suggested for a better understanding of market structure and factors effecting prices include: (1) more refined descriptive analysis of existing market place data; (2) structured sampling of buyers, suppliers, and marketers in a Delphi approach; and (3) trials of more market oriented research methodologies (such as conjoint analysis) with the intent of assessing the opportunities in these markets. The intent of this effort would be aimed at improving the inferences that could be drawn on the production and management alternatives for salmon produced from the AYK region of Alaska.

In particular techniques such as disaggregated demand analysis and conjoint analysis have been found to enable researches to discover the basis for consumer preferences and how they influence markets. This overall approach to market investigations was recommended to the Alaska Hatchery Policy group for the 1996 hatchery forum (Anderson and Sylvia, 1997). This type of technique could be helpful for providing direction on the Arctic Sun project mentioned above.

References:

Anderson, J.L. and G. Sylvia. 1997. Peer review of existing studies which address the impact of Alaskan hatcheries on the salmon industry. Contained as Section II in Clasby, B., J. McMillan, and M. Richard. January 16, 1997. Report to the Salmon Industry Response Cabinet. The Hatchery Policy Group. Juneau, Alaska.

Bill Atkinson, News Reports. 1997. Translation and reprints of weekly wholesale prices reported in Japanese trade press articles (Hokkai Keizai Shinbun).

Boyce, J. A comparison of demand models for Alaska salmon. Department of Economics, University of Alaska, Fairbanks. August 1990. Completed under a Professional Services Contract to the State of Alaska, Department of Fish and Game, Jeff Hartman contract administrator.

Herrmann, M. 1993. Using an International Econometric Model to Forecast Alaska Salmon Revenues. Marine Resource Economics, Vol. 8, pp.249-271.

Holmes, K. (Editor), The Arctic Sun, a Report of the AYK Salmon Market Development Project, Anchorage, Alaska. November 1996, February 1997, May 1997, September 1997, and December 1997.

Knapp, G., Project Director. 1996. "Markets for Alaska Chum Salmon". Salmon Market Information Service. Tables and graphs prepared as background material for the Hatchery Policy Group Forum, Anchorage Alaska, October 8-11, 1996. University of Alaska Anchorage.

Knapp, G., Project Director. 1997. Unpublished tables and graphs on ex-vessel and wholesale prices for fresh and frozen salmon and chum ikura. Salmon Market Information Service. University of Alaska Anchorage.

Kramer, Chin, and Mayo, Inc. 1975. Alaska Salmon Study: Management Study. Contract report for James W. Brooks, Commissioner, Alaska Department of Fish and Game, Juneau, Alaska by Kramer, Chin, and Mayo, Inc., Consulting Engineers, Architects, Applied Scientists. Seattle, Washingon.

Muse, B. 1984. Ex-vessel price models for Alaska salmon. unpublished CFEC discussion draft No. 84-6.

McNair, M. 1998. Alaska Salmon Enhancement Program 1997 Annual Report. Regional Information Report Number 5J98-03. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Juneau, Alaska.

Rogers, Don and K. Ramstad. 1997. Report to Pacific Seafood Processors Association. Fisheries Resource Institute. School of Fisheries. University of Washington, FRI-UW-9711. December, 1997.

Wessells, C.R. and J.L. Anderson. 1992. Innovations and progress in seafood demand and market analysis. Marine Resource Economics. 7(4):209-228.

Wessells, C.R. and J.E. Wilen. 1993. Economic analysis of Japanese household demand for salmon. Journal of the World Aquaculture Society, 24(3):361-379.

Ichthyophonus sp.

Fishermen in some sections of the Yukon River have noticed abnormal salmon skin and/or flesh conditions which could affect the fishes' health and/or marketability. Establishing a cause and effect relationship between a specific environmental condition and fish health is very difficult. Typically, these abnormalities are relatively rare.

One abnormality which appears to be of a low annual occurrence (although reports are increasing) is a fungal infection of chinook salmon. This fungus was first identified as *Ichthyophonus hoferi* in 1988 from a chinook salmon fillet which had brown streaks in the fish muscle. This fillet was sent from Galena to a fish pathology lab for analysis. *Ichthyophonus* is a collective name for a fungus infection which has been identified in many species of marine and freshwater fish. It is unclear if this fungus is one or several fungal species. Fungal infections may be of low or chronic incidence in some fish populations and in certain cases have been identified as having caused significant mortalities in wild herring, flounder, haddock, plaice, and cod populations (Noga, 1993).

Transfer of the fungus occurs from "fish" to "fish". A simplistic description of the general fungal life-cycle pattern, as outlined by Lauckner (1984), is that it begins with a healthy fish eating a fish or copepod which contains the *Ichthyophonus* fungus as a "resting spore". As the healthy fish digests the infected food, the spores are freed from the digesting flesh, and they germinate in the stomach becoming motile "amoeboids". These plasmodia penetrate the intestinal barrier and enter the blood stream to infect the host organs and/or muscle. Low numbers of fungal organisms may be contained by the host fish within granulomas, while heavily infected individuals will likely become internally covered with cysts and have distorted internal organs.

Fishermen from the Middle Yukon River Area have reported that the exterior appearance of the fish is normal (consistent with other published descriptions), but that white or brown streaks or nodules are distributed throughout the flesh of the fish. Additionally, the flesh will not air dry properly and becomes somewhat translucent/greasy with an unpleasant odor. Although *Ichthyophonus* is a fish pathogen which will not infect humans if consumed, the fungus does decrease the quality of the fish flesh, making it undesirable/unsuitable for consumption. Based on fungal biology, it is likely that Yukon River chinook salmon become infected with the *Ichthyophonus* fungus by eating infected herring while rearing in the Bering Sea and Pacific

Ocean. This naturally occurring fungus will likely continue to infect Yukon River chinook salmon at low levels, depending upon the level of incidence in the food source. Pathologists recommend against disposal of infected fish flesh into streams, rivers, or lakes because the fungus might be eaten by live fish, resulting in more infected fish. Fishermen should not allow infected fillets to touch uninfected fillets because the fungus can be spread by contact (McVicar, 1982).

References:
Lauckner, G. 1984. Agents: Fungi. In *Diseases of Marine Animals*, ed. O. Kinne. pp. 89-108. Hamburg, Federal Republic of Germany: Biologische Anstalt Helgoland. Ecology Institute, Volume IV, Part 1, Introduction, Pisces.

McVicar, A.H. 1982. Ichthyophonus infections of fish. In *Microbial Diseases of Fish*, ed. R.J. Roberts, pp. 243-269. New York: Academic Press.

Noga, E.J. 1993. Fungal Diseases of Marine and Estuarine Fishes. In *Pathobiology of Marine and Estuarine Organisms*, ed. J.A. Couch and J.W. Fournie. pp. 85-110. Boca Raton, Florida: CRC Press, Inc.

Lower Yukon River Sub-Basin

The lower Yukon River sub-basin includes the Yukon River and its tributaries from the mouth upstream to river mile 301, just downstream of the village of Anvik (ADF&G fishing Districts 1, 2, and 3).

Projects and Programs

Lower Yukon River Set Gillnet Test Fishery.

Test fishing to assess salmon abundance and timing in the lower Yukon River was initiated in 1963 at Flat Island. Set gillnets were fished 7 days per week, 24 hours per day through the chinook and summer chum salmon runs (late May to mid-July). In 1977, test fishing was expanded to include the fall chum and coho salmon runs (mid-July to the first of September) in the Big Eddy area near Emmonak. Test fishing at Flat Island was discontinued in 1979 and test fishing in the south mouth (Kwikluak Pass) was conducted throughout the season in the Big Eddy area. Test fishing was initiated in the Middle Mouth area (Kawanak Pass) in 1979. During 1980 and 1981, the Middle Mouth project was extended in duration to cover the fall chum and coho salmon season and geographically to cover the north mouth (Apoon Pass) of the delta.

With the expanded coverage, data collected from test fishing have generally increased in reliability for evaluating relative abundance and run timing in order to implement management decisions. However, test fishing information needs to be interpreted with care as catch levels can be influenced by a number of factors that are difficult to factor in quantitatively.

The lower Yukon River test fishing project continues to play an important role in the management of the lower Yukon River salmon fishery. The database from Big Eddy and Middle Mouth provides information on relative run timing, entry patterns and an index of relative salmon abundance by species. Management implications are significant. By monitoring the test fishery through the course of the season, the manager has a quantitative tool to assist in his assessment of total run strength, given the qualifications noted above. Trends in abundance as indicated by cumulative CPUE curves are generally established by mid-season, allowing for appropriate management regulations on the latter portion of the runs. Managers however, must be mindful of water levels, water temperature, wind direction and tides which all affect the catchability of salmon in the test nets.

Mountain Village Drift Gillnet Test Fishery.

The Mountain Village test fishing project was funded by BSFA and AVCP and cooperatively operated by BSFA and the Asacarsarmiut Traditional Council during 1995, 1996, and 1997. The initial objective during the first year was to evaluate the feasibility of the project to provide inseason information on patterns of fall chum and coho salmon run abundance and timing. Three drift sites were established approximately 4 miles upstream of Mountain Village on the mainstem Yukon River. One twenty minute drift is conducted at each of the three sites on a daily basis. Test fishing times and the number of salmon caught were recorded by site and reported to the department daily. Preliminary analysis indicated that the daily test fish CPUE for fall chum salmon from the 1995 and 1997 Mountain Village test fish project compared well to the preliminary Pilot Station sonar daily passage estimate. The 1996 CPUE was less correlated to other indicators.

East Fork Andreafsky River Weir.

Summer chum salmon escapement to the East Fork Andreafsky River was estimated by ADF&G using sonar from 1981 through 1984. Due to difficulties with high water, sonar limitations, and the lack of determining speciation, the department switched to counting migrating summer chum and chinook salmon from a tower during the period 1986 to 1988. ADF&G suspended the counting tower operation subsequent to 1988 due to budget reductions.

However, in 1994, the USFWS installed a floating resistance weir on the East Fork to assess chinook and summer chum salmon returns from early June into early August. This was partly in response to the poor summer chum returns of 1993 and was part of the USFWS's long-term research goals in the Yukon Delta National Wildlife Refuge. The project was heavily encouraged by the ADF&G, BSFA and YRDFA and supported by local fishermen in St. Mary's. The project has successfully operated each year since 1994. Staff include USF&WS personnel as well as local Native youth hired through funds passed from BSFA to the two local tribal councils, the Yupiit of Andreafsky and the Algaaciq Tribal Council. From 1995 through 1997, with the additional crew funding support provided by BSFA, the project has operated into mid-September to enumerate coho salmon as well.

References:

Abundance and Run Timing of Adult Salmon in the East Fork Andreafsky River, Yukon Delta National Wildlife Refuge, Alaska, 1994. Alaska Fisheries Progress Report Number 95-5, June 1995. Region 7, U.S. Fish & Wildlife Service, Department of the Interior.

Abundance and Run Timing of Adult Salmon in the East Fork Andreafsky River, Yukon Delta National Wildlife Refuge, Alaska, 1995. Alaska Fisheries Progress Report Number 96-1, March 1996. Region 7, U.S. Fish & Wildlife Service, Department of the Interior.

Abundance and Run Timing of Adult Salmon in the East Fork Andreafsky River, Yukon Delta National Wildlife Refuge, Alaska, 1996. Alaska Fisheries Progress Report Number 97-1, February 1997. Region 7, US Fish & Wildlife Service, Department of the Interior.

Pilot Station Sonar.

Mixed stock fisheries management in a large river system requires timely quantitative assessment of migrating salmon abundance. The ability to reasonably assess run strength allows managers to make informed harvest decisions, while still providing for the escapement goals in an escapement-based management program. The Yukon River Pilot Station sonar is located at river mile 123, approximately one mile upstream of the village of Pilot Station and near the middle of District 2. This is one of the few locations where the lower Yukon River runs through a single channel and has a bottom profile conducive to detecting passing salmon. The river is approximately 3,000 feet wide at the sonar site, with a maximum depth of nearly 80 feet.

The feasibility of estimating total salmon passage by species in the main stem lower Yukon River at Pilot Station was investigated by ADF&G from 1980 to 1985 using state-of-the-art hydroacoustic equipment. Sonar counts were apportioned by species based on test fishing catches using drift gillnets of several different size meshes. The project became operational in 1986 and provided estimates of the daily upstream passage of chinook, summer chum, fall chum, and coho salmon, but not without difficulties.

During the 1990 field season, staff first became aware of fish migrating further offshore than the 420 kHz frequency could detect. Regular down looking sonar transects were adopted to address this problem. A significant underestimate of the early portion of the fall chum salmon run occurred in 1991 when the Atchuelinguk sand bar developed close enough to the sonar transducer sites to provide an offshore migration corridor beyond the ensonified area. Down looking sonar transects had been suspended between the early and fall seasons as a labor saving measure. The 1991 field season singularly identified that the sonar operating frequency of 420 kHz had too many problems on the Yukon River to continue using the species estimates for management decisions. Department staff were prepared to eliminate the Yukon River sonar program in the spring of 1992 unless the problems of inadequate counting range and attenuation could be addressed. It was decided to suspend field operations during the 1992 field season to enable the refitting and purchase of new sonar equipment with a lower frequency of 120 kHz. It was thought this new frequency would avoid attenuation problems and extend the counting range further offshore. The new equipment was deployed in 1993. Attenuation problems were minimized and a significant improvement in ensonification range was realized. The new ensonified range covered about 330 feet on the right bank and 1,000 feet on the left bank (with bank defined as right or left when looking down river).

Sonar salmon passage estimates at Pilot Station were important for management of the Yukon River fisheries in 1993, particularly in light of the depressed returns of both summer and fall chum salmon that year. In 1993, sonar fish passage estimates generally appeared consistent with catch and escapement upstream. Operational problems at Pilot Station sonar in 1994 resulted in low passage estimates which resulted in lost fishing opportunity during the fall season. Additional staff focused on the project in 1995 and fish passage estimates appeared consistent with catch and escapement numbers upstream that year. Normal operation of this project was suspended in 1996 due to a staffing shortage and the project was conducted for training purposes only that year. In 1997, counting resumed at Pilot Station and estimates of king, summer chum, fall chum and coho salmon passage were generated. In 1997, fish passage estimates from the project appeared consistent with catch and escapement numbers upstream.

The pilot station sonar project has undergone a variety of development/transitions/staffing challenges since its inception in 1980. By using the current sonar system coupled with solid on-site quality control checks, it is felt that passage estimates from the project are reliable. ADF&G's goal is to provide for a stable, well-run operational program for this project.

References:
Maxwell, S. L. and D. C. Huttunen. 1998. Yukon River Sonar Project Report, 1996. Regional Information Report No. 3A98-07. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Maxwell, S. L. and D. C. Huttunen. 1998. Yukon River Sonar Project Report, 1997. Regional Information Report No. 3A98-12. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Data and Project Needs

Atchuelinguk (Chulinak) River.

The Atchuelinguk or Chulinak River enters the Yukon River at mile 126 just upstream of the village of Pilot Station and just upstream of the Pilot Station main river sonar site. Over 100 miles long, this tributary flows southwesterly draining the eastern slopes of the Andreafsky Mountains. Two smaller fork tributaries, the Nageethluk and the Kugukutauk, drain the Ilivit Mountains to the East and enter the Atchuelinguk in its lower half.

This river is noted as a concern for two reasons. First, local residents have reported log and debris jams as well as beaver dams which may block access of salmon to the spawning grounds. The second concern is that little data has been collected on the size of salmon spawning populations in the river. Chinook, summer chum and coho salmon have been documented in the river by aerial surveys. Since the nearby Andreafsky River is a major pink salmon producer, it is likely that some pink salmon spawning occurs although this is not yet verified. While it is generally accepted that populations are not as substantial as the nearby Andreafsky, leaving the Atchuelinguk unexamined makes for a small but potentially troubling blind spot for managers and fishermen. As a preliminary step, aerial surveys should be conducted during peak salmon spawning times, and if further investigation is warranted, a tower or weir should be operated for a few years to determine the magnitude of chinook, summer chum, and possibly coho salmon escapements.

Innoko River.

Of even greater concern than the Atchuelinguk is the vast drainage of the Innoko River which primarily enters the Yukon River at river mile 274 below the village of Holy Cross in District 3, but is also connected to the Yukon River in District 4 upstream of the village of Grayling. This watershed is more than 500 miles long and encompasses a large portion of Alaska's interior.

The drainage was home to the famous Iditarod gold rushes of the early 1900s and gold production continues to the present at select sites. The most extensive mining activity occurred on various smaller tributary creeks namely Ophir, Spruce, Ganes, Little, Yankee, Cripple, Boob, Candle, Otter, Flat, Moore, Slate, Chicken, Happy and Willow (Higgs, 1995). During the first half of this century it is likely that some salmon habitat was disrupted, although it would be next to impossible to quantify. No baseline data on salmon populations was collected prior to, during, or after the gold rush.

Present day gold mining practices are both less extensive and less disruptive to salmon habitat. As long as current levels of environmental monitoring and enforcement are maintained, this activity should not threaten salmon stocks. One particular habitat concern is the Illinois Creek gold and silver mine located in the Kaiyuh Mountains southwest of Galena in the northern portion of the Innoko River drainage. Although a large operation (with annual production goals of 50,000 ounces of gold and 400,000 ounces of silver over 6 years), its wastewater and leaching system will be self-contained, and extensive reclamation and environmental monitoring is required. Further information on this mine is presented in the succeeding section entitled "Illinois Creek Mine" in the middle Yukon River basin restoration projects and Issues of Concern.

Very little information is available at all on the biological status, spawning distribution or abundance of salmon within the drainage. Chinook, summer chum and coho salmon are known to spawn in the Innoko River (Alt, 1983). In 1994, pink salmon were reported in the lower region of the Innoko River upstream of the village of Shageluk. A more recent survey was conducted by the USF&WS in 1993 (Millard, 1995). This survey reported capturing 339 chum salmon in set gillnets during 121 hours of effort during July of 1993. USFWS genetic sampling trips which occurred in late July to early August, 1996, September, 1996 and July, 1997 identified salmon in Illinois Creek, California Creek, and Tolstoi Creek (USFWS trip reports dated 8/19/96 and 7/23/97 by B. Flannery).

The information gap on salmon within the Innoko River must be investigated. The first step should be a major campaign of extensive aerial surveys throughout the entire drainage, followed by boat and foot surveys of the areas with the highest concentrations of salmon spawning observed to identify potential escapement monitoring sites. At least one, if not two, towers or weirs should then be operated for several years to begin to establish spawning indices for various stocks. Researchers should also attempt to document salmon use or avoidance of habitat that was or is impacted by mining. Speculating that historic mining activities decreased the Innoko drainage's overall salmon production leads to the conclusion that salmon restoration opportunities likely exist in this drainage.

References:
Alt, K.T. 1983. Inventory and cataloging of sport fish and sport fish waters of western Alaska. Alaska Department of Fish and Game, Project F-9-15, Study G-1, volume 24:34-71, Juneau, AK.

Millard, M. J. 1995. Preliminary Assessments of the Salmon Stocks of the Innoko and Dishna Rivers, Innoko National Wildlife Refuge, Alaska, 1993. Fishery Data Series Number 95-2. United States Department of Interior Fish and Wildlife Service, Fishery Resource Office, Fairbanks.

Higgs, A.S. (Prepared by). 1995. A History of Mining in the Yukon River Basin of Alaska. Northern Land Use Research, Inc. Fairbanks, Alaska.

Restoration Projects or Issues of Concern

Other than the concerns listed below, the RPT generally agrees that, at present, there are few threats to salmon habitat in the lower Yukon River, and no salmon habitat or salmon stocks in the lower Yukon River are in need of direct restoration efforts. Lower Yukon RPT members are more concerned with the long term viability of their commercial fishery which is essential to maintaining their present way of life.

Sewer and Landfill Maintenance.
Although not a significant threat at present, lower Yukon RPT members expressed concern over potential future problems with waste disposal and landfill maintenance. The population has steadily grown in the region over the last 30 years along with associated waste. This is primarily a concern with Yukon Delta and coastal villages such as Hooper Bay, Scammon Bay, Sheldon's Point, Alakanuk, Emmonak and Kotlik. These low-lying villages along with local soil conditions make them subject to spring flooding and ground saturation. Higher ground for landfill and wastewater treatment is in limited supply and present systems are expensive to build and maintain. Villages from Mountain Village to Holy Cross are built on the foothills of the Andreafsky Mountains and Nulato Hills and thus have better soil conditions for community development.

A second associated concern is hazardous material disposal and treatment. The materials in question include auto, boat and snowmachine batteries, used motor oils and lubricants, paints and various cleaners and solvents. RPT members noted that there is inadequate public education about proper disposal or storage methods. The Lower Yukon Economic Development Commission is exploring options to have hazardous materials shipped out on backhauls of transportation and fuel barges.

Viability of Upper District 2 and District 3 Fishery.

Since the mid-1990s the portion of District 2 upstream of St. Mary's and all of District 3 have seen a noted decrease in processor and buying interest. As noted in the chinook salmon sub-section of Recent Market Trends and Issues, no sales of fish in the round have occurred in District 3 from 1995 through 1997. In the upper half of District 2, only Maserculiq Fish Processors (MFP) buys in the Marshall vicinity. Boreal Fisheries (the long time buying station based near Pitka's Point just below St. Mary's) stations tenders only as far upstream as Pilot Station. This contrasts with District 1 where Bering Sea Fisheries, Yukon Delta Fish Marketing Co-op, and Great Pacific are based and competition is stronger.

The level of processor interest or demand in turn affects the ex-vessel prices fishermen receive. In 1996, for example, prices paid in District 2 were 25 to 50 cents/pound lower than the price paid in District Y-1. In the past, prices in District 1 and 2 were essentially the same. In 1997, however, prices paid in the lower half of District 2 matched those paid in District 1, in part, due to the presence of more tenders from the District 1 based processors.

The greatest concern is the upper portion of District 2 where MFP is the only buyer. MFP is a subsidiary of Maserculiq, Inc., the village corporation for Marshall. Unlike the other lower Yukon buyers, MFP does not receive large pre-season cash advances or "pack loans" from a Japanese corporation. The result is that MFP must pay fishermen a lower price than the going rate and, as occurred in 1997, cannot match price increases when competition between buyers heats up.

A result of this decreased buyer presence and associated price instabilities has been a shifting of effort from Districts 2 and 3 to District 1. The most obvious is the dozen or so fishermen who used to fish in District 3. From 1995 through 1997 they had to shift their effort to District 2 or District 1 or forego fishing completely due to the lack of a buyer in District 3.

In District 2 the change is less dramatic but quite distinct as the following table illustrates.

Average number of permits per unrestricted mesh opening in Districts 1, 2 and 3 (ADF&G, Yukon Area AMR's, 1991-1997).

	1991	1992	1993	1994	1995	1996	1997
District 1	401	394	393	396	391	400	427
District 2	214	236	219	233	220	161	174
District 3	25	13	5	6	-0-	-0-	-0-
	640	643	617	635	611	561	601

Total number of permits fished/used during summer season, Districts 1-3 combined (ADF&G, Yukon Area AMR's, 1991-1997).

	1991	1992	1993	1994	1995	1996	1997
Y-1, 2 & 3	678	679	682	659	661	627	640

In addition to decreased buying presence in District 2, buyer participation in the chum salmon fishery declined in Districts 2 and 3. Although fishermen in all lower Yukon River districts have seen both chum salmon harvests and chum salmon markets decline in the 1990s, buyers routinely quit purchasing salmon in District 2 once the king fishery winds down. District 1 however still has two large freezing plants, Bering Sea Fisheries and Yukon Delta Fish Marketing Co-op, which can operate at a lower cost, and thus the District 1 fishery can extend a little longer into the season. From 1991-1997, the District 2 fisherman's total summer season fishing opportunity was limited to an average of 4.6 unrestricted mesh openings and 1.0 restricted mesh opening. In contrast, the District 1 fishermen had an average of 4.9 unrestricted mesh openings and 2.3 restricted mesh openings.

When examining harvest information from the Lower Yukon Area fishery, it must be acknowledged that District 2 has always had lower effort in processing and harvesting. However, if District 2 fishing effort continues to erode, it may become more difficult for the remaining operations, Boreal and MFP, to continue to operate. Conversely, if effort continues to increase in District 1, ADF&G managers will have to adjust fishing schedules and the length of periods to keep the commercial harvest at levels necessary to assure that subsistence needs and escapements are met.

References:

ADF&G. 1992. Annual Management Report Yukon Area, 1991. Regional Information Report 3A92-26. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

ADF&G. 1993. Annual Management Report Yukon Area, 1992. Regional Information Report 3A93-10. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

ADF&G. 1995. Annual Management Report Yukon Area, 1993. Regional Information Report 3A95-10. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

ADF&G. 1996. Annual Management Report Yukon Area, 1994. Regional Information Report 3A96-18. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

ADF&G. 1997a Annual Management Report Yukon Area, 1995. Regional Information Report 3A97-14. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

ADF&G. 1997b. Annual Management Report Yukon Area, 1996. Regional Information Report 3A97-41. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Viability of Chum Salmon Fishery.

Perhaps the most troubling trend in the 1990s is the steadily decreasing harvest of summer chum and fall chum salmon in the lower Yukon River. This has been attributed primarily to two factors, weaker runs and increased competition. First, summer chum salmon abundance declined steadily from 1990 to 1993 and the fall chum salmon runs in 1992 and especially in 1993 were well below average, while the 1994 Pilot Station main river sonar severely undercounted the return. Fall chum salmon fishing was closed on the lower Yukon River from 1992 to 1994. Second, and concurrent with this decline, was the continued growth of farmed salmon production and an increase in chum salmon hatchery production in Prince William Sound and southeast Alaska. This combination of events contributed to the loss of markets for the chum salmon fishery from the lower Yukon River.

Summer chum and fall chum salmon returns were stronger from 1994 through 1997, although Alaska hatchery production, (particularly in southeast Alaska), increased from 1.6 million fish in 1991 to 7.8 million chum salmon fish in 1994 which increased the competition in both the fresh and frozen markets. This made it unprofitable for processors to buy anymore than a token amount of summer chum salmon. Fall chum and coho salmon harvests resumed from 1995 through 1997 at significantly lower ex-vessel prices, which kept fishing and processing effort down.

Processors, faced with a shrinking wholesale fresh and frozen market and continued high airfreight and operational costs, (1) lowered ex-vessel prices, (2) cut back how much volume they would purchase, and (3) cut back how late into June or early July they would continue to operate once their chinook salmon order for their Japanese client was filled.

Under-utilized Pink Salmon Resource.

As described throughout this report chinook, summer chum, fall chum and coho salmon are the salmon species primarily utilized in both the commercial and subsistence fisheries. Pink salmon, however, spawn in relatively significant numbers in the lower Yukon River but are unutilized in both the commercial and subsistence fisheries. The primary reason pinks go relatively unused for subsistence is that chinook and summer chum are larger, easier to catch and process, and most importantly of all, richer and better tasting than pink salmon. Pinks by contrast only weigh about two to three pounds, begin to watermark very quickly after entering the mouth of the river and have soft flesh and a low fat content. Coastal villages such as Hooper Bay, Scammon Bay and Chevak do cut and dry pinks for human consumption, while small numbers of pinks are cut and dried for use as dog food by some lower Yukon River fishermen.

Pink salmon returns to the Yukon River, have the distinct even-year vs. odd-year abundance pattern. In even-numbered years (1992, 1994, 1996, etc.) on the Yukon River, pink salmon returns likely exceed one million fish. Odd-numbered year returns, however, are probably only a few thousand. Spawning distribution is widespread and concentrated in the lower Yukon River with returning populations dispersing to numerous small streams and creeks as well as larger rivers such as the Archuelinguk near Mountain Village, and the west and east forks of the Andreafsky.

Pink salmon spawning abundance is poorly documented. Pink salmon returns have been enumerated recently by the USF&WS weir located 22 miles up the east fork of the Andreafsky River (USF&WS 1994, 1995, 1996, 1997). This project documented annual counts of 316,530 pinks and 214,837 pinks in 1994 and 1996, respectively. Peak pink salmon passage at the weir ranged between July 16-19. These counts however must be considered very conservative estimates because large numbers of smaller pink salmon were able to pass through the weir uncounted. Pink salmon counts in 1995 and 1997 were 1,972 and 429 respectively. Although substantial runs in their own right, Yukon River pink salmon returns have never generated much processor interest.

Middle Yukon River Sub-Basin

The middle Yukon River sub-basin mainstem includes the Yukon River from river mile 301 upstream to approximately river mile 664, near the village of Tanana (ADF&G fishing District 4, excluding the Koyukuk River).

Projects and Programs

Anvik River Sonar.
Based on early aerial survey counts in the fifties and sixties the Anvik River was thought to be important as a spawning area for summer chum and chinook salmon. Escapement project counts were first conducted by ADF&G from 1972 to 1979 from two counting towers above the confluence of the Anvik and Yellow Rivers. From 1976 to 1979, two counting towers on the mainstem Anvik River near the confluence of Robinhood Creek were used. A pilot study using sonar to estimate salmon escapement to the Anvik River was conducted in 1979. Sonar enumeration replaced the counting towers beginning in 1980 and has been maintained annually since that time. The Anvik River sonar site is located approximately 47 miles upstream of the confluence of the Anvik and Yukon Rivers. Monitoring of escapement within the Anvik River drainage is important because it is estimated to account for a significant portion of the total Yukon River summer chum salmon production. Since 1980, Anvik River sonar passage estimates have ranged from 362,912 to 1,486,182 fish annually with a Department BEG of greater than 500,000 summer chum salmon.

The literature cited section in Sandone, 1996, contains a complete list of past references for the Anvik River salmon counting projects.

Reference:

Sandone, G. J. 1996. Anvik River Salmon Escapement Study, 1995. Regional Information Report No. 3A96-12. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Kaltag (Stink Creek) Test Fish Wheel.

To determine the relative run timing and abundance of summer chum salmon, continuous operation of a test fish wheel on the north bank of the Yukon River at river mile 444 (approximately 4.5 miles upstream from the confluence of Stink Creek) was used from 1981 through 1985. This project typically operated from the later part of June or beginning of July to near the end of July. Project operational dates and resulting salmon catches are reported in the 1981 to 1985 ADF&G Yukon Area Annual Management Reports.

Kaltag River Tower.

The Kaltag River tower project first operated in 1991 in response to the lack of middle Yukon River summer chum salmon monitoring projects. The University of Alaska Fairbanks Cooperative Extension Service has been the project coordinator with funds coming from a variety of federal, state, and private sector grants. Local youth have been the primary employees with the Kaltag City office assisting with many aspects of this project. The tower site is located approximately 0.6 miles upstream on the Kaltag River from its terminus on the Yukon River at river mile 450. The first three years of operation (1991-1993) were not useful for inseason management due to the late seasonal startups as a result of funding limitations. However, the project has produced useful inseason information since 1994.

Beginning in 1994, the project was funded partially or completely by the Bering Sea Fishermen's Association through BIA funding. This enabled counting operations to begin annually on approximately June 20th, near the arrival of summer chum to the creek, and continue until the last week of July. The project has also documented timing and abundance of chinook salmon to this stream. Project results now provide timely and useful data for inseason management of the Subdistrict 4-A summer chum salmon fishery.

Information on this project is on file with the ADF&G and BSFA.

Nulato River Tower.

Prior to 1994, salmon escapements to the Nulato River drainage were indexed by aerial surveys. It was realized that a more comprehensive inseason escapement monitoring project for chinook and summer chum salmon within the middle Yukon River was needed. Hopefully, results could serve as an index of escapement abundance to other middle Yukon River tributaries. Beginning in 1994, a cooperative project between BSFA, TCC, and ADF&G was initiated to estimate salmon escapement from counting towers. This cooperative project was successfully conducted through the 1997 field season with the Nulato Tribal Council replacing TCC as a cooperator in 1995. The two-tower counting site is located on the Nulato River approximately 3 miles upstream of its confluence with the Yukon River. The primary objective has been to enumerate chinook and summer run chum salmon escapement. Project dates have centered around June 20 to July 20, depending upon salmon run timing.

Summer chum salmon escapement was estimated as 149,000 in 1994, 237,000 in 1995, 130,000 in 1996, and 158,000 in 1997. Chinook salmon escapement estimates have ranged from a low of 760 in 1996 to a high of 4,800 in 1997, and have averaged 2,190 from 1994-1997.

References:

Headlee, P.G. 1996. Abundance and run timing of adult salmon in the Nulato River, West-Central Alaska, 1995, Project Summary. Wildlife and Parks Program, Tanana Chiefs Conference, Fairbanks.

Sandone, G.J. 1995. Nulato River salmon escapement study, 1994. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 3A95-19, Anchorage.

Paulus, R.D. 1997. Nulato River salmon escapement project, 1996. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 3A97-32.

Galena Test Fish Wheel.

In 1995 a Galena test fish wheel project at river mile 530 was funded by BSFA and operated one season in conjunction with the Louden Traditional Village Council. This was a feasibility project with the objective of providing inseason indices on run timing and relative abundance of fall chum and coho salmon in the middle Yukon River area. The fish wheel was located along the north bank of the Yukon River near the town road that parallels the river. The site used was not the preferred site and catches were low and did not appear to fluctuate in relation to run strength. The preferred site had been altered by shifting sandbars caused by spring ice breakup. Catch data from this project are on file with the ADF&G and BSFA.

Ruby Test Fish Wheels.

Beginning in 1980, a test fish wheel was operated on the north bank of the Yukon River at river mile 603 (Mouse Point) to determine run timing and abundance of upper Yukon River fall chum and coho salmon. This fish wheel operated annually until 1991, when funding reductions resulted in elimination of the project. Annual daily catch records for fall chum salmon from 1981 to 1991 are contained in: Ihlenfeldt-McNay, N. 1997.

From 1981 through 1986, a test fish wheel was also operated annually on the south bank of the Yukon River near the village of Ruby (river mile 590) to determine the run timing and relative abundance of fall chum and coho salmon. Brief summaries of this project are included in ADF&G Yukon Area Annual Management Reports for those years.

Reference:
Ihlenfeldt-McNay, N. 1997. 1997 Yukon River fall season data notebook. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Unpublished Report. Fairbanks, Alaska.

Melozitna River Sonar.
In 1981, the feasibility of using hydroacoustic techniques to document timing and magnitude of salmon escapements to a tributary stream in the middle portion of the Yukon River drainage was investigated. The project was operated by ADF&G at approximately river mile 4 of the Melozitna River.

In 1981, the project was initiated late and missed peak salmon passage. Only one sonar counter was operated from the east bank. The east bank sonar abbreviated passage estimate for 1981 was 19,707 salmon; primarily summer chum salmon, with a small unknown percentage attributed to chinook salmon. The 1981 passage estimate expanded to 96,000 summer chum salmon based on the 1982 and 1983 run timing and magnitude information. In 1982, the escapement was estimated to be 19,710 summer chum salmon (including a small but unknown number of chinook salmon) using two sonar units. The 1983 estimated total escapement using two sonar units was 20,126 summer chum salmon, with a small unknown portion of these being chinook salmon. The project was discontinued due to budgetary and logistical constraints.

A short project description is contained as an Attachment in the 1981, 1982, and 1983 ADF&G Annual Management Report, Yukon Area.

Data and Project Needs

The majority of summer chum salmon spawning occurs below the confluence of the Koyukuk River as well as throughout the Koyukuk River drainage. Despite that fact, assessing the abundance and timing of chinook and summer chum salmon utilizing the middle portion of the Yukon River sub-basin is important to avoid over harvest of these stocks in the intensive Subdistrict 4-A summer chum salmon fishery and Subdistrict 4-B and 4-C fishery. Both the Melozitna and Tozitna Rivers would be important rivers for establishing annual escapement enumeration projects.

The Melozitna River lies northwest of the Ray Mountains and flows southwest approximately 135 miles through the Kokrines Hills to the Yukon River near the village of Ruby. This river supports spawning populations of chinook and chum salmon.

The Tozitna River has its headwaters in the Ray Mountains and flows approximately 83 miles southwest between the Ray and Rampart Mountains to its confluence with the Yukon River. This river supports spawning populations of chinook and chum salmon. Coho salmon have also been documented in this river.

Restoration Projects or Issues of Concern

Viability of Subdistrict 4-A Single Species Roe Fishery.

The longstanding market concern for Subdistrict 4-A fishermen is the lack of additional commercial salmon fisheries other than the summer chum roe fishery. Chinook salmon do occur incidentally in the roe fishery, but the chinook salmon roe is not mature and the guideline harvest levels are not large enough to warrant sale or a directed fishery. Chinook salmon caught incidentally are important for subsistence use and are used as such by commercial fishermen. At the request of local fishermen, the Alaska BOF recently adopted regulations which prohibited the sale of chinook salmon roe in Subdistrict 4-A at their December 1997 meeting in Fairbanks. This was adopted to remove any temptation for the sale of subsistence caught chinook salmon roe, and to allow subsistence drift gillnetting for chinook salmon to occur concurrently with chum salmon directed commercial fisheries.

Unlike all the other Districts and Subdistricts of the Yukon Area, commercial fishing for fall chum and coho salmon is not currently allowed in Subdistrict 4-A. Some commercial harvests of fall chum salmon have likely occurred when summer chum fishing extended into late July. However, these harvests would still have been reported as summer chum salmon. No documented sales of coho salmon in Subdistrict 4-A have occurred.

In the recent debate over whether or not there should be a formal coho salmon management plan for the Yukon Area, Subdistrict 4-A fishermen have made it clear that should directed commercial fisheries on coho salmon be implemented, Subdistrict 4-A should receive at least a small allocation. However, if an allocation of coho salmon for Subdistrict 4-A were approved, other questions must also be answered, such as: how many incidental fall chum salmon could be harvested and from which other district(s) would the fall chum salmon be re-allocated? Would a directed salmon roe fishery be allowed? In addition, 4-A fishermen would have to figure out how to catch fall chum and coho salmon for commercial sale. Currently, fall chum and coho salmon are harvested for subsistence with short drift gillnets on the east bank of the Yukon. However, commercial fishing is only allowed with set gillnets or fish wheels, and good fishing sites are generally limited to the west bank. Therefore, fishermen would have to adjust their fishing pattern to comply with commercial regulations.

Without alternate commercial fisheries, Subdistrict 4-A fishermen will remain completely subject to commodity price fluctuations in the *ikura* roe market. Prices are predicted to rise or fall depending primarily on chum salmon production in both domestic and international marketplaces.

Currently salmon carcasses from the commercial fishery are cut and dried and used for human consumption and dog feed. This makes for a very efficient use of a single salmon, i.e. the roe is sold commercially and the carcass is used for subsistence. One long-term possibility might be to produce smoked salmon products from summer chum salmon carcasses. While this would certainly add value to the product, it would undoubtedly also add costs.

Viability of Subdistricts 4-B and 4-C Fishery.

Upstream of Subdistrict 4-A are Subdistricts 4-B and 4-C, the north and south banks of the Yukon River mainstem, respectively. Unlike Subdistrict 4-A, commercial fishing in these Subdistricts is allowed on all four major salmon runs in the Yukon River including chinook and summer chum salmon in late June and July and fall chum and coho salmon in August and September. Commercial fishing is concentrated in and around the large village (and former Air Force base) of Galena and the smaller village of Ruby.

Galena has three small salmon processing operations: two purchase primarily summer chum salmon roe harvested in Subdistricts 4-A and 4-B; the other purchases all four species for processing into "Native-style" smoked salmon. No processing plants are located in Ruby, thus salmon and/or roe must be tendered and/or flown to Galena, Manley or Fairbanks for processing.

On the positive side, fishermen in Galena and Ruby are not dependent on a single market like the summer chum roe fishery of Subdistrict 4-A. However, their fishery is steadily eroding due to the decline in ex-vessel and wholesale prices of wild salmon and particularly for blush or watermarked salmon which comprises a majority of their catch whether king, summer chum, fall chum or coho salmon. As discussed in Chapter Three, fishing and processing operations in rural western Alaska, including the Yukon Area, have always been low volume operations relative to other areas of Alaska. The tremendous growth worldwide of farmed and hatchery salmon production coupled with Alaska's record wild and hatchery production has increased competition in both domestic and foreign markets. Due to higher per pound production and transportation costs, Yukon River salmon products (despite lower prices paid to fishermen) are generally more expensive than their competition's in the wholesale market.

Although Galena and Ruby fishermen have both a summer and fall season fishery, given current market conditions their low volume harvest guidelines limit fishermen and processors. This has lead to a steady decline in the number of permits being fished in the Subdistricts. For example, Ruby in some years has had only one permit operating during the fall chum season and they have had to ship the product to Fairbanks by small plane as processors could not afford to operate tenders as in the past.

The best hope for fishermen and processors in Subdistricts 4-B and 4-C is for high and stable returns of all four species of Yukon salmon. Value-added operations such as smoking or filleting can produce more revenue, but only at high expense. Sustainable and predictable harvests could help to offset the unpredictable fluctuations in price and processor interest.

Illinois Creek Mine.

USMX of Alaska (USMXA), a wholly owned subsidiary of the Dakota Mining Corporation, is using open pit and heap leach techniques to mine five million tons of gold and silver ore deposits located near Illinois Creek within the Innoko River watershed. The deposit consists of approximately 5 million tons of ore averaging 0.069 oz/ton gold and 1.7 oz/ton silver. At full operation, the project will produce approximately 50,000 ounces of gold and 400,000 ounces of silver per year and will have a production life of approximately six (6) years. As of June 2, 1997, USMXA received all needed permits to begin production.

The mine is located on a State of Alaska mining lease on the south facing slope of the Kaiyuh Mountains. Galena is located 57 miles northeast of the mine site and the Yukon River is 23 miles to the west. Shageluk is the only village on the Innoko River and is located approximately 213 river miles and 120 air miles southwest of the site.

Illinois Creek is a small creek with an average width of approximately 15 feet and is approximately 30 feet at its widest point. Illinois Creek supports small populations of summer chum and coho salmon. Adult grayling, dolly varden, burbot, and sculpin have also been observed in the creek. California Creek, a slightly larger creek located east of the mine site, supports larger populations of chinook, summer chum, and coho salmon.

The Innoko River and some of its tributaries support runs of summer chum salmon, chinook salmon, and coho salmon (Millard, 1995). Freshwater resident fish include burbot, Dolly Varden, grayling, northern pike, sheefish, and various whitefish species. In 1994, pink salmon were reported in the lower region of the Innoko River and upstream of the village of Shageluk.

Ore will be removed from the east, central, and west pits, hauled to the 65 acre heap leach pad, and dumped for processing. The heap leach pad will be underlain with a double lined synthetic liner system. A diluted mixture of sodium cyanide (NaCN) will be sprayed over the ore heap. This process will dissolve the gold into solution. The solution will collect in the sump at the bottom of the containment system. This "pregnant" solution containing the dissolved gold will be pumped to the processing plant where the gold will be removed from the solution. The solution is then referred to as the "barren" solution. The barren solution will have additional cyanide added to increase strength and will be pumped back to the heap leach pad for continued gold extraction. Operation of the heap leach pad and containment system is designed to achieve "zero discharge" of the pregnant solution or processed waste water to the outside environment during operations.

Prolonged leaching of heavy metals from the ore heap, particularly arsenic, heightens concerns and puts paramount importance on long term monitoring of the treatment system. While USMXA proposes to use a NaCN solution for gold extraction, the high dilution rate of the surrounding area and natural breakdown of the chemical provides less of a concern for fisheries resources in the event processing fluids are released.

Recommendations are for citizen monitoring of the USMXA environmental policy and reclamation plan and continued sampling of surface waters, sediments, and fish tissues from the area by state and federal agencies.

All equipment, supplies, and personnel are flown to the site. Infrastructure on the mine site includes a wastewater facility, offices, processing plant, mechanical shop, electrical generators, satellite communications system, water supply, sewage treatment system, and a solid waste disposal site.

Reclamation of disturbed areas will occur during three project stages: post construction, concurrently with mining, and after final closure of operations. Final reclamation will include: removing structures, detoxification and re-contouring of the heap, soil fertilization, and re-vegetation of disturbed areas.

Current plans are to modify the cyanide shipping route from Anchorage via the Alaska railroad to Nenana, to Galena via Yutana Barge, to the mine site via aircraft; to a straight flight from Anchorage to the mine site. This would keep the chemicals off the Yukon River entirely.

References:
Headlee, P. G. 1996. Responses to Ecological Concerns Expressed by the Shageluk IRA Council Related to USMX Open Pit Gold and Silver Mine Operations Adjacent to Illinois Creek, TCC Water Resources Report No. 96-2.

Illinois Creek Mine Project, Summary Consolidated Mining Permit Application, January, 1996. USMX, Inc. 141 Union Blvd., Suite 100. Lakewood, Colorado 80228.

Millard, M. J. 1995. Preliminary Assessments of the Salmon Stocks of the Innoko and Dishna Rivers, Innoko National Wildlife Refuge, Alaska, 1993. Fishery Data Series Number 95-2. United States Department of Interior, Fish and Wildlife Service, Fishery Resource Office, Fairbanks

Morsell, J.W. 1991. Final Report, Aquatic Resources Assessment Study, Illinois Creek Gold Project. North Pacific Mining Corporation, Anchorage, Alaska.

Koyukuk River Sub-Basin

The Koyukuk River sub-basin includes the entire Koyukuk River drainage. The approximate mainstem drainage length of the Koyukuk River is 425 miles from its headwaters to its terminus at river mile 508 of the Yukon River.

Projects and Programs

Gisasa River Weir.
The Gisasa River flows northeasterly from its headwaters in the Nulato Hills, approximately 69 miles to its terminus on the Koyukuk River. This tributary supports summer chum and chinook salmon. Aerial survey salmon counts have been highly variable over the years. Thus, in 1994, the USFWS installed a resistance board weir to estimate salmon escapements. The weir site is

approximately 4 miles upriver from the mouth of the Gisasa River. The primary objectives of this project are to: 1) determine daily passage and run timing of chinook and chum salmon; 2) determine sex and size stock composition; 3) evaluate effectiveness of aerial survey estimation on the Gisasa River; and 4) determine presence and movement of resident fish. Start up in the first year of operation was delayed and only a partial season count was obtained. Escapement counts are listed in the table below.

	1994	1995	1996	1997
Summer Chum	51,116	136,886	157,589	31,802
Chinook	2,888	4,023	1,952	3,764

References:
Melegari, J.L. 1997. Abundance and run timing of adult salmon in the Gisasa River, Koyukuk National Wildlife Refuge, Alaska 1996. U.S. Fish and Wildlife Service, Fishery Resource Office, Alaska Fisheries Data Series Number 97-1, Fairbanks, Alaska.

Clear Creek Tower.
Clear Creek is a tributary of the Hogatza River. It is one of the most productive summer chum salmon producing streams in the Koyukuk River drainage for its size. Clear Creek is approximately 40 feet in width and generally less than three feet deep. The Hogatza River enters the Koyukuk River approximately 272 river miles from the its confluence with the Yukon River. Its terminus lies approximately mid-way between the villages of Huslia and Hughes.

Proposed placer gold mining by Taiga Mining Company within the upper reaches of chum salmon spawning habitat on Clear Creek provided the impetus for gathering more complete chum salmon abundance information as well as water quality data. During June and July of 1995 the TCC operated a salmon counting tower on Clear Creek immediately upstream of its terminus on the Hogatza River. Age-sex-length data and daily water quality information pertaining to mining compliance was collected. This project was operated in 1996 using tower counting methods under a cooperative effort by BSFA, USFWS, BLM, ADF&G, and TCC and during 1997 by the Tanana Chiefs Conference, Inc. with funding from the Bering Sea Fishermen's Association.

The 1995, 1996, and 1997 estimates of chum salmon returning to Clear Creek were 116,735, 101,250, and 76,454 fish respectively. Information collected during the 1995 season indicated very good water quality for the spawning and production of summer chum salmon. During June and July of 1995, turbidity ranged from 0.70 nephelometer turbidity units (NTU) to 4.83 NTU, mean= 2.14 NTU. The sex ratio of chum salmon for combined sampling stratum was 37% male, 63% female, n=750. Tissue samples were collected from 100 chum salmon and preserved in liquid nitrogen (N_2) for genetic stock identification analysis by the ADF&G genetics laboratory in Anchorage. Stock analysis indicate that Hogatza River chum salmon are most genetically similar to other summer chum salmon.

Run timing statistics in 1995 indicate the mid-point of the run was July 9, which correlates strongly with other lower Yukon River summer chum salmon spawning populations (Nulato, Gisasa, Kaltag, Anvik). It is assumed that the Hogatza River salmon are some of the earliest salmon to enter the Yukon River each season.

References:

Boswell, J. C. 1979. History of Alaskan Operations of United States Smelting, Refining, and Mining Company. Minerals Industry Research Laboratory. University of Alaska, Fairbanks, AK.

Headlee, P. G. 1996. Abundance and Run Timing of Adult Salmon and Water Quality in Clear Creek (Hogatza River), Northwest Alaska, 1995. Tanana Chiefs Conference, Inc. Fairbanks, AK. Water Resources Report 96-1.

Kretsinger, F. K., S. M. Will, and D. R. Hunt. 1994. Hogatza ACEC Aquatic Habitat Management Plan. U.S. Department of the Interior Bureau of Land Management Kobuk District, Alaska.

Van Hatten, G. K. 1997. Abundance and Timing of Summer Run Chum Salmon (Oncorhynchus keta) and Water Quality in Clear Creek – Hogatza River, Northwest Alaska, 1996. USFWS, Fairbanks Fishery Resource Office. Fairbanks, Alaska.

Hogatza Area of Critical Environmental Concern (ACEC) Aquatic Habitat Management Plan (HMP).

The Bureau of Land Management (BLM) has outlined its goals and objectives for managing the aquatic habitat within the combined Clear and Caribou Creek watersheds, tributaries to the Hogatza River. On the basis of watershed size, Clear and Caribou Creeks (152 mi^2 combined) provide some of the most productive summer chum salmon habitat in the state. In comparison, three other examples of Yukon River summer chum salmon drainages are: the Anvik River (1,700 mi^2), the East Fork Andreafsky River (835 mi^2), and the Gisasa River (566 mi^2).

In 1993 BLM began implementation of the HMP. Some of the actions called for in the plan are: documenting physical habitat composition and condition; mapping salmon spawning habitat and quantifying spawner use by stream reach; collecting stream flow and channel morphology data; and documenting existing macroinvertebrate community composition, substrate composition, and basic water chemistry parameters. Collection of this data is intended to provide a base level of information which will allow the monitoring of development activities within these two watersheds with the goal of maintaining the existing habitat production capability. Water quality monitoring is scheduled to continue for as long as development activities with the potential to impact fish habitat take place within this critical area.

References:
BLM 1997. Environmental Assessment and 43 CFR 3809 Plan of Operations for Taiga Mining Co., Inc. (FF090577) located in Clear Creek, Hogatza River Watershed, Alaska. EA Log No. AK-020-97-075. U.S. DOI, Bureau of Land Management, Fairbanks. 22p.

Brooks, A.H. 1923. The Alaska Mining Industry in 1921 In Mineral Resources of Alaska: Report on Progress of Investigations in 1921, by A.H. Brooks et al., pp. 1-44. U.S. Geological Survey Bulletin 739. U.S. Government Printing Office, Washington.

Snyder-Conn, E., M. Bertram, and P. Scannell. 1992. Contaminant data for water, sediments, and fish of Koyukuk National Wildlife Refuge and the Northern Unit of Innoko National Wildlife Refuge. Ecological Services, Fairbanks, Alaska, U.S. Fish and Wildlife Service, Technical Report NAES-TR-92-04. 78p.

Vinson, M. 1995a. Aquatic Benthic Macroinvertebrate Monitoring Report. Report prepared for the BLM Kobuk District by the U.S.D.I. Bureau of Land Management, Western Fish and Wildlife Staff, Aquatic Ecosystem Laboratory, Fisheries and Wildlife Department, Utah State University, Logan. 64p.

Vinson, M. 1995b. Aquatic Benthic Macroinvertebrate Monitoring Report. Report prepared for the BLM Kobuk District by the U.S.D.I. Bureau of Land Management, Western Fish and Wildlife Staff, Aquatic Ecosystem Laboratory, Fisheries and Wildlife Department, Utah State University, Logan. 87p.

Vinson, M. 1996. Aquatic Benthic Macroinvertebrate Monitoring Report. Report prepared for the BLM Northern District by the U.S.D.I. Bureau of Land Management, Western Fish and Wildlife Staff, Aquatic Ecosystem Laboratory, Fisheries and Wildlife Department, Utah State University, Logan. 61p.

Vinson, M. 1997. Aquatic Benthic Macroinvertebrate Monitoring Report. Report prepared for the BLM Northern District by the U.S.D.I. Bureau of Land Management, Western Fish and Wildlife Staff, Aquatic Ecosystem Laboratory, Fisheries and Wildlife Department, Utah State University, Logan. 71p.

South Fork Koyukuk River.
The South Fork Koyukuk River originates in the Philip Smith Mountains with the Jim River and Fish Creek as its major tributaries. The first salmon assessment project for this river was conducted by the USFWS in 1990 (Troyer, 1993). A sonar project was operated from August 2 to September 25, 1990 to estimate chum salmon escapement into the South Fork of the Koyukuk River. A total of 19,485 chum salmon were counted during the 55-day counting period. Difficulties with high water late in the season resulted in the recommendation that future salmon assessment on this river be considered using more sophisticated sonar equipment or a floating weir. A second study was conducted in conjunction with the sonar project during September, 1990 (Melegari and Troyer, 1995). This second study involved radio tagging 18 fall chum

salmon and tracking them to their spawning locations. The documented spawning locations corresponded with previous documented spawning areas in the South Fork Koyukuk River.

In 1996 and 1997, a resistance board weir was installed by the USFWS on the South Fork about 20 miles above its confluence with the mainstem Koyukuk River and 1 mile above the mouth of Fish Creek. Chinook, summer chum and fall chum salmon are counted and sampled weekly for age, sex, and size information. In 1996, during the periods when the weir was operational, 1,232 chinook, 37,450 summer chum, and 21,651 fall chum salmon were counted. In 1997, 1,642 chinook, 11,237 summer chum, and 2,685 fall chum salmon were counted. High water events are frequent during the fall period on the South Fork which causes lengthy suspensions to counting operations. Also, with the onset of winter, high water makes extracting weir materials from the river dangerous and difficult. As a consequence the USFWS is planning on operating the weir during the summer chum and chinook salmon season only. Other means of assessing the fall chum escapement will be explored.

References:
Melegari J.L. and K.D. Troyer. 1995. Distribution of Radio-tagged Fall Chum Salmon in the South Fork Koyukuk River, 1990. U.S. Fish and Wildlife Service, Fishery Assistance Office, Fishery Data Series Number 95-3, Fairbanks, Alaska.

Troyer, K.D. 1993. Sonar Enumeration of chum salmon in the South Fork Koyukuk River, 1990. U. S. Fish and Wildlife Service, Fishery Assistance Office, Alaska Fisheries Technical Report Number 19, Fairbanks, Alaska.

Wiswar, D.W. 1997. Abundance and run timing of adult salmon in the South Fork Koyukuk River, Kanuti National Wildlife Refuge, Alaska, 1996. U.S. Fish and Wildlife Service, Fishery Resource Office, Alaska Fisheries Data Series Number 97-5, Fairbanks, Alaska.

Data and Project Needs

After the chum salmon crisis of 1993, salmon escapement monitoring project efforts began in the Koyukuk River drainage. To adequately assess this large drainage it is important to continue at least two summer season monitoring projects. Currently the Gisasa River, Clear Creek, and South Fork Koyukuk River projects are fulfilling this function. However there are virtually no chinook salmon which spawn in Clear Creek. It is recognized that projects which enumerate both chinook and summer chum salmon would be more desirable for management information than a project which only enumerates one species. Alternative Koyukuk River tributaries which have been suggested for dual species evaluation include the main Hogatza River, Henshaw Creek, Kateel River, and Indian River.

Although fall chum and coho salmon do spawn in the Koyukuk River drainage, it is recognized that these stocks are numerically less than stocks in the Upper Yukon and Tanana River Sub-basins. The South Fork Koyukuk USF&WS weir was extended for fall season enumeration in

1996 and 1997 but high water interrupted counting for long periods of time during both seasons. Establishment of a fall season monitoring project in the Koyukuk River Sub-basin appears unrealistic given the relative size of the spawning stocks and the typical high water conditions experienced during the fall season.

Restoration Projects or Issues of Concern

Hogatza Mining.

The mineral potential of the Hogatza River drainage remained largely unexplored during the first part of the 20th century. Some of the earliest mining on Bear Creek dates back to 1921 (Brooks, 1923). In 1939, the United States Smelting, Refining and Mining Company began a drill prospecting program. In 1955 and 1956, they transported a large dredge from its Fairbanks-area operations (Livengood) to begin mining on Bear Creek, which flows into Caribou Creek (a tributary of the lower Hogatza River). The dredge ran from 1957 to 1975, was reactivated in 1981, shut down in 1984 and reactivated again in 1990. This dredge produced the majority of the 230,000 ounces of gold yielded from the Hughes Mining District from 1930 to 1975 (Higgs, 1995).

In 1993, the Taiga Mining Company began to seek operational permits for placer mining in the upper reaches of nearby Clear Creek and Aloha Creek. Clear Creek is a tributary located just upstream of Caribou Creek. Exploratory research in the 1940s indicated that Clear Creek was a promising area for mining. Taiga received its first permits in 1993, and planned to conduct exploratory trenching in the summer of 1997 in the area about 6 miles from the mouth of Clear Creek. In 1997, Taiga Mining proposed to conduct exploration and a full scale mining operation on Alaska Gold's patented land which is within the upper 5-7% of the summer chum salmon spawning range in Clear Creek. Taiga's proposal for federal claims upstream of the patented land was limited to just the exploration phase. Taiga Mining is also interested in Aloha Creek which flows into Clear Creek about 2.5 miles upstream of its mouth. Salmon counting tower operations at the mouth of Clear Creek have documented two of the three annual returns in excess of 100,000 summer chum salmon during June and July. The salmon counting tower operations have been a cooperative effort between various agencies as follows: TCC/BSFA in 1995, USFWS/BLM/BSFA/ADF&G in 1996, and TCC/BLM/BSFA in 1997. The proposed mining activity is being closely monitored by the BLM, ADF&G-Habitat Division and TCC. Approximately 40% of the main channel length of both Clear and Aloha Creeks are covered by state and federal mining claims or private land, indicating that these systems have mineral value and may be impacted by future development.

Caribou Creek, adjacent to Clear Creek and receiving waters for Bear Creek (the watershed with most of the historic and current mining development) is another important summer chum salmon spawning stream. The aerial survey BEG for Caribou Creek summer chum salmon is >9,000, which is actually higher than the Clear Creek BEG of >8,000. Since large-scale mining activity was initiated in Bear Creek in 1957, lower Bear Creek and approximately 7.5 miles of Caribou

Creek below Bear Creek have received thousands of tons of sediment above that of natural levels. The lack of pre-mining data makes it difficult to determine the loss of salmon spawning habitat within the Caribou Creek drainage due to sedimentation caused by mining. An aerial survey conducted by BLM in 1996 counted 17,643 chum (live and dead) in the Clear Creek drainage (including Aloha and Comeback Creek) as compared to 10,562 (combined live/dead count) in Caribou Creek (including Bear Creek). This aerial survey also documented the low numbers of salmon that spawn in Caribou Creek below Bear Creek (only 2.2%-120 chum out of the 10,562 observed) leading to the deduction that there has been a loss of spawning habitat due to mining. Previous to 1996, turbid water originating from mining activity in Bear Creek made it impossible to obtain complete counts in Caribou Creek below Bear Creek.

Reference:
Higgs, A.S. (Prepared by). 1995. A History of Mining in the Yukon River Basin of Alaska. Northern Land Use Research, Inc. Fairbanks, Alaska.

Upper Yukon River Sub-Basin

The upper Yukon River sub-basin includes the Yukon River and its tributaries from river mile 664 to the U.S./Canadian border at river mile 1,224 (ADF&G fishing District 5).

Projects and Programs

Tanana Village Subdistricts 5-A and 5-B Test Fish Wheels.
In the fall of 1993 fall chum salmon returns were at record low levels. Commercial fishing was not opened and subsistence fishing was at first heavily curtailed, and then completely closed by late August. ADF&G searched for a means to monitor run strength without killing fall chum salmon. Two local Tanana village fishermen were contracted to operate their fish wheels equipped with live boxes and report their daily harvests of fall chum and coho salmon. One fish wheel site was located on the north bank of the Yukon River mainstem in Subdistrict 5-B while the other fish wheel was operated on the south bank in Subdistrict 5-A below the mouth of the Tanana River. The north bank wheel operated from September 14 through October 6, 1993 while the south bank wheel operated from September 15 through October 1, 1993.

From 1994 through 1996, using BIA monies, and in 1997 using Yukon River Restoration and Enhancement funds, BSFA funded the operation of these fish wheels and contracted with the same two fishermen to operate them. Each year the wheels have fished the following schedule: the north bank wheel operates from approximately August 1 through September 15 and monitors the upper Yukon River and Canadian components of the fall chum salmon run while the south bank wheel operates from approximately August 15 through September 30 and monitors the Tanana River fall chum and coho salmon runs.

These test fish wheels have improved management by not only providing daily systematic catch reporting but also helping to distinguish between the timing and relative abundance of the earlier Yukon River mainstem fall chum salmon return compared to those of the later-running Tanana River stocks.

In 1996 and 1997, fall chum salmon catches from the Subdistrict 5-A fish wheel were examined for the presence of adipose fin-clipped salmon returning to the Toklat River. These salmon consisted of three and four year old fish from Toklat River fall chum salmon eggs incubated at the Clear hatchery during the winters of 1995/1996 and 1994/1995, respectively. This coded wire tag study was initiated in 1992 to test feasibility of restoration study logistics and techniques, and as an opportunity to assess the harvest rates of Toklat River fall chum salmon in proximal fisheries and possibly identify run timing.

Rampart Fall Chum Salmon Tagging Project.
1997 was the second consecutive year of a multi-year, combined mark-recapture (mass marking) and radio telemetry study conducted by the USFWS and National Marine Fisheries Service (NMFS). This study was initiated to provide fisheries managers with information on total and stock specific abundance, stock composition, run timing, and the location of undocumented spawning areas. The methods and infrastructure necessary for full implementation of the study are being developed over several years. In 1996, 17,751 fall chum salmon were captured in two fish wheels at the Yukon River Rapids, 36 miles upstream from the Yukon-Tanana confluence. Two recovery fish wheels operated 32 miles upstream of the tagging site captured 45,232 fall chums; about 3% (1,259) of the captured fish bore tags. A post-season Darroch population estimate of 654,296 ± 41,954 fish was within 8% of the estimate of 708,812 fall chum obtained by adding the post-season escapement estimates and harvest in the upper Yukon River in 1996.

1997 operations were similar to 1996 with the exceptions of starting the project 10 days earlier (20 July to 20 September), and clipping the left pelvic fin of all spaghetti-tagged fish to assess tag loss. Approximately 5% of the fish captured at the recovery wheels bore tags. Of the 9,697 fish examined for tag loss, none had lost their spaghetti tag. The preliminary population estimate of fall chum passing the Rapids was 369,547. This estimate was within 14% of the estimate of 428,340 fall chum obtained by adding the escapement estimates harvest in the upper Yukon River in 1997. One aspect of the study needing further investigation is the lower percentage of tagged fish captured at distant locations upriver. At Fort Yukon a total of 1,240 fish were examined from seven fish wheels, 2.9% had tags and there was no tag loss. Fish checked in the vicinity of Eagle had a 1.3% tag ratio, while in the Dawson area only 0.5% fish had tags. At all locations there were no indications of tag loss. Clearly, further study is warranted to determine the cause of declining recovery rates upriver.

Work by NMFS in 1997 focused on preparing for a full-scale telemetry study in 1998. Feasibility work in 1996 determined that fall chum salmon resumed upriver movements soon after being tagged with radio transmitters, and that the remote tracking system (RTS) used in previous telemetry studies (Eiler, 1995) was effective in recording the movements of radio-tagged fish at site on the Yukon River. In 1997, remote tracking stations were installed at sites on the U.S.-Canada border. Station sites were also located on major spawning tributaries within the upper drainage. Station equipment was also modified to enhance performance and extend operations into late fall-winter. The tracking stations were also used as part of a cooperative USFWS-Alaska Department of Fish and Game study to determine the movement patterns and spawning distribution of radio-tagged sheefish in the upper Yukon River.

References:
Eiler, J. H. 1995. A remote satellite-linked tracking system for studying Pacific salmon with radio telemetry. Transactions of the American Fisheries Society 124:184-193.

Gordon, J.A., S.P. Klosiewski, T.J. Underwood, and R.J. Brown. 1998. Estimated abundance of adult fall chum salmon in the upper Yukon River, Alaska, 1996. U.S. Fish and Wildlife Service, Fairbanks Fishery Resource Office, Alaska Fisheries Technical Report Number 45, Fairbanks, Alaska.

Underwood, T.J., J.A. Gordon, S.P. Klosiewski, and R.J. Brown. In progress. Estimated abundance of adult fall chum salmon in the upper Yukon River, Alaska, 1997. U.S. Fish and Wildlife Service, Fairbanks Fishery Resource Office, Fairbanks, Alaska.

JTC 1996. Capabilities and potential applications of adult salmon tagging methods in the Yukon River Basin. Prepared by the U.S./Canada Yukon River Joint Technical Committee. Whitehorse, Yukon Territory.

Sheenjek River Sonar.

Fall chum salmon escapement to the Sheenjek River has been estimated by ADF&G using sonar since 1981. This project is located approximately six miles upstream on the Sheenjek River from its terminus on the Porcupine River. Timing, relative magnitude, and age-sex-size information of fall chum salmon are collected annually. This drainage is a major contributor to the Yukon River fall chum salmon run and has a biological escapement goal (BEG) of greater than 64,000 fish. Sonar escapements have ranged from 31,421 to 247,965 between 1981 and 1997.

References for eight previously published Sheenjek River sonar project data reports are contained in Barton 1994.

Reference:
Barton, L.H. 1994. Sonar Enumeration of Fall Chum Salmon on the Sheenjek River, 1993. Regional Information Report No. 3A94-24. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Chandalar River Sonar.

From 1986 to 1990, the USFWS used sonar (Bendix) to estimate adult fall chum salmon in the Chandalar River. The sonar site was located at river mile 13.4. The results from this work revealed that the Chandalar River may rival the Sheenjek River in terms of fall chum salmon production. Seasonal totals ranged from 78,631 chum salmon in 1990 to 33,619 in 1988, averaging 58,628 annually. Three years of concurrent data from aerial surveys and sonar operation (1988-1990) indicated that aerial counts, even under good survey conditions, were not reliable indices of escapement in this drainage. The sonar project was suspended to shift resources in development of the U.S. border sonar project at Eagle, Alaska. Results of the five years of sonar operation are documented in Daum et al. (1992).

Due to the decline of Yukon River fall chum salmon stocks and the decreasing likelihood of an operational border sonar program, a five-year sonar study was initiated in 1994 on the Chandalar River to reassess fall chum salmon escapement. More sophisticated 200-kHz split-beam sonar technology was used with a 3-year project feasibility planned for the study. The first year, 1994, was used to develop site specific operational methods, evaluate site characteristics, and describe possible data collection biases. In 1995, in situ target strengths were evaluated and a post-season estimate of 280,999 chum salmon was generated. In 1996, final developmental aspects of the project were completed and preliminary counts were reported to ADF&G on a daily basis. The final adjusted sonar count for 1996 was 208,170 fall chum salmon. In 1997, all feasibility objectives had been completed and the project was fully operational with daily counts reported to ADF&G. A total of 199,874 chum salmon were counted in 1997. Osborne and Daum (1997) documents the 1996 split-beam sonar effort and provides references for the work conducted in 1994 and 1995.

References:

Daum, D.W., R.C. Simmons, and K.D. Troyer. 1992. Sonar enumeration of fall chum salmon on the Chandalar River, 1986-1990. U.S. Fish and Wildlife Service, Fishery Assistance Office. Alaska Fisheries Technical Report Number 16, Fairbanks, Alaska.

Osborne, B.M. and D.W. Daum. 1997. Enumeration of Chandalar River fall chum salmon using split-beam sonar, 1996. U.S. Fish and Wildlife Service, Fishery Resource Office. Alaska Fisheries Technical Report Number 42, Fairbanks, Alaska.

Fort Yukon Test Fish Wheels.

In 1995 and 1996, two Yukon River test fish wheels were operated by the Council of Athabascan Tribal Governments (CATG) near the village of Fort Yukon. Specific objectives were to determine the timing and relative magnitude of the fall chum salmon passage in the Upper Yukon Area using adjustable axle fish wheels equipped with a livebox. One fish wheel was located downstream of Fort Yukon (river mile 1,002) on the north bank of the Yukon River, below the most upstream mouth of the Porcupine River. The other wheel was located on the south bank of the Yukon River several miles upstream of Fort Yukon and the Porcupine River confluence. Catch rates for the north bank fish wheel in both years were variable and unpredictable, likely indexing both Porcupine River and upper Yukon River stocks. Results from the south bank wheel in 1995 appeared to correlate well with upper Yukon River fall chum salmon run strength and timing. However, in 1996 operational personnel and site location were changed for various reasons and catch rates and run strength indexing abilities were inconsistent and of limited value for inseason management decisions. Neither test fish wheel operated in 1997 due to these operational problems and lack of funding.

Beaver Creek Weir.

In 1996, BLM, with the assistance of USFWS, installed a resistance board weir in the upper portion of Beaver Creek. The weir was located approximately 200 river miles upstream of the Yukon River and 5.5 river miles above the confluence of Victoria Creek. The primary purpose of the project was to enumerate the number of chinook and chum salmon spawning within the BLM managed portion of the watershed. Secondary objectives included documentation of run timing; gather age, sex, and length data; and collect genetic samples for stock identification (in cooperation with the USFWS). It is anticipated that the project will run annually through the year 2000. The counts for chinook and chum salmon respectively were 192 and 654 in 1996 and 315 and 34 in 1997.

Reference:

Collin, N. and J. Kostohrys. 1998. Enumeration of Adult Salmon and Hydrological Data Collected at a Floating Weir on Beaver Creek, Alaska, 1996-1997. BLM-Alaska Open File Report No.70, BLM/AK/ST-98/011+6600+020. Department of Interior, Bureau of Land Management, Anchorage, Alaska 21p.

U.S./Canada Border Sonar Feasibility.

Assessing the number of salmon passing from the U.S. into Canada has become increasingly important as salmon border passage obligations were contained within an Interim Agreement, and may eventually move into a long-term agreement. Operational planning for the Yukon River border sonar project was initiated in 1991. The project was designed to investigate the feasibility of using split beam sonar equipment to assess the passage of chinook and chum salmon into Canada on the mainstem Yukon River at river mile 1,214, near the village of Eagle. A sonar subcommittee comprised of representatives of ADF&G, USFWS, and CDFO were tasked with planning and feasibility work. Equipment was purchased and site surveys were conducted in 1991. Field deployment of prototype split beam sonar equipment was initiated in 1992 and baseline acoustic and gillnet fishing data were collected. A full field season of acoustic data were collected in 1993 during which calibration and data handling protocol were established. In 1994, additional acoustic data was collected on both free-swimming fish and calibration spheres.

It was agreed that while split beam sonar was not yet ready for full scale implementation in a riverine application, based on the interim results to date, there is the expectation that future split beam sonar development will provide Yukon River border salmon passage estimates. However, given the lack of technical leadership available from both ADF&G and CDFO, in 1995, there was consensus by the JTC that this project would be postponed.

Black River Weir.
In 1997 and 1996, as in 1995, the CATG attempted to set up a weir to estimate the passage of salmon into the upper portion of the Black River drainage, a tributary of the Porcupine River. The project was to be located near the village of Chalkyitsik (river mile 1,084). Several weir sites were identified in 1995, and the operational plan directed that the weir was to be operational from early August until late September. Unfortunately, high water levels prevented the deployment of the weir in both 1995 and 1996. In 1997, plans were made to move the weir materials further upstream but due to budgetary and personnel problems this was not accomplished.

Data and Project Needs

Similar to the perspective presented in other sub-basins, it is important for management evaluation to maintain at least two escapement projects for each species and/or run for which the sub-basin supports spawning salmon populations. The Upper Yukon River sub-basin is adequately covered for the fall season species, but lacks summer season species assessment. A weir on the Black River continues to be assessed as a potentially promising summer and fall season monitoring project and the feasibility of using a floating resistance weir to count chinook salmon in the Sheenjek River is being evaluated.

Restoration Projects or Issues of Concern

Fortymile River.
Gold was first discovered in the Fortymile River in 1886. The Fortymile River is the 6th largest producer of gold in the Yukon River region. Most of the placer mining occurred between 1886 and 1903 and dredging accounted for steady gold recovery until just before World War II. After the war, mining continued with hand methods, hydraulicking, bulldozer-dragline and limited dredging. Although small numbers of chinook salmon have been documented in this drainage, it is likely that this system is producing salmon at lower levels than prior to gold mining activities.

Birch Creek.
Placer gold was discovered in the Birch Creek drainage in 1883. Some level of placer mining has occurred since the discovery, although activity was reduced during World War II and the 1960's. Mining activity increased along with gold prices during the mid-1970s and up to 80 mining operations were active on the upper reaches of Birch Creek during the 1980s (BLM, 1988). The annual placer mining applications received by the state, for authorization to mine in the Birch Creek drainage was, 86 in 1985, 41 in 1990, and 46 in 1995. Townsend (1996) reports that increased fish species diversity and numbers within the Birch Creek drainage from 1984 to 1995 is likely due to water quality improvements, better mining practices, fewer mines, reclamation of

stream and riparian habitats, and enhanced fish passage in active mining areas. However, most of the tributaries that have been mined within the Birch Creek drainage still remain highly impaired in terms of fish habitat and support few fish.

References:
BLM (Bureau of Land Management). 1988. Birch Creek placer mining final cumulative environmental impact statement. USDI. 350 pp.

Townsend, A.H. 1996. Distribution of fishes in Alaska's upper Birch Creek drainage during 1984, 1990, and 1995. Alaska Department of Fish and Game, Division of Habitat, Technical Report. No. 96-4. 37pp.

Nome Creek (Beaver Creek Tributary).
BLM has reclaimed approximately 87 acres and 3 miles of riparian and aquatic habitat within the upper Nome Creek drainage that was subjected to placer mining. The project was initiated in 1991 and will continue depending on funding. Objectives include; riparian enhancement, channel and floodplain modification, and fish habitat structures. Currently, Nome Creek does not support an anadromous fishery although historically it did. Adult chinook salmon have been observed migrating in lower Nome Creek (1996) and juvenile salmon have been captured in the middle reaches of the drainage (1995).

Timber Harvest.
Limited logging of white spruce has been taking place in the Upper Yukon River Area above and below the Dalton Highway Yukon River bridge for a number of years. These activities can be characterized as personal use and are not large enough to be considered small-scale commercial. Past and current areas that have been logged are generally less than 20 acres in size. However, the Village of Fort Yukon has recently hired a consultant to conduct a feasibility study of operating a small sawmill. If such an operation is determined to be feasible, plans will be reviewed and monitored by the Division of Habitat and Restoration.

Viability of District 5 Commercial Salmon Fisheries.
Like their counterparts in Subdistricts 4-B and 4-C, the commercial fishermen of District 5 have both a summer and fall season fishery. Chinook salmon in July and fall chum salmon in August and September are the targeted species. However, summer chum and coho salmon are primarily only harvested in Subdistrict 5-A on the south bank of the Yukon River, below the mouth of the Tanana River, because these fish are primarily of Tanana River drainage origin.

Commercial fishing in the upper Yukon River basin is concentrated above and below the confluence of the Yukon and Tanana Rivers in Subdistrict 5-A and in Subdistrict 5-B, the north bank of the Yukon River. Fishermen from Fairbanks, Tanana and Manley operate from fish camps along the Yukon River or from their villages and are serviced by processors in Manley and/or Fairbanks. Within District 5, these two Subdistricts contain the majority of fishermen and receive the greatest processor interest.

Subdistrict 5-C encompasses the area between the villages of Rampart and Stevens Village. This area has less effort than Subdistricts 5-A and 5-B which is generally reflected by their lower harvests. In recent years buying effort has waned as wholesale salmon and salmon roe prices have declined. Tender services have declined and now fishermen must haul their catch up to the Dalton Highway bridge to meet the processors.

The farthest upstream and smallest commercial fishery in the U.S. portion of the Yukon River drainage occurs in Subdistrict 5-D which extends from Stevens Village to the Canadian border. On an annual basis, only three fishermen use their commercial permits in this area. The processor in Circle runs a small freezing operation and sells the fish directly to a wholesaler via truck delivery.

Many District 5 fishermen also register as catcher-sellers with the ADF&G. This registration enables them to sell their catch directly to the public such as chinook salmon to restaurants in Fairbanks or chum salmon to dog mushers or local residents. While this entrepreneurial spirit is to be commended it is also an indicator of the annual fluctuation in processor interest. In recent years, during times of low value, fishermen have retained fish caught during commercial periods for subsistence use, especially if tender support is lacking, which is another indicator of the low cash value of the fishery.

The best hope for fishermen and processors in District 5 is for new and expanded markets for king, summer chum, fall chum, and coho salmon. Value-added operations such as smoking or filleting are more feasible due to the proximity of the fishery to Fairbanks, which allows access to more affordable transportation and supplies. Sustainable and predictable harvests would help to stabilize the fluctuations in price and processor interest.

Tanana River Sub-Basin

The Tanana River sub-basin includes the entire Tanana River and its tributaries. The mouth of the Tanana River's confluence with the Yukon River is at river mile 695 (AFD&G fishing District 6).

Projects and Programs

Yukon and Tanana River Fall Chum Salmon Tagging Study, 1976-1980.
A fall chum salmon (*Oncorhynchus keta*) tagging study was conducted on the Yukon River in 1976, 1977, and 1978, and on the Tanana River in 1979 and 1980. A total of 1,217 fall chums were tagged in 1976, 5,359 in 1977, 9,668 in 1978, 7,259 in 1979, and 5,279 in 1980. Tag recoveries totaled 608 (50%), 1,951 (36%), 4,682 (48%), 1,346 (18%), and 1,234 (23%) for each of these years, respectively. Results indicate that upper Yukon fall chums migrate mostly along the north bank of the Yukon River in the Galena-Ruby area, while Tanana River fall chums

migrate mostly along the south bank. Run timing is earlier for the upper Yukon River stock (Buklis, 1981).

Reference:

Buklis, L.S. 1981. Yukon and Tanana River Fall Chum Salmon Tagging Study, 1976-1980. Alaska Department of Fish and Game, Division of Commercial Fisheries. Informational Leaflet No. 194. Anchorage, Alaska.

Tanana River Test Fish Wheels.

A contract test fish wheel was operated on the right bank near the village of Manley during 1984, 1985, and 1988-1994. A combination of changes in river hydrology, fish migration pattern, wheel susceptibility to debris (drift), and declining budgets resulted in suspension of this test fish project.

Beginning in 1988 and operating through 1997, a contract test fish wheel has also been operated on the right bank of the Tanana River near Nenana to assess run timing and relative magnitude for chinook, chum and coho salmon.

Another contracted test fish wheel was operated on the right bank near Fairbanks during September of 1988 to assess fall chum and coho salmon run timing and relative abundance.

References:

Hayes, J.S. 1997. 1997 Yukon River summer season data notebook. Alaska Department of Fish and Game, Commercial Fisheries Management and Development, Unpublished Report.

Ihlenfeldt-McNay, N. 1997. 1997 Yukon River fall season data notebook. Alaska Department of Fish and Game, Commercial Fisheries Management and Development, Unpublished Report.

Toklat River Foot Survey and Sonar.

The escapement database for Toklat River fall chum salmon consists of annual estimates of total spawning abundance dating back to 1974. Estimates were derived from expanded aerial and/or ground survey counts of the major spawning area at Toklat Springs, using stream life and migratory time density data collected from the Delta River fall chum salmon stock. Beginning in 1980, an annual ground survey of the major fall chum salmon spawning area at the Toklat Springs has been conducted during the period of peak spawning. The ground survey typically occurs during mid to late October with two people and lasts five to eight days. It was not until 1985 however, that the first attempt was made to prepare detailed notes on the distribution of spawners throughout the floodplain sloughs. Based on the historical database, the department has established a fall chum salmon minimum biological escapement goal (BEG) for the Toklat River of 33,000 spawners.

Due to concerns over the Toklat River fall chum salmon stock, the department conducted a more comprehensive assessment of escapement from 1994-1996 using hydroacoustic techniques, in addition to maintaining the ground surveys made of the Toklat Springs. Although the two independent estimates of fall chum salmon abundance obtained in 1994 complemented each other remarkably well, sonar-passage estimates obtained in 1995 and 1996 greatly exceeded the abundance estimates made from subsequent surveys at Toklat Springs in each of those years. Owing to the disparity among years between the two independent abundance estimates, it remains unclear how to interpret sonar passage estimates with respect to subsequent population estimates made from ground surveys. Thus, sonar counting operations were suspended in 1997, and a feasibility radio-telemetry study was implemented to determine if such a technique for studying salmon would be suitable for this river.

Reference:

Barton, L.H. 1997. Salmon escapement assessment in the Toklat River, 1994. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division. Regional Information Report 3A97-35.

Toklat River Coded Wire Tagging.

The department initiated a pilot study in 1992 on the feasibility of taking and rearing Toklat River fall chum salmon eggs at Clear Hatchery. This study was intended to evaluate the feasibility of conducting a large scale restoration effort on Toklat River fall chum salmon. The pilot study called for a relatively small egg-take from the Toklat River, with the primary objective to investigate the degree to which an egg-take could be conducted and rearing could be successfully completed.

The department was successful in taking fall chum salmon eggs, rearing those fish to a taggable size, tagging them with coded wire tags, and releasing them back at the egg take location, as follows:

Brood Year	Green Eggs	Fry Ponded	Total Tagged Fish Released	Transport Date To Sushana R.	Date of Release	Fed In Field	Release L/W (mm/g)
92	131,332	101,000	92,004	19-May-93	19-May93	No	55/1.4
93	208,207	200,000	162,800 [1]	19-Apr-94	25-Apr-94	Yes	42/0.6
94	394,431	349,800	323,779	17-Apr-95	23-Apr-95	Yes	51/1.1
95	228,957	212,759	185,704 [2]	10-Apr-96	18-Apr-96	Yes	50/1.0

[1] 32,104 untagged fish were also released into the Shushana River.

[2] 22, 880 untagged fish were destroyed.

Because coded wire tag fish externally look no different than an untagged fish, the international scientific community adopted the external sign of a missing adipose fin to signify a salmon tagged with a coded wire tag. All juvenile salmon tagged with a coded wire tag have their adipose fin cut off as part of the tagging process.

Since the Toklat River fall chum salmon pilot study was initiated, the motivation for conducting a large scale restoration effort has decreased with improved escapements to the Toklat River. Spawning ground counts in 1994 and 1995 were 2.3 and 1.7 times, respectively, the BEG minimum of 33,000 fall chum salmon. The first adult returns from these releases should have been age-3 salmon in 1995. No tag recovery effort was initiated due to the small number of three-year-old returns expected in the population. The first substantial return, consisting of age-4 and age-3 salmon from the 1992 and 1993 parent years, respectively, was expected in 1996. A tag recovery program was initiated in 1996, and continued in 1997 to evaluate the contribution, timing, and homing of Toklat River fall chum salmon in the proximal fisheries and to the spawning grounds. The study consists of four components: 1) sampling catches in Subdistrict 5-A on the Yukon River immediately downstream of the village of Tanana, 2) sampling catches in Subdistrict 6-A near the community of Manley, 3) sampling catches at Toklat River coded wire recovery field camp, and 4) sampling catches on the Toklat River fall chum salmon spawning grounds.

In 1996, a total of 22,019 fall chum salmon were randomly sampled and 219 were found to have had their adipose fin missing. Of the 219 heads sent to the CWT lab for analysis, 122 were found to contain coded wire tags. In 1997, a total of 17,901 fall chum salmon were randomly sampled and 93 were found to have their adipose fin missing. Of the 92 heads sent to the CWT lab for analysis, 58 were found to contain coded wire tags. The preliminary data analysis estimated 27% and 35% of the fish caught in the Subdistrict 5-A test fish wheel in 1996 and 1997 respectively, were Toklat River fish. The analysis also estimated the Toklat River chum salmon contribution to the Subdistrict 6-A fisheries was 31% in 1996 and between 11% to 100% in 1997.

No published reports have been produced as yet. The data is on file at the Fairbanks ADF&G office.

Toklat River Radio Telemetry.
A radio telemetry feasibility study was conducted on the Toklat River in Alaska during September and October of 1997. The purpose was to document the movement and spawning locations of adult fall chum salmon. A total of 123 fall chum salmon were tagged with pulse-coded radio transmitters from September 9 to September 28. Originally, all radio tags were to be deployed internally but due to problems with tag retention, attributed to digestive tract resorption, it was necessary to modify 100 of the 123 tags to an external application. Fish locations were successfully tracked using radio telemetry equipment from a boat, a stationary remote tracking station, aerial surveys, and spawning ground foot surveys. One hundred and fifteen tagged fish traveled upstream of the stationary remote tracking station near study km 11. The stationary data recorder documented the passage of 106 tagged fish while 9 passed undetected. On average, 95% of the radio-tagged fish were located on each of the seven aerial survey flights which were separated by four to ten days. Based on the estimated spawning location of 92 early-tagged fall chum salmon, approximately 71% of the run passing the tagging site from September 9-16, may have spawned in the Toklat Springs (confidence interval width ±17%). Eleven original internal tags were returned to the factory and converted to a smaller internal tag size. The smaller sized radio tag is a viable option for tagging fall chum salmon migrating long inriver distances which would be tagged relatively close to their spawning ground area. Radio telemetry techniques could be used to determine spatial and temporal spawner distribution of fall chum salmon within

the Toklat River on a larger scale. However, the cost to implement a study for tagging fish during the full run over multiple years would be very expensive.

Tanana River Tagging.

A cooperative fall chum salmon stock assessment project by ADF&G and BSFA was conducted on the Tanana River for the third consecutive year in 1997. A single fish wheel was operated in the Tanana River approximately 5 miles above the mouth of the Kantishna River to capture fall chum salmon for tagging (two wheels were used in 1995). Two additional fish wheels, which operated approximately 37-43 miles upstream of the tagging wheel site, were used to recapture tagged fall chum salmon and examine the marked to unmarked ratio. All wheels were equipped with a live box. Chum salmon were tagged with individually numbered spaghetti tags and had a fin clipped as a secondary mark.

The primary objective was to determine the feasibility of estimating the abundance of fall chum salmon in the Tanana River upstream of the Kantishna River using mark and recapture techniques as a reliable inseason management tool. In 1995, 3,993 fall chum salmon were tagged and 10,675 were examined at the recovery wheels, of which, 150 bore tags. The abundance estimate was 268,173 ± 42,330 (95% confidence interval) fall chum salmon upstream of the Kantishna River. In 1996, 4,016 fall chum were tagged and 6,935 were examined at the recovery wheels, of which, 187 bore tags. The resulting abundance estimate was 134,563 ± 33,212 fall chum salmon. There were 1,284 fall chum salmon tagged in 1997, and 4,057 examined at the recovery wheels, of which, 104 bore tags. The 1997 data are still under review, however, the preliminary 1997 abundance estimate is 71,661 ± 23,278 fall chum salmon. The project will remain in feasibility status at least until the 1997 data analyses have been finalized.

References:

Cappiello, T.A. and D.L. Bruden. Mark-recapture abundance estimate of fall-run chum salmon in the upper Tanana River, Alaska, 1996. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 3A97-37, Anchorage.

Cappiello, T.A., and J.F. Bromaghin. Mark-recapture abundance estimate of fall-run chum salmon in the upper Tanana River, Alaska, 1995. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Alaska Fishery Research Bulletin 4(1):12-35.

Tanana River Radio Telemetry.

To address questions regarding fall chum salmon spawner distribution with the intent of documenting previously unknown spawning areas, and to estimate the total number of fall chum salmon which spawned upstream of Fairbanks, a radio telemetry project was conducted in the fall of 1989. A total of 210 radio transmitters were deployed on fall chum salmon from mid-August to early October. External radio tags with low frequency (48-50 MHz) radio transmitters were used. Subsequent aerial radio tracking identified approximately 18 different fall chum salmon spawning areas within the Tanana River floodplain between upper Salchaket Slough and the Little Gerstle River. Although no previously undocumented major spawning areas were discovered in the upper Tanana River, the comparatively smaller mainstem spawning areas, when taken collectively, may in some years represent a more substantial contribution to total Tanana River fall chum salmon spawning escapement than previously realized. The proportion of fall chum salmon destined for the Delta River was estimated at 17.6% and represented the greatest proportion of tagged fish to any site-specific spawning area. In 1989, an estimated 121,556 fall chum salmon spawned upstream of Fairbanks.

Reference:
Barton, L.H. 1992. Tanana River, Alaska, fall chum salmon radio telemetry study. Alaska Department of Fish and Game, Division of Commercial Fisheries. Fishery Research Bulletin No. 92-01.

Nenana River Reconnaissance.
During the 1996 fall field season, the goal of the Nenana River reconnaissance project was to gain a better understanding of the contribution of Nenana River fall chum salmon and coho salmon (*O. kisutch*) to the Tanana River drainage. Limited information was available regarding abundance, run timing, and range of salmon within the Nenana River drainage. Gaining information on fall chum and coho salmon would assist fishery managers with the task of managing the District 6 (Tanana River) subsistence and commercial fisheries. District 6 is further divided into Subdistricts 6A, 6B, and 6C. The Nenana River is a tributary of the Tanana River within Subdistrict Y6B.

Funding for this project originated from the Bering Sea Fishermen's Association (BSFA), through a competitive grant process. The BSFA received federal funding to conduct salmon restoration, enhancement, and research activities within the Arctic-Yukon-Kuskokwim region of Alaska.

Between 17 September and 14 October, 1996 and 22 September and 10 October, 1997 the TCC conducted adult salmon surveys on the Nenana River drainage. The Nenana River is a tributary of the Tanana River located near the village of Nenana, Alaska. Cost effective methods used to obtain estimates of salmon abundance, range, and run timing are foot surveys, boat surveys, and aerial (rotary wing) surveys.

Twenty creeks or rivers were surveyed during the project and salmon were observed in fourteen. A total of 13,630 coho salmon, 70 chum salmon, and 2 chinook salmon were enumerated in 1996. Chum salmon and coho salmon ranged as far upstream as Healy Creek, and Lignite Spring Creek respectively. Over 98% of the coho salmon, 64% of the chum salmon, and 100% of the chinook salmon were observed in the lower section of the Nenana River drainage near Julius Creek and 17 Mile Slough. After 14 October, snow, ice and slush conditions within the drainage compromised the quality of the surveys and the project was ended. In 1997, 7,488 coho salmon and 259 fall chum salmon were observed in the 13 creek or river spawning areas surveyed.

References:
Alaska Department of Fish and Game, Habitat and Restoration Division, Fairbanks Office, Memorandum. RE: Anadromous Fish Streams, Nenana River. October 10, 1994.

Barton, L. H. 1987. Population Size and Composition of Chinook Salmon Spawners in a Small Interior Alaska Stream, 1986. Alaska Department of Fish and Game, Commercial Fisheries Division, Fairbanks. AYK Region, Yukon Salmon Escapement Report No. 32

Headlee, P. G. 1997. Adult Salmon Surveys within the Nenana River Drainage, 1996. Tanana Chiefs Conference, Inc. Fairbanks, AK. Water Resources Report 97-1.

Raymond, J. A. 1978. Clear Creek Weir, September 25 to October 11, 1978. F.R.E.D. Division, Alaska Department of Fish and Game.

Raymond, J. A. 1988. 1988 Salmon Returns to Clear Hatchery. Alaska Department of Fish and Game.

VanHatten. G.K. 1998. Adult salmon survey in the Nenana River drainage, 1997, Tanana Chiefs Conference, Inc. Fairbanks, Alaska. Water Resources Report No. 97-4.

Tanana River Sonar.

In 1989 the Legislature appropriated $185,000 identified for implementing a Tanana River sonar program. Sonar equipment for this program was purchased in 1989 but due to Divisional budget reductions operation of the project was delayed. In 1990, the sonar project was operated by ADF&G in a feasibility mode on the Tanana River at river mile 45 near Manley Hot Springs. The project used technology similar to that employed at the Yukon River sonar project. A field camp was established, and hydroacoustic target and free swimming fish data were collected. Drift gillnets were used to sample fish for species and size information. The project was assessed as requiring several more seasons of development before becoming fully operational. The project was suspended for the 1991 season and has not been reinstituted.

Chatanika River Assessment.

From 1980 to 1996, chinook salmon abundance was assessed with aerial or boat counts. In 1997, the Division of Sport Fish initiated a mark-recapture program to acquire a more accurate estimate of total chinook salmon escapement. A total of 149 fish were captured, tagged, and released. During the recapture event, 159 fish were examined for tags and secondary marks. Only 6 recaptures were recorded. This information resulted in a 1997 chinook salmon population estimate of 3,809 (SE=1,507) for the Chatanika River. The Division of Sport Fish is planning to implement a salmon tower counting program on the Chatanika River during the 1998 season.

Stuby, L. and M.J. Evenson. In prep. Salmon studies in interior Alaska, 1997. Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services. Fishery Data Series No. 98-XX.

Chena River Tower.

Prior to 1993, aerial survey estimates were the primary tool used to evaluate commercial, subsistence, personal use, and sport management of Chena River chinook and summer chum salmon. Aerial survey estimates provide only indices of escapement, and can be inconsistent depending upon factors such as turbidity, wind, light conditions, spawning stage, surveyor experience, etc. Beginning in 1986, Commercial Fisheries Management and Development Division began an assessment program using mark-recapture techniques to improve the estimated escapement of chinook salmon. This program was continued by Sport Fish Division through 1992. Although the mark-recapture program appeared to more accurately reflect spawner abundance, it was a post-season estimator and did not allow managers to respond inseason. In 1993, a tower counting program was initiated by Sport Fish Division primarily to enumerate chinook salmon escapement into the Chena River, but also provides information on summer chum salmon. The project is extended with CFMD support to more completely cover summer chum migration. Counting began in early July and continued to late July or early August. The counting site is located on Moose Creek Dam which was constructed as part of the Chena River flood control project, approximately 45 miles from the confluence of the Chena and Tanana Rivers. This location is downstream from most of the chinook and chum salmon spawning grounds. Tower counts have been conducted annually since 1993. Accuracy of the tower count estimates is heavily dependent on the water visibility during the counting period. Of the five years the tower has been operational, good, complete estimates have been obtained for three years, while poor, incomplete estimates were obtained for the other two years. The minimum aerial survey biological escapement goal for the Chena River is 1,700 chinook salmon, while no escapement objectives have been developed for summer chum salmon. In the 3 good years of tower operation (1993, 1994, and 1997) ADF&G has obtained chinook salmon population estimates of 12,241, 11,877, and 13,390.

Reference:

Evenson, M.J. 1996. Salmon studies in Interior Alaska, 1995. Alaska Department of Fish and Game, Division of Sport Fish. Fishery Data Series No. 96-17.

Stuby, L. and M.J. Evenson. In prep. Salmon studies in interior Alaska, 1997. Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services. Fishery Data Series No. 98-XX.

Salcha River Tower.

The history and operation of the Salcha River tower project is similar to that of the Chena River. Prior to 1993, aerial survey estimates were the primary tool used to evaluate commercial, subsistence, personal use, and sport management of chinook and summer chum salmon of this stock. Beginning in 1987, Sport Fish Division began an assessment program using mark-recapture techniques to improve the estimated escapement of chinook salmon. This program was continued through 1992. Although the mark-recapture program appeared to more accurately reflect spawner abundance, it was a post-season estimator and did not allow managers to respond inseason. In 1993, a tower counting program was initiated by Sport Fish Division primarily to enumerate chinook salmon escapement into the Salcha River, but also provides information on summer chum salmon. The project is extended with CFMD support to more completely cover summer chum migration. Counting began in early July and continued to late July or early August. The counting site is located on the Richardson Highway Bridge, approximately 3 miles from the confluence of the Salcha and Tanana Rivers. This location is downstream from most of the chinook and chum salmon spawning grounds. Tower counts have been conducted annually since 1993. Accuracy of the tower count estimates is heavily dependent on the water visibility during the counting period. Of the five years the tower has been operational, good, complete estimates have been obtained for four years (1993, 1994, 1995, and 1997), while a poor, incomplete estimate was obtained for one year (1996). The minimum aerial survey biological escapement goal for the Salcha River is 2,500 chinook salmon and 3,500 summer chum salmon. Chinook salmon tower counts for the four complete count years ranged between 10,000 and 19,000 fish.

Reference:
Evenson, M.J. 1996. Salmon studies in Interior Alaska, 1995. Alaska Department of Fish and Game, Division of Sport Fish. Fishery Data Series No. 96-17.

Stuby, L. and M.J. Evenson. In prep. Salmon studies in interior Alaska, 1997. Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services. Fishery Data Series No. 98-XX.

Delta River Foot Surveys.

The Delta River headwaters begin at Tangle Lakes in the Alaska Range and flows north 80 miles to the confluence with the Tanana River. It is a glacial stream which flows high and turbid during the summer months, with winter flow primarily from sub-permafrost springs in the lower one mile of the river. This spring area forms a unique fall chum salmon spawning area. Survey estimates of Delta River spawning fall chum salmon have occurred on an annual basis since 1972. Beginning in 1975, replicate foot surveys have been the preferred methodology to generate a spawner population estimate. The spawning area is surveyed on a weekly basis from the beginning to the end of spawning. The spawning abundance is estimated annually using the area-under-the-curve method and spawning residency data collected by Trasky in 1973 and 1974. In years for which weekly survey estimates are incomplete, a migratory time-density model has been developed for expanding the peak survey estimate. The minimum biological escapement goal for the Delta River is 11,000 fall chum salmon.

References:
ADF&G, Annual Management Reports for the Yukon Area

Barton, L.H. 1986. Historic data expansion of Delta River fall chum salmon escapements and 1985 population estimates based upon replicate aerial and ground surveys. Alaska Department of Fish and Game, Division of Commercial Fisheries. AYK Region, Yukon Salmon Escapement, Report No. 29.

Trasky, L.T. 1974. Yukon River anadromous fish investigations. Anadromous Fish Conservation Act, Completion Report for period July 1, 1973 to June 30, 1974. Alaska Department of Fish and Game, Commercial Fisheries Division, Juneau, AK. 111p.

Trasky, L.T. 1976. Yukon River king and chum salmon escapement studies. Anadromous Fish Conservation Act, Technical Report for period July 1, 1974 to June 30, 1975. Alaska Department of Fish and Game, Commercial Fisheries Division, Juneau, AK. 78p.

Delta Clearwater River Boat Surveys.
The Delta Clearwater River (DCR) is a major coho salmon producer in the Yukon River drainage. The river is a 20 mile long, spring-fed tributary of the Tanana River, located near Delta Junction. The river supports a popular sport fishery and spawning occurs throughout the mainstem river and in adjacent spring areas. Escapements of coho salmon into the DCR have been monitored by counting fish from a river boat since 1972. In recent years, aerial surveys have been conducted in non-navigable portions of the river. The minimum biological escapement goal into the Delta Clearwater River is 9,000 coho salmon.

Reference:
Evenson, M.J. 1996. Salmon studies in Interior Alaska, 1995. Alaska Department of Fish and Game, Division of Sport Fish. Fishery Data Series No. 96-17.

Stuby, L. and M.J. Evenson. In prep. Salmon studies in interior Alaska, 1997. Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services. Fishery Data Series No. 98-XX.

Chum Salmon Habitat and Productivity Research.
To address some of the limiting factors of chum salmon stocks, the U.S. Geological Survey, Biological Resources Division has undertaken intensive monitoring of special study sites on the Chena and Salcha Rivers for summer chum salmon and at Bluff Cabin Slough near Delta for fall chum salmon, to estimate freshwater survival and examine environmental influences on survival. The first year of field research occurred in 1996. Due to lack of funding, the plans for a second fall chum salmon site on the Toklat River had not been implemented (as of the spring of 1998). Research work is scheduled through the year 2000, with manuscripts to be submitted for publication in 2001.

Data and Project Needs

The Tanana River currently has two separate escapement projects for both the summer and fall seasons within this sub-basin. The summer season assessment projects on the Chena and Salcha Rivers are relatively close in proximity and project duration and in recent years has not fully captured the summer chum salmon abundance picture. Managers have identified the need for an inseason abundance estimate project for Tanana River chinook and summer chum salmon. Establishing a second coho salmon assessment project is a long term management objective.

Restoration Projects or Issues of Concern

Chena River Lakes Flood Control Project.

The Chena River Lakes Flood Control project was authorized by the Flood Control Act in August 1968, by the 90^{th} Congress. The project's purpose was to reduce the possibility of disastrous floods, like the one which devastated Fairbanks and North Pole in August 1967. Major project components include the Moose Creek Dam and floodway and a 20-mile levee paralleling the Tanana River. Initial project construction began in 1973, with most major construction concluded by 1984. U.S. Army Corps of Engineers supervised the phased construction. Moose Creek Dam extends for 7.1 miles between the Tanana River and low foot-hills just north of the Chena River. When a flood event occurs, the gates of the outlet structure in the dam at Chena River are closed. Excess water is stored along the upstream side of the dam. If the water volume is great enough, the excess water would be diverted down the floodway and into the Tanana River. Once the flood has passed, the stored water is released back into the Chena River.

ADF&G, YRDFA and local sport, commercial and subsistence fishermen have raised concerns about the dam's effects on springtime emigration of salmon fry and immigration of adults. In flood years such as 1985, 1991, and 1992, the dam's gates were closed to slow the Chena River's flow to manageable levels. This caused the river to back up and spread throughout the willow and spruce brush in the Chena River valley floodway. In some of these flood event years, seagulls and other birds were seen feeding off salmon fry at several locations. Three locations noted were; above the dam in the backed-up waters, below the dam's chutes where the smolt were dumped via small waterfalls, and in pools of water above the dam when the flood waters receded. The exact effects of these events upon salmon returns are unknown.

In the spring of 1993 YRDFA, through its Annual Meeting resolution 93-1, advocated that the "Corps of Engineers critically evaluate 1) possible modifications to the dam gate structure which would allow water flow over the top rather than under the gates; 2) implementation of design flow criteria; and 3) lowering the Tanana River sill structure." YRDFA also pushed for immediate implementation of salmon restoration projects on the Chena River both as compensation for past damage and as mitigation for current negative impacts of the dam to salmon populations.

In response Senator Stevens secured $250,000 in the FY94 Federal budget to the Army Corps of Engineers for new studies on the interaction between the dam and salmon. The Corps then contracted with the Alaska Cooperative Fish and Wildlife Research Unit of the University of Alaska Fairbanks. During the spring of 1995 and 1996, studies conducted by the Unit's graduate students trapped and sampled outmigrating chinook and chum salmon (Daigneault, 1997; Peterson, 1997). The studies concluded that health and condition and overall survival rates were good for both species. While this data is interesting, it does little to assess the effects of springtime dam closures on salmon populations because water levels were normal in 1995 and 1996.

References:

Daigneault, M.J. 1997. Health and condition of juvenile chinook and chum salmon near the Chena River Dam, Alaska. Master's thesis, University of Alaska, Fairbanks. 122p.

Peterson, B.D. 1997. Estimation of abundance and mortality of emigrating chum salmon and chinook salmon in the Chena River, Alaska. Master's thesis, University of Alaska Fairbanks, 108p.

Lambert, T.M. In Prep. Relation of the Chena River Lakes Flood Control Project to outmigration and abundance of juvenile salmonids. Master's thesis, University of Alaska, Fairbanks.

Chatanika River (Davidson Ditch) Dam.

The Davidson Ditch Diversion Dam is located approximately 1 mile (1.6 km) below the junction of Faith and McManus Creeks near Mile 69 (Km 111) of the Steese Highway north of Fairbanks. The dam was constructed by the Fairbanks Exploration Company from 1925-28 to divert water out of the Chatanika River into a canal and pipeline system that conveyed the water to active mines near Fox, Alaska, more than 35 miles away. The dam was severely damaged by the 1967 flood, with the top half destroyed and washed downstream. The remainder is a sheet pile structure approximately 100 feet (30 m) long and 4 feet (1.2 m) high and blocks the entire river channel. The flow diversion gates are inoperable and the overflow apron has been completely removed by ice and floodwaters. The dam has not been operational since the 1967 flood. The federal license was formally surrendered to the Federal Energy Regulatory Commission in 1979.

The dam has trapped sediment behind it since its construction and is believed to be a barrier to upstream fish migration. Only two species of fish (Arctic grayling and sculpin) are documented upstream of the dam (Al Townsend, ADF&G, Fairbanks, personal communication). Three species of salmon (chinook, chum, and coho salmon), three species of whitefish, sheefish, Arctic grayling, northern pike, burbot, suckers, and sculpin are documented in the Chatanika River downstream of the dam (Shallock, 1963).

On numerous occasions since the late-1960s, the Alaska Department of Fish and Game has sought funding for removal of the dam, or at a minimum, construction of an access channel around the dam. Estimated construction and post-monitoring costs for an access channel is $108,000. Approximately 65 miles (105 km) of upstream fish habitat would become available if fish passage past the dam is created. ADF&G will continue efforts to secure funding for restoration of fish passage around this structure.

Reference:
Shallock, E. 1963. Initial follow-up report for the upper Chatanika project. U.S. Fish and Wildlife Service. Juneau, AK. 52 p.

Timber Harvest.

Small to medium sized commercial logging operations have been in existence for approximately the past 10 years within this drainage. In the upper Tanana River drainage, logging of approximately 1.5 million board feet per year during the past 4 years has been taking place on Tetlin village corporation land. A rough estimate is that 1 acre of land produces 10,000 board feet. The logging in this area has been primarily in upland areas.

Logging of approximately 200,000 board feet (20 acres) per year during the past 10 years has been taking place on Healy Lake Village Corporation lands. All of this logging has been within the Tanana River flood plain.

Logging of approximately 900,000 board feet (90 acres) per year during the past 10 years has been taking place on Nenana Village Corporation lands. Approximately 65% has been within the Tanana River flood plain and the remaining 35% has been in upland areas.

Commercial logging on Native allotments within the Tanana River drainage has been limited with only two parcels having been logged. The total amount logged has been approximately 525,000 board feet (52.5 acres). Logging on both of these allotments has been within the Tanana River flood plain.

Other logging operations within the Tanana River drainage take place on state lands and account for approximately 1.1 million (110 acres) board feet per year. These operations are spread out between Fairbanks and Tok and are split approximately 50/50 between Tanana River flood plain and uplands.

The primary markets for this timber are local house logs, dried planed lumber, and rough cut lumber. Foreign markets include dimensional lumber for post and beam construction in Japan.

Mining.

Although not as famous as the Gold Rush areas of Iditarod and Nome, the Fairbanks mining district was, and is, the leading placer district in all of Alaska. Extensive mining activity occurred in and around every major creek north of Fairbanks (Higgs, 1995). From 1902-1906, more than nine million dollars worth of gold was high-graded from these creeks. Production peaked in 1909, but declined as efforts were forced to shift to deeply buried low-grade deposits.

In 1923, however, the Alaska Railroad from Fairbanks to the Port of Seward was opened, dramatically lowering transportation and production costs and enabling the introduction of new and larger mining equipment.

From 1924 through the late 1950s, major dredging operations occurred on creeks such as Goldstream, Cleary, Pedro, Fish, Little Eldorado, Cripple, Fairbanks and Sheep. Overall, more than 8 million troy ounces of gold were produced out of the Fairbanks district from 1880-1994. One of the most dramatic and disruptive actions to salmon habitat occurred with the construction of the 90-mile "Davidson Ditch" which dammed and diverted water from the Chatanika River for use in large-scale dredging activities. The diversion dam is still in place and prevents migration of adult chinook salmon to prime habitat upstream. It is unknown however, how much chinook salmon productivity would be improved if this habitat were made accessible to salmon.

Other areas of the Tanana River drainage have also seen limited placer mining activity. These include the Chena, Salcha, Delta, Chisana, Chatanika, and Goodpaster Rivers, Healy Creek, and Gold Creek. In the lower Tanana River drainage, extensive mining occurred in the Kantishna River drainage and in the Tofty area northwest of Manley Hot Springs.

It is likely that some salmon habitat was disrupted by placer mining and associated activities in the Tanana River drainage although it would be difficult to quantify. No data on salmon populations were collected prior to, during, or immediately after historic mining operations.

Present day gold mining activities in the Tanana River drainage include both small independent placer mining operations and one large corporate hard-rock project, Fort Knox. The smaller independent operations are primarily concentrated in the Tofty-Eureka mining district, a small number are located in headwater tributary streams of the Alaska Range foothills, and the remainder are widely dispersed throughout the drainage. Fort Knox gold mine is located approximately 15 miles northeast of Fairbanks, in the upper headwaters of Fish Creek Valley. The project is an open-pit mine which started in 1996 and is anticipated to have a 16 year project-life. Currently, exploration is continuing on development of the Pogo Mine, near the Goodpaster River, approximately 35 miles northeast of Delta Junction. Concerns affecting salmon which should be addressed in project planning include access routes and impacts on water quality and quantity. Probably the largest factor determining present day mining activity is market price. Mining activity will fluctuate in relation to market prices with exploration and mining increasing when prices approach $400 per ounce.

Reference:

Higgs, A.S. 1995. A History of Mining in the Yukon River Basin of Alaska. Northern Land Use Research, Inc. Fairbanks, Alaska.

Beaver Dams.
A concern shared with residents of other Yukon River drainage residents is the proliferation of beaver dams. With recent declines in fur markets for beaver pelts, trapping activity has decreased

to low levels. The concern over beaver dams is that they can potentially block spawning salmon access to small streams, side channels, sloughs, and backwaters. This is very important rearing habitat for juvenile coho salmon. This problem is avoided however if fall precipitation levels are normal or high or if seasonal flooding removes the dam.

The RPT recognizes the importance of this issue. The RPT also noted however that beaver dams can serve to create salmon rearing habitat, especially ponds, which are then used by coho salmon and other freshwater fish. More research is needed to understand the relationship between beaver populations and salmon productivity.

Urban Development.

The primary concern regarding urban development expressed by all RPT members was the health of the Chena River, which flows through the city of Fairbanks. Although quite healthy when compared to other urban river systems, the Chena could, nonetheless, be adversely impacted by a variety of problems. These include septic or sewer seepage, siltation and turbidity from stormwater runoff, bank erosion and hazardous material seepage or spills.

At present, no significant problems have been detected other than increased sedimentation due to the lack of flooding caused scour. However, if population growth in the Fairbanks area continues along with increased road building, construction activity, and increased recreational use, Chena River salmon productivity could be adversely impacted by the loss of streamside habitat.

Agricultural Impacts.

The area around the town of Delta Junction is the only area in the Yukon drainage with significant agricultural activity. About a dozen or so farms produce barley in the region. Citizens groups such as Alaska Survival and individual Alaska residents have raised concerns since the late 1980s about the use of pesticides and herbicides to control weeds and grasshoppers. Spring flooding or heavy fall rains could potentially wash these chemicals into important spawning and rearing habitat for salmon, particularly coho salmon. These high water events could also cause heavy siltation and streambank erosion.

Increasing Sportfishing.

Sport fishing for salmon in the Alaska portion of the drainage occurs almost exclusively in the Tanana River drainage, and is primarily targeted at chinook salmon. The largest harvests of chinook salmon occur in the Chena and Salcha rivers. Sport harvests have been increasing in recent years, and in 1996 harvests reached a record high of over 3,000 chinook salmon. It is likely that the larger escapements in recent years are a contributing factor in the large catches. Escapement goals based on aerial survey counts have been established for both stocks, and escapements for both are also monitored with tower counting projects. Many of the spawning streams in the Tanana River drainage are along the road system and can be easily accessed. As the population in this area continues to grow, sport fishing effort will likely increase as well, and the need for accurate in-season stock assessment in a number of streams will become increasingly important in agriculturally developed areas without adequate streamside buffer zones.

Sport Fish Stocking Program.

With in the Yukon River drainage, the Alaska Department of Fish and Game, Sport Fish Division stocks hatchery-reared fish only in the Tanana River drainage. Most of the stocking is for enhancing or establishing sport fishing opportunities. Stocking of anadromous salmon species for the purpose of enhancing wild stocks or creating new stocks by ADF&G and other groups does occasionally occur, and is discussed in other sections. Chinook and coho salmon are stocked into numerous land-locked lakes. Other species which are stocked into Tanana River waters include rainbow trout, Arctic grayling, Arctic char, and lake trout. Most of the lakes in the stocking program are land-locked and initially contained no sport fish. Over 90 different lakes are stocked annually or biennially. These water bodies range from very small gravel pits or ponds to large lakes. Only one stream, Piledriver Slough, is stocked with sterile rainbow trout. Most fish are stocked along the road system near population centers. The intent of the stocking program is to create new sport fishing opportunities and to divert sport fishing effort from wild stocks. Fish stocking is stringently regulated in Alaska. Title 16, Chapter 5 of the Alaska Statutes specifically addresses the transportation and possession of live fish. The stocking of all water bodies includes a formal planning and permitting process.

Reference:

Statewide Stocking Plan for Recreational Fisheries. 1977. Alaska Department of Fish and Game, Sport Fish Division. 333 Raspberry Road, Anchorage, Alaska.

SUPPLEMENTAL PRODUCTION METHODS

The techniques used in the supplemental production of salmon fall into one of two categories: (1) Enhancement--the application to a stock already at natural capacity of procedures designed to increase the numbers of harvestable fish to a level beyond that which could naturally be produced. This may be accomplished by using production systems (e.g. hatchery) or by increasing the natural productive habitat through physical or chemical modifications. (2) Restoration/Rehabilitation--the application to a depressed stock or endangered habitat of fish propagation, habitat restoration, or management techniques to return those stocks to a previously recorded/estimated level of production.

A risk assessment study is necessary to determine if significant biological, social, and economic impacts will result from implementation of enhancement or rehabilitation projects. In this context three primary issues are normally addressed: (1) planning procedures governing enhancement and rehabilitation efforts, (2) fishery management implications, (3) and genetic, disease, fish stocking, and lake fertilization policies and guidelines. Genetic impacts to wild, indigenous fish stocks may occur during the transporting of fish from one location to another for release and when hatchery fish are produced to enhance existing wild stocks. Two potential genetic hazards to wild fish populations are associated with producing hatchery stocks and then transporting them to other locations for release: (1) effects of gene flow between fish stocks and (2) maintenance of adequate genetic diversity within and between fish populations (Davis and Burkett, 1989).

The State of Alaska has a genetics policy that governs rehabilitation, enhancement, and development of salmon populations (Davis et al., 1985). This policy was written to provide guidelines for such activities while protecting the integrity and diversity of wild stocks, the mainstay of the various fisheries. Projects addressed in this plan will be evaluated for conformance to the genetic policy. Before approval, the commissioner will determine that a proposed project can be conducted in a manner to ensure the health and diversity of the stocks and species in the affected area.

The long-range goal of established fish disease policies is to prevent dissemination of infectious finfish and shellfish diseases within or outside the borders of Alaska without introducing impractical constraints for aquaculture and necessary stock-renewal programs (Meyers et al., 1987). Lake fertilization policies guide the efficient use of nutrient enrichment to effectively increase productivity of natural systems.

References:
Davis B. and B. Burkett. 1989. Background of the genetic policy of the Alaska Department of Fish and Game. FRED Division. FRED Report No. 95. Juneau. 13pp.

Davis B., B. Allen, D. Amend, B. Bachen, B. Davidson, T. Gharrett, S. Marshall, and A. Wertheimer. 1985. Alaska Department of Fish and Game Genetic Policy. Genetic Policy Review Team, PWSAC, SSRAA, NSRAA, SJC, UAJ, ADF&G, & NMFS. 25pp.

Meyers, T., P. Krasnowski, D. Amend, B. Bachen, J. Cochran, K. Hauck, K. Rawson, and R. Saft. eds. 1987. Regulation changes, policies and guidelines for Alaska fish and shellfish health and disease control. State Pathology Review Committee (1985-1987). 69pp.

Hatcheries

Generally, hatchery facilities are used as a production base (Figure 8) for salmon rehabilitation and enhancement programs because they are approximately eight times more efficient in converting eggs to juvenile fish than the natural environment (McMullen et al., 1982). The efficiency of such production shortens the time involved in rehabilitating depleted stocks. Because of sizable initial capital investments, hatcheries are an expensive means of supplementing salmon production. Also, the longer a hatchery holds fish, the more money it invests in each one; however, this factor is mitigated by improved survival because typically fish released at a larger size have a higher survival rate. Short-term rearing, for example, can double marine survival and substantially increase hatchery feasibility.

Reference:

McMullen, J. C., and M.W. Kissel. eds. 1982. Annual Report, Division of Fisheries Rehabilitation, Enhancement and Development, 1981. Alaska Department of Fish and Game. Juneau.

In-Stream Incubation Units

For in-stream incubation, a large container, which holds fertilized eggs and substrate in alternating layers, is placed in or alongside a stream. A plumbing system then forces water up through the substrate (Figure 9). These units control the water flow, substrate type, sedimentation, and predation to provide green-egg-to-fry survival rates as high as 90%. In-stream incubators are a low-cost enhancement or restoration technique that may be suited for small operations at remote sites. After artificial spawning of the brood stock and placing of eggs in the unit, minimal care is required. When they are used for enhancement of indigenous stocks, these units can eliminate the genetic and pathology concerns associated with transport of eggs or fry. To effectively apply this technique, the following prerequisites are needed: (1) high-quality water source, (2) adequate head (i.e., height differential to provide sufficient flow) without installing excessive length of piping, (3) suitable stream bottom, and (4) protected area for incubation units. These units can be used to bolster fry production independently or in combination with lake fertilization and/or fish passage projects.

Using artificial propogation along with a protected rearing environment allows for the increased production of fish. This is accomplished in a controlled environment (i.e. hatchery, instream incubator, etc.) which allows for substantial increases in the number of fish which are produced during the early life stages. Various types of incubation technology can increase spawner efficiency from 6 to 9 times greater than what would occur in nature.

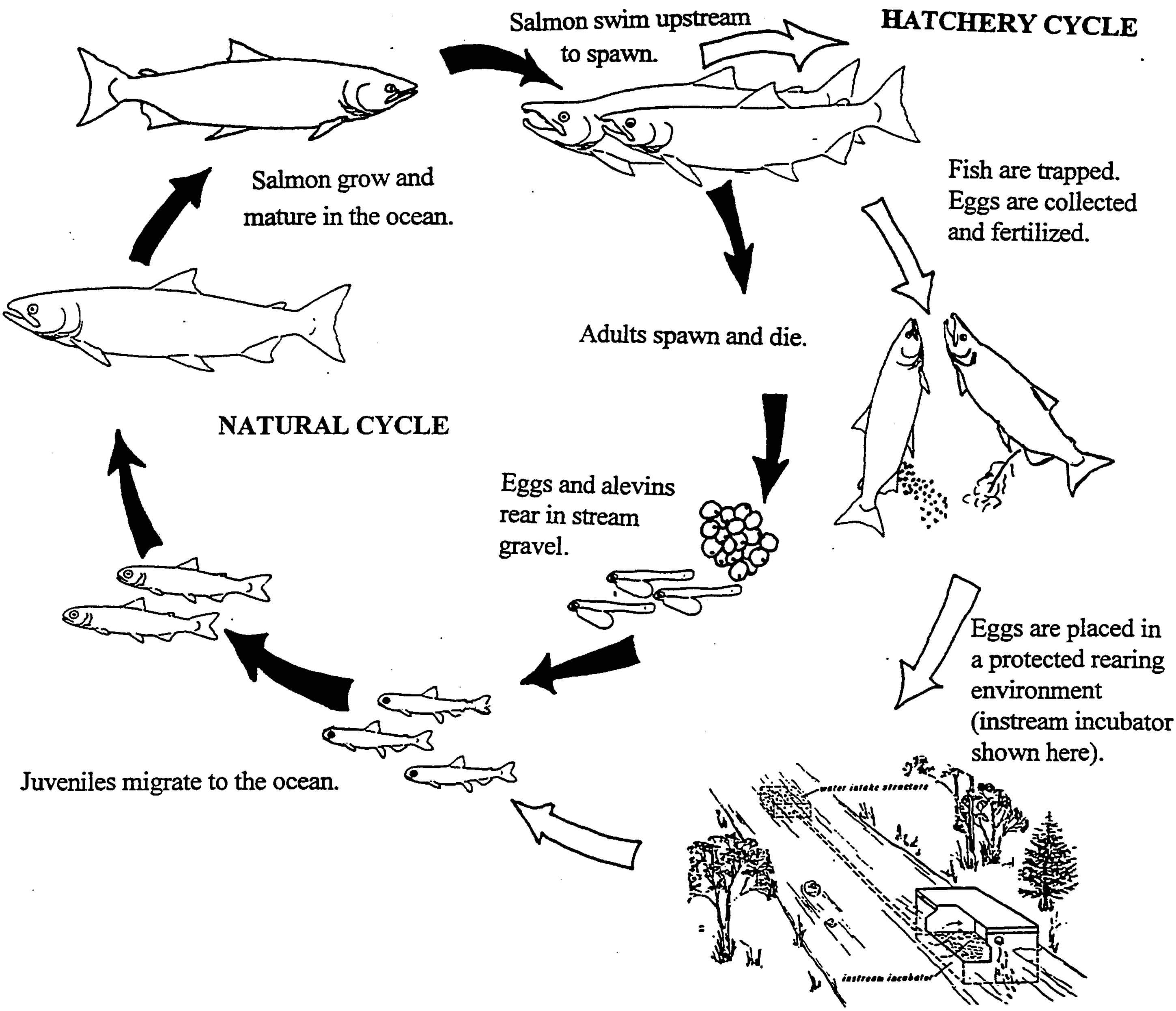


Figure 8. The natural and hatchery life cycle of salmon showing where artificial propagation and hatchery technology are used to increase fish survival.

The instream incubator (streamside incubator, hatch box, or incubation box) is an incubator designed to incubate salmon eggs in their home stream water in a protected environment with conditions similar to those in the natural spawning beds. Water is collected in intake box, which has a head height higher than the outlet of the incubator, and flows downstream through a pipeline into the bottom of the incubator. The water upwells through the substrate and eggs/alevins suppling the fish with a continous flow of oxygen-enriched water. The water exits the incubator via the outlet. Once the fertilized eggs have been placed in the incubator, little maintenance is required. The eggs/alevins develop through the winter and the young fry migrate out of the incubator in the spring. Once the fry leave the incubator they begin their long migration to sea, where they will grow into adults, and then return to their release site to spawn.

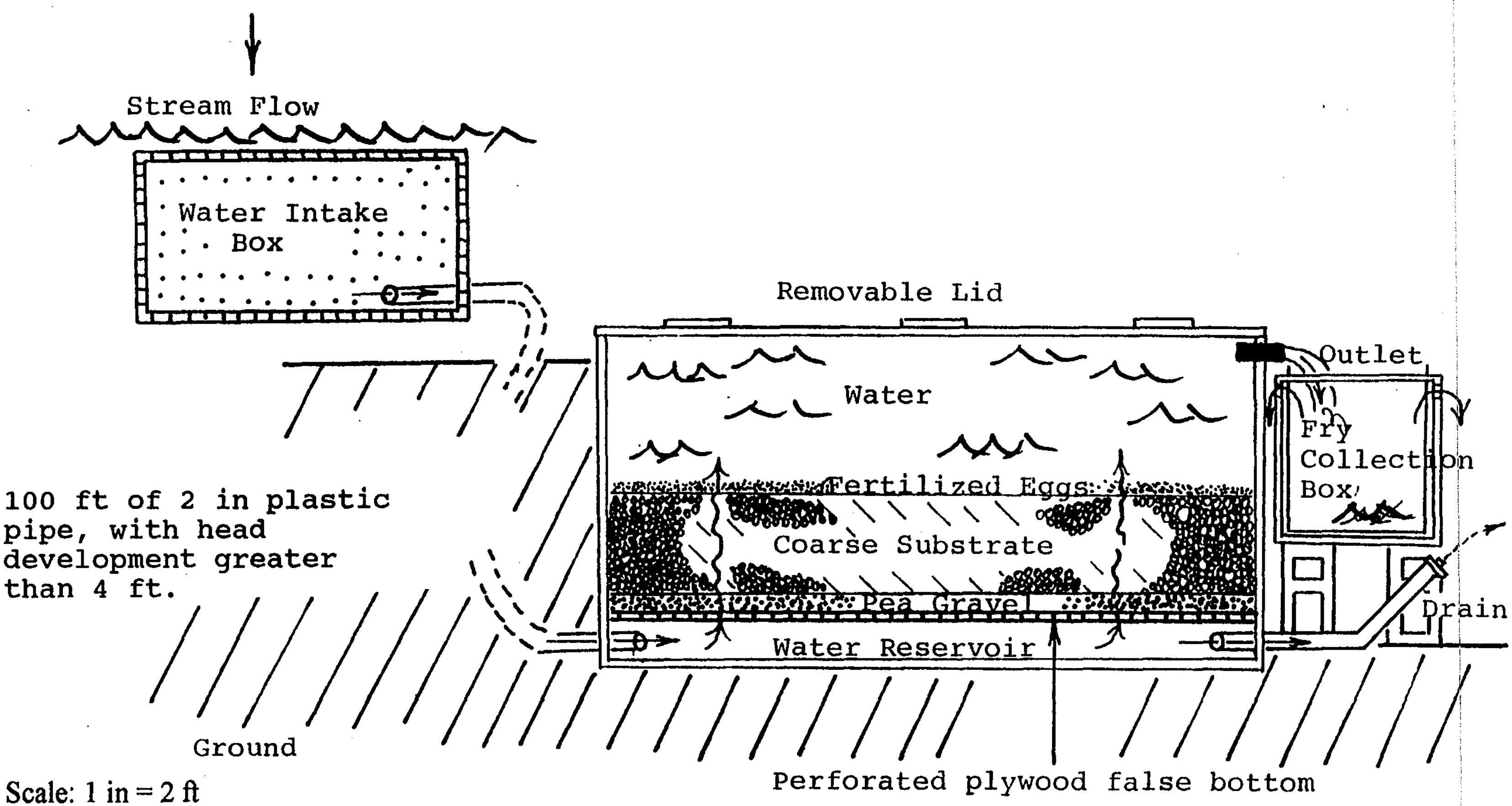


Figure 9. Diagram and explanation of instream incubation for salmon eggs.

Lake and Stream Stocking

When spawning area is limiting salmon production, the utilization of natural rearing area of lakes and streams can be maximized through stocking. Lakes serving as rearing habitat for juvenile salmon (including chinook, coho, and sockeye salmon) that are underutilized because of low escapements, can be maximized through lake stocking.

When streams have areas of underutilized habitat that can serve as natural rearing areas, a variety of stream-stocking techniques may be helpful in rehabilitating declining populations of wild stocks: (1) after artificial spawning, green eggs are planted; (2) after artificial spawning and partial incubation, eyed eggs are planted; (3) after artificial spawning and incubation, unfed fry are released; (4) after artificial spawning, incubation, and partial rearing, fed fry are released; and (5) after artificial spawning, incubation, and rearing, smolts are released into the stream.

Before a stocking project is implemented, specific criteria and procedures need to be considered, including but not limited to (1) prestocking studies as required by ADF&G stocking policy, including limnological and fisheries investigations to determine suitability of lakes for stocking, the rearing/stocking capacity, and to ensure optimal fry growth and survival; (2) basic tenets of genetic and pathology policies and guidelines need to be followed to preserve genetic/disease integrity of both wild and hatchery stocks; and (3) salmon returning to a stocked lake must be available for harvest and have minimal impact to returning wild salmon.

Reference:
ADF&G. 1980. Lake Stocking with Salmon Juveniles for Marine Production Policy Statement. Alaska Department of Fish and Game, March 21, 1980.

Lake Fertilization

Studies have shown significant correlations between the availability of food to juvenile salmon, their size at outmigration as smolts, and their survival in marine waters. Addition of nutrients to lakes that serve as nurseries for rearing salmon increases the quantity of phytoplankton and, in turn, the quantity of zooplankton, which is the major source of food for rearing fish. The goal of lake fertilization projects is to increase growth and survival of juvenile salmon by increasing primary productivity, without significantly changing the plankton community or the lakes trophic condition.

Because of inherent variability within and between lake systems, before an enrichment project is initiated, both limnological and fisheries investigations are done at least two years prior to actual fertilization. Prefertilization limnology field sampling entails water samples collected from two depths, temperature profile from surface to bottom, dissolved oxygen profile from surface to bottom, light penetration measurements, and two replicate zooplankton tows. Samples are typically collected four times the first year and six times the second year. Additionally, if a morphometric map is unavailable, mapping of the lake (transect depth soundings) is necessary. These evaluations of the physical, biological, and chemical status of a lake are required to determine if fertilization is feasible, on a lake-specific basis, and to use such information as a gauge to measure the success of a nutrient enrichment project.

Reference:
ADF&G, Lake Fertilization Team. 1979. Policy and Guidelines for Lake Fertilization. Alaska Department of Fish and Game, FRED, Commercial Fish, and Sport Fish Divisions, June 30, 1979.

Fish Habitat Restoration and Improvement

Spawning Channel

Artificial spawning channels are designed to increase and enhance natural spawning habitat through control of such factors as water flow, substrate, sedimentation, and predation, thereby increasing egg-to-fry survival rates. While the average egg-to-fry survival rate in a natural stream may be as little as 10% or 15%, the introduction of spawning channels may increase those rates to as high as 80%. Implementation of this technique requires a controllable water source, proper terrain, and sufficient brood stock.

Stream Clearance/Improvement

Despite its simplicity and cost-effectiveness, this technique must be considered carefully because of accompanying risks. Complete removal of physical barriers (e.g., beaver dams, rocks, logs, driftwood, or other debris) may result in an increase in water velocity, downstream scouring, and elimination of pooling areas; therefore, selective removal of a portion of a barrier sufficient to allow the passage of fish upstream without substantially altering the flow of water or downstream conditions is required. When evaluating potential stream clearance projects, assessments should be made of spawning or rearing habitat that will be made available, the portion of the barrier to be removed, availability of sufficient spawning populations, and the relative costs (e.g. time and equipment) involved.

Required applications vary from system to system. In some instances, the rearranging of rocks or logs by hand to provide resting pools and shorten jumps over falls may be all that is needed. One of the after effects of storms in an area is that gravel deposits and other debris frequently block the mouths of streams, effectively denying access to upstream spawning/and or rearing habitat. The partial removal of these obstructions can be an effective means of providing that access. Providing access to blocked side channels, lakes, or sloughs can also in some instances provide additional rearing area for coho salmon.

Fish Passage Improvements

The construction of a fish pass (fish ladder, steep pass, fishway) is a more permanent form of habitat modification to enable fish access to spawning and rearing habitat beyond impassable barriers such as high-velocity rapids or waterfalls. This technique can be applied either as a (1) fish pass made of concrete, steel, or aluminum to bypass a barrier or (2) as an alteration of the barrier itself through explosives to provide a series of ascending/resting pools. The success of either of these applications will depend on an adequate preconstruction or preblasting evaluation, including estimates of high- and low-water flows and number and species of fish using the system to ensure sufficient utilization and absence of conflicts with any unique fish stocks above a barrier. Generally, experience in the application of this technique over a broad range of barriered systems indicate that a well-placed fish pass can result in a significant increase in production.

Other Restoration and Improvement Techniques

In addition to spawning channels, stream clearance projects, and fish passes discussed in the previous sections, there are a number of other techniques that can be used to restore or improve fish habitat. Techniques such as stream bank stabilization or structures to maintain stream riffles and pools have been used in other areas of Alaska to improve salmon spawning and rearing habitat. Habitat structures such as boulders and large woody debris can be utilized in certain situations to improve rearing areas, thereby increasing production. Water level or water flow direction can be adjusted with the use of various structures to improve fish production. It is also possible to connect ponds to existing systems to expand available rearing areas and improve production. As with the other techniques discussed here, habitat manipulation projects must be carefully evaluated prior to their installation. Before implementing these projects, sites should be monitored and evaluated for a one-year period. Seasonal visits will be most critical during low-water flow and during extremely cold and hot periods. The most important parameters to evaluate include water temperature, volume, velocity, and dissolved oxygen content. A map of the existing and proposed habitats should be drawn, and engineering plans may need to be developed. Finally, when the project has been completed, it must be monitored and maintained on a regular basis to assure that it is operating as designed.

Test Fishing

Test fisheries depend on standardization of gear and methods from year to year. Test fisheries are all about relative abundance, and good timing information for management. The key is trying to operate similarly year to year in order to make comparisons. Fish wheel and gillnet gear should use the same methods year to year to be comparable. In order for the information to be comparable, the actual operational details need to be as similar as possible each year. For gill net test fisheries, that includes picking nets in the same manner, at the same time each day or stage of tide, and the same number of times per day. For test fish wheels, the wheels need to be of a consistent size each year, the leads need to be used in a consistent manner, and the wheel needs to be fished in a consistent way (distance from shore, how far the basket is fished off the bottom, the angle of the wheel to the current, etc). The easiest way to maintain operational consistency of test fish projects is to have the same operators return each year. Variables that are beyond the control of the test fishery operator include water level, fish sizes, weather, debris, etc.

Sonar

Precise management of salmon fisheries requires timely knowledge of abundance. To provide this information, riverine sonar abundance assessment technology has developed along two major lines; one line of development focused on tributary assessment and the other was designed to assess main river fish passage. In large main rivers like the Yukon, hydroacoustic sampling techniques hold the greatest opportunity to provide daily estimates of the total number of fish migrating upstream before component stocks arrive at smaller tributary streams where traditional fisheries abundance assessment techniques such as counting towers, weirs, and aerial surveys can be used. However, while sonar data can be used to generate fish abundance estimates in very large rivers, successful operations depend upon satisfying several rigid deployment requirements. In essence, this means that all or a known fraction of the target fish population must pass through the ensonified water column and be detected. The most critical elements which must characterize a candidate sonar site include a single, constricted channel with a linear bottom profile in the area used by migrating fish, preferably within 1000 feet of each shore. It must also be located far enough downstream to provide timely information to the manager. The key is to locate each sonar project as far downstream as we can find an acceptable complement of sonar assessment conditions.

Current state of the art sonar technology can provide fish passage estimates under reasonable acoustic assessment conditions, but species composition must be estimated through non-acoustic means. Typically this is accomplished with standardized gill net catch data, adjusted for size-dependent differences in catchability. Sonar and gill net catch data are subsequently co-processed into estimates of passage by species using sophisticated software developed for each large river sonar site. The need to conduct independent gill net operations typically more than doubles overall project costs however.

One factor which lends particular usefulness to sonar project abundance data lies in a quick turn around time from raw data acquisition to preliminary passage estimate production. This allows the manager an ability to evaluate run strength and respond with management actions quickly.

Advances in applicable sonar technology beyond that currently employed in large river fisheries applications are not likely to yield significantly better or more informative data in the foreseeable future. Fundamental acoustic problems, inherent to riverine applications in particular, limit the quality of the lowest level data collected. These problems, including very low signal to noise ratios and associated acoustic boundary issues at increasing listening ranges, will continue to minimize opportunities to automate the individual fish identification and tally process used to generate fish passage estimates. Rather, significant advances in contemporary sonar assessment capabilities are likely to be realized in advances in tributary sonar equipment, which will proceed from non-user configurable, black-box technology to user configurable, multiple simultaneous estimation technique capable equipment currently in development. However, under even the most optimistic scenario, this new generation equipment will not be operational for several years.

Mark-Recapture

The marking and recapture of fish is an old and powerful research tool available to fishery biologists. The first stage of a mark-recapture study involves the capture and marking of fish during a given time period at a given location, and recording the number that were released back into the population. During subsequent time periods, at the same location or different locations, as appropriate, a sample is obtained and examined for marks. The number of fish examined and the number of fish with marks in subsequent samples are recorded. Mark-recapture studies can be designed to provide several types of information. Common objectives include documenting presence of a given population at either the tag or recapture location, studying migration corridors or migration timing, estimating survival rates, estimating abundance of single stocks, and estimating the relative abundance of multiple stocks in a location where stocks are mixed.

A detailed discussion of the variety of information that mark-recapture studies could potentially provide is beyond the scope of this document. However, mark-recapture studies can provide fundamental and extremely important information to fishery managers and researchers. A common objective in a mark-recapture study is to provide an estimate of abundance of a given population. An estimate of abundance is often the single most valuable piece of information necessary for effective fishery management. To estimate abundance within a river, a sampling method (e.g. fish wheel) is utilized to capture and mark fish over a given time period. Fish are captured and examined for marks upriver of the release site. An estimate can then be computed of the number of fish that passed the sampling sites during the study period. Another objective may be to estimate the contribution of multiple stocks (either wild or hatchery origin) in a location where stocks are mixed. For example, for hatchery stocks, fish can be marked and released as fry. When the hatchery stocks return as adults, samples can be obtained from fisheries, existing projects, or newly designed sampling projects, to examine fish for marks. In this manner, estimates can be obtained of the hatchery stock contribution to fishery harvests or escapements where they have been sampled.

While mark-recapture techniques provide a powerful research tool, studies must be designed, implemented, and summarized with great care. The design of a sampling plan is particularly important to ensure the sample sizes will be adequate to meet the objectives of the study and to attempt to control for other influential factors which could bias study results. The analyses in a mark-recapture study must carefully examine the data and test assumptions whenever possible so that appropriate models are used. JTC (1996) provides a good summary of the capabilities and limitations of the technique, and discusses potential applications within the Yukon River drainage.

Reference:
JTC. April, 1996. Capabilities and Potential Applications of Adult Salmon Tagging Methods in the Yukon River Basin.

Catch-per-unit-effort

Catch-per-unit-effort (CPUE) statistics express the size of a catch relative to a unit of effort (e.g., boat-hours). In practice, it may be difficult to obtain a measure of effort that accurately reflects the efficiency of the fishing fleet. The information most commonly used to develop measures of effort are the number of fishermen participating in a fishery and the length of fishing periods. Although these are obviously significant, other factors may also influence the efficiency of a fleet. Over a short period of time, environmental factors such as water level and weather can have a profound influence on efficiency, in either direction. If a fishing fleet is extremely efficient or is large enough to saturate the available fishing grounds, the bulk of the harvest may be taken early in a fishing period, and a change in the length of fishing periods will not result in a corresponding change in the catch. In these cases, use of the length of fishery openings in the measure of effort can produce misleading results. Widespread and relatively rapid changes in gear can obviously influence the efficiency of a fleet, and complicate historical comparisons of CPUE. Changes in the efficiency of a fleet can also occur more subtly over a longer period of time. The gradual adoption of new technologies and accumulation of knowledge and experience by the fishermen often increases the efficiency of a fleet in ways that are difficult to account for. Similarly, gradual changes in the distribution of fish or in fishing patterns can produce significant changes in the relationship between catch and measures of effort over time.

CPUE is simple to compute and is intuitively meaningful. In many cases, it is the only indicator of abundance available to managers. Under the right conditions, it can be a helpful fishery management tool. However, care should be taken to develop a measure of effort that most accurately reflects the efficiency of the fleet. Even then, reliance on CPUE as an indicator of abundance should be tempered with an awareness that CPUE can be substantially influenced by factors that may be difficult to account for.

Aerial Surveys

Aerial survey escapement indices are normally used for trying to estimate relative salmon abundance and/or run timing for streams which are not assessed by any other escapement counting method. Typically, salmon counts made from aircraft are used as monitoring tools on spawning index streams or for exploring salmon abundance in unmonitored streams. Although, on the Yukon River, this information is usually not useful for in-season management decisions because the fish have passed beyond the fishery, it may be useful in assessing the effects of in-season management actions. Counting index sections allows the development of index objectives for escapement abundance by stream. The primary shortcoming of aerial surveys is that the comparability and annual success is highly dependent upon timing, aircraft, weather, personnel, fiscal constraints, and the stream habitat. Specific objectives of the aerial survey program for the Yukon Management Area are:

- Estimate the abundance of spawning salmon by species in selected spawning streams.
- Estimate the timing and distribution of spawning salmon by species in selected spawning streams.
- Monitor and protect fishery habitats.

Reference:
Barton, L.H. 1987. Yukon Area Salmon Escapement Aerial Survey Manual. Alaska Department of Fish and Game. Division of Commercial Fisheries. Fairbanks, Alaska. 14p.

Harvest Surveys

Effective fishery management requires estimating or documenting the number of fish harvested by all fisheries. Harvest surveys are important for documenting fish catches for areas which do not have a reporting requirement. Typically subsistence fisheries are the primary fishery without a reporting requirement. Managers have primarily used harvest surveys to estimate the subsistence harvest. Survey methods may include harvest calendars, personal interviews, telephone interviews, and mail questionnaires. Documenting subsistence harvests is important to show trends, document use, assist in allocating harvest among users, and establishing local need levels. The quality of the harvest estimate is dependent upon the collection of complete and accurate information. Survey problems include; inaccurate information due to poor memory as a result of post-season interviewing, inaccurate species identification, low response rate, false reporting, and inappropriate survey questions or methods. It is important that both managers and resource users have confidence in the survey information because accurate information is usually one of the first steps toward resolving harvest issues.

Towers

Counting towers are widely utilized around the state in streams where the water depth and clarity generally permit accurate visual observation of the number and species of migrating salmon. While most streams are subject to conditions which prevent accurate counting for some period of time, methods exist for estimating missed counts. If the time without counts does not exceed a few days, and there is good count information before and after the missed period, managers rely on estimates of the passage during the missed periods that are calculated using counts from the adjacent (before and after) time periods. Towers require minimal technology, training, and equipment, and are applicable and efficient on streams that fit basic clarity and depth criteria.

Tower platforms are utilized because they elevate the observer above the stream which allows them to see clearly into the water to the stream bottom and from bank to bank, or halfway out if using a dual-bank operation. Counting towers may be as simple as a high river bank or a tree stand. Steel or aluminum scaffolding is commonly used for a tower. Most tower counts are conducted during 15 to 20 minutes of each hour and expanded to an hourly count. Polarized sunglasses and a mechanical counting device (tally whacker) are the typical equipment necessary for counting fish from a tower.

Weirs

Weirs used for fishery management or research purposes can generally be described as some type of fence structure set in a waterway which allows documentation of fish passage beyond the fence. Weirs are typically used in small to medium sized tributaries which have stable bottom substrates. The primary cause of failure for weirs is the inability of the weir to withstand high water flows, typically associated with increased debris, which turns the weir into a dam and causes the weir to washout. Weirs used for counting fish will usually incorporate some type of trap in the middle of the structure to capture migrating fish for collection of biological information.

In small tributary streams, weirs may be constructed of "t-stakes" and wire fencing. In medium sized tributaries, wooden or metal tripods weighed down with sandbags typically form the base frame for attaching upper and lower perforated stringers through which metal or plastic pipe forms the fence. A more recent development, a "floating resistance weir" is usually used in medium sized tributaries. The "floating resistance weir" is less prone to wash out because the fencing is secured to a bottom cable track or rail in the stream bed. The fence lays or floats with the water flow. Debris collects at the top of the fencing and is easily cleared off. As the water level rises the floating fence rises also, up to a point. High stream flows can exceed the design capacity of floating resistance weirs and the water will begin flowing over the top of the weir. At high water flows these weirs are self cleaning.

Local Knowledge

An important tool for fisheries management is the use of local fishermen's and elders knowledge. This knowledge may either be based on generations of accumulated fishing experience or inseason observations. Usually the information is oral and not quantitative. The information comes in many forms and is not simply anecdotal information. Examples include:

- Where salmon occur in the drainage
- Predicting how springtime weather patterns and river conditions foretell fish behavior (timing and migrational pattern). A specific example is elders in the Lower Yukon Delta predicting the timing of the chinook salmon run and which mouth the fish will predominately enter the river based on the timing of the waterfowl returns and springtime weather conditions.
- Describing how weather patterns, river conditions, and/or seasonal events will affect fishing effort and efficiency
- Interpreting what the condition of fish harvested (bright, semi-bright, blush, watermarked, etc.) means for the remaining portion of the run and/or spawning destination
- how this year's run strength compares with other years. Commonly expressed in general terms but also in more definable terms such as fish caught per 30-minute drift or fish caught per hours of fish wheel operation
- how many fish have been seen entering local streams
- observations of fish migration patterns related to water currents, bottom substrate, bank preferences, is the run steady or moving in pulses, and at what depth are the fish traveling

Local knowledge is most valuable when combined with quantitative management tools.

LITERATURE CITED

(Note: This section contains the references for all literature cited in pages 1-59 of this report. References for the remainder of the report are provided at the end of each section heading.)

ADF&G (Alaska Department of Fish and Game). 1985. Annual management report, 1985, Yukon Area, Division of Commercial Fisheries, (Region III, unpublished report), Anchorage.

ADF&G (Alaska Department of Fish and Game). 1985. Socioeconomic Aspects of the Yukon River Salmon Fisheries, A Discussion Paper. Compiled by Sid O. Morgan. Juneau, Alaska.

ADF&G (Alaska Department of Fish and Game). 1987. Family Fish Camps of the Yukon River. Alaska Depar5tment of Fish and Game, Division of Subsistence. Wildlife Use Notebook Series No. 3.

ADF&G (Alaska Department of Fish and Game). 1993. Annual Management Report for Subsistence. Personal Use, and Commercial Fisheries of the Yukon Area, 1992. Division of Commercial Fisheries, Anchorage.

ADF&G (Alaska Department of Fish and Game). 1995. Annual Management Report, 1993, Yukon Area, Division of Commercial Fisheries, Anchorage.

ADG&G (Alaska Department of Fish and Game). 1997a Annual Management Report Yukon Area, 1995. Commercial Fisheries Management and Development. Regional Information Report No. 3A97-14. Anchorage, Alaska.

ADF&G (Alaska Department of Fish and Game). 1997b. Annual Management Report Yukon Area, 1996. Regional Information Report No. 3A97-41. Division of Commercial Fisheries Management and Development. Anchorage, Alaska.

ADG&G (Alaska Department of Fish and Game). 1997c. Salmon Fisheries in the Yukon Area, Alaska, 1997. Report to the Alaska Board of Fisheries. Regional Information Report No. 3A97-43. Anchorage, Alaska.

ADF&G (Alaska Department of Fish and Game). In Prep. Annual Management Report Yukon Area, 1997. Regional Information Report No. 3AXX-XX. Division of Commercial Fisheries. Anchorage, Alaska.

Allen, Henry T. 1887. Report of an Expedition to the Copper, Tanana, and Koyukuk Rivers, in the Territory of Alaska, in the Year 1885. Government Printing Office, Washington D.C.

Ando, S. 1986. Studies on the Food Biochemical Aspects of Changes in Chum Salmon, *Oncorhynchus Keta*, During Spawning Migration: Mechanisms of Muscle Deterioration and Nuptial Coloration. Memoirs of the Faculty of Fisheries. Hokkaido University. Vol. 33, No. 1-2.

Andrews, E. F. and M. C. Pete. 1991. "Non-competing Small-Scale Fisheries in Western Alaska: Subsistence and Commercial Fishing by Native Alaskans." In: La Recherche Face a la Peche Artisinale, Symp. Int. ORSTROM-IFREMER, Montpelier France, 3-7 Juillet 1989, J. R. Durand, J. Lemoalle et J. Weber (eds.). Paris, ORSTROM, t. II: 543-550.

Andrews, E. F. and D. Albrecht. 1992. "Participation in and Contributions to Fisheries Management by Alaskan Tribal Groups: Case Examples from the Salmon Fisheries of the Yukon and Kuskokwim Rivers." Paper presented at the American Fisheries Society, 122nd Annual meeting, Rapid City, South Dakota, September 14-17, 1992.

Aro, K.V. 1972. Recoveries of salmon tagged offshore in the North Pacific Ocean by Japan and the United States in 1970 and 1971, and additional recoveries form earlier tagging by Canada, Japan, and the United States. Fisheries Research Board of Canada, Manuscript Report 1186.

Aro, K.V., J.A. Thomson, and D.P. Giovando. 1971. Recoveries of salmon tagged offshore in the North Pacific Ocean by Japan and the United States, 1959-1969. Fisheries Research Board of Canada Manuscript Report 1147.

Berger, T.R. 1985. Village journey: The report of the Alaska Native Review Commission. Hill and Wang, New York.

Buklis, Lawrence S. 1993. Documentation of Arctic-Yukon-Kuskokwim Region Salmon Escapement Goals in effect as of the 1992 Fishing Season. Regional Information Report No. 3A93-03. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Anchorage Alaska.

Davis B. and B. Burkett. 1989. Background of the genetic policy of the Alaska Department of Fish and Game. FRED Division. FRED Report No. 95. Juneau.

Davis B., B. Allen, D. Amend, B. Bachen, B. Davidson, T. Gharrett, S. Marshall, and A. Wertheimer. 1985. Alaska Department of Fish and Game Genetic Policy. Genetic Policy Review Team, PWSAC, SSRAA, NSRAA, SJC, UAJ, ADF&G, & NMFS.

CFEC (Commercial Fisheries Entry Commission). 1997. State of Alaska Commercial Fisheries Entry Commission 1996 Annual Report. Commercial Fisheries Entry Commission. Juneau, Alaska.

Crapo, C. Progress Report, Analysis on Alaska Chum Salmon. Fishery Industrial Technology Center. Kodiak, Alaska. March 4, 1997.

Ellanna, L. J. 1980. Bering-Norton petroleum development scenarios and sociocultural impact analysis, volumes I and II. Technical Report No. 54. Bureau of Land Management, Alaska OSC, Anchorage, Alaska.

Feit, H. A. 1983. The future of hunters within nation-states: anthropology and the James Bay Cree, in E. Leacock and R. Lee (eds), Politics and History in Band Societies, Cambridge University Press.

Fitzgerald, R. 1995. Lost in a Sea of Salmon, Alaska's Prized Arctic Chums Lose Out in a Market Awash with Cheap Salmon. Seafood Leader, November/December, 86-88.

Gilbert, C.H., and H. O'Malley. 1921. Investigation of the salmon fisheries of the Yukon River. In Alaska Fishery and Fur-Seal Industries in 1920. Ward T. Bower, Agent. Bureau of Fisheries Document No. 909. Government Printing Office, Washington D.C.

Gilbert, C.H., and W.H. Rich. 1925. Second tagging experiment in tagging salmon in the Alaska Peninsula Fisheries Reservation, summer of 1923. U.S. Bureau of Fisheries, Fisheries Bulletin 42:27-75.

Greenberg, J.A., M. Herrmann, T. Johnson, and A. Streletsky. 1994. The Russian Salmon Fishery: Alaska's Next Big Threat. Agribusiness, Vol. 10, No. 3, 241-258.

Herrmann, M. 1993. Using an International Econometric Model to Forecast Alaska Salmon Revenues. Marine Resource Economics, Vol. 8, pp.249-271.

Higgs, A.S. (Prepared by). 1995. A History of Mining in the Yukon River Basin of Alaska. Northern Land Use Research, Inc. Fairbanks, Alaska.

JTC (United States/Canada Yukon River Joint Technical Committee). 1993. Yukon River Salmon Season Review for 1993 and Technical Committee Report. November 17-18, 1993. Whitehorse, Yukon Territory.

JTC (United States/Canada Yukon River Joint Technical Committee). 1995. Yukon River Joint Technical Committee Report. November 8-9, 1995. Whitehorse, Yukon Territory.

JTC (United States/Canada Yukon River Joint Technical Committee). 1997. Yukon River Salmon Season Review for 1997 and Technical Committee Report. November 5-6, 1997. Whitehorse, Yukon Territory.

Knapp, G., Project Director. 1996. Markets for Alaska Chum Salmon. Salmon Market Information Service. Background Material for Hatchery Policy Group Forum—October 8-11, 1996. University of Alaska, Anchorage. September.

Knapp, G., Project Director. 1998. Salmon Market Bulletin. Salmon Market Information Service. University of Alaska, Anchorage. April 17, 1998, No. 31.

McLean, R. and J.A. Raymond. 1981. Lower Yukon River Hatchery Site Investigation, Vol. II. Alaska Department of Fish and Game, Division of Fisheries and Rehabilitation, Enhancement and Development. Juneau, Alaska.

McLean, R. and J.A. Raymond. 1983. Lower Yukon River Hatchery Site Investigation, Vol. I. Fred Report Number 12. Alaska Department of Fish and Game, Division of Fisheries and Rehabilitation, Enhancement and Development. Juneau, Alaska.

McMullen, J. C., and M.W. Kissel. eds. 1982. Annual Report, Division of Fisheries Rehabilitation, Enhancement and Development, 1981. Alaska Department of Fish and Game. Juneau.

Medallion Laboratories. Y-1 Salmon "Fall Chum". Medallion Labs ID No. 96044133. Minneapolis, Minnesota. Date Submitted, 1996 August 21.

Meyer, K.G. 1983. Recoveries of salmon tagged offshore in the North Pacific Ocean by Japan and the United States in 1980, 1981, and 1982, and additional recoveries from earlier tagging by Canada, Japan, and the United States. Fisheries Research Institute, University of Washington, Seattle. FRI Circular 83-1.

Meyers, T., P. Krasnowski, D. Amend, B. Bachen, J. Cochran, K. Hauck, K. Rawson, and R. Saft. eds. 1987. Regulation changes, policies and guidelines for Alaska fish and shellfish health and disease control. State Pathology Review Committee (1985-1987).

Pope, D. 1980. The Freshwater Salmon Fisheries. Findings, conclusions and recommendations regarding the effects of controlling commercial entry into the upper Yukon and other freshwater salmon fisheries in the state. To the Eleventh Alaska Legislature. 912 West Sixth Ave., Anchorage, Alaska.

Richardson, W.P. [1900] 1964. Yukon River exploring expedition: winter conditions along the Yukon, 1899. Extracted from 56th Congress, 1st session-Senate Report 1023, Washington D.C.

Seeb, L.W., P.A. Crane, and R.B.Gates. 1995. Progress Report of genetic studies of Pacific Rim chum salmon and preliminary analysis of the 1993 and 1994 South Unimak Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report No. 5J95-07. 97pp.

The Lower Yukon/Kuskokwim Regional Planning Team. 1983. Lower Yukon/Kuskokwim Regional Salmon Fishery Overview. A Pre-Planning Document. Bethel, Alaska.

The Lower Yukon/Kuskokwim Regional Planning Team. 1983. A Bibliography: Salmon and Related Fisheries in the Lower Yukon and Kuskokwim Region. Alaska Department of Fish and Game Lower Yukon/Kuskokwim Regional Aquaculture Association.

Wolfe, R. J. 1981. Norton Sound/Yukon Delta sociocultural systems baseline analysis. Technical Paper No. 59. Prepared for Subsistence Division, Alaska Department of Fish and Game and Socioeconomic Studies Program, Alaska Outer Continental Shelf Office. Bureau of Land management.

Wolfe, R. J. 1984. Commercial Fishing in the Hunting-Gathering Economy of the Yukon River Yupik Society. Etudes/Inuit/Studies Supplementary Issue 8:159-183.

Wolfe, R. J. and R. J. Walker. 1987. Subsistence Economies in Alaska: Productivity, Geography and Development Impacts. Arctic Anthropology 24(2): 56-81.

Zagoskin, Lavrenti A. [1847] 1967. Lieutenant Zagoskin's travels in Russian America, 1842-44. Arctic Institute of North America, Anthropology of the North: Translations from Russian Sources, No. 7. Edited by Henry N. Michael. Toronto: University of Toronto Press.

DEFINITIONS

action point - is a threshold value for some quantitative indicator of stock run strength at which some explicit management action will be taken to reach the escapement goal. An action point may be derived from criteria about locations or dates and may include a statistical projection of abundance, escapement, or harvest.

ADF&G - Alaska Department of Fish and Game

alevins - newly hatched fish on which the yolk-sac is still apparent.

allocation - to apportion, through regulation, salmon harvest to various user groups (i.e., subsistence, sport, or commercial fishermen).

anadromous - fish such as salmon that are hatched in fresh water, migrate and feed at sea, and return to fresh water to spawn.

artificial propagation – human assisted fertilization of fish eggs.

aquaculture - culture or husbandry of salmon (or other aquatic fauna/flora).

aquatic plant - any species of plant, excluding the rushes, sedges, and true grasses growing in a freshwater, marine aquatic or intertidal habitat.

AVCP- Association of Village Council Presidents

barter - the exchange or trade of fish or game, or their parts, taken for subsistence uses for (1) other fish or game or their parts or (2) other food or for nonedible items other than money, if the exchange is of a limited and noncommercial nature.

BSFA - Bering Sea Fishermen's Association

benthic - bottom-dwelling fish such as burbot and sculpin.

biological escapement goal (BEG) - is the estimated escapement that produces the greatest yield, is the specific management objective for the escapement, is developed from the best available biological information, and is scientifically defensible on the basis of available biological information. The BEG is determined by ADF&G.

biomass - the combined weight of a group of organisms; for example, a school of herring.

Board of Fisheries - The seven member board appointed by the governor and confirmed by the legislature who have regulatory-making powers for conserving and developing the fishery resources of the state.

CATG- Council of Athabascan Tribal Government

brood stock - salmon contributing eggs and milt for supplemental culture purposes.

CFEC - Commercial Fisheries Entry Commission. Established by the legislature in 1973 as a regulatory and quasi-judicial state agency. The commission consists of three members appointed by the governor and confirmed by the legislature with regulatory authority to establish moratoria or limited entry systems for state-managed fisheries.

CFMD Division - Commercial Fisheries Management and Development Division

coded wire tag - magnetically detectable pin-head-sized tag implanted in the snout of a young fish for identification as an adult. Implanted fish also have their adipose fin removed as an external sign that they carry a coded wire tag.

commercial fishing - the taking, fishing for, or possession of fish, shellfish, or other fishery resources with the intent of disposing of them for profit, or by sale, barter, trade, or in commercial channels.

commissioner - principal executive officer of the Alaska Department of Fish and Game.

commissioner approval - formal acceptance by the commissioner of a comprehensive salmon production plan or other RPT product or recommendation.

comprehensive salmon production plan - a statutorily-mandated, strategic plan, spanning a specified number of years (10- to 20-year range), for perpetuation and increase of salmon resources on a regional basis.

criteria - accepted measures or rules for evaluation of programs, project proposals, and operations.

depressed stock - a stock (of fish) that is currently producing at levels far below its historical levels.

enhancement - strategies/procedures designed to supplement the harvest of naturally produced stock (e.g. salmon) beyond what could be naturally produced in its natural habitat. This can be accomplished by artificial or semi-artificial production systems or by an increase in the amount of productive habitat in the natural environment through physical or chemical changes.

escapement - is the annual estimated size of the spawning stock. Salmon that pass through the fisheries to return upstream to a spawning ground or used as brood stock in a hatchery.

Quality as characterized by sex and age composition may be considered in estimating escapement.

euphotic zone - constituting the upper layers of a body of water into which sufficient light penetrates to permit growth of green plants.

Exclusive Economic Zone - All waters within 200 nautical miles of Alaska and its outlying islands.

ex-vessel value - price paid to the commercial fishermen for their catch.

eyed egg - stage in which the eyes of the embryo become visible.

fecundity - number of eggs per adult female salmon (or other fish).

fingerling - stage of salmon life between fry and smolt.

fishery - a specific administrative area in which a specific fishery resource is taken with a specific type of gear.

fish pass - fish ladder to enable salmon to get past a barrier (e.g., waterfall) to reach spawning grounds.

fish stock - a species, subspecies, geographic grouping, or other category of fish manageable as a unit.

fish wheel - a fixed, rotating device for catching fish that has no more than four baskets on a single axle and is driven by river current or other means.

five-year action plan - section of a comprehensive salmon production plan that recommends projects for implementation within the next five years.

fry - stage of salmon life from emergence from gravel until it doubles its emergence weight.

gillnet - a net primarily designed to catch fish by entanglement in the mesh and consisting of a single sheet of webbing hung between cork line and lead line and fished from the surface of the water: (a) a set gillnet is one that has been intentionally set, staked, anchored, or otherwise fixed and (b) a drift gillnet is one that has not been intentionally staked, anchored, or otherwise fixed.

goals - broad statements of what a regional planning team, with input from the user groups, hopes to see accomplished within a specified period of time.

green egg - stage of salmon egg development from ovulation until the eye becomes visible, at which time it becomes an eyed egg.

habitat - the place or type of site where a plant or animal naturally or normally lives and grows.

hatchery - facility in which people collect, fertilize, incubate, and rear fish.

incidental catch - harvest of a salmon species other than the desired species for which the fishery is managed. Fish of another species and/or stock caught during harvest of specific species and/or stock.

in-river run goal - is defined by the Board of Fisheries for stocks that are subject to in-river harvest above the point where escapement can be estimated. The in-river run goal is comprised of the escapement goal plus specific allocations to in-river fisheries.

instream incubator - device located in or adjacent to a stream that collects water from the stream and is used to incubate and hatch salmon eggs.

limnology - the scientific study of physical, chemical, meteorological, and biological conditions in fresh waters.

littoral zone - pertaining to the shore and, in fresh waters, confined to those zones in which rooted vegetation occurs.

macrophytic vegetation - plant life on a body of water large enough to be viewed by the naked eye.

maximum sustainable yield (MSY) - is the greatest average annual yield from a stock. In practice, MSY is approached when a constant level of escapement is maintained on an annual basis regardless of run strength. The achievement of MSY requires a high degree of management precision and scientific information regarding the relationship between escapement and subsequent return.

mixed stock fishery - harvest of salmon at a location and time during which several stocks are intermingled. Harvest of more than one stock at a given location and/or period.

natural production - salmon that spawn, hatch, and rear without human intervention (i.e., in a natural stream environment).

optimal escapement goal (OEG) - is a specific management objective for the escapement that considers biological and allocative factors. The optimal escapement goal is determined by the Board of Fisheries. The optimal escapement goal may or may not be equal to the BEG but is always sustainable.

otolith - calcified ear bones of fish which may be used to determine age. They can be marked by manipulation of water temperature to produce distinctive otolith banding patterns in juvenile salmon, and these patterns can be used to identify specific groups of hatchery fish or differentiate between other hatchery and wild fish stocks.

pelagic - pertaining to the open ocean as opposed to waters close to shore.

periphytic vegetation - relating to small plant organisms that live attached to underwater surfaces or substrate; e.g., algae, diatoms.

personal use fishing - the taking, fishing for, or possessing of finfish, shellfish, or other fishery resources by Alaska residents for personal use and not for sale or barter with gill or dip net, seine, fish wheel, long line, or other means defined by the Board of Fisheries.

pot - box-like or conical trap covered with mesh for catching fish or shellfish.

plan development - composing, drafting, revising, and finalizing a comprehensive salmon production plan document.

PNP - private nonprofit: level and/or operational status of a private-sector organization without profit motives.

present condition - average catch for the last five years.

private nonprofit hatchery permit application - request presented by a private nonprofit corporation to ADF&G for a permit to operate a private nonprofit hatchery.

private sector - that group active in salmon resource development that is not employed by government.

production - perpetuation or increase of the salmon resource through maintenance, rehabilitation/ restoration, or enhancement programs and techniques.

project - unit of work having a beginning, middle, and end that functions according to defined performance criteria.

projected status - continuation of the present condition without additional supplemental production.

public sector - that group active in salmon resource development that is employed by government.

recruitment - upcoming or next generation of fish.

regional aquaculture association (RAA) - statutorily-based nonprofit corporation comprised of representatives of fisheries user groups organized for the purpose of producing salmon.

regional planning team (RPT) - statutorily mandated planning group, composed of ADF&G staff and regional aquaculture association representatives, designated to develop a comprehensive salmon plan.

rehabilitation/restoration - procedures applied to a depressed natural stock of fish (e.g., salmon) to increase or rebuild it to historical abundance using management, enhancement, habitat protection/restoration, or other applicable strategies.

review and comment process - collection of accepted procedures to solicit and generate examination and remarks.

revised plan - comprehensive salmon planning document resulting from incorporation of commissioner-approved material into a plan.

roe - eggs of a fish.

run - returning salmon stock(s) bound for spawning area; these stocks are often further described by their timing and numbers.

run strength - total run of salmon, including escapement plus harvest.

salmon - is any one of the five anadromous Pacific salmon species below:
Chinook (king) - Oncorhynchus tshawytscha
Chum (dog) - Oncorhynchus keta
Coho (silver) - Oncorhynchus kisutch
Pink (humpy or humpback) - Oncorhynchus gorbuscha
Sockeye (red) - Oncorhynchus nerka

salmon farming – rearing of salmon in pens or cages until harvest.

salmon ranching – early rearing of salmon of salmon in pens, cages, or a hatchery, after which the fish are released to the open sea and harvested upon their return to spawn.

salmon stock - is a locally interbreeding group of salmon that is distinguished by a distinct combination of genetic, phenotype, life history, and habitat characteristics. Salmon of a single species that are produced from a single geographic location and are of the same genetic origin.

seine (beach) - a floating net designed to surround fish that is set from and hauled to the beach.

smolt - salmon, trout, or char that have passed through the physiological process of becoming ready to migrate to salt water.

sonar - technology that uses sound waves in water to detect submerged objects such as migrating fish.

spawn - (verb) to produce or deposit eggs; (noun) a mass of spawned eggs.

spawning channel - engineered addition to natural salmon spawning habitat in which water flow, substrate, sedimentation, and predation are controlled to increase egg-to-fry survivals.

sport fishery - the taking of or attempting to take for personal use and not for sale or barter, any fresh water, marine, or anadromous fish by hook and line held in the hand, or by hook and line with the line attached to a pole or rod which is held in the hand or closely attended, or by other means defined by the Board of Fisheries.

stock - group of fish that can be distinguished by their distinct location and time of spawning.

stock restoration - *see* above definition for rehabilitation/restoration.

subsistence fishery - the taking of, fishing for, or possession of fish, shellfish, or other fisheries resources by a resident domiciled in a rural area of the state for subsistence uses with a gillnet, seine, fish wheel, longline, or other means defined by the Board of Fisheries.

subsistence use - the noncommercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural area of the state for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of nonedible by-products of fish and wildlife resources taken for personal or family consumption, and for the customary trade, barter, or sharing for personal or family consumption.

sustainable yield - is the average annual yield that results from a level of escapement that can be maintained on a continuing basis. A wide range of average annual yield levels are sustainable.

supplemental production - salmon produced by methods other than natural spawning using enhancement and/or rehabilitation methods.

take - taking, pursuing, hunting, fishing, trapping, or in any manner disturbing, capturing, or killing or attempting to take, pursue, hunt, fish, trap, or in any manner capture or kill fish or game.

terminal fishery - area where a terminal fishery harvest could be conducted.

TCC- Tanana Chiefs Conference

thermal band - several closely grouped and equidistantly spaced thermal rings that visually blend together at low magnification (<100X).

thermal cycle - occurrence of one ambient and one treated water event at a pre-identified temperature differential and combination of hours; one thermal cycle produces one thermal ring. A band or separation cycle is a modified thermal cycle designed to separate thermal bands by 2.5 times the distance between the rings.

thermal mark (TM) - discrete complex of rings on otolith resulting from temperature manipulations that identifies a specific brood stock or group.

thermal marking - process where a visibly enhanced increment or ring is induced in the microstructure of the otolith through controlled and repeated temperature fluctuations of the incubation water; these fluctuations result in an ordered complex of rings.

thermal ring - a single dark ring on the otolith resulting from temperature decline within one cycle. Microscopic viewing at high magnification (>100X) is required to resolve ring structure. A hatchmark is a dark ring or a tight complex of rings that are naturally induced in the otolith during hatching. Its visual structure is often similar to a thermal ring; therefore, marking the prehatch embryo is preferred.

thermocline - layer of water in a lake separating an upper warmer lighter oxygen-rich zone for a lower colder heavier oxygen-poor zone.

total run (run strength) - number of salmon returning in a year for a stock or area (escapement plus harvest number).

trawl - a bag-shaped net towed through the water to capture fish or shellfish: (a) a beam trawl is a trawl with a fixed net opening utilizing a wood or metal beam; (b) an otter trawl is a trawl with a net opening controlled by devices commonly called otter doors; and (c) a pelagic trawl is a trawl where the net, trawl doors, or other trawl-spreading devices do not operate in contact with the seabed, and which does not have attached to it any protective device, such a chafing gear, rollers, or bobbins, that would make it suitable for fishing in contact with the seabed.

troll - this gear group consists of a line or lines with lures or baited hooks that are drawn through the water from a vessel either by hand trolling, strip fishing, or other types of trolling and retrieved by hand power or hand-powered crank (i.e., hand troll) or drawn and retrieved by electrical, hydraulic, mechanical or other assisting devices or attachments (i.e., power troll).

uniform procedures - those practices that have been accepted by planning participants as appropriate for conducting or accomplishing a task.

user group - identification by method and/or reason for the harvest of salmon (commercial, sport, or subsistence).

vessel - a floating craft powered, towed, rowed, or otherwise propelled, which is used for delivering, landing, or taking fish within the jurisdiction of the state, but does not include aircraft.

weir – fence by which the stream migrations of salmon (or other fish) may be monitored for enumeration or holding purposes.

wild stock - any stock of salmon that spawns naturally in a natural environment and is not subjected to human-made practices pertaining to egg deposition, incubation, or rearing. Stocks that have not been rehabilitated or enhanced.

yield - is the number of fish harvested in a particular year or season from a stock.

YRDFA - Yukon River Drainage Fisheries Association.

zooplankton - free-swimming, drifting, or floating organisms, mostly microscopic in size, which are found primarily in open water and are an important source of food for small fish.