PLACE HOLDER FOR COVER PAGE

PUBLIC REVIEW DRAFT
YUKON RIVER COMPREHENSIVE SALMON PLAN

JUNE 2019

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CHAPTER 1: INTRODUCTION TO ALASKA'S FISHERY ENHANCEMENT PROGRAM

1.1 Overview: Authority, Purpose, and Historical Perspective

Comprehensive salmon planning represents an ongoing process of identifying fisheries restoration, rehabilitation, enhancement, research, and management priorities for the salmon resources in the Yukon River region. This chapter provides the legislative authority and background for the salmon fisheries enhancement program in the State of Alaska. Terms and definitions used throughout this document can be found in Appendix A.

1.1.1 Salmon Fishery Enhancement Program

The intent of the salmon fishery enhancement program in Alaska is to benefit the public by providing additional harvest opportunities to regional salmon fisheries without adversely affecting natural stocks. The methods, means, and constraints for providing these fish are addressed in Alaska statutes (AS) and in the regulations, management regimes, and policies of the Alaska Department of Fish and Game (ADF&G). The regional planning team (RPT) plays a pivotal, coordinating role in the realization of this program by (1) developing regional plans that establish production/project goals, objectives, and guidelines; and (2) assuming responsibility for insuring that proposed projects are consistent with the regional plan and that they optimize public benefits without jeopardizing natural stocks.

1.1.2 Constitution of the State of Alaska

The framework for management and protection of natural resources is enshrined in the Constitution of the State of Alaska in Article VIII - Natural Resources. These built in protections for sustained yield of fishery resources is a fundamental principle of the Alaska hatchery program. They are listed below:

§ 2. General Authority – The legislature shall provide for the utilization, development, and conservation of all natural resources belonging to the state, including land, and waters, for the maximum benefit of the people.

§ 3. Common Use – Whenever occurring in their natural state, fish, wildlife, and waters are reserved for the people for common use.

§ 4. Sustained Yield – Fish and all other renewable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses.

§15. No Exclusive Right of Fishery [as amended in 1972 to allow limited entry and aquaculture] – No exclusive right or special privilege shall be created or authorized in the natural waters of the State. This section does not restrict the power of the State to limit entry into any fishery for purposes of resource conservation, to prevent economic distress among fishermen and those dependent upon them for a livelihood and to promote the efficient development of aquaculture in the state.

With the adoption of the Alaska State Constitution, Ordinance No. 3 – Abolition of Fish Traps also was voted on by the convention members and passed, having the following language become effective on the adoption date of the constitution:

As a matter of immediate public necessity, to relieve economic distress among individual fishermen and those dependent upon them for a livelihood, to conserve the rapidly dwindling supply of salmon in Alaska, to insure fair competition among those engaged in commercial fishing, and to make manifest the will of the people of Alaska, the use of fish traps for the taking of salmon for commercial purposes is hereby prohibited in all the coastal water of the State.

In 1960, ADF&G assumed management authority over the fisheries from the federal government with the strong constitutional mandate to conserve wild stocks. This was further strengthened by the Legislature recognizing the importance of fish and game to the fledgling state, by designating ADF&G as a cabinet level department run by a commissioner, who answers directly to the Governor. The Legislature again emphasized the directives of the constitution by including as part of AS 16.05.020 the functions of the commissioner. The commissioner shall

(2) manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state.

While ADF&G was given the responsibility to manage fisheries to maintain sustained yield, the Board of Fisheries was given the responsibility for allocating that yield to the users of the resource. The clear separation of conservation authority from allocation authority is one of the strengths of Alaska's fishery management system (Meacham and Clark 1994).

1.1.3 Alaska Department of Fish and Game

ADF&G is responsible for salmon resource management in the State of Alaska. The overall mission of ADF&G is

To protect, maintain, and improve the fish, game, and aquatic plant resources of the state, and manage their use and development in the best interest of the economy and the well-being of the people of the state, consistent with the sustained yield principle.[1]

Responsibility for maintenance and management of salmon resources in the state is shared by several divisions within ADF&G.

The Division of Commercial Fisheries provides the services of stock management and assessment; laboratory services in genetics, pathology, and marking/tagging; aquaculture permitting, evaluation and oversight; and maintains programs for dissemination of information and public participation. The mission of the Division of Commercial Fisheries is

To manage subsistence, commercial and personal use fisheries in the interest of the general well-being of the people and economy of the state, consistent with the sustained yield principal, and subject to allocations through public regulatory processes.[2]

Formerly, the Fisheries Rehabilitation, Enhancement and Development (FRED) Division was responsible for developing and maintaining a comprehensive, long-range plan for salmon fisheries enhancement and rehabilitation efforts. In 1992, FRED was absorbed into the Division of Commercial Fisheries. Today a small section within that division, called Fishery Monitoring, Permitting, and Development, has the lead role for salmon fishery enhancement activities and

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[1] ADF&G website commissioner's office overview link to mission statement http://www.adfg.alaska.gov/index.cfm?adfg=about.mission (Accessed September 2016)

[2] ADF&G Website Commercial Fisheries, Division Overview, Mission and Core Functions http://www.adfg.alaska.gov/index.cfm?adfg=divisions.cfmission (Accessed September 2016)

permitting with ADF&G. Four regional resource development biologist positions assist Fishery Monitoring, Permitting, and Development by coordinating efforts with regional ADF&G offices (ADF&G 2010).

The mission of the Division of Subsistence is

> To scientifically gather, quantify, evaluate, and report information about customary and traditional uses of Alaska's fish and wildlife resources.[3]

Management of subsistence fisheries is conducted by the Division of Commercial Fisheries.

The Division of Sport Fish Strategic Plan 2015–2020 (ADF&G 2015) states the Division of Sport Fish vision is

> Excellence in fisheries management and research for the benefit of sport anglers, the state's economy, and future generations of Alaskans.

and the mission is

> To protect and improve the state's sport fishery resources.

The core functions of the Division of Sport Fish include fisheries management, research, enhancement, habitat protection and restoration, communication and outreach, and to provide and improve angler access, with the priority to manage recreational fisheries for sustained yield and recreational angler satisfaction.

The Division of Habitat provides oversight for protection of salmon spawning and rearing areas. Their mission statement is

> To protect Alaska's valuable fish and wildlife resources and their habitats as Alaska's population and economy continue to expand.[4]

1.1.4 Authority for Salmon Planning

The commissioner has the duty under AS 16.10.375–480 to designate regions of the state for the purpose of salmon production and have developed and amend as necessary a comprehensive salmon plan for each region. The commissioner also has the authority to establish RPTs within each designated region (5 AAC 40.300–370). The primary purpose of the RPT is to develop a comprehensive salmon plan for the region. Each regional planning team consists of 6 members. Three are department personnel appointed by the commissioner and 3 are appointed by the board of directors of the authorized Regional Aquaculture Association (RAA).

1.1.5 Regional Aquaculture Associations

RAAs are formed under the commissioner's authority for the purpose of enhancing salmon production and are developed in accordance to criteria set out in AS 16.10.380: (1) comprised of representatives of commercial fishermen in the region; (2) includes representatives of other user groups interested in fisheries within the region who wish to belong; and (3) possesses a board of directors that includes but is not limited to, commercial fishermen, sport fishermen, subsistence fishermen, processors and representatives of local communities. Appendix B provides a table of

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[3] ADF&G Website Subsistence, Division Overview, Mission and Core Functions http://www.adfg.alaska.gov/index.cfm?adfg=divisions.subsmission (Accessed September 2016)

[4] ADF&G website Sport Fish, Division Overview, Mission and Core Functions http://www.adfg.alaska.gov/index.cfm?adfg=divisions.sfmission (Accessed September 2016)

steps necessary to form a RAA. Each RAA has a board of directors weighted toward the commercial fishing interests that initially incorporated them. There is no approved RAA for the Yukon River CSP Region.

1.1.5.1 Yukon River Drainage Fisheries Association (YRDFA)

The Yukon River Drainage Fisheries Association (YRDFA), a 501(c) (3) non-profit association, was created in 1990 by a group of subsistence and commercial fishermen concerned about issues and the future of the Yukon River fisheries and to give a voice to the people of the region. The YRDFA mission is to protect and promote all healthy wild fisheries and cultures along the Yukon River drainage.

Home to the longest salmon migration in the world, the Yukon River provides critical nutritional, cultural and economic support for over 42 rural Alaskan villages. YRDFA acts at the interface of those that live and fish on the river and those tasked with sustainable management of the fishery and are an essential part of communications between fishers and fishery managers and represent village fishers at important state, federal and international decision making venues. YRDFA works to document and utilize Traditional Ecological Knowledge in fisheries management and to strengthen the long-term economic viability and sustainability of Yukon River communities. Its various programs are designed to include, inform and empower all Yukon River stakeholders to share, learn and participate in the ongoing use and sustainable management of this incredible resource.

The current Articles of Incorporation state;

- Establish communications between all user groups: subsistence, commercial, personal use, and sport, the management agencies to include all state and federal agencies that have jurisdiction over any activity that will affect fish stocks in the Yukon River drainage, whether it be direct or indirect.
- Take whatever actions are necessary to insure that all fish stocks in the Yukon River drainage are managed in such a manner as to provide for a stable and healthy fishery in the future.

YRDFA is led by a Board of 16 Directors and 14 Alternates that represent communities from the full length of the Alaska portion of the Yukon River and all ADF&G fishing districts.

1.1.6 Regional Planning Teams

The commissioner establishes the RPT. Each RPT consists of 6 members; 3 appointed by the commissioner and 3 appointed by the board of directors of the RAA. Additionally, nonvoting ex-officio members may be appointed by the commissioner or by the RPT as deemed necessary. Each RPT elects a chairman, who may or may not be a member of the RPT, and whose responsibilities are defined in regulation 5 AAC 40.310 Chairman of Regional Planning Team.

Alaska Statutes (16.10.375–16.10.480) and regulations (5 AAC 40.300–40.370) define the duties of the RPT as comprehensive plan development and amendment; review of hatchery permit applications, permit alteration requests, and recommendations to the commissioner; and review of and comment on proposed hatchery permit suspensions or revocations to the commissioner.

The users of the resource within each region determine what fishery enhancement is desirable and ADF&G determines what is appropriate within their mandate to protect natural production. The mechanism for this cooperative effort is the RAA working with ADF&G within the RPT process.

1.1.6.1 Yukon River Regional Planning Team

There is no approved RAA for the Yukon River CSP Region. Therefore, in 1993, the YRDFA nonprofit corporation was authorized by ADF&G Commissioner Rue to act in the role of a Regional Aquaculture Association for the Yukon River region in order to fulfill the statutory mandate for comprehensive salmon planning on an "ad hoc" RPT. The first Comprehensive Salmon Plan for the Yukon River, Alaska was published in 1998. YRDFA Board members were proposed and confirmed by ADF&G Commissioner Sam Cotten to act as the Regional Planning team for review and creation of a draft Yukon River Comprehensive Salmon Plan II in 2016. The YR RPT has operated with the same charge and membership seats since 1993 with the YRDFA seating 9 and ADF&G seating 4 voting members. The RPT Chairman has been elected from both entities over the years.

1.1.7 Regulatory Background

The current state hatchery program was developed in response to depressed salmon fisheries in the 1970s and was predicated on the concept of supplementing fisheries, not replacing wild stocks. The policies and laws implemented in Alaska were carefully considered to meet the state's constitutional mandate for sustained yield. There was a concerted effort by all parties involved to collectively support fisheries and minimize negative impacts to wild stocks to the greatest extent possible.

In 1971 the Alaska Legislature in AS 16.05.092 created the FRED division to oversee and develop salmon fishery enhancement programs. FRED division had 4 main responsibilities: (1) develop and maintain a state plan for long-range fishery rehabilitation, (2) encourage private investment in the development and use of Alaska's fishery resources, (3) assure the perpetuation of Alaska's fish resource, and (4) make an annual report to the legislature.

In 1974, the Private Non-profit Hatchery Act statutes (AS 16.10.375–16.10.620) authorized the issuance of hatchery permits to qualified private nonprofit (PNP) corporations. This was the method and means for establishing PNP salmon hatcheries in Alaska. The legislative intent of this act was

> "...to authorize private ownership of salmon hatcheries by qualified non-profit corporations for the purpose of contributing, by artificial means, to the rehabilitation of the state's depleted and depressed salmon fisheries. The program shall be operated without adversely affecting natural stocks of fish in the state and under a policy which allows reasonable segregation of returning hatchery-reared salmon from naturally occurring stocks." [5]

The regulatory background provides for checks and balances by giving the commissioner the authority to alter the conditions of the hatchery permit or revoke the permit. The Board of Fisheries may alter the terms of the hatchery permit relating to the source and number of eggs, the harvest of fish by the hatchery operator, and the location of the special harvest area (SHA). Fish are considered available for common use until they return to a SHA.

Some pertinent statutes and regulations affecting enhanced fish are included below.

AS 16.10.440 Regulations relating to released fish.

[5] Section 1 Chapter 111 Session Laws of Alaska.

(a) Fish released into the natural waters of the state by a hatchery operated under AS 16.10.400–16.10.470 are available to the people for common use and are subject to regulation under applicable law in the same way as fish occurring in the their natural state until they return to the specific location designated by the department for harvest by the hatchery operator. (b) The Board of Fisheries may, after the issuance of a permit by the commissioner, amend by regulation adopted in accordance with AS 44.62 (Administrative Procedure Act), the terms of the permit relating to the source and number of salmon eggs, the harvest of fish by hatchery operators, and the specific locations designated by the department for harvest. The Board of Fisheries may not adopt any regulations or take any action regarding the issuance or denial of any permits required in AS 16.10.400–16.10.470.

AS 16.10.445 Egg Sources.

(a) The department shall approve the source and number of eggs taken under AS 16.10.400–16.10.470. (b) Where feasible, salmon eggs utilized by a hatchery operator shall first be taken from stocks native to the area in which the hatchery is located, and then, upon department approval, from other areas, as necessary.

AS 16.10.450 Sale of salmon and salmon eggs: use of proceeds; quality and price.

(a) Except as otherwise provided in a contract for the operation of a hatchery under AS 16.10.480, a hatchery operator who sells salmon returning from the natural waters of the state, or sells salmon eggs to another hatchery operating under AS 16.10.400–16.10.470, after utilizing the funds for reasonable operating costs, including debt retirement, expanding its facilities, salmon rehabilitation projects, fisheries research, or costs of operating the qualified regional association for the area in which the hatchery is located, shall expend the remaining funds on other fisheries activities of the qualified regional association. (b) Fish returning to hatcheries and sold for human consumption shall be of comparable quality to fish harvested by commercial fisheries in the area and shall be sold at prices commensurate with the current market.

AS 16.10.375 Regional Salmon Plans.

The commissioner shall designate regions of the state for the purpose of salmon production and have developed and amend, as necessary, a comprehensive salmon plan for each region, including provisions for both public and private nonprofit hatchery systems. Subject to plan approval by the commissioner, comprehensive salmon plans shall be developed by regional planning teams consisting of department personnel and representatives of the appropriate qualified regional associations formed under AS 16.10.380.

5 AAC 40.170 Regional Planning Team Review.

(a) The appropriate regional planning team, as established under 5 AAC 40.300, shall review each application to determine if the proposed hatchery is compatible with the appropriate regional comprehensive salmon plan. The regional planning team shall use the following application review criteria:

The contribution the proposed hatchery would make to the common property fishery;

The provisions for protection of the naturally occurring stocks from any adverse effects which may originate from the proposed hatchery;

The compatibility of the proposed hatchery with the goals and objectives of the comprehensive plan for the region; and

Whether the proposed hatchery would make the best use of the site's potential to benefit the common property fishery.

(b) An applicant may review the regional planning team determination and comment on it by letter to the commissioner.

1.1.8 Application to Transboundary Salmon Stocks

The Yukon River originates in British Columbia, Canada and flows over 3,190 km (1,980 mi) through Yukon Territory, Canada and Alaska before emptying into the Bering Sea at the Yukon Delta. As a result, Yukon River Chinook and fall chum salmon populations are transboundary existing in Alaska and Canada with their respective total annual runs comprised of Canadian-origin and Alaskan-origin stocks. Yukon River summer chum, pink, and coho salmon stocks are not transboundary with their respective total annual runs comprised of Alaskan-origin stocks, although a small number of coho salmon have been observed migrating into Canadian waters in most years.

Management, assessment, enhancement, or restoration activities associated with Yukon River salmon stocks of Canadian-origin are governed between the United States (U.S.)/Alaska and Canada under the Yukon River Salmon Agreement (Agreement), an annex of the Pacific Salmon Treaty between the U.S. and Canada. Both countries have a vested interest and reliance upon the long term sustainability of Canadian-origin salmon stocks, which was the primary motivation for entering into an international treaty agreement. Additional details and background information on the Agreement can be found in Chapter 4, Section 4.2.2.2.

The Agreement only has application to Yukon River salmon stocks of Canadian-origin. Conversely, this Yukon River comprehensive management plan (CSP) only has application to enhancement activities associated with Yukon River salmon stocks of Alaskan-origin. Any enhancement activities on Yukon River Canadian-origin salmon stocks would be implemented in accordance with applicable laws and policies of Canada and its provinces or territories. Similarly, any enhancement activities on Yukon River Alaskan-origin salmon stocks would be implemented in accordance with applicable laws and policies of Alaska, inclusive of the specific goals, objectives, and desires of Yukon River salmon stakeholders as captured in this CSP.

Both countries would maintain a vested interest in any enhancement activities being implemented on these respective salmon stocks, although the interest would likely vary between countries. Alaska would have a vested interest in enhanced Alaskan-origin and Canadian-origin salmon stocks and would manage for harvest and utilization of both enhanced stocks in Alaska consistent with applicable laws and policies of Alaska. Canada would have a vested interest in enhanced Canadian-origin salmon stocks only, inclusive of Alaskan harvest of enhanced Canadian-origin stocks, and would manage for harvest and utilization of enhanced Canadian-origin salmon stocks in Canada consistent with applicable laws and policies of Canada. Since any enhanced Alaskan-origin salmon stocks would not migrate to Canada they would only need to be managed for harvest and utilization in Alaska. If Canada had any interest in enhanced Alaskan-origin salmon stocks, it would likely be limited to any effect on wild or enhanced Canadian-origin salmon stocks.

CHAPTER 2: YUKON RIVER COMPREHENSIVE SALMON PLAN FOR ALASKA 1998 – PHASE I

2.1 Background of the Yukon River Comprehensive Salmon Plan For Alaska 1998

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.

<u>Specific actions promoted by this plan include the following</u>:

1. Improve management of existing regional salmon fisheries by:
    a. 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[6] 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

[6] The life cycle for Yukon River salmon is described in Appendix I1

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 (2001 through 2015, Yukon River Alaska portion only) with the 5 lowest harvest years removed. The estimated annual subsistence harvest needs by species are as follows:

Chinook	49,000
Summer Chum	80,000
Fall Chum	90,000
Coho	20,000

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 (Appendix I2). 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	Midpoint		Upper-end
Chinook	98,250	to	129,150
Summer Chum	800,000	to	1,200,000
Fall Chum	196,625	to	320,500

Currently, no guideline harvest levels exist for coho or pink salmon. Both of these species are typically harvested incidentally during directed commercial fisheries towards Chinook, summer chum, and fall chum salmon. Commercial fisheries directed towards coho and pink salmon may be implemented by specific management plans.

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.

2.2 Historical Fishery Use

The people of the Yukon River basin have been utilizing salmon since inhabiting this area. Archaeological evidence indicates salmon have been harvested the in the Yukon basin as long as 11,500 years ago (Halffman et al. 2015). 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 opportunities, including commercial fishing activities, became available to rural residents (ADF&G 1985b). 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 subsequent 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.

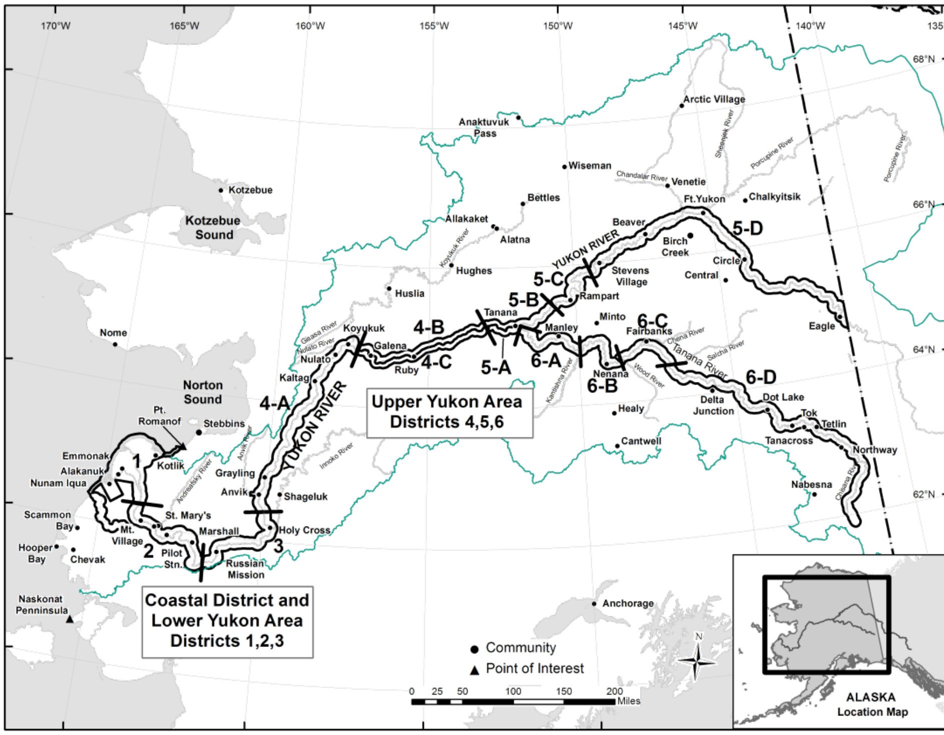

Figure 2.1.–Yukon River Fisheries Management Area.

2.2.1 Subsistence Fisheries

Subsistence harvest of salmon is an integral part of the way of life of most residents of the communities of the Yukon River region (Figure 2.1). Fishing activities are usually based from a fish camp or a home community. Extended family groups, representing two or more households, often work together to harvest, cut, and preserve salmon for subsistence use. Some households from Yukon River tributary communities may operate or share in the operation of fish camps along the mainstem Yukon River. The majority of subsistence and personal use harvests are made up of Chinook, chum, and coho salmon.

Subsistence salmon fishing activities in the Yukon Area typically begin in late May and continue through early October, depending on river ice conditions. Subsistence salmon harvested for human consumption are commonly dried, smoked, or frozen. There is usually little wastage of fish taken for subsistence purposes, although damp weather may cause some drying fish to spoil and some fish are lost to disease (e.g. Ichthyophonus) or predation (e.g. birds and/or bears).

In addition to human consumption, salmon are fed to dogs, which are used for recreation, transportation, and as haul animals. Small ("jacks"), summer chum, fall chum, and coho salmon are primarily harvested to feed dogs in the Upper Yukon Area (Andersen and Scott 2010). Most of the subsistence salmon used for dog food are dried summer chum salmon or "cribbed" (frozen in the open air) fall chum and coho salmon. The practice of keeping sled dogs is more common in the Upper Yukon Area than in the Lower Yukon Area. During the active fishing season all areas feed scraps from salmon processing to dogs. Relatively few whole fresh salmon are fed to dogs in the Lower Yukon Area but due to the larger numbers of dogs in the Upper Yukon Area harvesting salmon for dogs throughout the summer is more common. A gradual reduction in the need for salmon as dog food began around 1930 when airplanes began replacing sled dogs as the primary mail and supply carrier. This decline accelerated in the 1960s with the introduction of snow machines to Interior Alaska (Andersen and Scott 2010). Beginning in the early 1980s, there was a renewed interest in recreational use and racing of sled dogs, thereby increasing the number of subsistence salmon harvested for dog food. From 1991 to present day there has been a decline in the number of households with dog teams (Andersen and Scott 2010). The decline is due in part to poor chum salmon runs from 1998 to 2002 combined with the steep rise in cost of equipment (boat, motor, nets, fuel) needed to harvest fish for dog food.

Subsistence and personal use fishermen in the Yukon Area primarily use drift gillnets, set gillnets, and fish wheels to harvest salmon. Set gillnets are used throughout the Yukon Area, whereas under state regulations, drift gillnets are only allowed from the mouth of the Yukon River to approximately 18 miles below the community of Galena (River Mile 530) to harvest salmon. Drift gillnets are allowed under federal regulations in Subdistricts 4-B and 4-C for a portion of the summer during regulatory openings. Although fish wheels are a legal gear type for subsistence fishing throughout the drainage, they are essentially used only in the Upper Yukon Area where water conditions and fishing locations are more suitable. Building materials, such as logs and young spruce trees used for the raft, axle and axle stanchion, lead, and basket construction are also more available in the Upper Yukon Area.

Subsistence salmon fishing in the Yukon Area primarily occurs in non-permit areas where harvest information is estimated by the annual subsistence survey. Permit areas include the entire Tanana River and portions of the Yukon River that are accessible from the road system. Fishing households are required to obtain a subsistence or personal use permit and submit records of their harvests in these areas (Figure 2.2). Subsistence permits are used to document harvest data, otherwise much harvest would go unreported because of the transient nature of these fishermen and the fact that most do not reside in a surveyed community.

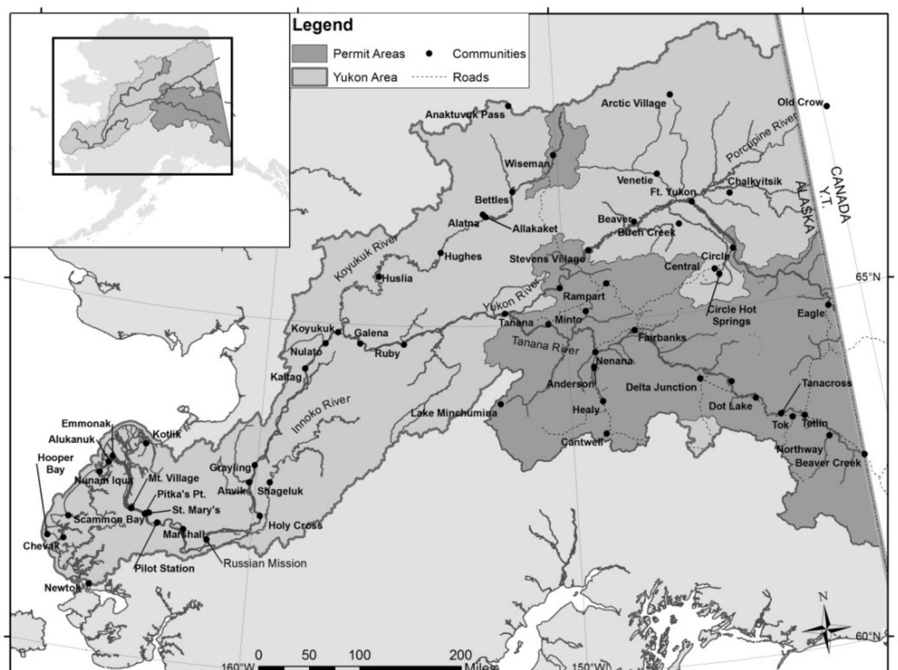

Figure 2.2.–Yukon River Subsistence and Personal Use Permit Areas.

A personal use fishery was implemented in 1986 and currently takes place in the Fairbanks Nonsubsistence Area (Figure 2.3). The management area was established in 1992 due to the heavy demand urban fishermen could potentially place on the resource. In this nonsubsistence area, fishermen must possess a personal use household permit and a resident sport fish license. State regulations dictate that personal use fishing has a lower priority than subsistence fishing. Similar to subsistence fishing permits, data collected from personal use permits allow managers to track harvest.

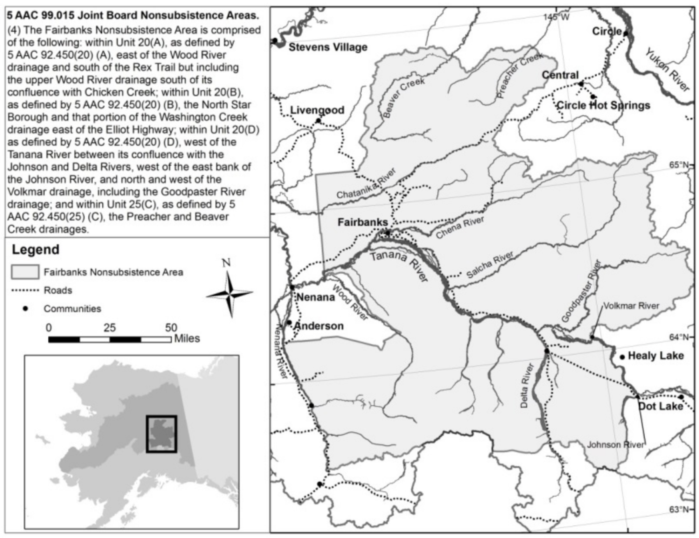

Figure 2.3.–Yukon River Subsistence and Personal Use Permit Areas.

History of Regulations:

Prior to the arrival of European and Russian explorers Alaska Natives harvested fish in the Yukon River drainage. After the United States purchased the territory of Alaska from Russia in 1867 the federal government managed all fish and wildlife resources. Pennoyer et al. (1965) stated: “The history of regulation on the Yukon and Kuskokwim has been one of trying to protect the large Eskimo and Indian subsistence fisheries in these rivers.” This has mainly been accomplished by restricting the commercial fishery. Prior to 1953, when the first permanent federal manger was assigned to the region, fisheries were not explicitly managed in the Yukon River drainage (Carey 1980). However, the first regulations on the commercial fishery occurred in 1919 (Bower 1920; Gilbert 1922). When Alaska became a state in 1959 ADF&G assumed management of all Alaska subsistence and commercial fisheries. Shortly after statehood subsistence fishing was closed during commercial openings. In 1978, the Alaska legislature enacted a law establishing subsistence as the highest priority use of the state’s fish and game resources. In the mid-1980s ADF&G was delegated authority to open and close fisheries in-season in the Yukon River (Brown and Godduhn 2015). In 1980, Congress passed the Alaska National Interest Lands Conservation Act. The law established a rural subsistence priority on Federal lands. In 1982, later refined in 1986, a state regulation established a subsistence priority for rural residents. The regulation was overturned in 1989 by the Alaska Supreme court (Mc Dowell v. State of Alaska, 785 P.2d 1) because it violated the equal access clause of the state constitution. The state ruling that all Alaska residents are able to participate in subsistence activities remains in effect today.

Since 2001, the subsistence fishery has been based on a schedule implemented chronologically by ADF&G and consistent with migratory timing as the run progresses upstream. Subsistence fishing is open seven days per week until the schedule is established. The subsistence salmon fishing schedule is based on current or past fishing and provides reasonable opportunity for subsistence during years of average to below average runs. The objectives of the schedule are to 1) reduce harvest early in the run when there is a higher level of uncertainty in run assessment, 2) spread the harvest throughout the run to reduce harvest impacts on any particular component of the run, and 3) provide subsistence fishing opportunity among all user groups during years of low salmon runs.

2.2.2 Commercial Fisheries

The contents of this section are largely sourced from recent Yukon Area Annual Management Reports (Estensen et al. 2012, 2017). The majority of commercial fishermen are residents of the Yukon River drainage. 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 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 require cash. The average annual unadjusted unemployment rate in the area, and excluding the FNSB, (i.e., Kusilvak, Yukon-Koyukuk, Southeast Fairbanks Census areas, and Denali Borough) was 16.8% from 2012 to 2016.[7]

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.

The first recorded commercial salmon harvest in the Alaskan portion of the Yukon River drainage occurred in 1918. Relatively large harvests of Chinook, chum, and coho salmon were taken during 1919 to 1921 (ADF&G 1985a). The majority of these harvests were taken outside of the river mouth because of restrictions imposed within the river. The early commercial fishery was closed from 1925 to 1931 because of concerns for the large inriver subsistence fishery. Commercial fishing for Chinook salmon was resumed at a reduced level in 1932 and has continued since that time. Commercial harvests of chum and/or coho salmon occurred during 1918 to 1921, 1952 to 1954, 1956, and since 1961. Pink salmon commercial harvests to date within the Yukon River have been very small due to an extremely limited market.

From 1954 to 1960, a 65,000 Chinook salmon commercial harvest quota was in effect for the Alaskan portion of the Yukon River. Chinook salmon commercial harvests began increasing during the late 1970s, likely due to increased fleet efficiency and the duration of above average run sizes. Concern for possible over-exploitation resulted in more conservative fisheries management; therefore, reduced harvests occurred during the late 1980s into the 1990s. The drastic decline of salmon stocks from 1998 through 2002 significantly changed the character of Yukon

[7] Alaska Dept of Labor and Workforce Development. http://live.laborstats.alaska.gov/labforce/csv/aklabforce.csv. Accessed 2/14/2017

River salmon fisheries and, since 2001 the management action plan adopted by the BOF, has been conservative.

Summer chum salmon commercial harvests increased greatly during the 1980s as a result of regulation changes (e.g., mesh size specifications and earlier openings), greater availability of processing facilities and tendering, higher exvessel prices, development of Japanese markets, and the occurrence of several very large run sizes. In February 1990, the BOF established a river-wide guideline harvest range and was later modified in 2016 to 500,000-1,200,000 summer chum salmon. Summer chum salmon commercial harvests declined from 1990 through 1993 in response to below average run sizes. Beginning in 1994, declining chum salmon flesh markets limited the harvest, particularly in the lower river. In March 1994, the BOF adopted the Anvik River Chum Salmon Fishery Management Plan (5 AAC 05.368.), which established regulations allowing for a commercial summer chum salmon roe fishery within the Anvik River. Low commercial harvests, related to low summer chum salmon runs and decreasing market interest, continued riverwide through 2003. Additionally, in order to conserve summer chum salmon, inseason management actions were taken to reduce subsistence fishing beyond the regulatory schedule and restrict subsistence gear types.

The directed commercial fishery for fall chum salmon began in 1961. Fall chum salmon commercial harvests increased beginning in 1979. Low fall chum salmon spawning escapements in the mid-1980s resulted in more conservative management and therefore reduced commercial harvests from 1986 to 1990. Guideline harvest ranges for fall chum salmon were reduced by the BOF in 1986, but the upper end increased to their original levels in 1990. The BOF adopted the Yukon River Drainage Fall Chum Salmon Management Plan (5 AAC 01.249.) in March 1994. The management plan has been reviewed and modified by the BOF several times since then.

Coho salmon runs to the Yukon River are of lesser magnitude than fall chum salmon. Typically, coho salmon were harvested incidentally to the directed fall chum salmon commercial fishery. Management of directed coho salmon commercial fishing is complicated by their overlapping run timing with fall chum salmon stocks. Prior to 1999, no regulation was in place guiding the commercial harvest of coho salmon. In response, in November of 1998, the BOF adopted the Yukon River Coho Salmon Management Plan (5 AAC 05.369) that provided guidance for directed coho salmon commercial fishing. Since then, the plan has been revised several times.

The majority of the Yukon Area salmon harvest is presently processed as a fresh or frozen product in contrast to earlier years when canning and salting was more important. Currently, most salmon are processed at shore based or floating operations or transported by aircraft outside the area for processing. However, limited “value added” products such as smoked salmon and salmon sausage are now being produced within the Yukon Area. In most of the Upper Yukon Area, chum salmon is difficult to market due to high transportation costs and the degradation of flesh caused by freshwater and advancing sexual maturity. In contrast, the quality of chum salmon roe is considered excellent by the industry. As a result, the sales of chum salmon roe increased from 1980 to 1997.

2.2.3 Sport Fisheries

The contents of this section are largely sourced from Wuttig and Baker, *in prep*. Sport fishing for salmon occurs throughout the Yukon River drainage. Within the Division of Sport Fish the Yukon River drainage is divided into two separate management areas; the Yukon Management Area (YMA) which excludes the Tanana River (District 6; Figure 2.1), and the Tanana River

Management Area (TRMA; Figures 2.4 and 2.5). Overall, sport harvests of salmon have historically been, and continue to be, primarily from streams of the TRMA, and to a lesser extent the Andreafsky and Anvik rivers within the lower YMA.

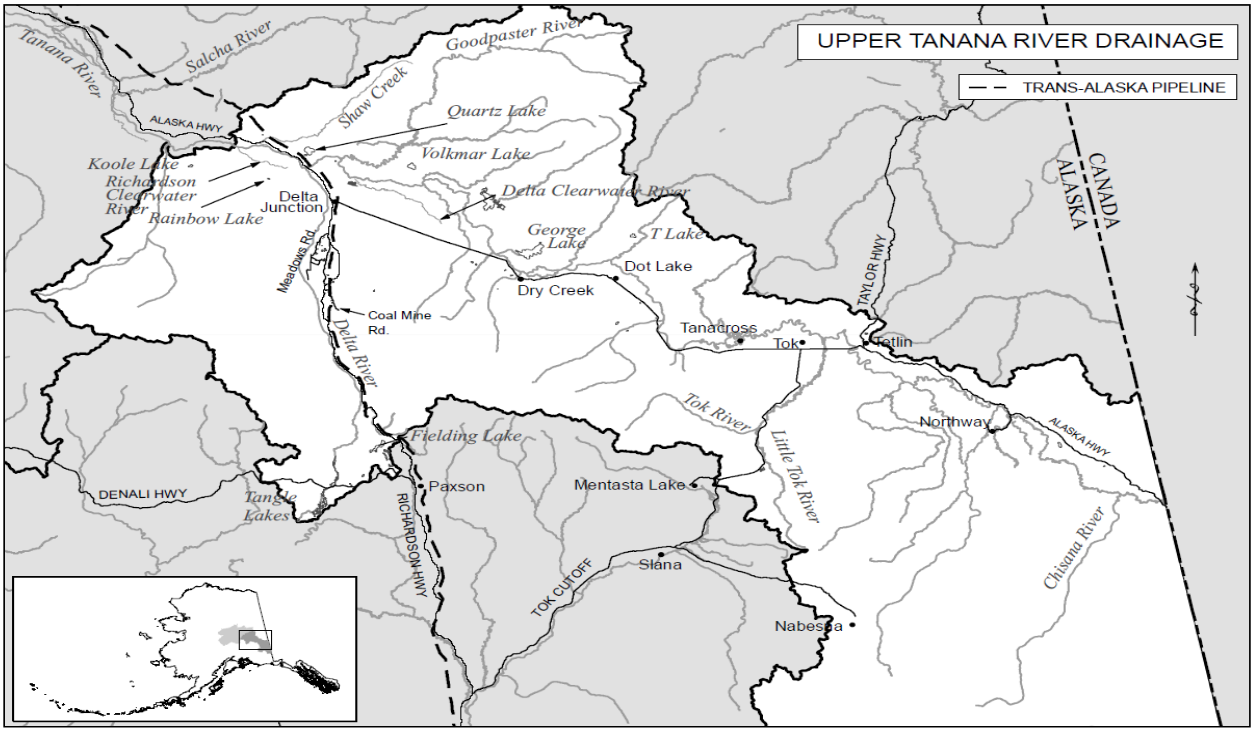

Figure 2.4.–Upper Tanana River Management Area.

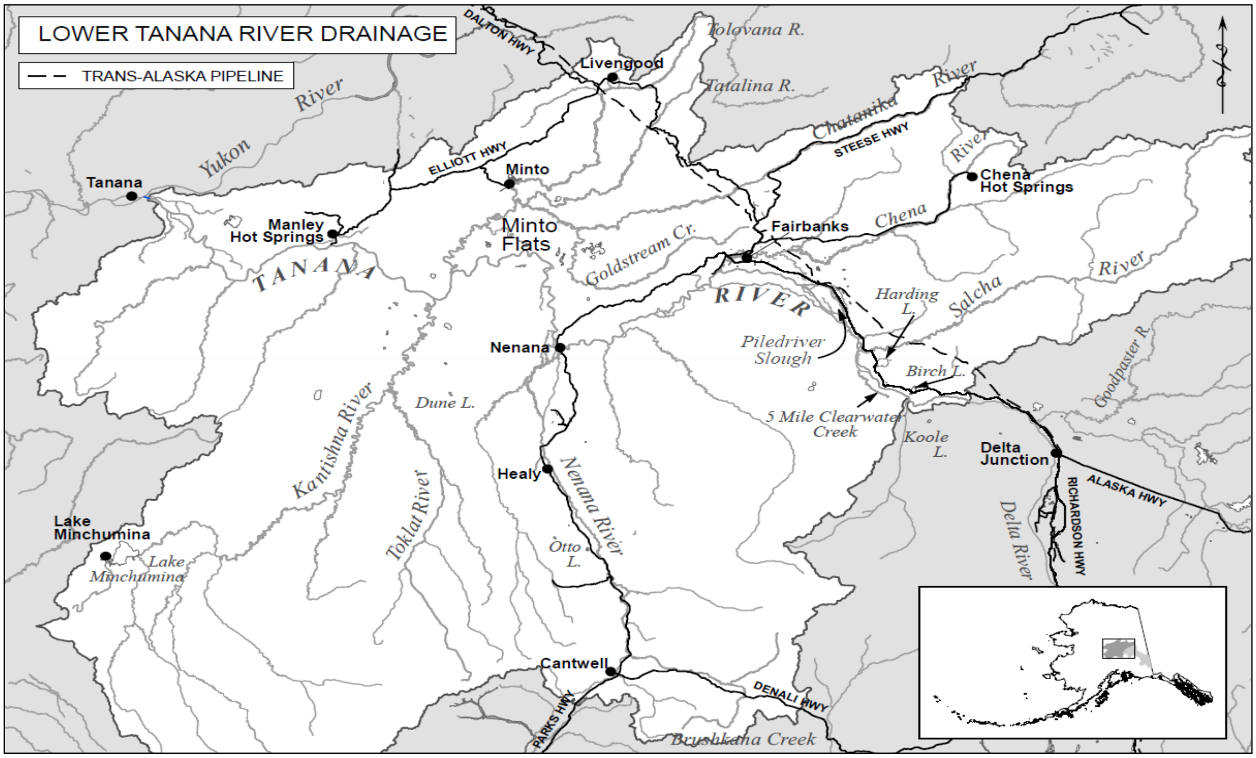

Figure 2.5.–Lower Tanana River Management Area.

Within the TRMA, a Chinook salmon sport fishery has occurred at the Chena River since before statehood. The river is easily accessible in the lower portion of the Chena River with multiple boat launch and walk-in sites located throughout Fairbanks and North Pole. The salmon fishery is closed above the Moose Creek Dam.

The Chena River Chinook salmon sport fishery continues to be relatively small, especially when compared with fisheries in Southcentral and Southeast Alaska; however, it remains very popular because it provides one of the few opportunities to catch large fish near Fairbanks. Most sport anglers release their catch because the salmon flesh has deteriorated significantly by the time the fish have traveled the 1,000 or more miles from the Bering Sea.

The Salcha River within the TRMA has also supported salmon sport fishery. This fishery is accessible from either a vehicle trail just west of the Richardson Highway Bridge or the nearby Salcha River State Recreation Site (campground). Boaters launch at the campground and travel downstream to fish near the confluence of the Tanana and Salcha rivers. The salmon fishery on the Salcha River is closed above a marker located ~0.5 miles upriver from the Richardson Highway Bridge (about 5 miles upstream from the confluence of the Salcha and Tanana rivers). Spawning occurs upstream of the marker.

Until 1989, the Salcha River Chinook salmon sport fishery had greater harvests than were seen on the Chena River. Subsequently, harvest and catch did not increase as dramatically in the Salcha River as in the Chena River, but average harvest continues to be slightly higher on the Salcha River, even with a much smaller portion of the river open to salmon fishing. In recent years this is probably due in part to more restrictions being placed on the Chena River Chinook salmon fishery.

Although a limited amount of sport fishing for salmon occurs throughout the YMA, the Anvik River supports the most popular sport fishery. Since 1996, the Anvik River Lodge has offered guided sport fishing opportunities to both resident and non-resident anglers. They operate throughout the open water season and typically target all five species of Pacific salmon. In recent years, due to restrictions to Chinook salmon fishing the salmon catch and harvest has become dominated by coho salmon and freshwater species.

The bag and possession limits for Chinook salmon in the TRMA have remained unchanged since the early 1960s, at 1 fish 20 in (~510 mm) or longer. I, the YMA the bag and possession limits for Chinook salmon 20 inches or longer is 3 per day 3 in possession – only 2 of which may be 28 inches or longer, and for Chinook salmon less than 20 inches – 10 per day, 10 in possession.

CHAPTER 3: AREA OF COVERAGE

3.1 Description and Maps

The area encompassed by the *Yukon River Comprehensive Salmon Plan* (YRRPT 1998) includes the 6 salmon districts (5 AAC 01.200; Figure 3.1). Subdistrict boundaries within each district were established to facilitate management of individual salmon stocks. The Yukon River originates in British Columbia, Canada, within 30 miles of the Gulf of Alaska, and flows over 3,190 km (1,980 mi) through Yukon Territory, Canada and Alaska, United States before emptying into the Bering Sea at the Yukon-Kuskokwim Delta. It drains an area of approximately 832,700 km^2 (321,500 mi^2) of which 195,200 mi^2 lies within Alaska. Excluding the Fairbanks North Star Borough (FNSB; approximately 98,957 residents), there are approximately 22,397 rural residents in the Alaskan portion of the drainage (Husinger 2017), the majority of whom reside in 43 small communities scattered along the coast and major river systems. Village populations range from approximately 30 to 850 people, with typical villages having fewer than 300 residents. Most of these people are dependent, to varying degrees, on fish and game resources for their livelihood.

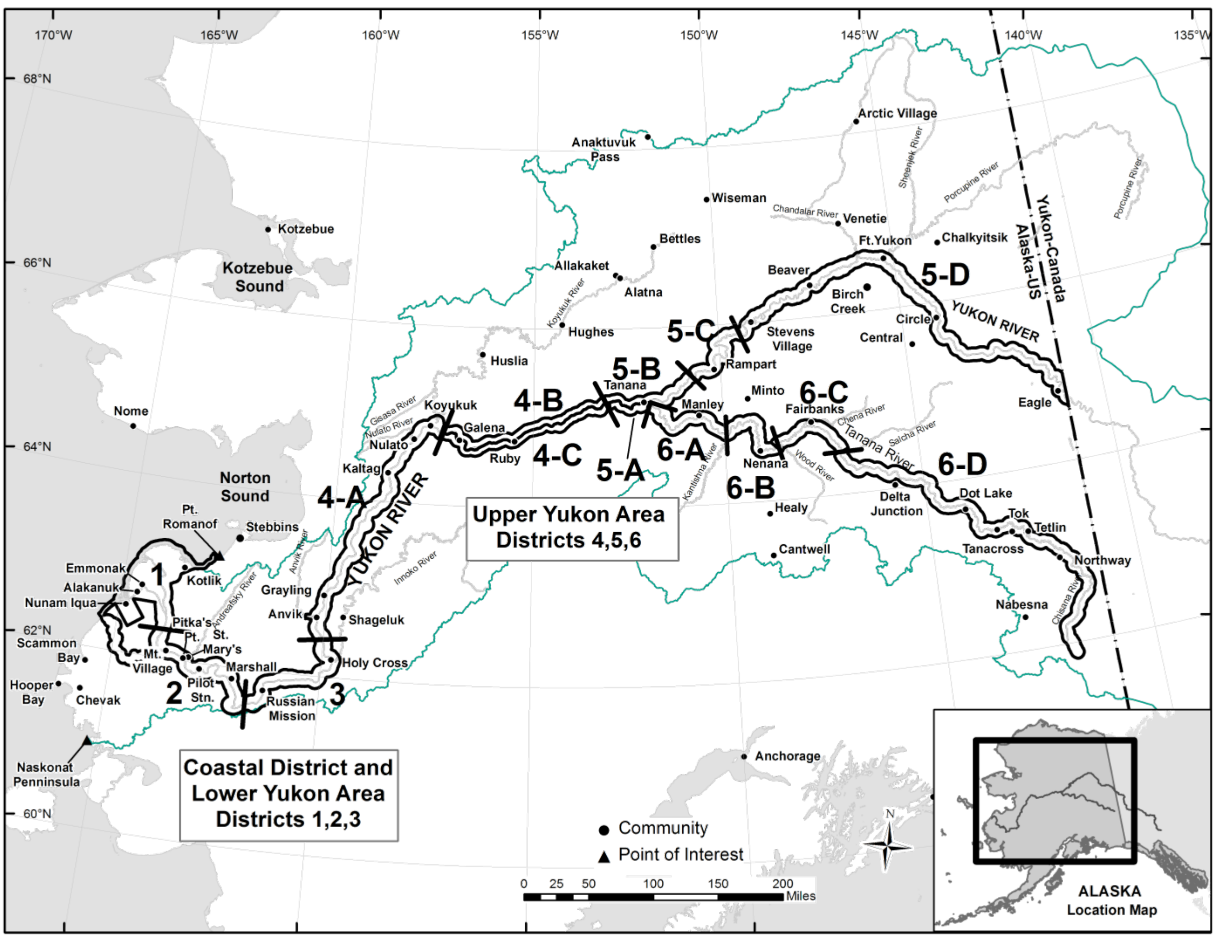

Figure 3.1–Yukon River Districts.

District 1 consists of the Yukon River drainage from the latitude Point Romanof, south and west along the coast of the delta to the mouth of the Black River (including the Black River), extending three nautical miles seaward from grassland bank, upstream to the upstream bank of the mouth of the Anuk River (Figure 3.2).

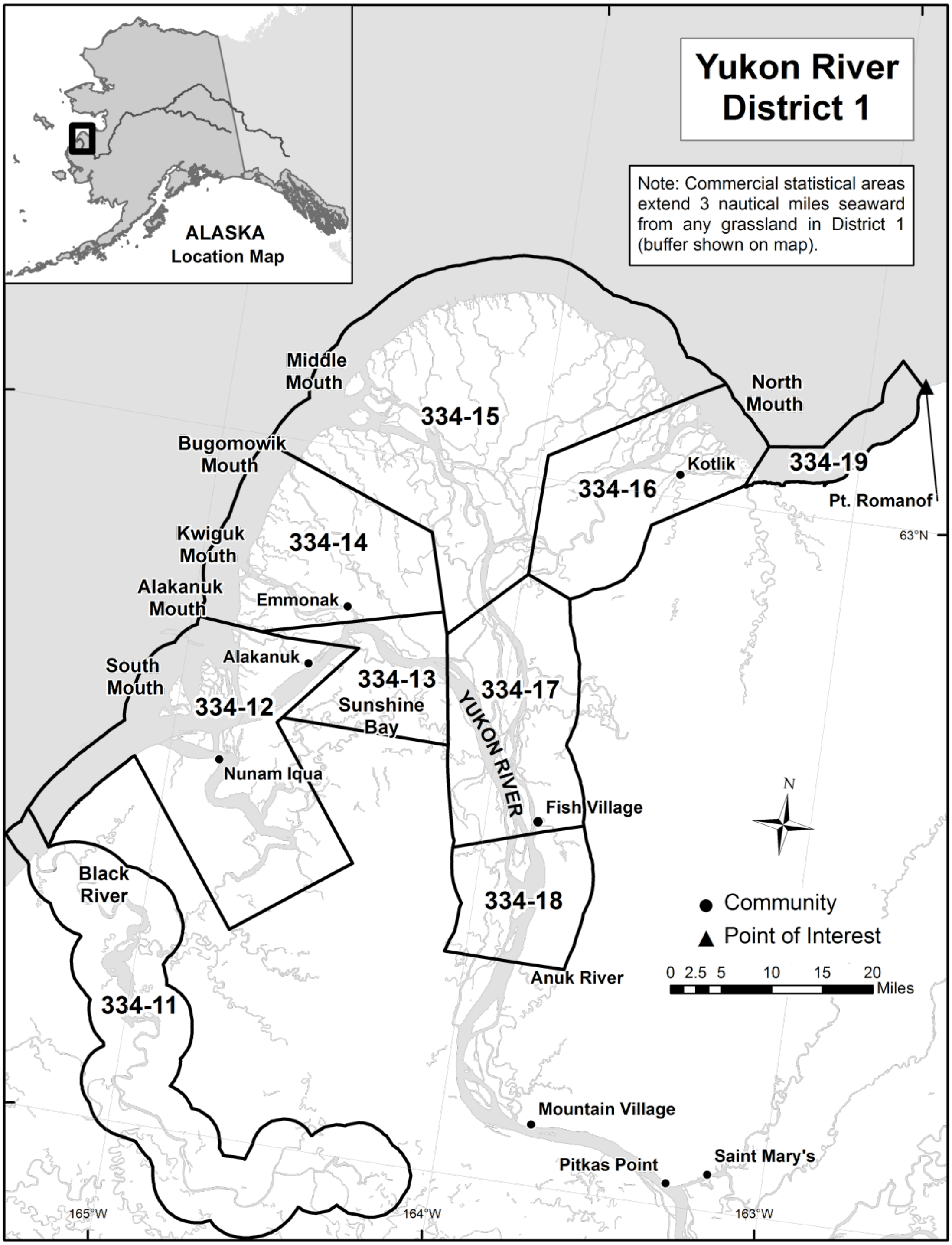

Figure 3.2.–District 1.

District 2 consists of the Yukon River drainage from the upstream bank of the mouth of the Anuk River to Toklik, including the Anuk River drainage (Figure 3.3).

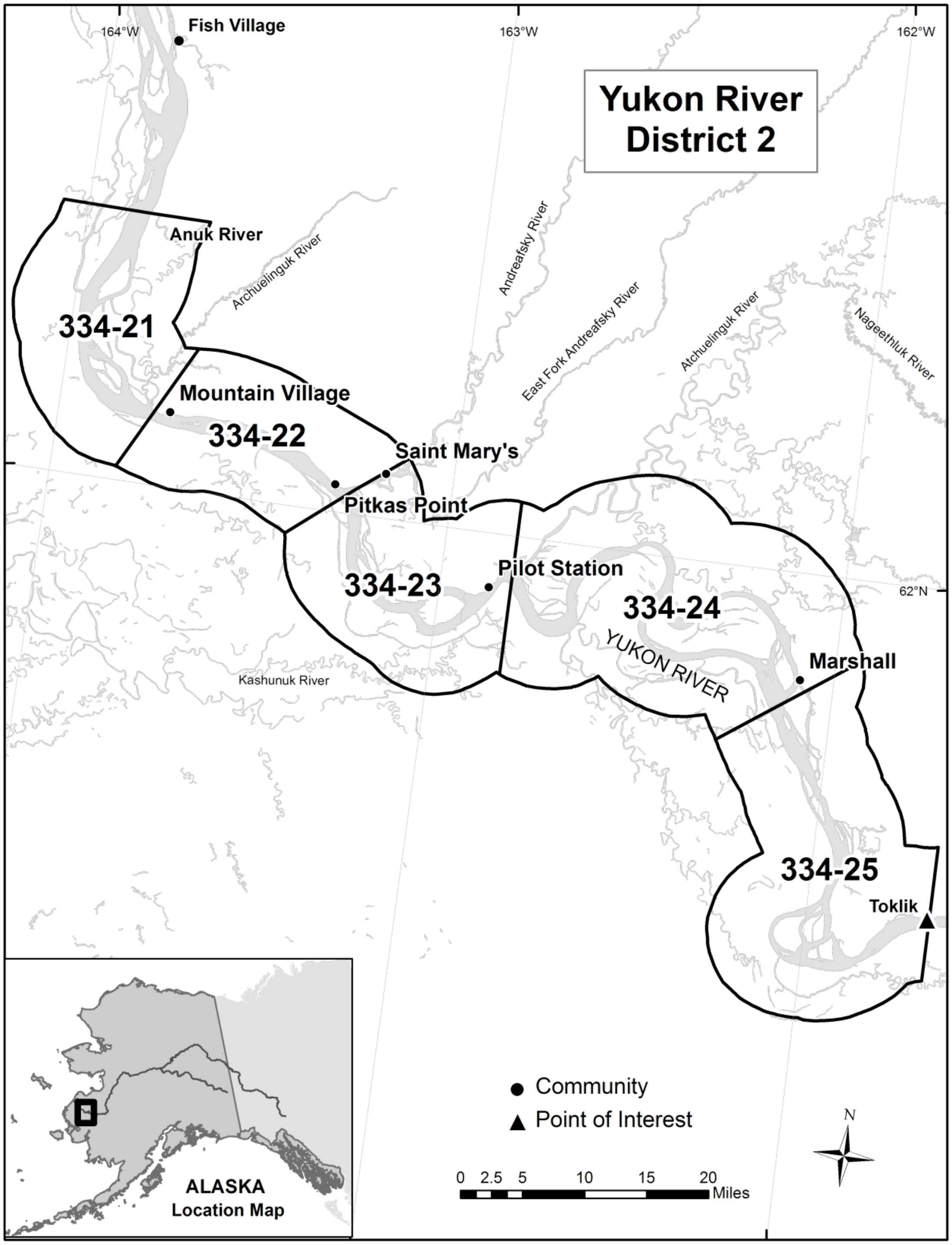

Figure 3.3.–District 2.

District 3 consists of the Yukon River drainage from Toklik upstream to the mouth of an unnamed slough three-fourths of a mile downstream of Old Paradise Village (Figure 3.4).

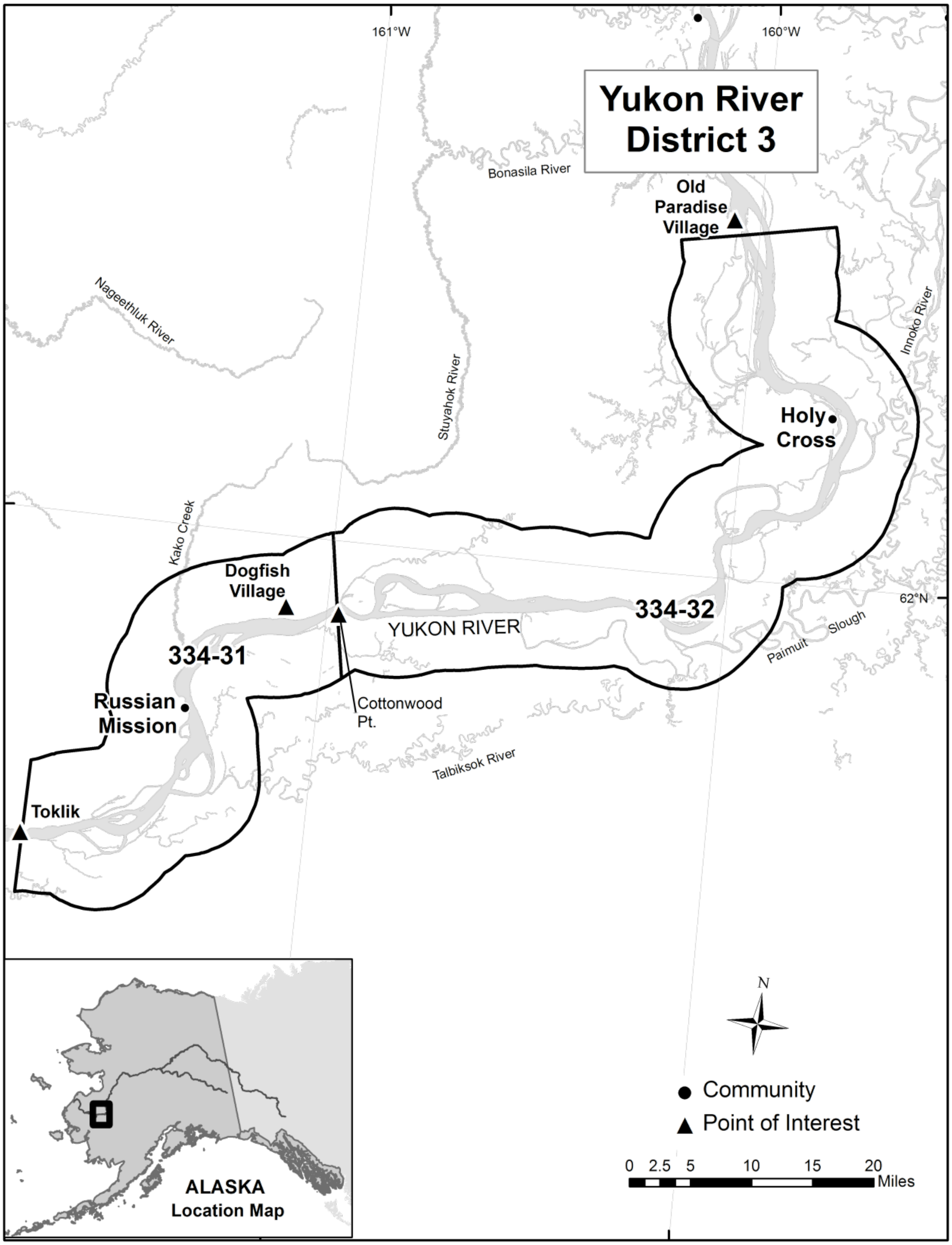

Figure 3.4.–District 3.

District 4 consists of the Yukon River drainage from the mouth of an unnamed slough three-fourths of a mile downstream of Old Paradise Village upstream to the western edge of the mouth of Illinois Creek (Figure 3.5).

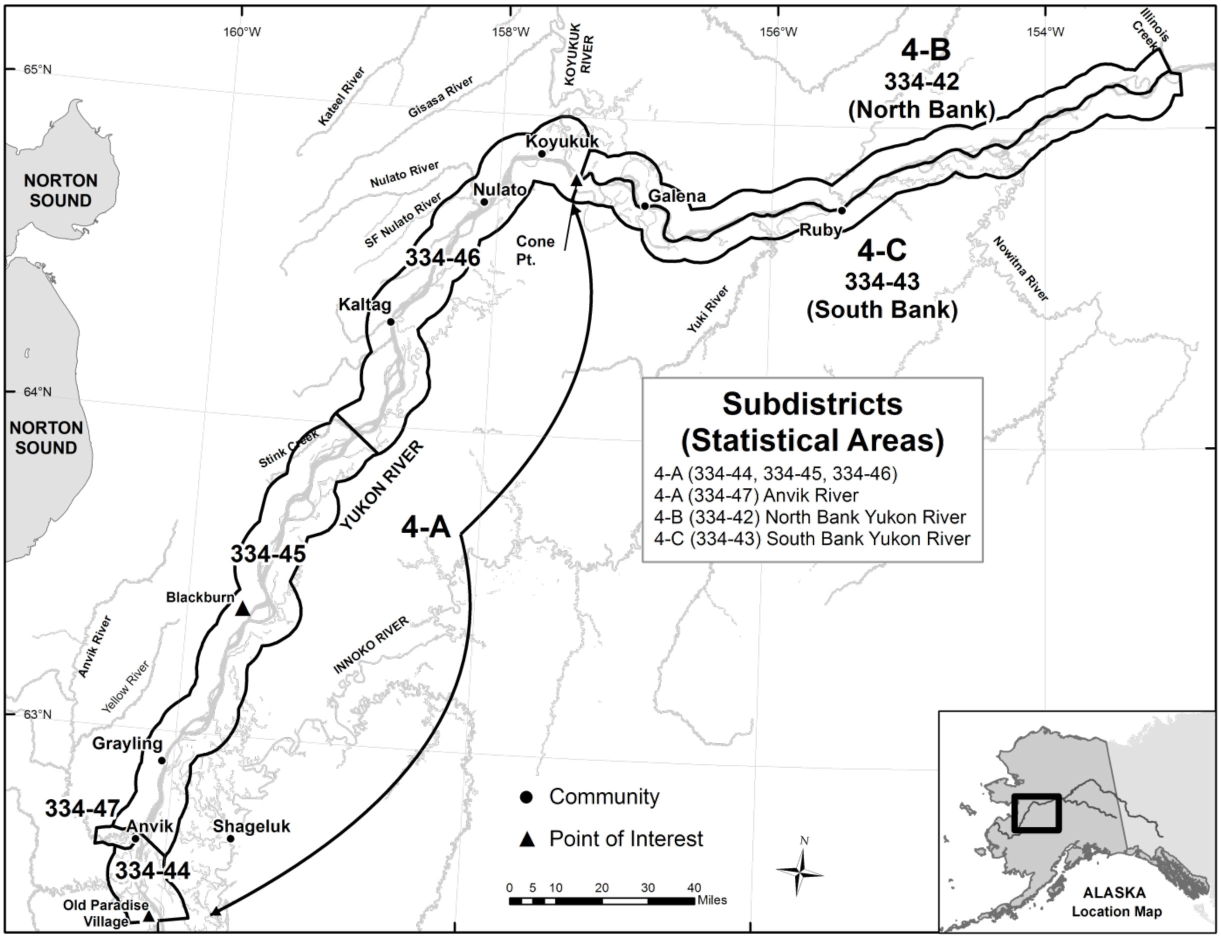

Figure 3.5.–District 4.

Subdistrict 4-A consists of the Yukon River drainage from the mouth of an unnamed slough three-fourths of a mile downstream of Old Paradise Village upstream to the tip of Cone Point.

Subdistrict 4-B consists of the Yukon River drainage from the tip of Cone Point upstream along the north bank to the westernmost edge of Illinois Creek including the following islands: Cook, Lark, Serpentine, Louden, Fish, Dainty, Yuki, Melozi, Dasha, Straight, Kit, Fox, Hardluck, Mickey, Florence, Doyle, Chokoyik, Lady, Liner, Flora, Cronin.

Subdistrict 4-C consists of the Yukon River drainage from the tip of Cone Point upstream along the south bank to a point opposite the westernmost edge of Illinois Creek and includes the flowing islands: Cat, Hen, Jimmy, Big, Ninemile, Ham, Emerald, Edith, Kathleen, Henry, Burns, Youngs, Weir, Clay, Large, Brandt.

District 5 consists of waters of the Yukon River drainage (excluding the Tanana River drainage) from the western edge of Illinois Creek upstream to the US-Canada border, including the Illinois Creek drainage (Figure 3.6).

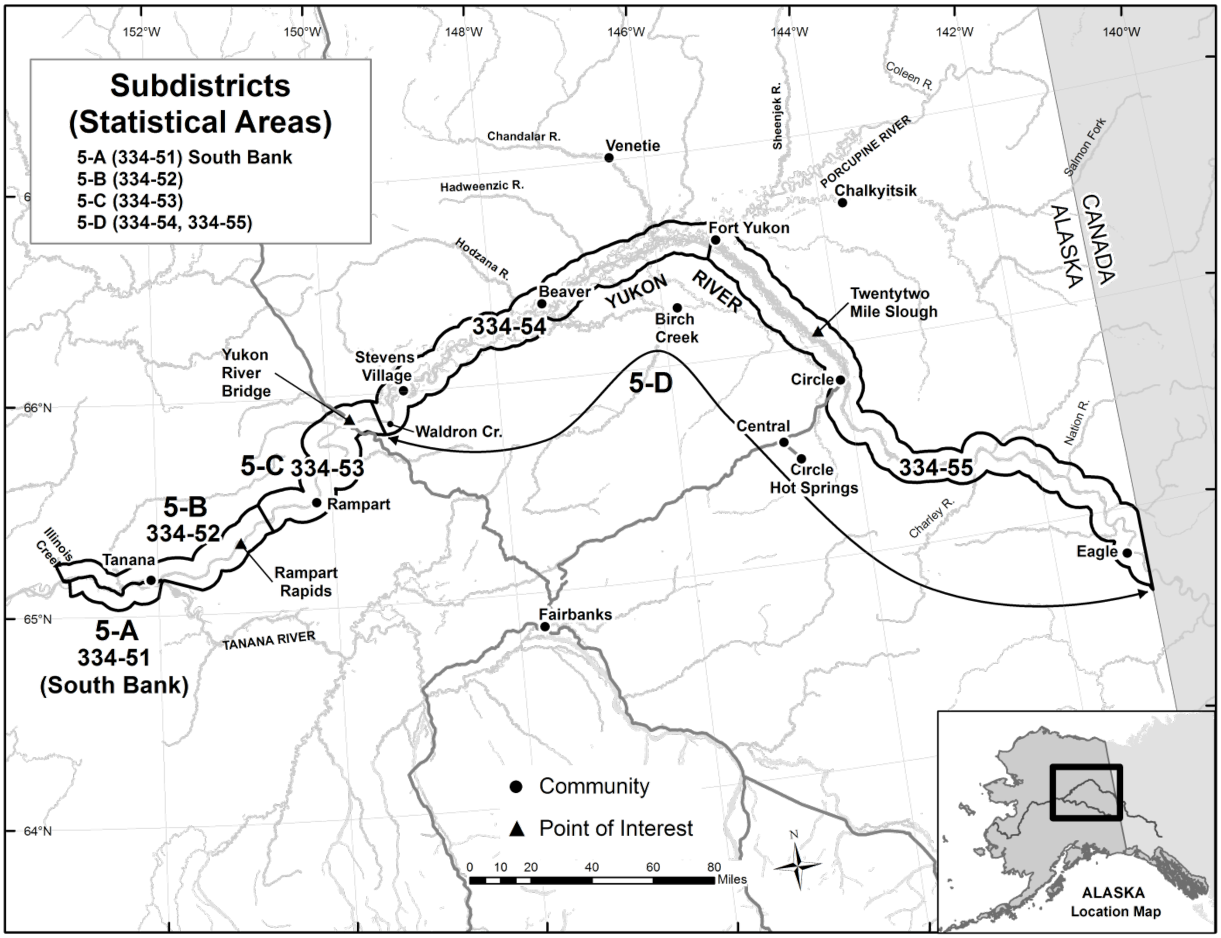

Figure 3.6.–District 5.

Subdistrict 5-A consists of the Yukon River drainage from a point opposite the westernmost edge of Illinois Creek upstream along the south bank of the river to the easternmost edge of the Tanana River mouth and includes the following islands: Second, Corbusier, Sixmile, Deet´laa´, Swanson, Blind, Basco, Sword, Leonard, Still, Tanana, and Mission.

Subdistrict 5-B consists of the Yukon River drainage from the westernmost edge of Illinois Creek upstream along the north bank to a point opposite the Tanana River mouth upstream along both banks of the Yukon River to the westernmost tip of Garnet Island and includes the following islands: Willow I, II, and III, Steamboat, Grant, Darvin, Little Joker, Station, Tozitna, Circle, Bull, and Long.

Subdistrict 5-C consists of the Yukon River drainage from the westernmost tip of Garnet Island upstream to a regulatory marker approximately two miles downstream from Waldron Creek.

Subdistrict 5-D consists of the Yukon River drainage from a regulatory marker approximately two miles downstream from Waldron Creek upstream to the US-Canada border.

District 6 consists of the Tanana River drainage to its confluence with the Yukon River.

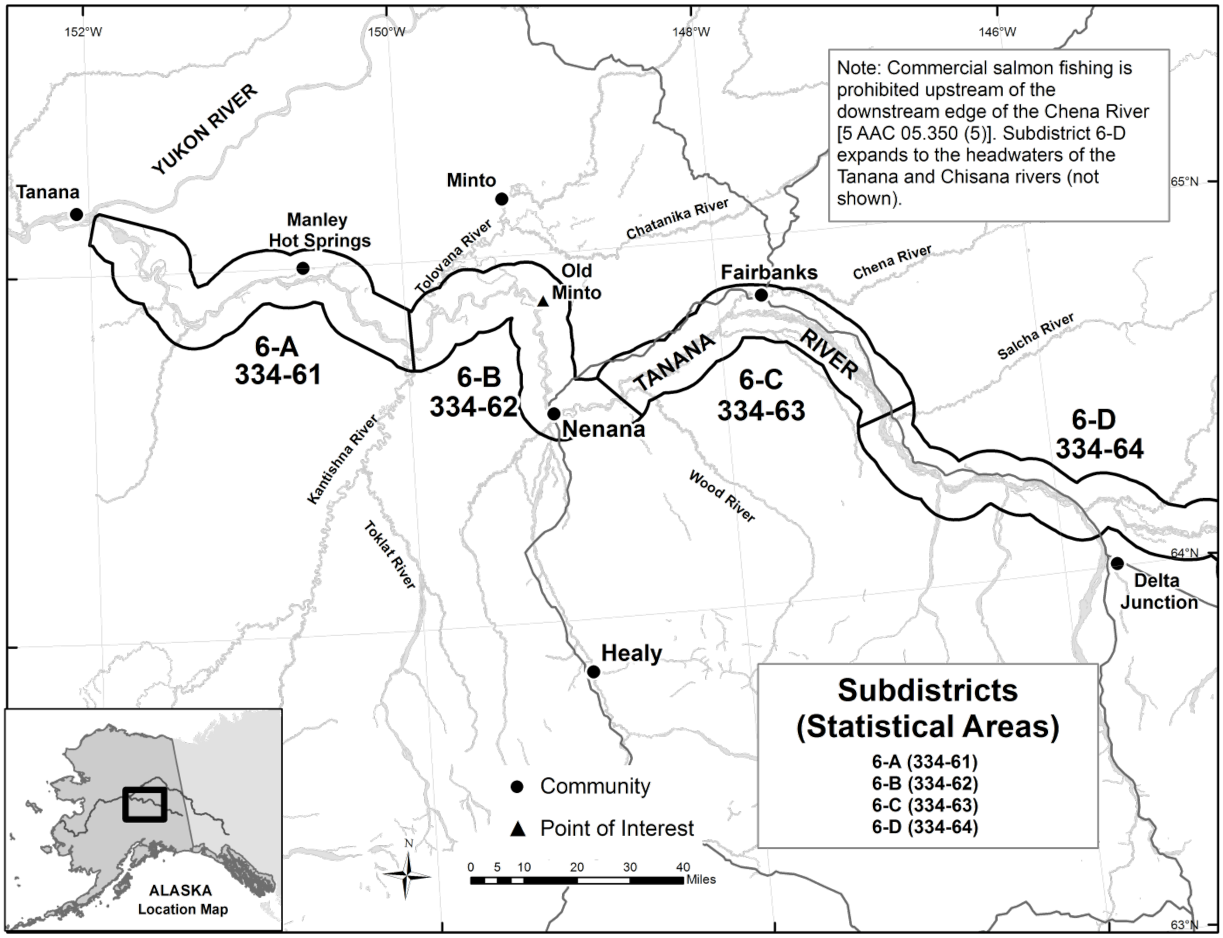

Figure 3.7.–District 6.

Subdistrict 6-A consists of the Tanana River drainage from its mouth upstream to the eastern edge of the mouth of the Kantishna River and includes the Kantishna River drainage.

Subdistrict 6-B consists of the Tanana River drainage from eastern edge of the mouth of the Kantishna River upstream to the eastern edge of the mouth of the Wood River and includes the Wood River drainage.

Subdistrict 6-C consists of the Tanana River drainage from eastern edge of the mouth of the Wood River upstream to the eastern edge of the mouth of the Salcha River and includes the Salcha River drainage.

Subdistrict 6-D is not defined in regulation. However, it consists of the Tanana River drainage from the upstream to the eastern edge of the mouth of the Salcha River to the headwaters or the Tanana and Chisana rivers.

3.2 Major Fishery Systems (Estensen et al. 2012, 2015, 2017)

The Yukon River salmon fisheries are managed according to specific salmon species plans; Yukon River King Salmon Management Plan (5 AAC 05.360); Yukon River Summer Chum Salmon Management Plan (5 AAC 05.362); Yukon River Drainage Pink Salmon Management Plan (5

AAC 05.359); Yukon River Drainage Fall Chum Salmon Management Plan (5 AAC 01.249); Yukon River Drainage Coho Salmon Management Plan (5 AAC 05.369). The Anvik River Chum Salmon Fishery Management Plan (5 AAC 05.368) and Tanana River Salmon Management Plan 5 AAC 05.367 are managed as terminal fisheries as discussed at the district level. The Biological Escapement Goal (BEG) range for the Yukon River drainage is 500,000 to 1,200,000 summer chum salmon (Conitz et al. 2015). The Sustainable Escapement Goal (SEG) range for the Yukon River drainage is 300,000 to 600,000 fall chum salmon. No drainagewide escapement goals exist for Chinook, coho, pink salmon.

3.2.1 Coastal District

Escapement goals and management strategies for the Coastal District

Subsistence fishing occurs in marine waters of the Coastal District and residents of Coastal District communities frequently travel to District 1 to engage in subsistence and commercial fishing activities. The fishing communities include: Hooper Bay and Scammon Bay located south of the Yukon River Delta on the Bering Sea coast. The main species targeted by Coastal District fishermen are Chinook, summer and fall chum and coho salmon. Whitefish species (i.e. Bering cisco, least cisco, broad and humpback whitefish, and sheefish) and lamprey are also important subsistence, and to a lesser degree commercial, species. There is no closed season for subsistence fishing of salmon and non-salmon species in the Coastal District, although restrictions on fishing gear, time, or area may be implemented by emergency order for the purposes of conservation. Commercial salmon fishing only occurs within the boundaries of District 1 with seasons and periods established by emergency order. Currently, there are no escapement goals for the Coastal District.

3.2.2 District 1

Escapement goals and management strategies for District 1

Subsistence and commercial fishing occurs throughout District 1. The fishing communities include: Nanam Iqua, Alakanuk, Emmonak, and Kotlik. The main species targeted in the district are Chinook, summer and fall chum and coho salmon. Whitefish species (i.e. Bering cisco, least cisco, broad and humpback whitefish, and sheefish) and lamprey are also important subsistence, and to a lesser degree commercial, species. The subsistence salmon fishing season and periods are established by emergency order. However, there is no closed season for subsistence fishing of non-salmon species. In District 1, subsistence salmon fishing consist of two 36-hour periods per week, except for closures before, during or after commercial fishing periods. Commercial salmon fishing seasons are established by emergency order and close by September 1 (5 AAC 05.310 (1)) or by September 10 under the *Yukon River Coho Management Plan* (5 AAC 05.369(e)(1)). Commercial periods within this time frame are allowed by emergency order. Commercial salmon have been purchased every year since 1998, except in 2001 due to low returns of salmon. In 2016, one commercial fish buyer was processing salmon and non-salmon species. Currently, there are no escapement goals for District 1.

3.2.3 District 2

Escapement goals and management strategies for District 2

Subsistence and commercial fishing occurs throughout District 2. The fishing communities include: Mountain Village, Pitka's Point, Saint Mary's, Pilot Station, and Marshall. The main subsistence and commercial species in the district are Chinook, summer chum, fall chum, and coho salmon, and lamprey. Whitefish species (including i.e. Bering cisco, least cisco, broad and humpback whitefish, and sheefish) and Arctic lamprey are also important subsistence species. The subsistence salmon fishing season and periods are established by emergency order. However, there is no closed season for subsistence fishing of non-salmon species. In District 2, subsistence salmon fishing consist of two 36-hour periods per week, except for closures before, during or after commercial fishing periods. Commercial salmon fishing seasons are established by emergency order and close by September 1 (5AAC 05.310 (1)) or by September 10 under the *Yukon River Coho Management Plan* (5 AAC 05.369(e)(1)). Commercial periods within this time frame are allowed by emergency order. Commercial salmon have been purchased every year since 1998, except in 2001 due to low returns of salmon. In 2016, one commercial fish buyer was processing salmon and non-salmon species.

Currently, the East and West forks of the Andreafsky River each have a SEG for Chinook salmon. The Chinook salmon SEG for the East Fork Andreafsky River weir, operated by the USFWS, is 2,100–4,900; the West Fork Andreafsky River has an aerial survey SEG of 640–1,600. In addition, the East Fork Andreafsky River has a summer chum salmon SEG of >40,000 (Conitz et al. 2012).

3.2.4 District 3

Escapement goals and management strategies for Subdistrict 3

Subsistence fishing occurs throughout District 3. The fishing communities include: Russian Mission, Holy Cross, and Shageluk. The main species targeted in the district are Chinook, summer and fall chum and coho salmon. The subsistence salmon fishing season and periods are established by emergency order. However, there is no closed season for subsistence fishing of non-salmon species. In District 3, subsistence salmon fishing consist of two 36-hour periods per week, except for closures before, during or after commercial fishing periods. Commercial salmon have been purchased in three years since 1998 (i.e. 1999, 2006–2007) mainly due to the absence of a fish buyer. In 2016, no commercial fish buyer was processing salmon and non-salmon species. Currently, there are no escapement goals for District 3.

Innoko River subsistence fishing is open 7-days a week. Commercial fishing is not permitted in the Innoko River.

3.2.5 District 4

3.2.5.1 Subdistrict 4-A

Escapement goals and management strategies for Subdistrict 4-A

Subsistence fishing occurs throughout Subdistrict 4-A. The fishing communities include: Anvik, Grayling, Kaltag, Nulato, and Koyukuk. The main species targeted in the subdistrict are Chinook, summer and fall chum and coho salmon. The subsistence salmon fishing season and periods are established by emergency order. However, there is no closed season for subsistence fishing of non-salmon species. In Subdistrict 4-A, subsistence salmon fishing consists of two 48-hour periods per week. Commercial salmon have been purchased in seven years since 1998 (i.e. 2007–2014). Fish buyers were located in Anvik (2007 and 2009) and Kaltag (2008, 2010–2014). In 2016, no commercial fish buyer purchased or processed salmon in Subdistrict 4-A. However, Arctic lampreys were purchased in 2016.

Subsistence fishing in the Koyukuk River is open 7-days a week. A subsistence fishing permit is required for the South Fork Koyukuk River drainage upstream of the mouth of Jim River and the Middle Fork Koyukuk River drainage upstream of the mouth of the North Fork (Figure 2.2). Commercial fishing is not permitted in the Koyukuk River.

The *Anvik River Chum Salmon Fishery Management Plan* (5 AAC 05.368.) allows a commercial harvest of the available Anvik River summer chum salmon above spawning escapement goals and to decrease the harvest pressure on non-Anvik River summer chum salmon stocks located in the mainstem Yukon River. Under this plan, the Anvik River may be opened to summer chum salmon commercial fishing if a surplus beyond the escapement goal of 500,000 fish is available. Summer chum salmon were harvested in this terminal area only during the years 1994–1997.

There are several escapement goals in Subdistrict 4-A for both Chinook and summer chum salmon. In the Anvik River the summer chum salmon BEG is 350,000–700,000 based on sonar estimated; the Chinook salmon SEG is 1,100–1,700 based on aerial survey counts. The Nulato River (including both forks) Chinook salmon SEG is 940–1,900 based on aerial survey counts (Conitz et al. 2012).

3.2.5.1 Subdistrict 4-B

Escapement goals and management strategies for Subdistrict 4-B

Subsistence fishing occurs throughout Subdistrict 4-B. The main species targeted in the subdistrict are Chinook, summer and fall chum and coho salmon. The fishing communities include: Galena and Ruby. The subsistence salmon fishing season and periods are established by emergency order. However, there is no closed season for subsistence fishing of non-salmon species. In Subdistrict 4-A, subsistence salmon fishing consists of two 48-hour periods per week. Since 1998, commercial salmon were only purchased one year in 1999. Fish buyers were based in Galena and Fairbanks. In 2016, no commercial fish buyer purchased or processed fish in Subdistrict 4-B.

3.2.5.2 Subdistrict 4-C

Escapement goals and management strategies for Subdistrict 4-C

Subsistence fishing occurs throughout Subdistrict 4-C. The fishing communities include: Galena and Ruby. The main species targeted in the subdistrict are Chinook, summer and fall chum and coho salmon. The subsistence salmon fishing season and periods are established by emergency order. However, there is no closed season for subsistence fishing of non-salmon species. In Subdistrict 4-C, subsistence salmon fishing consists of two 48-hour periods per week. Commercial salmon have been purchased in two years since 1998 (i.e. 1999 and 2003). Fish buyers were based in Galena and Fairbanks. In 2016, no commercial fish buyer purchased or processed fish in Subdistrict 4-C.

3.2.6 District 5

3.2.6.1 Subdistrict 5-A

Escapement goals and management strategies for Subdistrict 5-A

Subsistence fishing occurs throughout Subdistrict 5-A. Tanana is the only community near Subdistrict 5-A. The main species targeted in the subdistrict are Chinook, summer and fall chum and coho salmon. The subsistence salmon fishing season and periods are established by emergency order. However, there is no closed season for subsistence fishing of non-salmon species. In Subdistrict 5-A, subsistence salmon fishing consists of two 48-hour periods per week. Commercial salmon have not been purchased since 1996. In 2016, no commercial fish buyer purchased or processed fish in Subdistrict 5-A. Currently, there are no escapement goals for this subdistrict.

In Subdistrict 5-A, commercial salmon fishing is managed as a terminal fishery under *Tanana River Salmon Management Plan* 5 AAC 05.367 and is based on the assessment and timing of salmon stocks bound for the Tanana River drainage.

3.2.6.2 Subdistrict 5-B

Escapement goals and management strategies for Subdistrict 5-B

Subsistence fishing occurs throughout Subdistrict 5-B. Tanana is the only community in Subdistrict 5-B. The main species targeted in this subdistrict are Chinook and fall chum salmon. The subsistence salmon fishing season and periods are established by emergency order. However, there is no closed season for subsistence fishing of non-salmon species. In Subdistrict 5-B, subsistence salmon fishing consists of two 48-hour periods per week. Commercial salmon fishing seasons are established by emergency order and close by October 1 (5 AAC 05.310 (3)) or by October 5 under the *Yukon River Coho Management Plan* (5 AAC 05.369(e)(2)). Commercial periods within this time frame are allowed by emergency order. Commercial salmon have been purchased in 15 years since 1998 (i.e. 1998–1999, 2002–2007, and 2011–2016). Fish buyers were based in Galena, Manley Hot Springs, and Fairbanks. In 2016, two commercial fish buyers purchased salmon in Subdistrict 5-B. Currently, there are no escapement goals for this subdistrict.

3.2.6.3 Subdistrict 5-C

Escapement goals and management strategies for Subdistrict 5-C

Subsistence fishing occurs throughout Subdistrict 5-C. Rampart is the only community in Subdistrict 5-C. The main species targeted in this subdistrict are Chinook and fall chum salmon. The subsistence salmon fishing season and periods are established by emergency order. However, there is no closed season for subsistence fishing of non-salmon species. In Subdistrict 5-C, subsistence salmon fishing consists of two 48-hour periods per week. A subsistence fishing permit is required in the Yukon River drainage from the westernmost tip of Garnet Island to the mouth of the Dall River (Figure 2.2). Commercial salmon have been purchased in eight years since 1998 (i.e. 1998–1999, and 2002–2007). Fish buyers were based in Fairbanks. In 2016, no commercial fish buyer purchased fish in Subdistrict 5-C. Currently, there are no escapement goals for this subdistrict.

3.2.6.4 Subdistrict 5-D

Escapement goals and management strategies for Subdistrict 5-D

Subsistence fishing occurs throughout Subdistrict 5-D. The fishing communities include: Stevens Village, Beaver, Birch Creek, Venetie, Fort Yukon, Chalkyitsik, Circle, Central, and Eagle. The main species targeted in this subdistrict are Chinook and fall chum salmon. The subsistence salmon fishing season and periods are established by emergency order. In Subdistrict 5-D, subsistence fishing is open 7-days a week. A subsistence fishing permit is required for a portion of the Yukon River drainage near Stevens Village and from 22 mile slough (near Circle) to the Canadian border (Figure 2.2). Commercial salmon have been purchased in four years since 1998 (i.e. 1998–1999, and 2002–2003). Fish buyers were based in Fairbanks. In 2016, no commercial fish buyer purchased fish in Subdistrict 5-D.

Fall chum and Chinook salmon escapement goals occur in three rivers in this subdistrict. The BEG fall chum salmon in the Chandalar River is 74,000–152,000 based on sonar estimates. The fall chum salmon interim management escapement goal (IMEG) is 22,000-49,000 for escapements into the Canadian Fishing Branch River, a tributary of the Porcupine River. In the Sheenjek River, the fall chum salmon BEG was 50,000–104,000 based on sonar estimates (Conitz et al. 2012), but this goal was discontinued in 2015 due to the lack of monitoring project to assess the goal. At the U.S./Canada border the IMEG is 42,500–55,000 Chinook salmon and 70,000–104,000 fall chum salmon based on the Eagle sonar project estimates.

3.2.7 District 6

District 6 commercial salmon fishing is managed as a terminal fishery under the *Tanana River Salmon Management Plan* 5 AAC 05.367. Management is based on the assessment and timing of salmon stocks bound for the Tanana River drainage. Commercial salmon fishing seasons are established by emergency order and close by October 1 (5 AAC 05.310 (3)) or by October 5 under the *Yukon River Coho Management Plan* (5 AAC 05.369(e)(2)). Commercial periods within this time frame are allowed by emergency order. The Tanana River fall chum salmon has a BEG of 61,000-136,000 (Eggers 2001).

3.2.7.1 Subdistrict 6-A

Escapement goals and management strategies for Subdistrict 6-A

Subsistence fishing occurs throughout Subdistrict 6-A. Manley Hot Springs is the only community in Subdistrict 6-A. The main species targeted in the subdistrict are Chinook, summer and fall chum and coho salmon. The subsistence salmon fishing season and periods are established by emergency order. However, there is no closed season for subsistence fishing of non-salmon species. In Subdistrict 6-A, subsistence salmon fishing consists of two 42-hour periods per week. Harvesting salmon in this subdistrict requires a subsistence salmon permit (Figure 2.2.). Commercial salmon have been purchased in five years since 1998 (i.e. 1998, 2008–2009, and 2014–2015). In 2016, no commercial fish buyer purchased or processed fish in Subdistrict 6-A. Currently, there are no escapement goals for this subdistrict.

In the Kantishna River drainage subsistence salmon fishing is open 7 days per week. Commercial fishing is not permitted in the Kantishna River.

3.2.7.2 Subdistrict 6-B

Escapement goals and management strategies for Subdistrict 6-B

Subsistence and commercial fishing occurs throughout Subdistrict 6-B. Minto and Nenana are the two communities in Subdistrict 6-B. The main species targeted in the subdistrict are Chinook, summer and fall chum and coho salmon. The subsistence salmon fishing season and periods are established by emergency order. However, there is no closed season for subsistence fishing of non-salmon species. In Subdistrict 6-B, subsistence salmon fishing consists of two 42-hour periods per week, except in the Old Minto Area (open 5 days per week). Harvesting salmon in this subdistrict requires a subsistence salmon permit (Figure 2.2). Commercial salmon have been purchased in 17 years since 1998 (i.e. 1998–1999, and 2002–2016). In 2016, two commercial processors and two catcher-sellers purchased fish in Subdistrict 6-B. Currently, there are no escapement goals for this subdistrict.

3.2.7.3 Subdistrict 6-C

Escapement goals and management strategies for Subdistrict 6-C

Subdistrict 6-C is within the Fairbanks Nonsubsistence Area (FNSA, Figure 2.3, 5 AAC.915(a)(4)) and is managed as a personal use fishery for salmon and non-salmon species. Fairbanks, North Pole and Salcha are the main communities in Subdistrict 6-C. The main species targeted in the subdistrict are Chinook, summer and fall chum and coho salmon. Harvesting salmon in this subdistrict requires a personal use salmon permit. The personal use salmon fishing season and periods are established by emergency order. In Subdistrict 6-C, personal use salmon fishing consists of two 42-hour periods per week. Commercial salmon fishing is not permitted upstream of the Chena River. Commercial salmon have been purchased in 14 years since 1998 (i.e. 1998–1999, 2002–2009, 2011–2012, and 2015–2016). In 2016, one commercial processor and one catcher-seller purchased fish in Subdistrict 6-C.

There are two escapement goals in Subdistrict 6-C for Chinook salmon. In the Chena River the Chinook salmon BEG is 2,800–5,700 based on tower estimates. The Salcha River Chinook salmon BEG is 3,300–6,500 based on tower estimates (Conitz et al. 2012).

3.2.7.3 Subdistrict 6-D

Escapement goals and management strategies for Subdistrict 6-D

There are two areas within this subdistrict. The lower portion is within the FNSA; the personal use harvest of whitefish and suckers are authorized with a permit. The upper portion is a subsistence fishing area. Harvesting fish in this area requires a subsistence fishing permit. In the lower portion of Subdistrict 6-D salmon are abundant, while in the upper portion, whitefish species are more abundant and are the targeted species. Upstream of the FNSA, subsistence fishing is open 7-days a week. Commercial salmon fishing is not permitted in this subdistrict. Delta Junction, Dot Lake, Tanacross, Tok, Northway are the main communities in Subdistrict 6-D.

Two escapement goals are currently in place for fall chum and coho salmon within Subdistrict 6-D. The Delta River fall chum salmon BEG of 6,000–13,000 is based on replicate foot surveys. The coho salmon SEG in the Delta Clearwater River of 5,200–17,000 is based on replicated boat surveys.

3.3 Current Status of Fisheries (1998–2016) (Estensen et al. 2012, 2017)

3.3.1 Subsistence

Today, approximately 1,500 households participate in subsistence salmon fishing throughout much of the Yukon River drainage. In summer, subsistence fishermen harvest salmon with drift and set gillnets in the main rivers and coastal waters. Fish wheels and set gillnets are primarily used by fishermen in the Upper Yukon River and Tanana River. Subsistence fishermen also use beach seines and dipnets to harvest schooling or spawning salmon and other species of fish. A major portion of subsistence fish taken during the summer months is air dried, smoked, frozen, or canned for later consumption by residents.

In October 1999, federal subsistence management started by regulation in Alaskan rivers, lakes, and limited marine waters within, and adjacent to, federal public lands. The Federal Subsistence Board or U.S. Fish and Wildlife Service may close fishing for other uses in these waters and implement a priority for federally qualified rural subsistence users if it is determined that state-managed fishery management is causing subsistence or conservation concerns (Ward and Horn 2003). The State of Alaska area managers are the lead agency staff with authority throughout the entire Yukon Area while the Federal management authority is primarily limited to overlapping waters adjacent to Federal Conservation Units. In some cases, State regulations can be superseded by a Federal Special Action.

One method for assessing the relative success of Yukon Area fishermen is to compare the annual drainagewide estimated subsistence harvest to historic averages and to the "amounts (reasonably) necessary for subsistence" (ANS) harvest ranges established by the board (ADF&G 2001). The ANS levels outlined in 5 AAC 01.236 are 45,500–66,704 Chinook; 83,500–142,192 summer chum; 89,500–167,900 fall chum; 20,500–51,980 coho; and 2,100–9,700 pink salmon. The pink salmon ANS was established in 2013 (Estensen et al. 2015).

Chinook salmon is the most targeted subsistence species by number of fishermen with total Alaska harvests since 1998 averaged about 39,500 fish. Subsistence fishermen target Chinook salmon throughout the Yukon River drainage and coastal waters. Since 1998, Chinook salmon have returned in low to weak runs. Yukon River Chinook salmon have been designated as a yield concern by the Board of Fisheries (BOF) from September 2000 to present. Restrictions to subsistence fishing opportunity, because of poor run sizes of Chinook salmon since 2007, have severely limited their harvest in recent years. Reduced fishing periods were implemented for the subsistence fishery throughout the drainage in 2008, marking the beginning of a trend of more active management for this fishery to conserve Chinook salmon to achieve escapement goals. Even greater restrictions were implemented in 2009, 2011, and 2012. Subsistence fishing time on the mainstem was reduced in all three years and gear restrictions have been implemented since 2012, in addition to subsistence fishing closures. Closures and gear restrictions were even more extensive in 2013 and 2014. Subsistence harvest of Chinook salmon (including Canadian domestic and aboriginal harvest) averaged about 15,600 fish since 2012, with the lowest harvests in 2013 (13,135), 2014 (2,845) and 2015 (7,815; Appendix I3).

Summer chum salmon provide the largest subsistence harvest in terms of numbers, averaging about 75,000 since 1998 (Appendix I4). Subsistence fishermen mainly target summer chum salmon in the Lower Yukon River. Though, summer chum salmon are found as far upstream as the lower portion of Districts 5 and 6 fishermen do not target them due to their poor quality. Similar to Chinook salmon, production of summer chum salmon began a sharp decline beginning in 1998.

Yukon River summer chum salmon were designated a stock of management concern in September 2000 by the BOF and then delisted in January 2007 (Bergstrom et. al 2009). Though their recovery has occurred much faster, harvest levels have been impacted by subsistence fishing restrictions due to their overlap in run timing with Chinook salmon. During this time, beach seines, dipnets and fish friendly fish wheels were required to minimize the capture of and live release of Chinook salmon. Subsistence harvest of summer chum salmon averaged about 80,300 fish since 2012 (Appendix I4).

Fall chum salmon provide the second largest subsistence harvest in terms of numbers, averaging about 73,000 since 1998. Subsistence fishermen target fall chum salmon throughout the Yukon River drainage, with the majority of the harvest occurring in the Upper Yukon River and Tanana River late in the season. Harvest generally coincides with freezing weather, which allows some dog mushers to "crib" for use as dog food (Andersen and Scott 2010). Production of fall chum salmon began a sharp decline beginning in 1998. Yukon River fall chum salmon stocks were designated a yield of concern by BOF and then delisted in January 2007 (Borba et al. 2009). Toklat and Fishing Branch rivers fall chum salmon stocks were designated as a management concern in September 2000 by BOF and delisted January 2004 (Hayes et al. 2011). Recovery has occurred much faster and subsistence fishing harvest levels increased due recent low runs of Chinook salmon. Subsistence harvest of fall chum salmon (including Canadian domestic and aboriginal harvest) averaged about 97,300 fish since 2012 (Appendix I5).

Coho salmon harvests generally occur incidentally while targeting fall chum salmon. The subsistence harvest has averaged about 18,000 fish since 1998 (Appendix I6). Much of the coho salmon harvest occurs in Districts 5 and 6, late in the season. Some dog mushers also "crib" coho salmon once freezing weather allows (Andersen and Scott 2010). Subsistence harvest (including Canadian aboriginal) has remained relatively stable, averaging about 15,800 fish since 2012 (Appendix I6).

Pink salmon are harvested for subsistence primarily in the lower river districts. In the past decade, pink salmon have exhibited an abundance cycle alternating between high and low every two years, with high abundance typically observed during even numbered years. Even year subsistence harvests for the entire drainage since 2004 have averaged 6,100 fish. Since 1998, subsistence harvests averaged 3,924 pink salmon.

3.3.2 Personal Use Fishery

A household permit is required for personal use salmon fishing in the portion of the Tanana River drainage within the Fairbanks Nonsubsistence Area (Figure 2.3). Fishermen are required to document their personal use harvest on household permits and return them to ADF&G at the end of the season. From 2005-2015, on average 68 household permits were issued annually and since 1998 salmon harvest has averaged 129 Chinook, 215 summer chum, 357 fall chum and 196 coho salmon (Appendices I3, I4, I5 and I6).

3.3.3 Commercial

Although commercial salmon fishing is allowed throughout the Yukon River drainage, the majority of the commercial harvest of all species has occurred in the lower River Districts 1 and 2 (Appendices I3, I4, I5, I6, and I7). Since 1998, Yukon River Chinook salmon stocks have experienced a drastic downward shift in production. The cause of this decline is largely unknown, but many issues including climate change, freshwater survival, and marine conditions are known factors. Drastic declines of salmon stocks from 1998 through 2002 have significantly changed the character of Yukon River salmon fisheries and, since 2001 the management action plan adopted by the BOF, has been conservative. The decline coincided with a shrinking market, and overall lower commercial fishery participation level, from 1998-2016 (Appendices I8, I9 and I10). However, recent rebounds in chum and coho markets are encouraging. In 2016, the ex-vessel value of the Yukon River salmon commercial fishery was the highest since 1998, with the highest ex-vessel values of summer and fall chum, coho and pink salmon in 2016. In 2016, the ex-vessel values of the fall chum and coho salmon fisheries were the highest in Yukon River commercial history.

Commercial Chinook salmon harvests since 1998 have averaged 19,782 fish (Appendix I3). However, because of poor Chinook salmon runs, no Chinook salmon directed commercial fishing has occurred in the Yukon Area since 2007. Beginning in 2012, the sale of incidentally caught Chinook salmon in the summer chum salmon directed commercial fishery was not allowed.

Commercial harvests of summer chum salmon since 1998 have averaged 184,758 fish (Appendix I4). Restrictions to the Chinook salmon directed commercial fisheries have had recent impacts on the commercial harvest of summer chum salmon as a substantial portion of their runs overlap. Beginning in 1994, low commercial harvests, related to low summer chum salmon runs and decreasing market interest, continued riverwide through 2003. Beginning in 2004, the summer chum salmon run strength began to increase following poor run sizes from 1998 to 2002. However, most of the available surplus went unharvested between 2002 and 2006 due to a lack of market interested. Beginning in 2007, following increased roe market interest and strengthening run sizes, commercial exploitation of summer chum salmon roe was renewed in Subdistrict 4-A at a much smaller scale than before 1998. Despite harvestable surpluses available in 2007 through 2010, the redevelopment of this fishery was hindered by management strategies taken to reduce incidental harvest of co-migrating Chinook salmon. In 2013, gear types such as dipnets and beach seines, which select for the capture of summer chum salmon while minimizing the capture and allowing the live release of Chinook salmon, were adopted as legal gear. Commercial harvests of summer chum salmon since 2011 have averaged 417,204 fish (Appendix I4).

Commercial harvests of fall chum salmon since 1998 have averaged 144,481 fish (Appendix I5). Like summer chum, fall chum experienced decreased market interest and low fall chum returns from 1998 to 2004. A considerable amount of uncertainty has been associated with run forecasts, particularly in the last decade, because of unexpected run failures (1998 to 2002) followed by strong runs from 2003 through 2008. Beginning in 2008, markets began to improve, but run sizes lacked consistency. Since 2011, both the market and run productivity has been steady, with averaged commercial harvests of fall chum salmon of 256,531 (Appendix I5). Weakness in these salmon runs prior to 2003 was generally attributed to reduced productivity in the marine environment and not to low levels of parental escapement. Similarly, improvements in productivity (2007–2010) have been attributed to the marine environment.

Historically, Chinook, summer chum, and fall chum salmon were targeted in the commercial fisheries, while coho salmon were harvested incidentally during fall chum-directed fisheries. Commercial harvest of coho salmon since 1998 has averaged 57,238 fish (Appendix I6). Since 2009, ADF&G has had the flexibility to conduct late season coho salmon-directed commercial fishing if certain stipulations are met (such fisheries occurred in 2009–2011 and 2014, 2015, and 2016). Record coho salmon harvests have been taken each year in 2014, 2015 and 2016. Since 2011, commercial harvest of coho salmon has averaged 90,337 fish (Appendix I6).

The ex-vessel value of the Yukon River Commercial fishery averaged \$2,673,012 from 1998 to 2016 (Appendix I8). The ex-vessel values ranged from a high of 5,248,549 in 2016, to a low of 718,953 in 2009 (excluding 2001 when there was no commercial fishing). The average earning per commercial salmon permit fished was \$5,022 from 1998-2016. The average earning per permit fished ranged from a high of \$10,668 in 2016, to a low of \$1,309 in 2000 (excluding 2001). The exvessel value has improved in recent years, as has the average earning per permit fished. Since 2012, the average ex-vessel value has been \$3,533,206 and average earnings per permit fished is up to \$7,293. However, the number of permits fished during this time has declined, with an average of 508 permits fished from 1998-2016, and an average of 484 permits fished from 2012-2016 (Appendix I8).

3.3.4 Sport Fishery

The contents of this section are largely sourced from Wuttig and Baker *in prep*. A period of increased variability in run strength of Yukon River Chinook and chum salmon began in 1999 with runs in 2000 the lowest up to that time on record for both species. In September 2000, the BOF classified the Yukon River Chinook salmon stock as a yield concern. In response to this sport fishing for Chinook salmon has been restricted in recent years.

Alaska sport fishing effort and harvests are monitored annually through a statewide sport fishery postal survey. Harvest estimates are not available until approximately one calendar year after the fishing season; therefore, 2016 estimates were not available for this report. Total sport harvest of salmon during 2015 in the Alaska portion of the Yukon River drainage (including the Tanana River) was estimated to be 0 Chinook, 194 chum, and 593 coho salmon (Appendices I3, I4, and I6). The recent 5-year (2011–2015) average Yukon River drainage sport salmon harvest was estimated to be 200 Chinook, 511 chum, and 662 coho salmon.

Most of sport fishing effort for the Yukon River occurs in the Tanana River drainage along the road system. From 2011 to 2015, harvests in the Tanana River represented, on average, 56%, 8% and 30% of the total Yukon River drainage Chinook, chum, and coho salmon sport fish harvest, respectively. In the Tanana River, most Chinook and chum salmon are harvested from the Chena, Salcha, and Chatanika rivers, whereas most coho salmon are harvested from the Delta Clearwater and Nenana river systems. In the Yukon River drainage, excluding the Tanana River, most sport fishing effort for salmon takes place in the Anvik and Andreafsky rivers.

Since 2005, all freshwater sport fishing guides and guide businesses operating in Alaska have been required to be licensed. In addition, sport fishing guides and businesses are required to report sport fish harvest and fish released in logbooks. From 2011 to 2015, guided sport harvests in the Yukon River drainage (excluding the Tanana River drainage) averaged 66 Chinook and 241 coho salmon.

In 2015, the preseason, drainagewide Chinook salmon run was projected to be 118,000–140,000 fish, far below average in size, but stronger than the 2014 run (JTC 2016). In recent years, total run sizes have fallen near the lower range of preseason projections and a similar trend was anticipated in 2015. Achieving escapement objectives with a run of this size was expected to be challenging and conservation steps were deemed necessary. The sport fishery for Chinook salmon in the YMA was closed on May 11, 2016 prior to the arrival of Chinook salmon, and remained closed for the season.

Within the TRMA from 2011–2015, all Tanana River tributaries were restricted to Chinook salmon catch-and-release only by emergency order. This action was taken because downriver indicators suggested that the Chinook salmon run was weak, and in 2011 and 2014, counting towers on the Chena and Salcha rivers were inoperable due to high water. Unlike the YMA, in 2016, early indices of run strength projected an average-sized run and down river subsistence fisheries were permitted but at restricted levels level to ensure escapements. The tributaries of the Tanana were summarily restricted by prohibiting the use of bait from July 2 to August 10.

CHAPTER 4: YUKON RIVER REGIONAL COMPREHENSIVE SALMON RESTORATION, REHABILITATION AND ENHANCEMENT PLAN FOR ALASKA – PHASE II

4.1 Overview

The focus of this document is very specific, as directed by statute and regulation, and pertains only to activities on the Alaska side of the border. However, the RPT recognizes the influence of other activities, organizations and entities that affect Yukon River salmon. The RPT is bound by regulations, but we must consider some type of nexus to broader issues because if not, then this plan alone is too narrowly focused to provide adequate protection of the Yukon salmon resource.

Additionally, climate and environmental change will undoubtedly effect salmon survival which will impact restoration, rehabilitation, and/or enhancement efforts and should be considered using the best available science, local and traditional knowledge, and current information.

4.2 Mission, Goals, and Strategies

The mission of the CSP, the harvest goals described in it, and the strategies to achieve the goals, have been crafted with the input of salmon users of the region and are intended to assist project planners to design projects that will better understand and meet the needs of the affected communities.

4.2.1 Mission Statement

The mission of the Yukon River Comprehensive salmon restoration, rehabilitation and enhancement plan is

> To promote, through biological, cultural, and traditional practices, activities to maintain or increase salmon production in the Yukon River region for the maximal social and economic benefits of the users consistent with the public interest.

The RPT recognizes that factors such as natural fluctuations in fish populations, the mixed- stock nature of the Yukon River fishery, changing environmental conditions, 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 ensure the natural productivity of Yukon River salmon stocks so that each year:

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.

In accordance with this intent, the RPT will recommend activities in the region that will be consistent with the protection of the existing wild salmon stocks and the habitats upon which they depend. Artificial propagation shall not be used as a substitute for effective fishery regulation, stock conservation, and habitat management or protection. There is concern that enhancement projects designed to create new runs of fish could significantly impact wild stocks and management of mixed stock fisheries and are to be approached with great caution.

The priorities for implementing projects shall be in this order:

(1) rehabilitating habitat and wild stocks,

(2) restoring habitat and wild stocks,

(3) enhancing habitat,

(4) enhancing existing common property fisheries, and

(5) creating new common property fisheries through enhancement.

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. Large-scale enhancement projects (i.e. hatcheries) designed to create new runs of fish are opposed
3. Influences to salmon fisheries shall be reviewed in planning restoration, rehabilitation, and enhancement projects. Local elders, fishermen, and village residents will be consulted when projects are being proposed or planned for salmon stocks or their habitat.
4. Projects that involve habitat manipulation, supplemental production or other significant influences to salmon productivity shall be carefully planned and proceed in a conservative manner to minimize negative effects to wild salmon stocks and/or to existing fisheries.
5. Habitat must be identified, protected, and maintained to ensure productivity of spawning and rearing areas as well as migration routes of Yukon River salmon to achieve the objectives of this plan.
6. Information gaps on salmon stocks must be continually addressed. More understanding on total abundance, escapement distribution, genetic stock identification, return-per-spawner productivity, egg survival, out-migrant survival and migration timing, and patterns of use are needed to provide for sustained yields or optimal yields as established by the Alaska Board of Fisheries.
7. Habitat or wild stock restoration and rehabilitation projects shall have priority over enhancement projects.
8. Fish mortality shall be minimized as much as possible while conducting salmon projects. Reasonable attempts should be made to donate fish killed to local subsistence users (with elders receiving priority), tribal entities or charities.
9. All harvest of Yukon River salmon (subsistence, commercial, personal use, sport, incidental, bycatch, etc.) should be monitored for their impacts to Yukon River drainage salmon populations.
10. The strictest genetic and disease policies shall apply to projects on the Yukon River. Only Yukon-origin salmon may be released within the Yukon River drainage. Furthermore, the introduction of Yukon River salmon beyond the Yukon River area is opposed.
11. All projects will be required to have a permitted plan for evaluation of objectives, and impacts to other stocks and fisheries, prior to project implementation.

Careful planning is necessary before undertaking restoration, rehabilitation, or enhancement projects that might impact wild stocks. Projects shall be evaluated by the RPT in accordance with a regional comprehensive salmon plan. Careful assessment and inventory of wild stocks and their health, habitat, and life history must be an integral part of restoration, rehabilitation, and enhancement planning. Alaska fish genetics and fish disease policies will be applied to all salmon restoration, rehabilitation, and enhancement projects. When appropriate, the RPT will solicit an evaluation of the ecological and genetic risks and sociocultural and economic impacts of proposed restoration, rehabilitation, and enhancement activities and will attempt to identify alternative or additional actions, including but not restricted to fishery management actions, to achieve the goals.

4.2.1.1 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.

4.2.2 Phase II Goals

In order to evaluate the consistency of proposed projects with the needs and desires of fishery users of the region, the RPT is tasked with describing the harvest goals of the region. Community meetings, public input at RPT meetings, and a survey of salmon users were utilized by the RPT in an attempt to gain an understanding of the desired production and harvest goals by district, subdistrict or community. Desired harvest goals for subsistence are based on when there were abundant salmon runs and unrestricted harvests. A list of all public meetings held and summaries of the community meetings and the survey responses are included in Appendix H.

Fisheries management goals are aimed at maintaining and improving salmon runs by achieving proper escapement for each stock and full utilization of fish surplus to escapement needs. The precision of management policies may be limited by insufficient knowledge of run size, stock composition, timing, optimal escapement rates and levels, and behavioral characteristics of both juvenile and adult salmon. These factors represent essential information needed for optimal natural and supplemental fish production. There are many necessary and associated research studies not directly expressed in production or harvest numbers that may directly or indirectly result in more fish. Such studies will contribute to a stronger harvester/manager/resource relationship that, in turn, will contribute to increased production and harvests. Additional goals supported by the RPT are identification of the use of anadromous waters by salmon in Alaska (spawning areas and rearing habitat), identification of impaired salmon habitat and its restoration or rehabilitation, and Traditional Ecological Knowledge (TEK) studies. The RPT recognizes, supports and sees the need and value of research and documentation of salmon use by governmental agencies, nongovernmental agencies, residents and fishery users.

4.2.2.1 Production and Harvest Goals

Harvest data by species are provided below. The subsistence harvest data result from an aggregation of the post-season household survey, catch calendars, and permits, where required, and includes all years, even those where subsistence restrictions were in place. These data are the basis for the Amounts Reasonably Necessary for Subsistence (ANS) ranges determined by the Alaska Board of Fisheries (BOF) in 2001. While the ANS ranges are based on these historical data, they exclude years where subsistence restrictions were in place by species. It is important to keep in mind that ANS ranges are not harvest goals or limits, or guarantees of harvest; rather they reflect reported and unrestricted harvests of salmon over time (1990-1999) by Yukon River residents.

The 1989 to 2013 peak drainage-wide subsistence harvest of salmon was estimated as 74,808 Chinook salmon, 195,270 summer chum salmon, 164,558 fall chum salmon, and 61,358 coho salmon.

The peak drainage-wide commercial harvest of salmon was estimated as 174,668 Chinook salmon (from 1961-2013), 1,760,291 summer chum salmon (from 1967-2013), 685,546 fall chum salmon (from 1961-2016), and 209,147 coho salmon (from 1961-2016).

The 1996 to 2015 peak drainagewide sport harvest of salmon was estimated as 4,300 Chinook salmon, 3,500 chum salmon, and 3,000 coho salmon.

The following goals are based on the highest annual estimated harvest by species in each district.

Coastal District

A description of the district and historical salmon harvest is included in Chapters 2 and 3 and in Appendix I.

At the time of this writing, the district desired harvest goals for subsistence are for harvest to be unrestricted. The district desired harvest goals for subsistence were estimated to be at least: 2,882 Chinook salmon, 24,171 summer chum salmon, 559 fall chum salmon, and 502 coho salmon.

There is no commercial fishery activity within the Coastal district. Costal district desired harvest goals for commercial fisheries are contained within the District 1 goals.

There were no district desired harvest goals identified for sport fisheries.

The combined district desired harvest goals for all fisheries were estimated to be at least: 2,882 Chinook salmon, 24,171 summer chum salmon, 559 fall chum salmon, and 502 coho salmon.

District 1

A description of the district and historical salmon harvest is included in Chapters 2 and 3 and in Appendix I.

At the time of this writing, the district desired harvest goals for subsistence are for harvest to be unrestricted. The district desired harvest goals for subsistence were estimated to be at least: 10,423 Chinook salmon, 44,753 summer chum salmon, 7,770 fall chum salmon, and 5,426 coho salmon.

The district desired harvest goals for commercial fisheries were estimated to be at least: 104,350 Chinook salmon, 645,322 summer chum salmon, 226,576 fall chum salmon, and 113,669 coho salmon.

There were no district desired harvest goals identified for sport fisheries.

The combined district desired harvest goals for all fisheries were estimated to be at least: 114,773 Chinook salmon, 690,075 summer chum salmon, 234,346 fall chum salmon, and 119,095 coho salmon.

District 2

A description of the district and historical salmon harvest is included in Chapters 2 and 3 and in Appendix I.

At the time of this writing, the district desired harvest goals for subsistence are for harvest to be unrestricted. The district desired harvest goals for subsistence were estimated to be at least: 13,442 Chinook salmon, 32,566 summer chum salmon, 7,382 fall chum salmon, and 6,587 coho salmon.

The district desired harvest goals for commercial fisheries were estimated to be at least: 50,004 Chinook salmon, 424,461 summer chum salmon, 213,225 fall chum salmon, and 67,208 coho salmon.

There were no district desired harvest goals identified for sport fisheries.

The combined district desired harvest goals for all fisheries were estimated to be at least: 63,446 Chinook salmon, 457,027 summer chum salmon, 220,607 fall chum salmon, and 73,795 coho salmon.

District 3

A description of the district and historical salmon harvest is included in Chapters 2 and 3 and in Appendix I.

At the time of this writing, the district desired harvest goals for subsistence are for harvest to be unrestricted. The district desired harvest goals for subsistence were estimated to be at least: 7,715 Chinook salmon, 12,143 summer chum salmon, 2,706 fall chum salmon, and 1,549 coho salmon.

The district desired harvest goals for commercial fisheries were estimated to be at least: 7,020 Chinook salmon, 54,471 summer chum salmon, 3,722 fall chum salmon, and 3,988 coho salmon.

There were no district desired harvest goals identified for sport fisheries.

The combined district desired harvest goals for all fisheries were estimated to be at least: 14,735 Chinook salmon, 66,614 summer chum salmon, 6,428 fall chum salmon, and 5,537 coho salmon.

District 4

A description of the district and historical salmon harvest is included in Chapters 2 and 3 and in Appendix I.

At the time of this writing, the district desired harvest goals for subsistence are for harvest to be unrestricted. The district desired harvest goals for subsistence were estimated to be at least: 16,269 Chinook salmon, 35,812 summer chum salmon, 20,875 fall chum salmon, and 8,429 coho salmon.

The district desired harvest goals for commercial fisheries were estimated to be at least: 3,582 Chinook salmon, 554,587 summer chum salmon, 52,098 fall chum salmon, and 1,095 coho salmon.

There were no district desired harvest goals identified for sport fisheries.

The combined district desired harvest goals for all fisheries were estimated to be: 19,851 Chinook salmon, 590,399 summer chum salmon, 72,973 fall chum salmon, and 9,524 coho salmon.

District 5

A description of the district and historical salmon harvest is included in Chapters 2 and 3 and in Appendix I.

At the time of this writing, the district desired harvest goals for subsistence are for harvest to be unrestricted. The district desired harvest goals for subsistence were estimated to be at least: 21,365 Chinook salmon, 24,164 summer chum salmon, 76,098 fall chum salmon, and 12,376 coho salmon.

The district desired harvest goals for commercial fisheries were estimated to be at least: 6,374 Chinook salmon, 12,997 summer chum salmon, 93,575 fall chum salmon, and 1,409 coho salmon.

There were no district desired harvest goals identified for sport fisheries.

The combined district desired harvest goals for all fisheries were estimated to be at least: 27,739 Chinook salmon, 37,161 summer chum salmon, 169,673 fall chum salmon, and 13,785 coho salmon.

District 6

A description of the district and historical salmon harvest is included in Chapters 2 and 3 and in Appendix I.

At the time of this writing, the district desired harvest goals for subsistence are for harvest to be unrestricted. The district desired harvest goals for subsistence were estimated to be at least: 2,712 Chinook salmon, 11,661 summer chum salmon, 49,168 fall chum salmon, and 26,489 coho salmon.

The district desired harvest goals for commercial fisheries were estimated to be at least: 3,338 Chinook salmon, 68,453 summer chum salmon, 74,117 fall chum salmon, and 21,778 coho salmon.

The district desired harvest goals for sport fisheries were estimated to be at least: 4,300 Chinook salmon, 3,500 chum salmon (primarily fall chum), and 3,000 coho salmon.

The combined district desired harvest goals for all fisheries were estimated to be at least: 10,350 Chinook salmon, 80,114 summer chum salmon, 126,785 fall chum salmon, and 51,267 coho salmon.

4.2.2.2 Management Goals

Fisheries management in Alaska

The RPT understands that fisheries management is guided by other bodies, but feels it is important to provide an overview of fisheries management in Alaska. ADF&G manages salmon fisheries to ensure long term sustainability through escapement-based management. Salmon in excess of escapement needs represent a harvestable surplus that can be utilized by various fisheries. Subsistence use is designated as the highest priority fishery use, with harvestable surpluses above subsistence needs available to commercial, sport and personal use fisheries. To ensure sustainability, ADF&G salmon management is structured by regulatory management plans, guideline harvest ranges (GHR), harvest allocations, and all associated fisheries regulations as established by the Alaska Board of Fisheries (BOF). The BOF has seven members appointed by the governor and confirmed by a joint session of the state legislature. As the state's regulatory authority, the BOF passes regulations to conserve and develop Alaska's fisheries resources and is charged with making regulatory decisions for Alaska's fisheries. ADF&G uses emergency order (EO) authority delegated by the Commissioner to adjust time, area, and gear consistent with all applicable regulations as adopted and established by the BOF. Regulatory management plans have been adopted for Yukon Area Chinook, summer chum, fall chum, coho, and pink salmon (5 AAC 05.360, 5 AAC 74.060, 5 AAC 05.362, 5 AAC 01.249, 5 AAC 05.369, 5 AAC 05.359) and for terminal fishing areas of the Anvik River for summer chum salmon (5 AAC 05.368) and Tanana River (5 AAC 05.367). Guideline harvest ranges have been established for Chinook, summer chum, and fall chum salmon commercial fisheries throughout the Alaska portion of the drainage (Estensen et al. 2017). Stakeholders are notified of EOs through local radio stations; ADF&G's website; social media platforms; VHF radio where available; and fax and email to select communities, processors, buyers, and fishermen. Additionally, most processors and buyers are notified of EOs by telephone.

Management of the Yukon River salmon fishery is complex due to overlapping multispecies salmon runs, allocation issues, overlapping state and federal jurisdiction boundaries and international treaty with Canada, and the immense geographic expanse of the Yukon River drainage. Salmon fisheries within the Yukon River drainage may harvest stocks that are up to several weeks and over a thousand miles from their spawning grounds. Management on the Yukon River is separated seasonally with Summer Season management focused on co-migrating Chinook and summer chum salmon, and Fall Season management focused on co-migrating fall chum and coho salmon. Because these are mixed stock/species fisheries, some tributary populations may be under or over exploited in relation to their actual abundance. Based on current knowledge, it is not possible to manage for individual stocks in most areas where fishing occurs, though considerable efforts are made to use species-selective gear and adjust time and area to reduce impacts to specific species/stock groups when necessary and possible.

ADF&G uses an adaptive management strategy that projects run strength preseason to establish initial management approaches and to anticipate harvestable surplus that may be available for various fisheries, and evaluates run strength inseason to adapt those strategies and expectations to real-time observations of run strength. To develop preseason predictions and to obtain real-time observations of run strength, various salmon assessment and research programs are operated by ADF&G alongside U.S. Fish and Wildlife Service (USFWS), Canada's Department of Fisheries and Oceans (DFO), National Marine Fisheries Service (NMFS) and numerous local and nongovernmental organizations. Preseason forecasts are based on a variety of data collected annually and current forecast tools vary for different salmon species (JTC 2017; Murphy et al. 2017; Brenner and Munro 2017). Inseason run assessment includes abundance indices from test fisheries; passage estimates from various sonar projects; spawning escapement estimates using aerial and ground-based projects (Appendices I11, I12, I13, I14 and I15); genetic stock identification; age, sex, and size composition data; and catch and effort data. Additionally, juvenile studies and mark-recapture studies provide information post-season pertinent to run size, productivity, distribution patterns and various forecasting abilities. (*See 4.2.2.3 for research and assessment program details*)

Commercial salmon fishing is allowed along the entire 1,200 mile length of the mainstem Yukon River in Alaska, the lower 225 miles of the Tanana River, and the lower 12 miles of the Anvik River. Commercial fisheries typically employ the same gear types as is used by subsistence harvesters (i.e. set and drift gillnets, fishwheels, and beach seines and dip nets during times of particular conservation), and like the subsistence fishery, allowable gear varies in different areas of the river. In recent years, most commercial salmon fishing has occurred in the lower river (Districts 1 and 2), with much smaller commercial harvests occurring in the middle Yukon (District 4) and the Tanana River (District 6). Commercial fishery harvests in the Yukon River are constrained by salmon abundance and by buyer availability and processing capacity.

The Yukon River subsistence fishery primarily uses set and drift gillnets and fishwheels, with predominant gear types varying in different areas of the river. In recent years, during times of Chinook salmon conservation, selective gear types of dip nets and beach seines have been used so that summer chum salmon can be targeted and co-migrating Chinook salmon can be released alive back into the water. Similarly, fishwheel gear and operations have been modified for live release of Chinook salmon during times of conservation need. Since 2001, a subsistence fishing schedule, based on current or past fishing, has been used to provide reasonable opportunity for subsistence harvest during years of average to below average runs. The objectives of the schedule are to 1) reduce harvest early in the run when there is a higher level of uncertainty in run assessment, 2) spread harvest throughout the run to reduce harvest impacts on any particular component of the run, and 3) provide subsistence fishing opportunity among all user groups during years of low salmon runs. Additional measures to adjust or restrict time available for subsistence fishing (e.g. fishing closures on the first pulse of Chinook salmon) have been implemented in some years to achieve escapement needs.

Because significant federal lands exist in a patchwork along the Yukon River, Yukon Area subsistence fishery management is coordinated among federal and state managers. The State of Alaska area managers are the lead agency staff with authority throughout the entire Yukon Area and the federal management authority is primarily limited to waters within and adjacent to Federal Conservation Units. The federal Alaska National Interest Lands Conservation Act (ANILCA) of 1980 provides a subsistence priority for rural Alaska residents. This contrasts with the state subsistence priority which applies to all Alaska residents irrespective of rural or urban residency. The Federal Subsistence Board or USFWS managers may take a Special Action restricting fishing to federally qualified rural subsistence users in these waters if it is determined that the rural subsistence priority is being impacted. Federal Special Actions close any state commercial, sport, personal use, or subsistence fisheries in those waters and supersede state management actions. A Special Action has only occurred once in 2009 on the Yukon River.

Transboundary fisheries management (U.S./Canada)

Yukon River Chinook and fall chum salmon populations are transboundary existing in Alaska and Canada. Approximately half of the total Yukon River Chinook salmon run is produced by Canadian spawning stocks and approximately one-third of the total fall chum salmon run is produced by Canadian spawning stocks. As a result, harvest of these species in Alaska is comprised of Alaskan and Canadian stocks and Alaskan fisheries rely upon the long term sustainability of Alaskan and Canadian stocks combined. Management of these transboundary salmon stocks falls under the guidance and objectives laid out in the Yukon River Salmon Agreement (Agreement) under the Pacific Salmon Treaty between the U.S. and Canada. ADF&G is the lead management entity for the U. S. in Alaska and coordinates adherence to Agreement objectives alongside USFWS and DFO based on advice and recommendations from the bi-lateral Yukon River Panel (Panel). Compliance with this international Agreement drives many management decisions that also impact Alaskan-origin stocks in Yukon River mixed stock fisheries.

Negotiations for the development of the Agreement were initiated in 1985 between the U.S. and Canada. The purpose of these negotiations was 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 it was realized reaching a comprehensive long term agreement remained a formidable challenge given some of the key unresolved issues. However, both parties recognized there would be benefits that could be realized by more formally implementing areas of agreement to date. In February 1995, an interim Agreement went into effect through an exchange of diplomatic notes. In 1999, the Pacific Salmon Treaty was updated to adopt abundance based management principles and in 2000 the Yukon River Salmon Act established the structure of the U.S. Section of the Panel and authorized the appropriations of the Restoration and Enhancement Fund (R&E Fund). In 2001, the final Yukon River Salmon Agreement was negotiated and was officially annexed into the Pacific Salmon Treaty in December 2002.

The Panel consists of six United States members and six Canadian members. The U.S. Section of the Panel consists of four Alaskan Yukon River drainage fishermen, one Alaska state government official, and one U.S. federal government official with an alternate for each member. An advisory group of Alaskan Yukon River drainage fishermen provides input to the U.S. Section. A Joint Technical Committee (JTC) comprised of U.S. and Canadian technical representatives provides technical support and recommendations to the Panel. The Panel and JTC each meet biannually (each fall and spring) and include discussions of the past season, outlooks for the coming season, review research programs and analysis, and conduct other business as warranted. The JTC publishes an annual report documenting Alaskan and Canadian stock assessment, harvest, outlooks and management strategies, and activities of the JTC and Panel (JTC 2017).

A key component of the Agreement is administration of the R&E Fund by the Panel to address the restoration and enhancement of Canadian-origin salmon stocks. As outlined in the Agreement, the U.S. contributes $1.2 million per year into the R&E Fund. R&E Fund programs must be consistent with the Guidelines and Principles as described in the Agreement. Specifically, the R&E Fund Principles are:

1. Restoration, conservation, and enhancement programs and projects shall be consistent with the protection of existing wild salmon stocks and the habitats upon which they depend.
2. Given the wild nature of the Yukon River and its salmon stocks, and the substantial risks associated with large-scale enhancement through artificial propagation, such enhancement activities are inappropriate at this time.
3. Artificial propagation shall not be used as a substitute for effective fishery regulation, stock and habitat management or protection.

The Pacific Salmon Commission puts out the call for proposals annually and the JTC reviews the proposals for technical merit and provides recommendations to the Panel. The Panel reviews the proposals and recommendations and makes final decisions on which projects receive funding during their spring meeting. Further information pertaining to the Agreement, the Panel, JTC, and the R&E Fund can be found at the following website: http://www.yukonriverpanel.com/.

Escapement Goals

Escapement goals in Alaska are evaluated and established based on policies adopted into regulation by the Alaska Board of Fisheries (BOF), specifically the Policy for the management of sustainable salmon fisheries (SSFP: 5 AAC 39.222) and the Policy for statewide salmon escapement goals (Escapement Goal Policy: 5 AAC 39.223). These policies outline certain criteria and a review process for salmon escapement goals which is concurrent with the BOF regulatory cycle.

Escapement goal review in the Arctic–Yukon–Kuskokwim (AYK) Region is led by a review team that includes regional research coordinators and fisheries scientists from the Divisions of Commercial Fisheries and Sport Fish. The team meets multiple times well in advance of AYK BOF regulatory cycles for preliminary data compilation and review by area staff, and to discuss new information and changes in methodology, stock status, and public input since the previous review cycle. Area staff receives direction from the team on finalizing review and analysis of individual stocks in preparation for a series of public meetings. Review is coordinated with counterparts from other agencies and stakeholders who may have interest in specific goals or the review process. After these meetings, preliminary escapement goal recommendations are prepared for all areas, announced to stakeholders, and published in a report to the BOF (Conitz et al. 2015). Escapement goal recommendations are reviewed and approved jointly by the ADF&G Directors of the Division of Commercial Fisheries and Division of Sport fish by delegated authority from the ADF&G Commissioner.

The Yukon Management Area in Alaska currently has 15 established escapement goals which includes 6 for Chinook salmon, 3 for summer chum salmon, 5 for fall chum salmon, and 1 for coho salmon. Not included in this listing are 3 goals for Canadian stocks established bilaterally by the U. S. and Canada as part of the Yukon River Salmon Agreement under the Pacific Salmon Treaty. Escapement targets for these Canadian stocks includes mainstem Yukon River Chinook salmon, mainstem Yukon River fall chum salmon, and Fishing Branch River fall chum salmon. They are set annually based on recommendations of the Panel and analysis of the JTC (JTC 2017). Escapement goals and escapement data for Canadian-origin salmon can be found in Appendix I16, I17, and I18.

4.2.2.3 Research Goals

The RPT understands that fisheries research is guided by other bodies, but feels it is important to provide an overview of Yukon River fisheries research in Alaska. ADF&G's research mission is to conduct research and assessment in support of management of fisheries. Core research and assessment needs include efforts to estimate escapement, run timing, run abundance and stock composition information, as well as to conduct studies that improve management understanding for predicting future run sizes, understanding productivity and spawning distributions and factors influencing migration timing. This is distinguished from other types of research that may not have a direct application to ADF&G management of Yukon River fisheries in Alaska.

The types of monitoring projects operating in the Alaska portion of the drainage include (Estensen et al. 2017) [8]:

1. *Catch and Effort Assessment*: Commercial salmon fishing is monitored using fish tickets of commercial sales of salmon. In the majority of the Yukon Area, there is no regulatory requirement for fishermen to report their subsistence salmon harvest. The subsistence salmon harvest from communities is estimated through a voluntary household survey program. In areas of the drainage with road access, fishermen must obtain subsistence or personal use household permits on which their daily harvest is recorded. Similarly, sport fishing harvest and effort is estimated by Division of Sport Fish using mail-out questionnaires to sport fishing permit holders.
2. *Test Fishing*: Test fishing projects are operated in the lower Yukon River using set gillnets to index the Chinook salmon run relative abundance, and drift gillnets to index Chinook, summer chum, fall chum, and coho salmon runs. Test fisheries also provided run timing and age composition information. A test fishery in Mountain Village also indexes fall chum and coho salmon run timing and relative abundance using drift gillnets.
3. *Mainstem Sonar Projects*: Hydroacoustic equipment is operated in the mainstem Yukon River near Pilot Station to obtain inseason salmon passage estimates by species and near Eagle to estimate passage of Chinook and chum salmon migrating into Canada. These projects include associated test gillnet fisheries for the purpose of species apportionment applied to the sonar counts.
4. *Tributary Sonar Projects*: Hydroacoustic equipment is operated in the Anvik River to estimate summer chum salmon escapement, and in the Chandalar River to estimate fall chum salmon spawning escapements.
5. *Age, Sex, and Size Composition*: Data are collected from salmon harvested in commercial and subsistence fisheries, as well as test fisheries and escapement projects located throughout the Yukon River drainage. Samples are collected using gillnets, fish wheels, beach seines, weir traps, and carcass surveys.
6. *Genetic Stock Identification:* Genetic samples are collected in select test fisheries throughout the drainage. Analyses of Chinook and chum salmon are conducted to identify various stocks for inseason management purposes and for postseason estimation of stock-of-origin in Alaskan harvests.
7. *Aerial and Ground Surveys of Salmon Spawning Streams*: Aerial surveys are flown to monitor spawning escapements in major spawning tributaries throughout the Yukon River drainage. Fall chum salmon foot surveys are conducted at selected areas in the Tanana River drainage.
8. *Tower Projects*: Tower counting projects are used on the Chena, Goodpaster, and Salcha rivers to estimate escapement of Chinook and summer chum salmon.
9. *Weir Projects*: Weirs are operated on the East Fork Andreafsky River, Gisasa River, and Henshaw Creek.
10. *Juvenile Studies*: In recent years, a project assessing juvenile salmon as they migrate out of the Yukon River Delta and into the marine environment has occurred. Additionally, a surface trawl survey is conducted in the northeastern Bering Sea (Nunivak Island north to Bering Strait and east of St. Lawrence Island) to assess abundance, size, diet and condition of juvenile salmon after they have spent their first summer in the ocean. An adult run-size forecast has been developed for Canadian Yukon River Chinook salmon based on the abundance of juveniles observed in this survey.

[8] For information on projects operated in the Canadian portion of the Yukon River Drainage, see JTC (2017).

11. *Radiotelemetry*: Large-scale radiotelemetry projects periodically occur in the Yukon River to estimate abundance and distribution of salmon.

Propagative research has been virtually absent in the Alaskan part of the drainage. A small scale hatchery does exist in Whitehorse, Canada that primarily serves to mitigate fish loss from the Whitehorse Dam and hydropower operations. The Whitehorse Hatchery cultures freshwater fish (lake trout, arctic char, bull trout, rainbow trout, kokanee salmon) and Chinook salmon. Recent hatchery release targets have been 150,000 Chinook salmon smolt: in 2015 the hatchery released 141,396 Chinook salmon smolt (JTC 2017).

ADF&G Division of Subsistence conducts research on the customary and traditional uses of fish and wildlife resources, including salmon, by Alaskans. State and federal laws define subsistence uses as the "customary and traditional uses" of wild resources for food, clothing, fuel, transportation, construction, art, crafts, sharing, and customary trade. Subsistence uses are central to the customs and traditions of many cultural groups in Alaska, including the multiple Yup'ik, Athabascan and Cup'ik communities that reside along the Yukon River and its coastal areas and tributaries. Over the past decade, Division staff have researched the patterns and trends of salmon fishing in Yukon River communities, customary trade in the upper Yukon River, the effects of the 2009 Chinook salmon disaster declaration, and more generally the role of salmon in the annual subsistence cycle of rural communities through comprehensive subsistence survey studies.

4.2.3 Strategies to achieve production goals

There are many techniques or tools that can be used to achieve salmon production goals. The choice of which technique is appropriate to use in each case is dependent upon what the goal is, what is limiting the production that needs to be remedied, and the location and the species desired. Restoration entails restoring altered or decimated habitat, or severely depleted or extirpated fish stocks, to a previous level of natural production. Rehabilitation entails repairing altered or impacted habitat, or depressed fish stocks, to a previous level of natural production. Enhancement entails creating new or artificially improved habitat, or producing runs of fish where they do not naturally occur or above what could be naturally produced there, in order to create fish that are available specifically for harvest. Fish runs produced by enhancement projects would not exist otherwise and will no longer exist if that project is discontinued, whereas fish runs produced by restoration or rehabilitation projects were previously in existence naturally and will continue as natural production once the project is completed.

4.2.3.1 Habitat Restoration, Rehabilitation and Enhancement

Salmon habitat improvement is usually specific to a particular life stage and for that reason may benefit a specific salmon species. Chum and pink salmon benefit primarily from spawning habitat improvements and the removal of barriers to migration. Salmon with freshwater juvenile rearing requirements such as Chinook, sockeye and coho salmon also benefit from improved summer and winter rearing habitats and increased feeding opportunities. The following methods are suggested for this region.

Stream Clearance and/or Modification of Barriers

The clearance of periodic blockages (e.g., debris-choked culvert, instream debris, beaver dams etc.) of portions of streams can facilitate the passage of salmon into spawning and rearing areas that otherwise would lose production potential for some species of salmon. Many of these blockages occur on an intermittent basis and are of a size that removal could be accomplished by designated personnel. Authority to remove these stream blockages requires approval by Habitat Division, Department of Natural Resources, or the Corp. of Engineers on a case-by-case basis.

Rearing Ponds

Rearing ponds may benefit salmon with freshwater juvenile rearing requirements, primarily Chinook and coho salmon, by providing new habitat for these species. These projects have been associated with road projects in some areas, in part due to the formation of ponds by gravel extraction practices. The creation of a pond of sufficient depth to avoid freeze down is the primary size determinant. It is important to have an upwelling area where ground water will provide oxygenated water during the ice covered portion of the year. This can be arranged by placing the pond below the winter water table in riparian corridor. Another important character is to incorporate a source of nutrients in the pond to support macroinvertebrates over the year. This can be accomplished by encouraging beavers to colonize the pond or to mimic that situation by placing organic matter like tundra sod in the water. The most successful ponds have both a littoral shelf and a deep portion to the pond to help warm the water during the summer and to provide for some vegetative growth for cover and water quality.

Habitat Rehabilitation (stream channel)

These projects address stream bed conditions that have been impacted by natural factors or human activities. Migration corridors or spawning conditions can often be improved with a one-time project which makes these projects attractive even when the cost can be high. The most common of these projects is spawning channel substrate cleaning.

Nutrient Enrichment

This strategy is only useful for salmon which are resident in the river/lake system as rearing juveniles. With these types of project, commercial grade fertilizer is mixed into lake water to enhance the production of algae, which in turn is consumed by zooplankton, a favorite food of juvenile sockeye salmon. These projects require ongoing operation and production monitoring. The fertilization rate is tuned over time to the specific site and stock. Adjustments can be made on an annual basis to stabilize production and minimize costs.

4.2.3.2 Stock Restoration and Rehabilitation

Salmon stock restoration and/or rehabilitation generally entail strategies designed to restore depleted or depressed populations to prior levels of production. Various fish culture methods can be employed to achieve restoration and rehabilitation goals. Fish culture methods range from artificial manipulation of salmon egg fertilization and incubation to rearing of juvenile salmon from emergence through various juvenile life stages. The following are fish culture methods that could be considered for restoration or rehabilitation of Yukon River stocks.

Eyed-Egg Planting

This is one of the methods used to stock river systems with juvenile salmon. Salmon eggs are collected, fertilized, and incubated to a point of development approaching hatch. The eggs are then planted into suitable substrate for rearing following hatch as alevins. Advantages to this method, versus planting as fry, are reduced financial and water needs. In both cases, the fry can be marked prior to hatch for evaluation. Disadvantages include low survival to adult return, limited planting sites, and the logistics of planting eggs during the coldest part of the year.

Instream or stream-side incubation boxes

This method has the disadvantage of very limited methods of marking fish produced to allow for subsequent evaluation. The ability to mark fish production to evaluate the efficacy and effects of the project and justify costs is important. In this northern climate, periodic site checks are needed to ensure operation of the incubator boxes in cold temperatures. Freezing at the incubator outlet is a common problem which creates a cascade of system failures if left uncorrected.

4.2.3.3 Fishery Enhancement

Salmon fishery enhancement generally entails strategies designed to increase salmon production beyond natural levels for the specific purpose of harvest.

Central Incubation Facility

The central incubation facility is a hatchery type that is most often constructed where there is available water and infrastructure, but fish are not necessarily released or returning there. Multiple stocks of salmon from a variety of locations can be incubated in a central incubation facility. Stocks in a central incubation facility are kept discreet and remain separated out of concern for potential genetic and pathologic effects on stocks where they are to be released. Measures to disinfect both the facility effluent as well as the source water are often required. Generally, the complexity of these facilities requires a fully developed hatchery program with remote stocking, egg takes, and water treatment. Central incubation facilities are not necessarily production facilities, although they can support production programs, smaller restoration programs, and/or small scale programs producing fish for public use.

Production Hatchery

Production hatcheries are intended to produce salmon returns on a large enough scale to support directed fisheries. Typically these hatcheries produce 1 or 2 stocks of salmon to be released in a location that has no natural runs of salmon. A cost-recovery fishery is often associated with the hatchery release site if an area has been designated as a special harvest area (SHA) for it. Broodstock for future production and a cost-recovery harvest for supporting the facility through sales of fish are allowed at these locations. In some instances other release sites, designated as terminal harvest areas (THA), are allowed where the entire return to that location is managed as a common property fishery. The genetic makeup of these types of production hatchery releases are not necessarily restricted to 1 specific genetic line. Sometimes the initial broodstock may be derived from multiple natural runs of the same species in the general vicinity of the release site. Because the entire return is harvested in these situations, there is less concern for affecting the natural-run genetic lines.

4.3 Public Participation

The salmon fishery enhancement program is stakeholder driven in Alaska. The state, through laws passed by the legislature, created a framework of guidance that includes public participation that the program is to operate within. This legal framework and the organizations established by it are discussed in more detail in Chapter 1.

Public participation and input was sought throughout the process of updating this CSP. The Yukon River Drainage Fisheries Association co-drafted this CSP with guidance from board members representative of salmon users from throughout the region. ADF&G co-drafted this CSP in partnership with the YRDFA through participation on the RPT. Additional fishery stakeholder organizations participated as ex-officio members of the RPT. The RPT held numerous public meetings and utilized a survey to solicit input from salmon users during the drafting process. And the RPT hosted a final public meeting, following a formal public comment period, to solicit additional input prior to finalizing and submitting this CSP to the commissioner of ADF&G for approval (Appendix H).

If there is a salmon hatchery permit application received for a project in the region, it must be reviewed by the RPT at a public meeting, and the RPT must forward a recommendation to approve or deny it to the commissioner as part of the hatchery permitting process. The RPT will utilize public participation and the CSP to help determine the appropriateness of any proposed hatchery project in regards to the desires of the effected salmon users in the region.

Once salmon are produced and return, they are available for harvest. The harvest of salmon is guided by regulations approved by the Alaska Board of Fisheries. Public participation in development and approval of fisheries regulations is achieved through local advisory committees, through public regulation proposals, and through providing testimony to the Board of Fisheries regarding regulation proposals. Additional information about the Alaska Board of Fisheries and regulations can be found on the ADF&G website.

CHAPTER 5: PLANNING, PERMITTING, AND REPORTING REGULATIONS, POLICIES AND PUBLIC BENEFITS

This chapter is intended to provide enough information to understand the permitting process, regulations and policies, and how they interact with each other. This chapter is also intended to provide information that an aquaculture association should consider during the development of a project and the RPT should consider when reviewing a project for the commissioner.

5.1 Fishery Enhancement

5.1.1 Overview of the PNP Permitting Regulations

Hatcheries are heavily regulated. The PNP Hatchery permits are authorized under AS 16.10.400-16.10.480 and AS 16.43.410–16.43.440 and under regulations in 5 AAC Part 1 Commercial and Subsistence Fishing and Private Non-Profit Salmon Hatcheries, Chapters 40 and 41. These regulations and statutes require 4 main documents for operation: hatchery permit with basic management plan (BMP), annual management plan (AMP), fish transport permit (FTP), and annual report.

The following figure (Figure 5.1) shows a flow chart of the regulation of PNP hatcheries in Alaska and how the progression of permits results in the release of fish. Appendix C has a more detailed roadmap which includes considerations to be made by an aquaculture association when planning a project, such as information needs, permits and department requirements. Appendix D provides a roadmap for the hatchery permitting process and Appendix E provides a blank hatchery permit application.

5.1.1.1 Hatchery Permit and Basic Management Plan

The hatchery permit authorizes the operation of the hatchery, specifies the maximum number of eggs of each species that a facility can incubate, authorizes release locations and numbers, and identifies the broodstock to be used for each species. The basic management plan (BMP) is a part of the hatchery permit (an addendum) and outlines the general operation of the hatchery. The BMP may describe the facility design, operational protocols, hatchery practices, broodstock development schedule, donor stocks, harvest management, release sites, and consideration of wild stock management. The hatchery permit and BMP are nontransferable and remain in effect until relinquished by the permit holder or revoked by the commissioner of ADF&G.

The hatchery permit and BMP may be amended through a permit alteration request (PAR). The hatchery's permitted capacity, broodstock source, or approved release sites must be changed through the use of a PAR. ADF&G and the RPT review the PAR and provide a recommendation to the commissioner of ADF&G for consideration and final decision. If the RPT is unable to reach an agreement on a recommendation the PAR is sent to the commissioner without a recommendation (but generally with a summary of the discussion).

A management feasibility analysis (MFA) is required before a hatchery permit application is submitted. The analysis is conducted by ADF&G is based on information provided by the applicant. The following information is required: (1) location of the facility, (2) species desired for hatchery production, (3) run timing by species, (4) incubation and rearing levels desired during the first reproductive cycle by species, and (5) incubation and rearing levels desired at full capacity by species. After submittal of a request for a MFA, ADF&G will, within 90 days (business), complete the MFA which includes as a minimum, the following information: (1) an estimate of potential contributions to the common property fishery, (2) potential size and location of a special harvest area, (3) special management considerations or the need for additional studies, (4) potential broodstock sources, (5) an assessment of production potentials for each species, and (6) additional factors considered by ADF&G to be relevant to the proposed hatchery operation. Regulations regarding the MFA are located at 5 AAC 40.130.

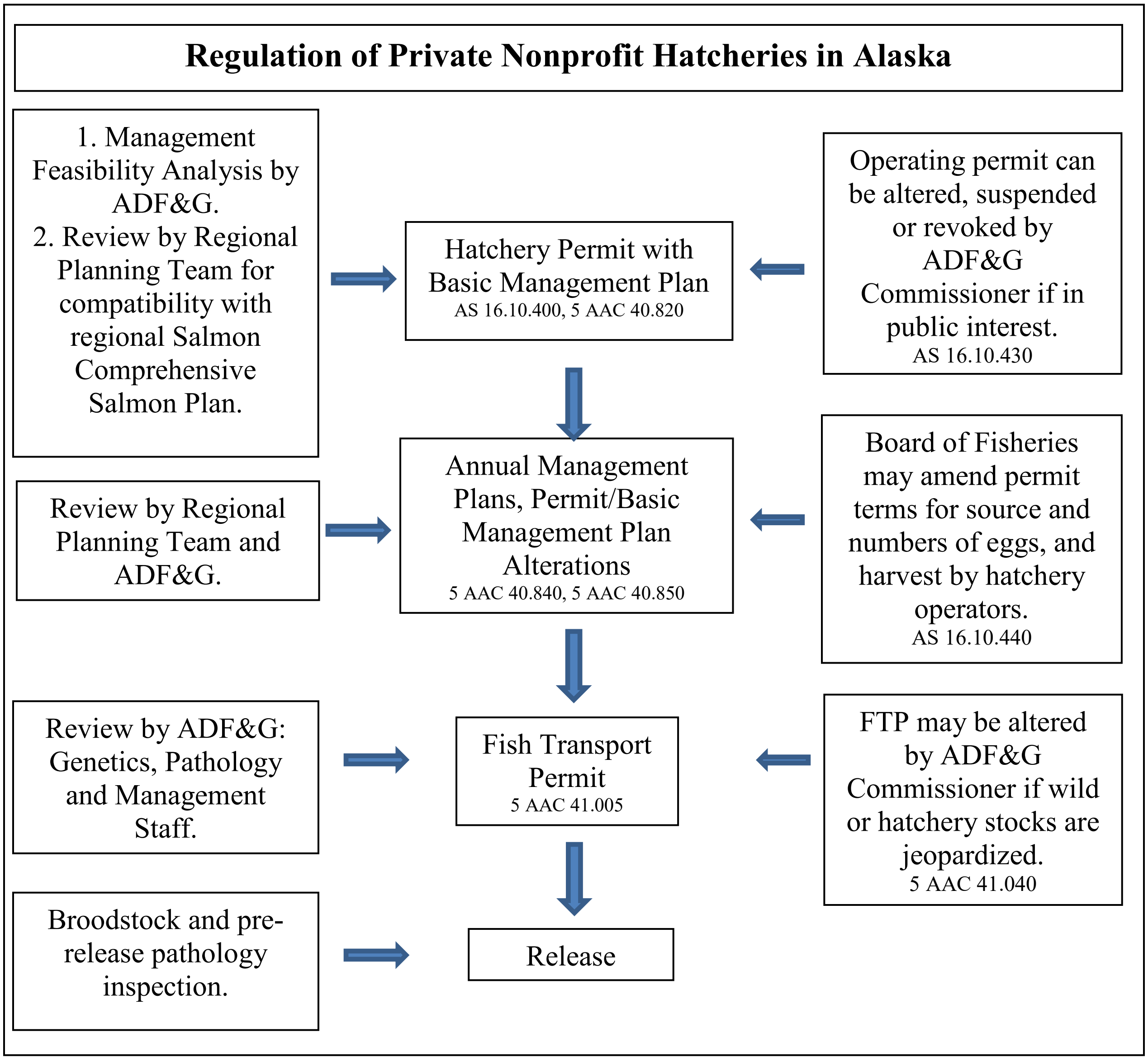

Figure 5.1–Regulation of private nonprofit hatcheries in Alaska (Stopha 2013).

5.1.1.2 Annual Management Plan

The AMP outlines the year's operations regarding production goals, broodstock development, and harvest management of hatchery returns on an annual basis (5 AAC 40.840). The AMP is in effect until superseded by the following year's AMP. The AMP must be consistent with the hatchery permit and BMP. The AMP generally contains the upcoming year's egg-take goals, fry or smolt releases, expected adult returns, harvest management plans, FTPs required or in place and fish culture techniques. The RPT may review the AMP and provide a recommendation to approve or deny to the commissioner.

5.1.1.3 Fish Transport Permit

FTPs are required to transport, possess, export from the state, or release into the waters of the state, any live fish or eggs (5 AAC 41.001–41.100). Permits are subject to a department review that takes approximately 45 days. Department review includes pathology, genetics, area management staff, a regional resource development biologist, and possibly other staff if appropriate. Reviewers may make recommendations as to whether the permit should be issued or suggest conditions to be imposed with the permit. FTPs are valid for a fixed term identified in the permit.

Additional information on FTPs, Fish Resource Permits, and Salmon Incubation (classroom projects) can be found on the ADF&G website[9].

5.1.1.4 Annual Report

The annual report is due by December 15 of each year and includes, but is not limited to, information on species, brood stock source, number of egg collected, juvenile releases, current year run sizes, contributions to fisheries, and run projections for the following year (AS 16.10.470). ADF&G takes information from all the submitted annual reports and prepares a summary annual report which is provided to the Alaska State Legislature.

5.1.2 Regulation of Broodstock

AS 16.10.445 states

> (a) The department shall approve the source and number of salmon eggs taken under AS 16.10.400–16.10.470. (b) Where feasible, salmon eggs utilized by a hatchery operator shall first be taken from stocks native to the area in which the hatchery is located, and then, upon department approval, from other areas, as necessary.

Broodstock are examined for disease prior to use in a hatchery. The sale of salmon and salmon eggs by hatchery operators is addressed in AS 16.10.450. After a PNP hatchery operator uses funds from these sales for reasonable operating costs, including debt service, facilities expansion, and salmon rehabilitation or research projects, remaining funds must be expended on other fisheries activities of the qualified regional associations for the area in which the hatchery is located. In accordance with AS 16.05.730, the Board of Fisheries may direct ADF&G to manage fisheries to achieve an adequate return of fish from enhanced stocks to enhancement projects for broodstock in a manner consistent with sustained yield of wild fish stocks.

5.1.3 Regulation of Harvest of Enhanced Fish

Fish released by a hatchery are available for common use in the same manner as natural stocks until they return to the SHA established by ADF&G (AS 16.10.440). The harvest of fish by the PNP Hatchery Permit holder within the SHA falls under the authority of AS 16.43.400–16.43.440, and regulations specific to the SHA promulgated by the Board of Fisheries. Additionally, AS 16.05.730 requires fisheries to be managed in a manner consistent with that of sustained yield of wild salmon stocks, and the conservation of wild stocks is given the highest priority among competing uses.

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[9] http://www.adfg.alaska.gov/index.cfm?adfg=otherlicense.aquatic_overview (accessed October 2016).

5.1.3.1 Special Harvest Area

A definition of a SHA is provided in statute AS 16.10.455(g)(2), and in regulation 5 AAC 40.990 (12) *special harvest area* means an area designated by the commissioner or the Board of Fisheries, where hatchery returns are to be harvested by the hatchery operators, and in some situations, by the common property fishery.

5.1.3.2 Terminal Harvest Area

A definition of a THA is provided in 5 AAC 40.990 (13) and means an area designated by the commissioner, Board of Fisheries regulation, or department emergency order where hatchery returns have achieved a reasonable degree of segregation from naturally occurring stocks and may be harvested by the common property fishery without adverse effects.

A hatchery operator should be prepared for ADF&G to require the cleanup of a SHA/THA if the common property fishery or cost-recovery fishery is allowing aggregations of hatchery-produced salmon to accumulate, in order to minimize the risk of straying. This may be a condition written in the BMP, the AMP, or the FTP, or just a directive from ADF&G. In order to facilitate cleanup if necessary, all possible gear types such as purse seine, hand purse seine, beach seine, fyke net, drift gillnet, set gillnet, dip net, and troll should be listed for flexibility purposes as allowable gear types in a SHA and the THA. However, gear restrictions may occur due to wild stock interception concerns. Fishermen may wish to approach the Board of Fisheries and ask for gear modifications within a THA to more effectively harvest returning fish produced by an enhancement program.

5.1.4 Performance Review of Hatcheries

ADF&G has the right to inspect a hatchery facility or perform a consistency review at any time while the facility is operating under AS 16.10.460. The goal is to inspect each facility at least every other year or as needed.

5 AAC 40.860 Performance Review

(a) Based upon a department internal review, the PNP coordinator will notify the commissioner if a hatchery operator's performance is inadequate, according to the conditions under which the permit was granted.

(b) The commissioner will, in his or her discretion, consider a permit alteration, suspension, or revocation in accordance with AS 16.10.430. If the commissioner decides to consider a permit alteration, suspension, or revocation, the coordinator will notify the appropriate regional planning team. The regional planning team may make a written recommendation to the commissioner on the proposed alteration, suspension, or revocation. The regional planning team shall use the following performance standards in their review, evaluation and recommendation to the commissioner, including whether:

(1) survivals in the hatchery are more than the minimum standards described in (c) of this section for a period of greater than four years;

(2) the transport of broodstock from wild sources does not continue for longer than one cycle of the particular species without reevaluation of hatchery operations;

(3) the hatchery contributes to the common property fishery;

(4) the hatchery does not significantly impact wild stocks in a negative manner;

(5) the hatchery fulfills the production objectives described in the terms of the hatchery permit; and

(6) are there any mitigating circumstances which were beyond the control of the hatchery operator.

(c) Minimum hatchery survival standards are as follows:

	Survival for this Stage	Cumulative Survival
For captured brood stock to egg take	70%	
Green egg to eyed egg	80%	80%
Eyed egg to emergent fry	85%	68%
Emergent to fed fry[1]	90%	61%
Fed fry to fingerling[2]	90%	55%
Fingerling to smolt	75%	41%

[1] Fry achieving up to 25% weight gain from swim up.
[2] Fry achieving substantially more than 25% weight gain from swim up.

Internal consistency reviews check to see that the hatchery is operating according to its permits and that the permits are current and consistent with each other, and that they provide an accurate description of current hatchery practices. The operations are compared to the goals and expectations of the regional comprehensive plan. The review also compares for consistency with the policies governing Alaska hatcheries that can be summarized by the categories of genetics, fish health, and fisheries management (Stopha 2013).

5.1.5 Public Benefit and Hatchery Funding

5.1.5.1 Public Benefit

Public benefits are generally measured by the number of hatchery-produced fish harvested in common property fisheries. Contribution to common property fisheries is a criteria used by both the commissioner and the RPT when reviewing hatchery permit applications. Furthermore, contribution to common property fisheries is a criteria used to evaluate state loans to PNP hatchery programs. It is understood that PNP hatchery programs will need to harvest a certain percentage of the returning hatchery-produced fish to cover the cost of operation, commonly referred to as cost recovery. A PNP hatchery program has to balance between the needs of the business (cost recovery) and providing public benefit by contributing hatchery-produced fish to common property fisheries.

5.1.5.2 Hatchery Funding Overview

Hatchery facilities and programs are expensive to start and operate. In regions of the state with developed aquaculture programs, both RAAs and nonregional PNP corporations sought public funding to provide initial capital and operating expenses, but it was the intent of the legislators who designed the program that funding for enhancement of the state's fisheries would come from those who benefitted from that production; that is, a user-pays fiscal policy (Burke 2002). The legislature granted fishermen the right to assess themselves the salmon enhancement tax (SET). Further details can be found in Section 5.1.5.4. The intent of this tax was to provide organizational funds, collateral for loans and operating expenses. Hatchery operators were also given the right to conduct cost-recovery harvest of a portion of the returning fish to the SHA. Further details can be found in Section 5.1.5.5. Many associations have been successful in finding grant sources for specific projects and some associations have developed tourist attractions and gift shops to earn additional funds. In the Norton Sound region, it is probable that any hatchery program will need to have some additional source of funding as the traditional forms of revenue generation (SET and cost recovery) will likely not be adequate to meet the financial needs of the operation by themselves.

5.1.5.3 Fisheries Enhancement Revolving Loan Fund

The Alaska State Legislature created the Fisheries Enhancement Loan program as a way to promote the enhancement of the state's fisheries through long-term, low-interest loans for hatchery planning, construction, and operation as well as for implementing other enhancement and rehabilitation activities such as lake fertilization and habitat improvement. This loan program is established under AS 16.10.500–16.10.560.

5.1.5.4 Salmon Enhancement Tax

In 1980 the legislature adopted the Salmon Enhancement Act. This legislation established statutes (AS 43.76.001–43.76.040) authorizing either a SET upon a 51% affirmative vote of all commercial salmon permit holders within the region. The SET is levied on the exvessel value of salmon harvested in the region. Department of Revenue is responsible for the collection of the SET. The tax revenues are then deposited in the general fund, and appropriated yearly by the Legislature to the RAA for the region. Only RAAs are legally allowed to receive SETs, nonregional associations must rely on cost recovery to fund operations, or grants/donations on collaborative projects with the RAA. The price of fish, along with the volume of commercial harvest, greatly influences the amount of funds generated.

5.1.5.5 Cost Recovery

The intent of the legislation (AS 16.10.440) authorizing PNP hatcheries to harvest a portion of the hatchery-produced fish returning to the SHA is to develop a *user pay* approach so that hatcheries can have a self-supporting income necessary to support programs and operate salmon fishery enhancement facilities. AS 16.10.455 Cost Recovery Fisheries specifies how a hatchery permit holder is allowed to conduct a cost-recovery fishery. A hatchery permit holder may conduct cost-recovery harvest of hatchery returns within a SHA, or cost-recovery funds can be collected from an assessment tax on a commercial common property fishery in a THA.

Legislation authorizing SHA entry permits and conditions of use can be found in AS 16.43.400–16.43.440. A PNP hatchery permit holder may be issued a SHA entry permit that is valid for 1 year and applies to an SHA designated by ADF&G. Authorized gear for cost-recovery fishing in the SHA is designated by the Board of Fisheries.

Effective in 2006, the legislature amended AS 16.10.455 to allow an assessment tax on common property harvest in a THA to be used for cost-recovery funding. The assessment is levied on the value of salmon that the fishermen takes in the THA and sells to a licensed buyer. The Alaska Department of Revenue sets the rate of the assessment levied on salmon taken in the THA in consultation with the Alaska Department of Commerce, Community, and Economic Development; the permit holder; and representatives of affected commercial fishermen. Considerations when setting the assessment include the estimated return and harvest of salmon in the THA, the projected price to be paid for the salmon, the amount of the existing reserve held by the hatchery permit holder, and the amount by which the assessment collected the previous years exceeded or fell short of the amount anticipated to be collected. The total rate of the assessment may not exceed 50% of the value of the salmon.

Alaska Statute clearly outlines the uses of cost-recovery funds in AS 16.10.450 Sale of salmon and salmon eggs: use of proceeds; quality and price.

> (a) Except as otherwise provided in a contract for the operation of a hatchery under AS 16.10.480, a hatchery operator who sells salmon returning from the natural waters of the state, or sells salmon eggs to another hatchery operating under AS 16.10.400–16.10.470, after utilizing the funds for reasonable operating costs, including debt retirement, expanding its facilities, salmon rehabilitation projects, fisheries research, or costs of operating the qualified regional association for the area in which the hatchery is located, shall expend the remaining funds on other fisheries activities of the qualified regional association.

Management of traditional wild stock fisheries is not to be restricted by cost-recovery needs (economic escapement) of hatcheries. This concept is embodied in AS 16.05.730. There is not envisioned any circumstance where a traditional wild stock fishery should be interrupted to assure a cost-recovery harvest.

5.2 Habitat Enhancement and Rehabilitation

Habitat enhancement and rehabilitation is another potential tool for restoring, rehabilitating, or enhancing salmon fisheries. There are several types of habitat restoration, including lake and stream restoration and fish passage improvement. Whether improving existing habitats or returning degraded habitats to their natural condition, these attempts to benefit fish populations through protection of healthy habitats and rehabilitation of impacted habitats is an important aspect of fishery restoration, enhancement, and development. Work on impacted and healthy habitats to restore riparian habitat, restore fish passage, enhance fish habitat, and provide educational opportunities on these subjects is desirable.

5.2.1 Habitat Permit (AS 16.05.871)

Alaska's fish habitat protection statutes were adopted shortly after statehood and remain unchanged to this day. This reflects the longstanding Alaska ideal that fishery resources and habitats are assets that improve our quality of life and merit protection from unnecessary human disturbance. Land and Water use permits from ADF&G are issued through the Division of Habitat. ADF&G has the statutory responsibility for protecting freshwater anadromous fish habitat and providing free passage for anadromous and resident fish in fresh water bodies (AS 16.05.841–16.05.871). Any activity or project that is conducted below the ordinary high water mark of an anadromous stream requires a Fish Habitat Permit. A Fish Habitat Permit is required before any action is taken to construct a hydraulic project; use, divert, obstruct, pollute, or change the natural flow or bed of a specified river, lake, or stream; or use wheeled, tracked, or excavating equipment or log-dragging equipment in the bed of a specified river, lake, or stream.[10]

5.3 Fishery Research and Education

Projects that have a research and/or educational objective rather than a fishery enhancement objective may still provide a benefit to salmon populations and fisheries. Most public and

[10] ADF&G Website Lands & Waters, Fish Habitat Permits http://www.adfg.alaska.gov/index.cfm?adfg=uselicense.main (Accessed January 2015).

commercial uses of Alaska's fish resources are closely regulated by the Alaska Board of Fisheries. However, people may wish to use fish or their eggs in other ways too. Researchers sometimes collect or kill fish for reference specimens. Organizations or individuals sometimes need to move fish or their eggs between points within Alaska. When done properly, the capture, collection, holding, or propagation of fish can also have considerable educational value. ADF&G authorizes, monitors, and evaluates potential effects of these uses by issuing different types of fish resource permits for qualifying projects by individuals and organizations.

5.3.1 Aquatic Resource Permit

Aquatic resource permits are only issued to applicants who are engaged in legitimate scientific, educational, propagative, or exhibition activities. The fish transport permit and aquatic resource permit regulations (5 AAC 41.001- 5 AAC 41.899) govern permits needed for collecting, holding, and propagating fish, shellfish, or aquatic plants for research or educational purposes. Permits are required for anyone who wants to transport, possess, or release into the waters of the state, any live fish (the broad legal definition) or their eggs. Violating the terms of aquatic resource permits or associated regulations may be found to be a Class A misdemeanor or more serious offense under Alaska law.[11]

5.4 Pertinent ADF&G Policies

In Alaska, the purpose of salmon hatcheries is to supplement natural stock production for public benefit. Hatcheries are efficient in improving survival from the egg to fry or smolt stage (Stopha 2013). For example, estimates of pink salmon *Oncorhynchus gorbuscha* survival in the wild ranged from less than 1% to 22% with average survivals from 4% to 9% (Groot and Margolis 1991) while hatchery survivals are usually 90% or higher. For Chinook salmon the egg to fry survival under natural conditions, while variable, is expected to be 30% or less (Groot and Margolis 1991) with additional mortality occurring to the emigrating smolt stage. Policies were developed to guide the hatchery program while protecting wild stocks.

> Alaska hatcheries do not grow fish to adulthood, but incubate fertilized eggs and release resulting progeny as juveniles. Juvenile salmon imprint on the release site and return to the release location as mature adults. Per state policy, hatcheries generally use stocks taken from close proximity to the hatchery so that any straying of hatchery returns will have similar genetic makeup as the stocks from nearby streams. Also per state policy, Alaska hatcheries do not selectively breed. Large numbers of broodstock are used for gamete collection to maintain genetic diversity, without regard to size or other characteristic. In this document, *wild* fish refer to fish that are the progeny of parents that naturally spawned in watersheds and intertidal areas. *Hatchery* fish are fish reared in a hatchery to a juvenile stage and released. *Farmed* fish are fish reared in captivity to market size for sale. Farming of finfish, including salmon, is not legal in Alaska (AS 16.40.210). (Stopha 2013)

A variety of policies guide the permitting of salmon fishery enhancement projects: ADF&G's *Genetic Policy* (Davis et al. 1985); *Regulation Changes, Policies, and Guidelines for Fish and Shellfish Health and Disease Control* (Meyers 2014); and fisheries management policies such as the 5 AAC 39.222 Policy for the management of sustainable salmon fisheries. The policies are

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[11] ADF&G Website Licenses & Permits, Aquatic Resource Permits http://www.adfg.alaska.gov/index.cfm?adfg=otherlicense.aquatic_resource (Accessed February 2018).

used by ADF&G staff to assess hatchery operations for genetic, health, and fishery management issues in the permitting process (Stopha 2013).

5.4.1 Genetic Policy

The State of Alaska developed a provisional genetic policy in 1975 to protect wild stocks from enhancement activities. The genetic policy was revised in 1978 and again in 1985, to provide guidelines for Alaska's aquaculture program while maintaining protections of wild stocks as the principle objective. ADF&G's genetic policy is the policy in effect today. The intent of this policy is to meet the goal of greater fish production through enhancement while maintaining healthy wild stocks. Additional information regarding background and intent of the policy can be found in *Background of the Genetic Policy of the Alaska Department of Fish and Game* (Davis and Burkett 1989). Both of these publications are in Appendix F.

The genetic policy statement is broken down into 3 parts: stock transport, protection of wild stocks, and maintenance of genetic variance. Guidelines and justifications are presented to further explain policy statement. Stock transport is broken down into 3 categories: interstate, inter-regional, and regional transports.

Interstate

Transfer of salmonids, including gametes, will not be imported from outside the state, with the exception of some transboundary river projects.

Inter-regional

Stocks will not be transported between major geographic areas: Southeast, Kodiak Island, Prince William Sound, Cook Inlet, Bristol Bay, Artic-Yukon-Kuskokwim, and Interior.

Regional

Transports are acceptable within regions as long as (a) the phenotypic characteristics of the donor stock is appropriate for the region and the transfer meets the goals set in the regional comprehensive management plan; and (b) noting that transplants occurring over greater distances may have a higher rate of straying and reduce the likelihood of a successful project, the distance of the proposed transport does not have a high probability of failure.

It should be noted that regions mentioned in the genetic policy do not correlate with regions identified by the commissioner for enhancement. Furthermore, the guidelines and justifications section of the genetic policy note that the environment can vary greatly from one region to another in a state as large as Alaska; therefore, considerations may be given to regional border areas, especially when no suitable donor stock is available within the region.

5.4.1.1 Significant or Unique Stocks (genetic policy)

The genetic policy also recommends the identification and protection of *significant and unique* wild stocks:

> Significant or unique wild stocks must be identified on a regional and species basis so as to define sensitive and non-sensitive areas for movement of stocks.

In addition, it suggests that drainages be established as wild stock sanctuaries where no enhancement activity is permitted except for gamete removal for broodstock development. The wild stock sanctuaries were intended to preserve a variety of wild types for future broodstock development and outbreeding for enhancement programs.

These stock designations are interrelated with other recommendations of the genetic policy, including (1) hatchery stocks cannot be introduced to sites where the introduced stock may have interaction or impact on significant or unique wild stocks; (2) a watershed with a significant stock can only be stocked with progeny from the indigenous stocks; and (3) fish releases at sites where no interaction with, or impact on, significant or unique stock will occur, and which are not for the purposes of developing, rehabilitation, or enhancement of a stock (e.g., releases for terminal harvest or in landlocked lakes) will not produce a detrimental genetic effect. Davis and Burkett (1989) suggest that RPTs are an appropriate body to designate significant and unique wild stocks and wild stock sanctuaries.

The genetic policy recommends the regional designation of significant and unique wild stocks. This designation of criteria for runs of fish that are considered significant would greatly expedite the evaluation process. However, *significance* must be defined not only by the magnitude of the run, but also in the context of local importance and utilization. A small sockeye salmon stock near a village in southeast Alaska may be *significant*, whereas the same size population may be too small to be considered a manageable entity in Bristol Bay. Because local utilization is an important concern, a regional planning group such as the RPTs, should consider what criteria will be used to determine significant stocks within a region and recommend such stock designations.

Different regions of the state have approached this issue in different ways in their comprehensive plans. *The Cook Inlet Regional Salmon Enhancement Planning Phase II 2006-2025* (CIRPT 2007) further defined the terms *significant* and *unique* and then as they reviewed each system, determined if it was *significant*. They stated, *significant stocks* are being identified by size, and that size varies by species. For purposes of planning the Cook Inlet Regional Planning Team (CIRPT) has set the following minimum size criteria for *significant* stocks in Cook Inlet: Chinook salmon, 400 fish; coho salmon and chum salmon 800 fish; sockeye salmon, 2,000 fish; and pink salmon, 5,000 fish.[12] CIRPT, for their planning purposes defined a *unique stock* as an *atypical stock* that can be identified by exhibiting gross characteristics that are noticeably different from the prevailing regional patterns for that species.[13] Using this definition, CIRPT reached the conclusion there were no stocks it could designate as unique, and therefore discussion of unique stocks does not occur in each individual unit chapter (CIRPT 2007, 3–12, 3–16).

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[12] Supplementary notes: This definition was developed and adopted by the CIRPT in the absence of any other suggested definition. Stocks that are designated *significant* must be of a sufficient size to maintain themselves. In this case what is being identified is a stock that can continue to be the optimum level of what the habitat could probably support. This definition should not be construed to devalue the collective importance of the many smaller or *nonsignificant* stocks. Applying this designation amounts to identifying the major discrete components of the total salmon resource of the planning unit being considered.

[13] Supplementary notes: This definition was developed and adopted by CIRPT in the absence of any other suggested definition. The term *unique stocks*, as it seems to be most commonly used, implies an undefined level of discrimination among stocks and varying degrees of positive connotation associated with the word *unique*. In the most absolute sense each individual fish is *unique*, but this level of discrimination is beyond practical ability to recognize or act on the *uniqueness*. In addition, the level of *uniqueness* is regularly and continuously subjected to alteration through such natural phenomena as were discussed in the concept of genetic integrity. For the purposes of this type of planning and for day-to-day management such a use of the *uniqueness* concept is not functional. The degree to which such a difference or *uniqueness* has a particular value (positive or negative) must be judged on a case-by-case basis.

In the *Comprehensive Salmon Enhancement Plan for Southeast Alaska: Phase III*,[14] the RPT developed a *stock appraisal tool* that looks at 4 stock characteristics: wildness, uniqueness, isolation, and viability. The Joint Northern/Southern Southeast RPT stock appraisal tool splits the viability into population size and population trend and adds a criterion that addresses the human use pattern. In the Southeast *stock appraisal tool* each of the 6 characteristics has a nonnumeric gradient ranging from the quality that would indicate less significance (left side of scale) to the quality that would indicate more significance (right side of scale). The combined assessments of the 6 characteristics provide a qualitative estimate of significance. While they admit this is not a perfect method it does provide a consistent framework upon which to make professional judgments about the significance of wild stocks in the neighborhood of a proposed project. When this assessment is documented, it provides a record as part of the project development process.[15]

The *Kodiak Comprehensive Salmon Plan Phase III, 2010-2030* (KRPT 2011) did not address the genetic policy issue of significant or unique but did develop a *New Project Opportunities Form* located as Appendix F of their comprehensive plan.

The *Prince William Sound–Copper River Phase 3 Comprehensive Salmon Plan*, (PWSRPT 1994) also did not define any significant or unique stocks but did develop a checklist for new project evaluations, but they have not been consistently using the form (Stopha 2013).

The *Yukon River Regional Comprehensive Salmon Plan* (YRRPT 1998) did not address significant or unique stocks. In this updated version, considerations for fishery enhancement planning and a stock appraisal tool was included for use by the RPT to determine significant or unique stocks when evaluating a project. This combined form was modeled after other RPTs stock appraisal tools and project criteria and is located in Appendix C.

The stock appraisal tool portion identifies some key factors for determining whether a stock impacted by an enhancement project should be considered *significant or unique* under the ADF&G genetic policy. It is meant to be an objective and consistent framework for use by ADF&G biologists, hatchery associations, and the RPT when planning a project and evaluating permit applications. It will look at the 5 characteristics—population trend, supplementation, isolation, uniqueness, and human use pattern of the stock—using a nonnumeric gradient ranging from the least significance on the left hand side of the scale to the right hand side of the scale indicating more significance. Combining the assessments of these 5 characteristics will provide a qualitative estimate of significance or uniqueness that can be used in the development and evaluation of a project.

Considerations for the fishery enhancement portion identify and provide supplemental information to the hatchery permit application. The project checklist focuses questions for consideration in 5 categories: project feasibility, land use, management, cost, and stock identification. An aquaculture association should be evaluating and considering these items during the development of a project. The information should be passed on to the RPT for their consideration during the review of the hatchery permit application.

It is the intent that these tools can be updated and adjusted by the RPT as appropriate over time without having to update or amend the whole comprehensive plan.

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[14] Joint Northern/Southern Southeast Regional Planning Team. 2004. Comprehensive salmon enhancement plan for Southeast Alaska: Phase III. Unpublished document obtained from Sam Rabung, ADF&G PNP Hatchery Program Coordinator, Juneau.

[15] Ibid.

5.4.2 Pathology (fish health)

The regulation designed to protect fish health and prevent spread of infectious disease in fish and shellfish is 5 AAC 41.080 Reporting and control of fish diseases at egg-take sites, hatcheries, and rearing facilities. Additional information can be found in Meyers 2014. The *Alaska Sockeye Salmon Culture Manual* (McDaniel et al. 1994) provides practices and guidelines specific to the culture of sockeye salmon. These regulations and policies are used by ADF&G fish pathologists to review hatchery plans and permits. The pathology procedures seek to ensure that pathogens are not introduced into watersheds where they don't naturally occur.

With respect to fish diseases, Alaska's geographic isolation and colder water temperatures minimize the amount of pathogens that occur; however, it has within its boundaries large areas of separated watersheds supporting wild stocks that have never been examined for disease. Therefore, there is a risk of unknowingly transporting diseases from 1 major geographic area to another that may not be detected at the 5% level per 60 adult fish examined prior to transport (60 fish is the state's required disease screening sample size for any fish transports). To minimize this risk, ADF&G discourages the transplant of wild fish stocks between major geographic zones: Southeast, Kodiak Island, Prince William Sound, Cook Inlet, Bristol Bay, Alaska Yukon/Kuskokwim, and the Interior. To maintain consistency with the ADF&G genetic policy, this policy includes hatchery stocks as well, although exceptions may be considered on a case-by-case basis under stringent constraints. Proposals to do so must have adequate justification for using a nonlocal stock and be for gametes only (Meyers 2014).

5.4.3 Salmon Escapement Goal Policy

ADF&G and the Board of Fisheries developed and implemented 5 AAC 39.223 Policy for statewide salmon escapement goals. The purpose of this policy is to establish the concepts, criteria, and procedures for establishing and modifying salmon escapement goals and to establish a process that facilitates public review of allocative issues associated with escapement goals. The establishment of salmon escapement goals is the joint responsibility of ADF&G and the Board of Fisheries working collaboratively in order to meet the charge of managing the Alaska salmon fisheries on the sustained yield principal. Escapement goals for the Norton Sound region are discussed in Section 3.4.

5.4.4 Sustainable Salmon Fishery Policy

What is commonly referred to as the *Sustainable Salmon Fishery Policy* (SSFP) can be found in regulation 5 AAC 39.222 Policy for the management of sustainable salmon fisheries (Appendix G). In this section, we will highlight sections of the policy specific to enhancement planning.

Section (c)(1)(D) – ". . . effects and interactions of introduced or enhanced stocks on wild salmon stocks should be assessed; wild salmon stocks and fisheries on those stocks should be protected from adverse impacts from artificial propagation and enhancement efforts."

Section (c)(3)(J) – ". . . proposals for salmon fisheries development or expansion and artificial propagation and enhancement should include assessments required for sustainable management of existing salmon fisheries and wild salmon stocks."

Section (c)(3)(K) – ". . . plans and proposals for development or expansion of salmon fisheries and enhancement programs should effectively document resource assessments, potential impacts, and other information needed to assure sustainable management of wild salmon stocks."

The main points of Section (c)(5)(A) are: "(i) consideration of the needs of future generations and avoidance of potentially irreversible changes;

(ii) prior identification of undesirable outcomes and of measures that will avoid undesirable outcomes or correct them promptly;

(iii) initiation of any necessary corrective measure without delay and prompt achievement of the measure's purpose . . .;

(iv) that where the impact of the resource use is uncertain, but likely presents a measurable risk to sustained yield, priority should be given to conserving the productive capacity of the resource;

(v) appropriate placement of the burden of proof . . ."

Section (f)(34) defines *salmon stocks* as a locally interbreeding group of salmon that is distinguished by a distinct combination of genetic, phenotypic, life history, and habitat characteristics or an aggregation of 2 or more interbreeding groups which occur within the same geographic area and is managed as a unit.

The *burden of proof* concept mentioned above in the SSFP is further discussed in the *Comprehensive Salmon Enhancement Plan for Southeast Alaska: Phase III* (JNSSRPT 2004), referencing the Food and Agriculture Organization of the United Nations (FAO 1996). The FAO states that the precautionary approach does not imply a prohibition against fishing (or by inference, enhancement or other activities affecting the fish resource)

> "…until all potential impacts have been assessed and found to be negligible. Waiting for a complete analysis of all potential impacts would constitute a reversal of the burden of proof, where an action is assumed to be harmful unless proven otherwise. Conversely, it should not be assumed that potential impacts are negligible until proven otherwise."

The FAO also states the standard for proof of impacts

> "…should be commensurate with the potential risk to the resource, while also taking into account the expected benefits of the activities…"

This shows the importance of the concept of burden of proof while also being careful that it not be misused.

CHAPTER 6: PROJECTS

6.1 Potential Systems for Fishery Restoration, Rehabilitation and Enhancement Projects

The highest priority projects are those that address rehabilitation or restoration of wild stocks or habitat. Creating new common property fisheries through enhancement activities will be of a lower priority. Consideration of impacts to wild stocks will be given and may be grounds for not supporting proposals. Section 6.4 describes RPT review criteria and considerations in more detail.

Several rivers, streams, or lakes throughout the region were identified in the 1998 CSP (YRRPT 1998) as systems where production of salmon may be increased through implementation of various restoration, rehabilitation, or enhancement techniques to benefit regional fishermen with increased harvests. This section provides an update to that list. In the 1998 CSP the RPT selected habitat restoration/improvement and recirculating and/or instream incubation techniques as the most practical and cost-effective strategies to investigate in the region. The current RPT recognizes that without all of the project information available it is not possible to determine the most practical or cost-effective strategy in advance; therefore they will review project proposals on a case by case basis as they proceed through the permitting process. The 1998 CSP further stated that before beginning any projects it will be necessary to learn as much as possible about the physical, chemical, and biological characteristics of selected systems, identify the appropriate strategy, and determine the feasibility of proposed projects.

Systems included in this section were based on information received from fishermen, RPT members, ADF&G staff, and public comments received during the village information meetings. The criteria used to determine systems that would initially be included are:

1. importance to community
2. size of system
3. proximity to communities
4. potential for increased salmon production based on historical escapement and harvest information, and
5. status of land surrounding the system.

The *ADF&G Anadromous Water Catalog*[16] is updated annually and can be used to determine if a system has been formally identified as being used by salmon or other anadromous species.

6.1.1 Yukon River Drainage

Yukon River

This system headwaters in Marsh Lake Yukon Territory Canada and flows about 1,500 miles northwest into Alaska to Fort Yukon, then southwest to Bering Sea. Chinook, chum, coho, pink and sockeye salmon are present within the drainage as they migrate upriver to spawning locations. Chinook and a fall run of chum salmon migrate into Canada while the summer run of chum along with coho salmon range primarily within/and downstream of the Tanana River drainage. Pink salmon primarily range as far upriver as the Anvik River with some strays farther up river near

[16] www.adfg.alaska.gov/sf/SARR/AWC/

Galena. Stray sockeye salmon have been documented as high up as Fairbanks in the Tanana River with larger concentrations expanding into the Andreafsky and Anvik rivers.

The following subsections describe notable Yukon River salmon tributaries within each management district. The *ADF&G Anadromous Water Catalog* provides a more comprehensive documentation of all known Yukon River salmon tributaries in Alaska and is continually updated. Additionally, Brown et al. 2017, catalogs known Chinook salmon spawning areas in the entire Yukon River Basin.

6.1.2 Coastal District

Pastolik River

This system flows north 65 miles into Pastol Bay at Apoon Mouth as part of the Yukon Delta northeast of Kotlik. Chinook and chum salmon spawning are noted to occur in this system and pink and coho salmon are noted as present. Tributaries Ecuilnguaraq and Qerritaq rivers both have documented Chinook and chum salmon spawning.

Pastoliak River

This system flows northwest 30 miles into Pastol Bay as part of the Yukon Delta. Chum and pink salmon are present in this system.

Kotlik River

This system flows north 30 miles into Apoon Pass as part of the north mouth of the Yukon River.

Kun River by Scammon Bay

Kashunuk River – by Hooper Bay and then flows into the YR by Pilot Station. It's a spur off the Yukon River to go out to the Bering Sea.

Muknalovik – place to rest between Black River and Kun River. Named by the original settlers of Scammon Bay and they spent a year to rest there.

Black River

This system flows from across from Mt. Village and Kusilvak and down to the Bering Sea between Nunam Iqua and Scammon Bay

6.1.3 District 1

No major salmon spawning tributaries of the Yukon River are documented in this district.

Fish Village Slough – a lake water system where pike, whitefish, and others have been caught in the past.

Nanvaranak (means little land) goes up to and is fed by Three Finger Lake – could be called New Hamilton Slough – Burbot, pink salmon, pike, sheefish, whitefish and others are caught here.

6.1.4 District 2

Ananuk River – place to go out – It is just upstream of the ADF&G boundary on the border with Y-1 and separates Y-1 and Y-2.

Archuelinguk River

This system is downstream of Mt. Village and flows southwest 35 miles to the Yukon River. Chinook, chum, coho and pink salmon spawning as well as Chinook salmon rearing is documented in this system.

Atchuelinguk or Chuilnak River

This system is upstream of Pilot Station and flows southwest 165 miles to the Yukon River. Adult Chinook and chum salmon have been documented as spawning within this system with coho salmon also noted as present. Chinook and coho salmon rearing is also documented in this system.

Andreafsky River

This system flows southwest 120 miles to the Yukon River. Chinook, chum, coho and pink salmon spawn in this system and Chinook salmon rearing has been documented. Sockeye salmon have also been documented as present in this system.

Reindeer River

This system is a probable anabranch of the Yukon River which flows northwest 60 miles. Chum and pink salmon have been documented as spawning within this system with coho salmon also noted as present as well as rearing in this system.

Owl Slough - it goes in across from Marshall and comes out a little upstream of Pilot Station on the main stem of the Yukon River. Contains another slough called Nooksook that drains into Owl Slough.

Devil's Elbow Slough – Across from the abandoned village of Ohagimiut.

6.1.5 District 3

Kako Creek

This system flows southwest 30 miles to the Yukon River. Chinook, chum and pink salmon spawning occurs and coho salmon adults have also been documented in the system. Kako Lake located at the mouth of the creek supports chum salmon spawning.

Innoko River

This system flows northeast then southwest 500 miles to the Yukon River. Adult Chinook, chum, pink, coho and sockeye salmon are documented as present in the system. Chinook and coho salmon rearing has also been documented.

Piamiut Slough – Just upstream of Dogfish and Russian Mission, has lakes (Pikefish, white). The current goes both ways and can be tricky

High Portage Slough – Across and a little downstream of Russian Mission.

Tucker and Steamboat Sloughs – Upstream of Russian Mission on the north side of the Yukon River. Steamboat Slough flows into Tucker Slough.

Koserefski or Kozherevsky River

This system is approximately 5 miles upstream of Holy Cross on the north side of the mainstem Yukon River and flows southeast 30 miles to the Yukon River. Adult chum and pink salmon are documented as present in this system. There is an unnamed tributary river that flows into the Koserefski River.

6.1.6 District 4

Bonasila River

This system flows southeast 125 miles entering the Yukon River via a slough approximately 10 miles downstream of Anvik near Paradise. Chinook, chum, and coho salmon are documented as spawning and pink salmon are documented as present in the system. Chinook and coho salmon rearing has also been documented in this system.

Anvik River

This system flows southeast 140 miles to the Yukon River just upstream of Anvik. Chinook and chum salmon are documented as spawning and coho, pink and sockeye salmon are documented as present in the system. Chinook salmon rearing has also been documented.

Rodo River

This system flows northeast 32 miles to the Yukon River approximately 36 miles southwest of Nulato. Chinook and chum salmon spawning and Chinook salmon rearing is documented in this system.

Kaltag River

This system flows northeast 20 miles to the Yukon River. Adult spawning Chinook and chum salmon and rearing Chinook salmon are documented in this system.

Nulato River

This system flows northeast 71 miles to the Yukon River. Adult spawning Chinook and chum salmon and rearing Chinook salmon are documented in this system.

Koyukuk River

The Koyukuk River sub-basin includes the entire Koyukuk River drainage. This system flows southwest 425 miles to the Yukon River at river mile 508. Adult spawning Chinook and chum salmon and rearing Chinook salmon are documented in this system. The following rivers are located within the Koyukuk River drainage as indicated.

Gisasa River – Koyukuk River drainage

This system flows northeast 70 miles to the Koyukuk River. Chinook, chum, pink and sockeye salmon are documented as spawning in this system. Chinook salmon rearing is also documented in this system.

Kateel River– Koyukuk River drainage

Flows northeast from near the headwaters of the Shaktoolik River some 175 river miles to the Koyukuk River. It is located approximately 110 river miles from Huslia and 90 river miles north of Koyukuk. There is documented chum salmon spawning and rearing in this system.

Huslia River– Koyukuk River drainage

Flows easterly and then southerly some 75 air miles into the Koyukuk River from the continental divide south of the Selawik River, joining the Koyukuk River just upstream of Huslia. The north and south forks of the Huslia River are located 15 air miles from Huslia. There is documented chum salmon spawning and rearing in this system.

Dakli River– Koyukuk River drainage

Flows south from the Eastern Brooks range about 30 air miles joining the Koyukuk River some 20 air miles upstream of Huslia. There is documented chum salmon spawning and rearing in this system.

SF Koyukuk River– Koyukuk River drainage

This river flows some 200 miles southwestwardly from the eastern Brooks Range joining the main fork about 45 miles upstream of Allakaket. There is documented king and chum salmon spawning and rearing in this system.

Caribou Creek – Koyukuk River drainage

This system headwaters in the Zane Hills and flows east 17 miles as a tributary of the Hogatza River which is 35 miles west-northwest of Hughes. Chum and coho salmon are documented as spawning and Chinook salmon are documented as present in this system.

Clear Creek – Koyukuk River drainage

This system headwaters in the Zane Hills and flows east 18 miles as a tributary of the Hogatza River which is 36 miles west-northwest of Hughes. Chum, coho and sockeye salmon are documented as spawning in the system as well as adult Chinook salmon presence and juvenile rearing. Coho salmon juveniles also documented as rearing in the drainage.

Kanuti Kilolitna River– Koyukuk River drainage

This system flows northeasterly some 65 air miles from the Ray Mountains joining the Koyukuk River about 15 air miles downstream of Alatna. This system has documented chum and king salmon spawning and rearing

Henshaw (Sozhekla) Creek – Koyukuk River drainage

This systems east fork headwaters from Heart Mountain in the Alatna Hills and flows south 30 miles to the junction with its west fork that originates from a lake in the Alatna Hills. The west fork flows southeast 24 miles to the junction and together they flow an additional 15 miles to the Koyukuk River 12 miles east of Allakaket. Chinook and chum salmon have been documented as spawning within this system with sockeye salmon also noted as present.

Melozitna River

This system heads 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.

6.1.7 District 5

Tozitna River

This system headwaters in the Ray Mountains and flows approximately 83 miles southwest between the Ray and Rampart Mountains to its confluence with the Yukon River and the confluence is located 10 miles west-southwest of the community of Tanana. Chinook, chum, sockeye and coho salmon are documented as spawning in this system. Chinook salmon rearing occurs in this system and sockeye salmon are documented as present.

Schieffelin Creek

This system enters the Yukon River from the north 22 miles upriver of Tanana.

Morelock Creek

This system enters the Yukon River from the north 26 miles upriver of Tanana.

Bear Creek

This system enters the Yukon River from the north 44 miles upriver of Tanana.

Canyon Creek

This system enters the Yukon River from the north 50 miles upriver of Tanana.

Hess Creek

This system enters the Yukon River from the south 30 miles upriver of Rampart, 36 miles below the Dalton Highway bridge across the Yukon River.

Big Salt River

Flows eastward from the eastern Ray Mountains some 35 air miles, joining the Yukon River about 7 river miles downstream of the Dalton Highway bridge. There is documented king and chum salmon spawning and king and coho salmon rearing in this system.

Ray River

Flows eastward from the eastern Ray Mountains some 45 air miles, joining the Yukon River about 2 river miles downstream of the Dalton Highway bridge. There is documented king and chum salmon spawning in this system.

Hodzana River

Flows east and southeast from southern foothills of the Brooks Range some 90 air miles, joining the Yukon River about 20 river miles downstream of Beaver. There is documented chum salmon presence in this system.

Beaver Creek

This system flows northwest 180 miles to the Yukon River and is located 9 miles southwest of the community of Beaver in the Yukon Flats. Chinook, chum and coho salmon have been documented as present in this system and Chinook salmon spawning and rearing are also documented.

Birch Creek

This system flows north 150 miles into the lower and upper mouths, its distributaries, before entering the Yukon River in the Yukon Flats and is located 26 miles southwest of Fort Yukon. The community of Birch Creek is located on the lower Birch Creek mouth. Chinook salmon spawning and rearing has been documented in this system. Adult Chinook, chum and coho salmon have been documented as present in both the upper and lower mouths.

Teedriinjik River (Chandalar River)

The river name refers to ‘light shining through the water” (Edward Alexander, Personal Communication). It headwaters in the Brooks Range in the Smith Mountains and flows southeast 100 miles to the Yukon River and contains several third order spawning tributaries. This system is 20 miles northwest of Fort Yukon. Chinook and chum salmon are documented as spawning in the system. Chinook salmon rearing has been documented in this system.

Christian River (Teetlaiinjik River)

The river name refers to “meandering river” or “river that goes back and forth” (Edward Alexander, Personal Communication). Headwaters of this system are in the Smith Mountains of the Brooks Range and flow south 100 miles to the Yukon River. This system is 20 miles northwest of Fort Yukon. Chinook and chum salmon are documented in the system.

Porcupine River

This system headwaters in the Ogilvie Mountains within the Yukon Territory of Canada and flows west 460 miles to its terminus with the Yukon River 2 miles northwest of Fort Yukon. The headwaters of this system include the Fishing Branch River in Canada which is a fall chum salmon producer. Chinook, chum, and coho salmon are documented as present, as most of the system is a migration corridor to spawning tributaries in Alaska such as the Sheenjek and Colleen rivers in addition to salmon migrating to Canadian spawning tributaries.

Sheenjek (Sheenjik) River – Porcupine River drainage

This system headwaters in the Brooks Range in the Davidson Mountains and flows south 200 miles to the Porcupine River within Alaska. This system is 23 miles northeast of Fort Yukon. Chum (fall stock) and coho salmon have been documented as spawning in this system. Adult Chinook salmon are documented as present in this system.

Draanjik River (Black River) – Porcupine River drainage

The river name refers to “caches along the river” or “elevated caches” (Edward Alexander, Personal Communication). This system flows northwest 200 miles to the Porcupine River within Alaska and is located 17 miles northeast of Fort Yukon. Chinook and fall chum salmon are documented as spawning in the system. Coho salmon are documented as present in this system.

Coleen River– Porcupine River drainage

This system headwaters in the Brooks Range and flows south southeast 52 miles to the upper portion of the Porcupine River within Alaska. Chum salmon are present and Chinook salmon are documented as spawning in this system.

Charley River

Flows about 37 air miles northeast entering the Yukon River about 70 river-miles upstream of Circle. There is documented king and chum salmon presence in this system.

Fortymile River

Multiple forks flow eastward and northeastward from just north of the upper Tanana River about 130 air miles, entering the Yukon in Canada about 50 river-miles upstream of Eagle. There is currently no documented salmon spawning or rearing in this system, but there is some evidence that salmon were in the system prior to mining beginning near the turn of the century.

Kandik River

Flows about 80 air miles southwest from the Nahoni range in Canada, entering the Yukon River just upstream of the Charley. There is documented king and chum salmon spawning and king salmon rearing in this system.

Nation River

Flows some 45 air-miles southwest from Canada, entering the Yukon River 49 river-miles downstream of the Canadian border. There is documented king and chum salmon spawning and king salmon rearing in this system.

6.1.8 District 6 (Tanana River)

Tanana River

This systems headwaters in the Wrangell Mountains by rivers formed from the Chisana and Nabesna glaciers and flows northwest 440 miles to the Yukon River with the terminus 3.5 miles east of the community of Tanana. Chinook, chum and coho salmon have been documented as present in the system traversing to their spawning and rearing areas. Adult sockeye salmon have been recorded straying into the Tanana River on occasion. Additionally, fall chum salmon are documented spawning in the mid-reach of the Tanana River mainstem between Fairbanks and Delta Junction. Chinook and coho salmon are documented as rearing in this system. The following rivers are located within the Tanana River drainage or its tributary drainages as indicated.

Fish Creek

This small system flows from the east about 14 miles, entering the Tanana about 14 river-miles upstream of Tanana. This system does not appear in the Anadromous Catalog.

Paterson Creek

Flows eastward about 25 air-miles from north of Bean Ridge, entering the Tanana 30 river-miles upstream of Tanana. This system does not appear in the Anadromous Catalog.

Redland River (Chitanana River)

Flows about 60 air miles northeast from the north slope of the Alaska Range, entering the Tanana River about 32 river miles upstream of Tanana. This system does not appear in the Anadromous Catalog, but there is reported salmon presence in the system.

Cosna River

Flows about 75 miles northward from the Kuskokwim Mountains into the Tanana River some 26 miles downstream from Manley Hot Springs. There is documented Chinook salmon spawning in this system.

Zitziana River

Flows about 100 miles northeastward from the Kuskokwim Mountains, meeting the Tanana River about seven river miles upstream from Manley Hot Springs. This system does not appear in the Anadromous Waters Catalog as of 2016.

Baker Creek/Hutlinana Creek (Tanana River sub-drainage)

These two creeks flow from the northeast some 75 miles, entering the Tanana River about 7 miles upstream from Manley Hot Springs. These systems both have documented chum salmon spawning and rearing.

Kantishna River

This system heads at the junction of Birch Creek and McKinley River and flows north 108 miles to the Tanana River. The system is 32 miles northwest of the community of Nenana. Much of the system is glacially influenced and Chinook, chum, coho and sockeye salmon have been documented as present in the system traversing to their spawning and rearing areas in its tributaries.

Toklat River – Kantishna River drainage

This system flows northwest 85 miles to the Kantishna River though it has glacial influence in the summer season. During the winter the system is dominated by clear upwelling springs that remain open through the season. Chum and coho salmon are documented as spawning at this location and Chinook salmon are listed as present.

Barton Creek – Toklat River drainage

This system is a clearwater tributary of the Toklat River which heads in the foothills south of the old Stampede Trail, paralleling the Sushana River for some distance before entering the Toklat River from the east at approximately river mile 15. Barton Creek supports one of the largest Chinook salmon runs in the Kantishna River drainage. In the fall season, coho salmon ascend the creek and spawn near the source of the springs, upstream from Chinook salmon spawning areas.

Tolovana River

This system's headwaters are a junction of Livengood and Olive creeks and flows 117 miles to the Tanana River 26 miles east of Manley Hot Springs. Chum and coho salmon are documented as present in this system.

Chatanika River – Tolovana River drainage

This system heads at the junction of McManus and Smith Creeks and flows southwest 128 mile to the Tolovana River 48 miles northwest of Fairbanks. Chinook and chum salmon spawning is documented in this system and coho salmon have been documented as present in the system as well as Chinook salmon rearing.

Nenana River

This system headwaters at the Nenana Glacier in the Alaska Range and flows north 140 miles to the Tanana River at the community of Nenana. Chinook, chum and coho salmon have been documented as spawning in the system. A number of small tributaries in this system will be referred to within this document such as (Clear, Glacier, Foster, Wood and Julius creeks as well as Seventeen mile and Lost sloughs).

Teklanika River– Nenana River drainage

Flows north some 50 miles from the Alaska Range, entering the Nenana River just upstream from Nenana. There is documented king, chum, and coho salmon spawning in this system.

Chena River

This system heads at the junction of North and West Forks Chena River and flows southwest 100 miles to the Tanana River and transects the community of Fairbanks at the confluence. Chinook and chum salmon presence has been documented in this system with spawning listed in the Middle, South and East Fork as well as Chinook salmon rearing.

Salcha River

This system flows southwest 125 miles to the Tanana River and is 33 miles southeast of Fairbanks. Chinook and chum salmon are documented as spawning throughout the drainage and includes rearing of Chinook salmon.

Delta River

This system headwaters at Tangle Lakes in the Alaska Range and flows north 80 miles to the confluence with the Tanana River at Big Delta. Chum and coho salmon are documented as spawning in the lower 1.5 miles of the drainage and coho salmon also rear in the system.

Delta Clearwater River

Flows eastward about 25 air miles, entering the Tanana River just upstream from Big Delta. There is documented coho and chum salmon spawning and coho salmon rearing in this system

Goodpaster River

This system flows southwest 91 miles to the Tanana River and is located 7 miles east of Big Delta. Chinook and chum salmon spawning has have been documented in this system as well as Chinook salmon rearing.

6.2 Past and Current Project Descriptions

6.2.1 Drainagewide

YRDFA Inseason Management Teleconferences (ongoing)

Since its inception in 2000, the In-season Salmon Management Teleconference Program (Teleconferences) has provided a practical and useful method for fishers, processors, managers, and other stakeholders in Yukon River salmon fisheries to discuss the complexities of salmon management and gain immediate real-time information across the more than 2,000 mile expanse of the Yukon River. Facilitated by the Yukon River Drainage Fisheries Association (YRDFA), these teleconferences have enabled local users to provide valuable insight to Yukon River fisheries managers staff at Alaska Dept of Fish & Game (ADFG) and the US Fish and Wildlife Service (USFWS) on in-season salmon subsistence needs, river conditions, and abundance and quality of salmon available. Information from the fishers allows managers to adjust timing and gear types for meeting their management goals. Additionally, subsistence users gain a better understanding of the different research projects and management tools the state and federal managers are utilizing and the status of fishing conditions in other areas of the drainage. Members of the public, Yukon River fishers and community members, state and federal agencies, tribal Governments and tribal consortia, fish processors and others have participated in in-season salmon management teleconferences since they have been initiated. As this program has evolved it has become a regular fixture of Yukon River in-season salmon management. Calls are hosted by YRDFA, once a week (each Tuesday at 1pm), beginning in early June as the Chinook salmon enter the river and ending the last week of August. The US Fish and Wildlife Service Fisheries Resources Monitoring Program funds these calls in conjunction with the Yukon River Panel.

Pre-Season Salmon Fishery Preparation Meeting (ongoing)

The Pre-Season Salmon Fishery Preparation (Pre-season) meetings have been hosted by YRDFA since 2010 (except 2013) and have become an integral and important part of the annual planning cycle for the subsistence and commercial fisheries on the Yukon River. Taking place in the spring with attendance of fishers from the local communities the full length of the river, managers, researchers and other stakeholders come together for a full day designed to prepare everyone for the fishing season ahead. These meetings alternate between Anchorage or Fairbanks and host roughly 80 Yukon River fishers and community representatives and 20 fishery managers, staff and fishery researchers. The Pre-season meeting is the primary opportunity for Yukon River fishers, community members and fishery managers to come together for reviewing last year's fishing season, to preview the upcoming season and discuss in detail and build consensus on management approaches that will achieve meeting escapement, subsistence and commercial harvest and conservation and escapement goals. This approach has shown its value over many years and across the complex and vast geography of the Yukon drainage and especially in times of low Chinook salmon abundance, as the level of cooperation and understanding built is so necessary for meeting critical escapement goals in Canada and within Alaska. This meeting is funded annually by the Yukon River Panel.

In-season Subsistence Harvest Survey Reports

The YRDFA In-season Subsistence Harvest Surveyor Program is an important communication tool in that it qualitatively informs managers how fishers in key locations throughout the drainage are doing in-season, enabling managers to make timely decisions allowing the maximum number of fishers to meet their subsistence needs. YRDFA surveyors gather information directly from fishermen, providing managers with weekly information about fishers' concerns, observations, and their ability to harvest salmon throughout the Alaskan portion of the Yukon River drainage. These reports are also shared on the YRDFA In-Season Salmon Management Teleconferences (Teleconferences) for the benefit of managers and other fishermen. The In-Season Surveyor reports address the need to have consistent reporting to fisheries managers and the public about subsistence harvests, run strength, fishing conditions, and fishermen's concerns. They also ensure consistent participation and reporting each week regarding subsistence harvests and observed abundance on the Teleconferences. In-season surveys were implemented to assist in meeting the mandate set forth in the Alaska Native Interest Lands Conservation Act (ANILCA) and the State of Alaska Statute 16.05.258 Subsistence use and allocation of fish and game, both of which require a priority for subsistence over other consumptive uses. This program has been in existence since 2002 and has evolved over time to meet the changing needs on the river. The program, funded by the USFWS Fisheries Resource Monitoring Program, is an adaptive communication program maximizing fishers' voices and enabling managers to send important conservation messages directly into fisher's households in 10 key villages. The program goal is to contribute local information into fisheries management discussions and build capacity along the river to participate in fisheries management.

Traditional Knowledge in Fishery Management

Many organizations work with fishers and Elders to ensure their knowledge is included in Yukon River fishery management. Organizations include YRDFA, BSFA, ADFG Subsistence Division, US Fish & Wildlife Service, University of Alaska, and/or non-profits such as Calista Education and Culture, Tanana Chiefs Conference, Yukon-Koyukuk School District, Kawerak Inc., the Association of Village Council Presidents, the Yukon River Inter-Tribal Fish Commission, Council of Athabascan Tribal Governments, and the Yukon River Inter-Tribal Watershed Council, and the Tanana Valley Watershed Association. This has been accomplished through social science research projects documenting Traditional Ecological Knowledge (TEK) and contemporary local fisher observations. Often these projects are conducted in partnership with other organizations. Examples of past TEK projects include documenting traditional place names, natural indicators of salmon run timing and abundance, and language based Elders workshops.

Commercial Fishery Catch-per-unit-effort Information (ongoing)

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 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.

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 inseason to provide for adequate escapements while harvesting the available surplus. CPUE is a run strength indicator available to managers from ADF&G test fisheries, commercial fishing periods, and in-season subsistence reports.

Inseason Subsistence Harvests Reports (ongoing)

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 develop a list of subsistence fishermen contacts in each village that are willing to relay their harvest information or identify a village resident who is knowledgeable of others' subsistence harvests. Although this information may be 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 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.

Programs have also been developed and implemented since 2004 by USFWS and currently operated by YRDFA to survey inseason a subset of fishing households in select communities to determine subsistence fishermen’s progress towards meeting their salmon harvest goals (Brown et al. 2007). Other information gathered at times includes environmental factors, size and health of the fish, gear type, area fished, and number of families sharing the harvest.

Age, Sex, and Length Data (ongoing)

Samples of age, sex, and length (ASL) of Yukon River salmon have been obtained by ADF&G since 1961 (Schumann 2014). ASL sample collection has evolved overtime to include projects and programs operated by a variety of other agencies, organizations, and groups engaged in Yukon River salmon assessment. ADF&G coordinates ASL sample collection, aging, data processing, reporting, and data archiving. 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 (DuBois 2016).

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. From 1982 through 1986 the ASL report is in the Technical Data Report series. ASL report in 1987 and 1998 are in the Technical Fishery Report series and from 1989 through 2003 were in the Regional Information Report series. Since 2004, ASL information is reported in the Fishery Data Series.

Aerial Surveys (ongoing)

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 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 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 (Barton 1984).

Yukon Area aerial survey techniques are documented in the Yukon Area Escapement Aerial Survey Manual and is on file with ADF&G (Barton 1987).

Current catalog of Yukon River salmon can be found at the following link.

https://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=maps.AWCData

Salmon Stock Identification (ongoing)

It was recognized as early as 1964 that ADF&G 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, ADF&G 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.

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 (DuBois 2016). The lower and middle run stocks spawn in the Alaska portion of the drainage, and the upper run stock spawns in Canada. Scale pattern analysis was the method used from 1981 through 2003 to estimate Chinook salmon stock compositions in the Yukon River harvests.

In 1984, a study was initiated by the Canadian Department of Fisheries and Oceans (DFO) 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 (Wilmot et al. 1992). From 2004 to present, genetic analysis has been the primary method for stock identification using single nucleotide polymorphisms (SNPs) by ADF&G's Gene Conservation Laboratory. Consistent with the scale pattern analysis, the genetics data has maintained that 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 (1981–2015).

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

Since 2004, ADF&G has been supplying tissue samples of chum salmon from the mainstem Yukon River sonar project drift gillnet test fish operations to USFWS, who analyses the genetic composition using microsatellites (Flannery et al 2006). There remain limitations in discriminating between summer chum salmon stocks, however fall chum salmon have three main components Canadian-origin, Border U.S. (Chandalar/Sheenjek/Black) and Tanana rivers. Average contributions to the total Alaskan and Canadian stocks by region of origin include 54% Border U.S., 29% Canada and 17% U.S. summer stocks enter during the fall season. This data has been used more for inseason management than applying to apportionment of commercial and subsistence chum salmon harvests to date (Flannery and Wenburg 2015).

Postseason Yukon River Subsistence Survey and Permits (ongoing)

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 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 focused on 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 estimates in comparison to past surveys.

In areas where subsistence salmon fishing permits are required, ADF&G 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 Haul Road bridge between Hess Creek and the Dall River (extended downstream to include the community of Rampart in 2004); (2) the upper portion of District 5 between the upstream mouth of Twenty-Two Mile Slough and the U.S./Canada border (accessed via Circle/Central and Eagle); and (3) the Tanana River near Fairbanks. Beginning in 1988, subsistence (or personal use) permits have been required within the Tanana River drainage. In 2004 permits were also required for the road accessible portion of the upper Koyukuk River.

Annual reports have been generated for this project and are available online. The most recent publication of the project report is included here (Jallen et al. 2017) but preliminary values for more recent years' harvests by community and district are available in Yukon Area Annual Management Reports.

ADF&G Salmon in the Classroom Program (ongoing)

ADF&G Division of Sport Fish Region III coordinates the Salmon in the Classroom program in Fairbanks and North Pole. Schools have the opportunity to raise coho salmon from the egg to the fry stage in classroom incubator systems. Salmon eggs have traditionally been procured from coho in the Delta Clearwater River. All fry are subsequently released into preapproved landlocked lakes or destroyed. The program is relatively small in Region III. There are generally between ten and twenty participating classes each school year.

UAF 4-H Fisheries, Natural Resource and Youth Development Program

4-H UAF Cooperative Extension Service also coordinates a Salmon in the Classroom program to remote schools in the Yukon watershed. This program started in 1991 and has primarily focused on learning opportunities associated with incubating salmon eggs in special classroom incubator aquariums. Coho eggs are shipped from William Jack Hernandez Sport Fish Hatchery in Anchorage to the village locations and are released into ADF&G approved land locked lakes in the spring, or destroyed at the end of the project. While this program is separate from the ADF&G Division of Sport Fish Region III program, ADF&G staff has periodically partnered with 4H UAF Cooperative Extension by participating in in-service trainings for teachers from rural communities.

Teachers are provided with necessary incubation equipment and training in aquarium maintenance and related educational materials including math, statistical methods, and chemistry through fish counts, survival calculations, temperature monitoring, and water quality testing.

The program has survived and had expanded through partnerships with school districts, local communities, agencies, and corporate or independent businesses. However, due to budget cuts over the past several years, this program has decreased to approximately 10 schools annually. While logistical support is still provided, large scale teacher in-service trainings have not occurred recently.

Marine juvenile salmon surveys (ongoing)

Fisheries and oceanographic research surveys in the northern Bering Sea shelf were initiated in 2002 as part of the Bering-Aleutian Salmon International Survey (BASIS; NPAFC 2001). BASIS was developed by member nations of the North Pacific Anadromous Fish Commission (NPAFC) (United States, Russia, Japan, Canada, and Korea) to improve our understanding of marine ecology of salmon in the Bering Sea. These surveys use pelagic rope trawls to sample fish at or near the surface. The surveys are designed to support broad-scale marine ecosystem research. Although investigators, vessels, funding support, and research objectives of these trawl surveys have varied with time, attempts have been made to occupy a core station grid to improve the consistency of data collected during these research surveys over time. Stations are typically sampled during September along a systematic latitude and longitude grid with stations separated by approximately 30 miles.

Pelagic trawl surveys in the northern Bering Sea capture Yukon River salmon stocks during their first summer at sea at the juvenile life-history stage. Yukon River Chinook salmon (Alaskan and Canadian stocks combined) are the primary stock group of Chinook salmon in the northern Bering Sea during the summer and trawl surveys have been used to provide stock-specific juvenile abundance estimates (Murphy et al. 2017). Juvenile Chinook salmon abundance estimates provide an early indicator of stock status due to the relatively stable marine survival after the stage at which juveniles are sampled in the northern Bering Sea. Juvenile abundance-based projections for the Canadian origin stock group have been provided since 2013, and forecast ranges appeared to be good predictors of adult run abundance in 2014 and 2016.

Western Alaska Salmon Stock Identification Program (2006-2009)

In May 2006 a group of eleven signatories to a memorandum of understanding created the Western Alaska Salmon Stock Identification Program (WASSIP). Signatories included ADF&G and various western Alaska fishery stakeholder organizations ranging from the Alaska Peninsula/Aleutian Islands through Kotzebue. WASSIP was a comprehensive program to sample commercial and subsistence chum and sockeye salmon fisheries in coastal marine areas of western Alaska, from 2006 through 2009. This program was unprecedented in its magnitude and scope, including salmon fisheries from Chignik Bay to Kotzebue Sound, stretching over 3,000 km of shoreline. During the four years of fishery sampling, approximately 320,000 samples were collected and some 156,000 samples were analyzed by the ADF&G Gene Conservation Laboratory to estimate stock composition of fishery harvests with the finest resolution possible. Additional populations have been added to the genetic baselines for both species and the number of DNA markers has been greatly expanded to provide for increased stock resolution. WASSIP increased understanding of stock composition of harvests in western Alaska fisheries and the effects these fisheries have on salmon stocks in this vast region.

Representatives from signatory groups functioned as an Advisory Panel (AP). The AP operated by consensus to guide sampling strategy, choose analytical methods, and provide input to execution of the project. In 2008, a four member Technical Committee (TC) was formed to provide independent scientific review of analytical and statistical approaches developed by ADF&G, and to provide input for improving those methods. The TC was a distinguished group of internationally recognized scientists with extensive expertise in genetics, population dynamics, biometrics, and salmon life history and migratory patterns. Funding for sampling and analysis was provided by the State of Alaska and through cooperative grants with NOAA-Fisheries.

Results of the WASSIP program were documented in over 35 written ADF&G reports, journal publications, and technical documents in addition to a multitude of oral presentations and program posters presented at various meetings and conferences spanning many years. Two primary publications are most applicable to the Yukon River regarding chum salmon. Decovich et al. 2012 addresses the genetic baseline for western Alaska chum salmon stocks and Munro et al. 2012 addresses harvest and harvest rates of western Alaska chum salmon stocks. A summary of WASSIP results applicable to Yukon River stocks can be found in Section 6.3 of this report under Marine Interceptions. The most comprehensive source of overall WASSIP program information can be found on the ADF&G website at: http://www.adfg.alaska.gov/index.cfm?adfg=wassip.main

6.2.2 Coastal

Chinook Salmon Run Timing Forecast (ongoing)

A cooperative project between NOAA, ADF&G and AOOS has been ongoing since 2012 to include environmental factors as a forecast tool for the arrival date of Chinook salmon to the Lower Yukon River (Mundy and Evenson 2011). The timing forecast for Chinook salmon arrival is based on the relationship between the dates of the three percentiles (15%, 25%, and 50%) including sea ice concentrations and air and sea surface temperatures.

Yukon Delta Smolt Outmigration (ongoing)

A cooperative project between ADF&G, NOAA, and YDFDA began in 2014 to study out migrating salmon smolts in the Yukon River Delta (Howard et al. 2017). Sampling stations to capture juvenile salmon are located within the delta distributaries and along the edge of the freshwater plume. Important information on size and timing of marine entry has been collected as well as catch rates, distribution, predator/prey relationships and nutritional status of juvenile salmon with a particular focus on Chinook salmon.

Dall Point Offshore Drift Test Fishery (2009-2011)

A test fishery feasibility study occurred from 2009–2011, operated out of Hooper Bay and Scammon Bay, approximately 90 miles south of the Yukon River mouth. The coastal test fishery was attempting to assess run abundance, species composition and run timing information of salmon bound for the Yukon River in offshore waters to assist with timely management decisions inriver. Drift gillnets were fished from early June to mid-July, using 8.5 inch mesh and 5.5 inch mesh targeting Chinook and chum salmon respectively. Chinook salmon CPUE was generated as 3.73, 10.65 and 2.59, for 2009–2011 respectively. Chum salmon CPUE was generated as 233.70, 1,197.08 and 339.27, for 2009–2011 respectively. Each year some fishing days were suspended due to bad weather. In 2009, operations went through August 11 and CPUE was 18.83 and 0.40

for fall chum and coho salmon respectively, however this time frame does not represent the entire run.

Information for this project is on file with ADF&G[17].

6.2.3 District 1

Lower Yukon River Gillnet Test Fishery (ongoing)

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. Beginning in 2001 both the summer and fall season drift gillnet test fisheries were implemented and replaced the chum and coho salmon set gillnet test fishery altogether. Chinook salmon test fishery still uses the standard set gillnet test fishery but also conducts supplemental drift gillnetting as well.

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 (LYTF) 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 the assessment of total run strength, given the qualifications noted above. Trends in abundance as indicated by cumulative catch per unit effort (CPUE) curves are generally established by mid-season, allowing for appropriate management actions 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.

Information for this project is on file with ADF&G. Padilla and Gleason 2016 and Sollee and Hayes 2003 are examples of reports which have summarized project data.

6.2.4 District 2

Mountain Village Drift Gillnet Test Fishery (ongoing)

The Mountain Village test fishing project was originally funded by BSFA and AVCP and cooperatively operated by BSFA and the Asacarsarmiut Traditional Council during 1995–2012. Currently the project is funded through Yukon River Research and Management Funds through a

[17] Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage office, Memorandum. RE: Data summary for the Yukon River cooperative offshore salmon test fish feasibility at Dall Point, 2009–2010. By Stacey Bukelew to Steve Hayes. January 21, 2011.

consultant working with the Asacarsarmiut Traditional Council. 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. By 1997, the timing of operations was moved up to July 17 to match the transition date of summer to fall chum salmon in this area of the river. Originally, three drift sites were established approximately 4 miles upstream of Mountain Village on the mainstem Yukon River. One twenty minute drift was conducted at each of the sites on a daily basis (in 2016 reduced to two sites but each is fished twice a day). Test fishing times and the number of salmon caught are recorded by site and reported to ADF&G daily. ADF&G calculates the daily CPUE for fall chum and coho salmon to standardize the data for comparison within and between seasons. Age, sex and length data has been collected since 2001 for chum and coho salmon as well.

Similar to the LYTF project, this project provides an important role in the management of the fall season salmon fisheries. This project is located where the river is more channelized than on the delta distributaries, the estimates of relative abundance of each pulse in most years are better related to the sonar passage than is the LYTF project. Since the pulses of fall chum salmon move through the river rapidly this project helps get a better idea of the run size before the fish migrate out of the lower river where most of the commercial harvest occurs. Additionally fall chum and coho salmon migrate at different rates once within the river thus the project plays an important role in fisheries management.

The cooperative project was operated by Gene Sandone Consulting and ADF&G. The test fishery operated from approximately June 2 to July 17 both years and produced a CPUE index of Chinook salmon captured in 7.5 inch mesh drift gillnets. ADF&G aged all the scale samples collected as part of the age, sex, and length data collected from this project to characterize the catches.

Annual information for this project is on file with BSFA, R&M and ADF&G. Sandone 2012 and Sandone 2015 are recent examples of annual reports from this project.

East Fork Andreafsky River Weir (ongoing)

Summer chum salmon escapement to the East Fork Andreafsky River was estimated by ADF&G using sonar from 1981 through 1985. Due to difficulties with high water, sonar limitations, and the lack of determining speciation, ADF&G 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.

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 salmon 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 ADF&G, BSFA and YRDFA and supported by local fishermen in St. Mary's. The project has successfully operated each year since 1994 (Appendices I12 and I13, with the exception of 2001 which had a late startup. The project annually counts through the summer season; enumerating primarily Chinook and summer chum salmon, and to a lesser degree pink, sockeye salmon and a few early arriving coho salmon (Mears and Morella 2017). The project was extended into mid-September from 1995 through 2005 to count through the coho salmon run providing a snapshot of the level of escapement the system supports.

Mainstem Yukon River Sonar near Pilot Station (ongoing)

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 mainstem Yukon River sonar is located at river mile 123, approximately one mile upstream of the village of Pilot Station (Lozori and McIntosh 2014). 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 mainstem lower Yukon River at Pilot Station was investigated by ADF&G from 1980 to 1985 using dual-beam 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 operations in 1990 field season it was revealed that the 420 kHz frequency sonar could not detect fish swimming farther offshore. Among other issues field work was suspened in 1992 to enable the refitting and purchase of new sonar equipment with a lower frequency of 120 kHz. The new equipment was deployed in 1993 and 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 passage estimates at mainstem Yukon River were important for management of the Yukon River salmon 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 mainstem Yukon River 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 operations of this project were suspended in 1996 due to a staffing shortage and the project was conducted for training purposes only that year. In 1997, counting resumed at mainstem Yukon River sonar project. Because of changes in counting methodology, data collected from 1995 through 2012 are not directly comparable to previous years. In 2001, the equipment was changed from dual-beam to the current split-beam sonar system configured to operate at 120 kHz. Since 2005 a multi-beam dual-frequency identification sonar (DIDSON) was incorporated in the left bank near shore counts.

The mainstem Yukon River sonar project has undergone a variety of development, transitions, and staffing challenges since its inception in 1980. By using the current sonar system, a combination of fixed-location split-beam and multi-beam DIDSON equipment coupled with solid on-site quality control checks, it is felt that passage estimates from the project are reliable. A series of gillnets with different mesh sizes are drifted through the acoustic sampling areas to apportion the passage estimates to species. In 2004, the selectivity models used in species apportionment were refined through biometric review and analysis of historical catch data from the project test fishery. Historical passage estimates from 1995 to present were again adjusted in 2016 after the adoption of a new species apportionment model. ADF&G's goal is to provide for a stable, well-run operational program for this project to generate inseason estimates of Chinook, summer chum, fall chum and coho salmon passage.

Acoustic Radio Tagging (2011-2012)

ADF&G acoustic radio tagged and tracked Chinook and summer chum salmon to determine the physical distribution as they migrate in the Yukon River past the mainstem sonar project located upstream of Pilot Station. In 2011 and 2012, tagging occurred in St. Mary's to give the fish time to resume upriver migration. This project was to provide evaluation of assumptions about detectability of salmon with the shore based sonars, and the availability of these fish to drift gillnets used in species apportionment to ultimately identify areas to improve in current methods of enumerating salmon passage for inseason fishery management.

Information for this project is on file with ADF&G and on the AKSSF website[18].

Marshall Drift Gillnet Test Fishery (1999-2008)

This test fish project was operated for primarily Chinook salmon in 1999 and 2000 then suspended from 2001–2004, the years the Chinook salmon radio telemetry project was conducted. The project was resumed from 2005–2008 and provided additional information on the Chinook salmon run timing and relative abundance (Waltemeyer 2008). As the Chinook salmon run began to decline in 2008 only restricted commercial periods were allowed late in the season and in 2009 the project funding was not secured as commercial fisheries on Chinook salmon were not anticipated to be offered in the near future.

Information for this project is on file with ADF&G.

6.2.5 District 3

Chinook Salmon Radio Telemetry (2000-2004)

A cooperative, interagency radio telemetry project, primarily between NMFS and ADF&G with many other prominent supporters, was conducted from 2000 to 2004 to determine run characteristics of Chinook salmon returning to the Yukon River basin (Spencer at al. 2009). Chinook salmon were captured with drift gillnets near the village of Russian Mission each year (some years included sites near Marshall). The Russian Mission location consisted of a relatively narrow, unbraided portion of the Yukon River, increasing the ability to capture fish, was located downstream of most of the spawning areas and was upstream of the major commercial and subsistence fisheries in the lower districts. The radio tagged fish were tracked using an array of towers setup along the Yukon River mainstem and cordoning off the major tributaries including those in the Canadian portion of the drainage.

Data from this project provided important information on stock composition, run timing and movement patterns of Chinook salmon migrating into the Yukon River. Mark-recapture abundance estimates of Chinook salmon in the Yukon River were also generated from this project based on second event sampling in the numerous and various escapement monitoring projects throughout the drainage (Eiler et al. 2014).

[18] http://www.akssf.org/default.aspx?id=2463

Summer Chum Salmon Radio Telemetry (2014-2015)

Similar to the large-scale Chinook salmon radio telemetry project, a cooperative project between NMFS and ADF&G was conducted as a small-scale feasibility study on summer chum salmon migrating up the Yukon River in 2004 (Spencer and Elier 2007). Summer chum salmon were captured in the lower Yukon River near the village of Russian Mission and marked with spaghetti and radio tags. Information on upriver movements was collected with remote tracking stations and a limited number of aerial surveys. One hundred and nineteen fish were recorded moving up river from the 208 fish tagged and were tracked to terminal spawning tributaries including lower tributaries, Koyukuk River, and middle river tributaries such as the Tanana River. Radiotagged summer chum salmon traveled an average of 28.8 km/day and ranged between 16 km/day and 38.8 km/day representing seasonal differences.

It was not until 2014 that ADF&G secured funding for a large-scale summer chum salmon telemetry project that operated for two years (Larson et al. *In prep*). A total of 2,431 summer chum salmon were fitted with radio-transmitters and their spawning migration was monitored using the same network of towers as was used for the Chinook salmon radio telemetry project. Additionally, aerial surveys were conducted to locate and track tagged fish in otherwise unmonitored reaches of the mainstem Yukon River, its tributaries, and terminal spawning areas. Summer chum salmon had a wide distribution within the Yukon River drainage and entered over 60 tributaries to spawn; however, roughly 50% of tagged fish entered the Anvik, Koyukuk, and Bonasila rivers each year. Summer chum salmon from the upper river entered the Yukon River earlier and traveled up the river faster than those from the lower river. In addition, summer chum salmon tended to have a short recovery period after being tagged, traveled relatively fast within the mainstem Yukon River, and then slowed down after entering their spawning tributaries. The 2014 mark-recapture abundance estimate was 2,107,000 fish, which matched up well with summer chum salmon passage at the mainstem Yukon River sonar near Pilot Station. The 2015 mark-recapture abundance estimate was 2,127,000 fish, which was larger than the summer chum salmon passage at the mainstem Yukon River. The summer Tanana River stocks being a middle run were not covered as well as would have occurred if the project covered both the summer and fall chum salmon runs.

6.2.6 District 4

Anvik River Sonar (ongoing)

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 1975 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 (Lozori 2015, 2016). The Anvik River sonar site is located approximately 47 miles upstream of the confluence of the Anvik and Yukon rivers and approximately 3 miles below Theodore Creek and the project is operated from mid-June to late July.

Monitoring of escapement within the Anvik River drainage is important because it is estimated to account for a significant portion of the total summer chum salmon production in the Yukon River. Since 1980, Anvik River sonar passage estimates have ranged from 193,000 (2009) to 1,500,000

(1981) fish with a median of 484,000 summer chum salmon (Table X). The current BEG range is 350,000 to 700,000 summer chum salmon. Aerial surveys have continued for Chinook salmon enumeration since 1980 and estimates have ranged from 212 (1989) and 3,304 (2004) fish with the current SEG range of 1,100 to 1,700 Chinook salmon. Sockeye, pink and coho salmon are also documented in this system.

The Anvik River sonar program produces escapement estimates of Anvik River Summer chum salmon. Historically the percentage of summer chum salmon bound for the Anvik River compared with the run size at the mainstem Yukon River sonar at Pilot Station has fluctuated and can be broken into 2 distinct time periods. During the period from 1995 to 2002 the average contribution was 49.6%. However, from 2003 to 2016, the average contribution was 21.4%. At present the reason for the shift in production is unknown.

Kaltag River Tower (1991-2005)

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 was the project coordinator with funds coming from a variety of federal, state, and private sector grants. Local youth were the primary employees with the Kaltag City office assisting with many aspects of this project. The tower site was 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.

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 20 near the arrival of summer chum salmon to the creek, and continued until the last week of July to provide timely and useful data for inseason management of the Subdistrict 4-A summer chum salmon fishery. The project also documented timing and abundance of Chinook salmon to this stream. Summer chum salmon escapement estimates ranged from 3,056 (2003) to 77,193 (1995) fish with an average of 28,269 fish from 1994–2005 (excluding 2004). Chinook salmon escapement estimates ranged from 20 (2000) to 241 (1994) fish with an average of 127 fish, during the same time period. In 1995, attempts were made to extend the project into the coho salmon season however it did not succeed partly due to the flashiness of how coho salmon rush into a stream during periods of high water and the students being school during the fall.

Kaltag Fall Season Drift Gillnet Test Fishery (1999-2008)

This cooperative test fish project was operated by the City of Kaltag with ADF&G from 1999–2008. The project was operated for assessment of fall chum and coho salmon in the middle Yukon River (Burnham 2006). Three drift gillnet test fishing sites were established near the community, one on each bank and one off a large sandbar. One twenty minute drift was conducted at each of the sites once a day from approximately July 25 to September 18. Test fishing times and the number of salmon caught were recorded by site and reported to ADF&G daily. ADF&G calculated the daily CPUE for fall chum and coho salmon to standardize the data for comparison within and between seasons. The test fishery being located at river mile 450 was far enough up river for the distinct pulses of fall chum salmon to spread out based on swimming speed and provided assessment of the migration timing that would be seen in the upper river fisheries and escapements. Additionally, this project was used to assess the ability to capture coho salmon in this part of the Yukon River since they were not normally targeted.

Nulato River Tower (1994-2003)

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 primarily Chinook and summer chum salmon escapement from counting towers (Sandone 1995). This cooperative project was successfully conducted annually through 2003 (excluding 2001) field season with the Nulato Tribal Council replacing TCC as a cooperator in 1995 (Crawford and Lingnau 2004). The two-tower counting site is located on the Nulato River approximately 3 miles upstream of its confluence with the Yukon River. The project is operated from approximately June 20 to July 20, depending upon salmon run timing. Chinook salmon escapement estimates ranged from 756 (1996) to 4,766 (1997) fish with an average of 1,951 fish from 1994–2003 (Table X). Summer chum salmon escapement estimates ranged from 17,814 (2003) to 236,890 (1995) fish with an average of 96,589 fish, during the same time period.

Melozitna River Sonar (1981-1983)

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.

Aerial surveys were conducted of the system during the summer season in 1990–1993 and 2009–2012 however counts were minimal with less than 20 Chinook and less than 3,000 chum salmon annually.

Galena Test Fish Wheel (1995)

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.

Ruby Test Fish Wheels (1980-1991)

Beginning in 1980, a test fish wheel was operated on the right (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[19].

From 1981 through 1986, a test fish wheel was also operated annually on the left (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.

Koyukuk River Sub-Basin (District 4)

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.

Gisasa River Weir (ongoing)

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. 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 (Carlson and McGuire 2017). 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 movements of resident fish. The project typically operates from mid-June to end of July. Summer chum salmon escapement estimates range from 10,155 (1999) to 261,306 (2006) fish with a median of 66,438 fish from 1994–2016. Chinook salmon escapement estimates range from 1,126 (2013) to 4,023 (1995) fish with a median of 1,991 fish, during the same time period (Table X). Small numbers of pink and sockeye salmon (<100) have also been counted through the weir.

Henshaw Creek Weir (ongoing)

Henshaw Creek is a tributary of the Koyukuk River located within the Kanuti National Wildlife Refuge. Aerial surveys were conducted from 1969–1999 and in 2000, the USFWS installed a resistance board weir in Henshaw Creek to assess Chinook and summer chum salmon returns from July 1 to approximately August 5 (McKenna 2015). Chinook salmon escapement estimates range from 193 (2000) to 2,391 (2015) fish with an average of 1,082 fish from 2000–2016 (excluding 1999 and 2006). Summer chum salmon escapement estimates range from 21,400 (2003) to 292,082 (2012) fish with an average of 145,598 fish, during the same time period (Table X).

This project was initiated based on identified needs from the 1998 plan since this system is useful for enumerating multiple species compared to Clear and Caribou Creek projects.

Koyukuk River Mark-Recapture and Radio Telemetry Projects (2013-2016)

USFWS and TCC conducted a radio telemetry and mark recapture project on chum salmon within the Koyukuk River drainage in 2013–2016. High water hindered tagging and recovery efforts throughout the first year of the study. Distribution was estimated throughout the drainage based

[19] Ihlenfeldt-McNay, N. 1997. 1997 Yukon River fall season data notebook. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Unpublished Data. Fairbanks.

on aerial tracking of radio tags and observations of both tag types in the weir and tower projects within the drainage; however abundance estimates have not been made.

In 2014, a total of 1,376 chum salmon were captured in 2014 with 1,169 receiving spaghetti tags and 134 fish receiving an additional radio transmitter (Harris et al. 2014). Aerial surveys covered the mainstream of the Koyukuk River drainage from the mouth up to and including the north and middle forks of the River. Surveys encompassed 20 tributaries and recaptures occurred in 11 of the 20 tributaries. Radiotagged fish were tracked to the Gisasa, Kateel, Huslia, Hogatza, Indian, and Alatna Rivers along with Dakli Wheeler, Hughes, and Henshaw Creeks. In addition, three fish were suspected of spawning in the mainstream of the Koyukuk River at Huggins Island near the mouth of the Indian River. No fish were detected upstream of Henshaw Creek or in the Kanuti and Dulbi Rivers. Results from 2015–2016 are not available at this time.

Clear Creek Tower/Video (1995-2007)

Clear Creek is a tributary of the Hogatza River. It is one of the most productive summer chum salmon 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 confluence with the Yukon River. Its terminus lies approximately mid-way between the villages of Huslia and Hughes (Boswell 1979).

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 (Kretsinger et al. 1994). 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 (Headlee 1996). 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 tower project was operated from approximately June 22 through July from 1995–2005 however counts were affected by high water in 1998 and 1999 (Van Hatten1997; Esse and Kretsinger *In prep(a)*). The project was subsequently transitioned to video counting by BLM during the 2006 and 2007 seasons (Esse and Kretsinger *In prep(b)*). Summer chum salmon escapement estimates ranged from 3,674 (2001) to 116,735 (1995) fish with an average of 39,484 fish from 1995–2007 excluding partial operations in 1998 and 1999. Based on preliminary data from the radio telemetry study conducted on summer chum salmon by ADF&G in 2014–2015 the Koyukuk River stocks were some of the earliest salmon to enter the Yukon River.

Caribou Creek Tower (2004-2007)

Caribou Creek is a tributary of the Hogatza River which also produces summer chum salmon. Summer chum salmon passage was conducted using video counts from approximately June 22 to the end of July in 2004–2007 by BLM. Summer chum salmon escapement estimates ranged from 14,605 (2005) to 24,039 (2006) fish with an average of 17,929 fish during this time period.

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

Hogatza Area of Critical Environmental Concern Aquatic Habitat Management Plan (1993)

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 Aquatic Habitat Management Plan (Snyder-Conn et al. 1992; Vinson 1995a, 1995b, 1996, 1997). 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 (BLM 1997).

South Fork Koyukuk River Sonar/Weir (1990-1999)

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 were 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 (Wiswar 1997). 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 as occurred in 1999. Also, with the onset of winter, high water makes extracting weir materials from the river dangerous and difficult. As a consequence future project are recommended to operate during the summer chum and Chinook salmon season only. Other means of assessing the fall chum escapement would need to be explored.

6.2.7 District 5

Chandalar River Sonar (ongoing)

From 1986 to 1990, the USFWS used sonar (Bendix) to estimate adult fall chum salmon in the Chandalar River (Daum et al. 1992). The sonar site was located at river mile 13.4 and sonars were operated on each bank. The results from this work revealed that the Chandalar River rivaled the Sheenjek River in terms of fall chum salmon production. Seasonal total fall chum salmon estimates ranged from 78,631 (1990) to 33,619 (1988) and averaged 58,628 fish. 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.

Due to the decline of Yukon River fall chum salmon stocks and the decreasing likelihood of an operational border sonar program, a 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 and the first year 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 was generated. In 1996, final developmental aspects of the project were completed and preliminary counts were reported to ADF&G on a daily basis. In 1997, all feasibility objectives had been completed and the project was fully operational with daily counts reported to ADF&G.

In 2007, the project sonar equipment was further upgraded to DIDSON technology (Melegari 2015). The Chandalar sonar enumeration has continued to present times. Since the ability to count until the end of the run, due to the onset of winter, the sonar counts have been extrapolated through October 9. This drainage is a major contributor to the fall chum salmon run to the Yukon River and has a biological escapement goal (BEG) range of 74,000 to 152,000 fish. Passage estimates of fall chum salmon escapements have ranged from 71,047 (2000) to 526,838 (2005) with a median of 211,913 fish from 1995–2016 (excluding 2009; Table X).

Mainstem Yukon River -U.S./Canada Border Sonar near Eagle (ongoing)

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 during ongoing negotiation between the U.S. and Canada. 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 was collected in 1993 during which calibration and data handling protocols were established. In 1994, additional acoustic data was collected on both free-swimming fish and calibration spheres (Konte et al. 1996). 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 was the expectation that future split beam sonar development will provide Yukon River border salmon passage estimates.

In 2003, ADF&G carried out a study to identify a more suitable location to deploy hydroacoustic equipment to estimate salmon passage into Canada (Pfisterer and Huttunen 2004). A 45 km section of river from the DFO mark–recapture fish wheel project at White Rock, Yukon Territory to 19 km downriver from Eagle, Alaska was explored. A total of 21 river transects were narrowed down to the 2 most promising sonar deployment locations at Calico Bluff and Shade Creek. Although sonar was not deployed in 2003, the bottom profiles at the preferred sites indicated that it should be possible to estimate fish passage with a combination of split-beam sonar on the longer, linear left bank and DIDSON on the shorter, steeper right bank. ADF&G carried out a 2-week study in 2004 to test sonar at the two preferred sites and it was found that Six Mile Bend (11.5 km downriver from the town of Eagle and immediately upstream of Shade Creek) was the most ideal site. In 2005, a full-scale sonar project was conducted from July 1 to August 13 to estimate Chinook salmon passage in the Yukon River at Six Mile Bend site. In 2006, project duration was extended to provide an estimate of fall chum salmon passage.

Sonar counts attributed to Chinook salmon escapements have ranged from 30,725 (2013) to 84,015 (2015) with an average of 56,383 fish from 2005–2016 (Table X). Similar to the Chandalar sonar data, the passage estimates at Eagle for fall chum salmon are extrapolated, in this case to October 18, to encompass the entire run after sonar operation cease for the onset of winter (Lozori and McDougall 2016). Passage estimates of fall chum salmon escapements have ranged from 101,737 (2009) to 265,007 (2007) with an average of 180,344 fish from 2006–2016 (Table X).

Distribution and genetic origin of Chinook salmon rearing in Nonnatal streams (2008-2010)

This was an investigation to determine the distribution and genetic origin of Chinook salmon rearing in nonnatal tributary streams of the Yukon River between the U.S.-Canada border and Tanana, Alaska. Juvenile Chinook salmon were captured in 45 of the 57 streams sampled. Mixed-stock analysis of genetic samples revealed that Canadian-origin Chinook salmon contributed between 88% and 100% of the yearly mixtures, with Canadian percentages decreasing with increased distance downstream from the U.S.-Canada border.

Tozitna River Counting Tower (2001-2009)

The Bureau of Land Management initiated a tower project through a Cooperative Agreement with the Tanana Tribal Council on the Tozitna River. The project site was located at river km 80.4, approximately 0.4 river kms upstream from the confluence of Dagislakhna Creek. A counting tower, partial weir, and contrast panels were installed in 2001. The project enumerated both Chinook and summer chum salmon. Chinook salmon escapement estimates ranged from 494 (2007) to 1,880 (2004) fish with an average of 1,052 fish from 2003–2009. Summer chum salmon escapement estimates ranged from 8,470 (2003) to 39,700 (2005) fish with an average of 18,224 fish from 2003–2009.

Information for this project is on file with BLM.

Tanana Village Subdistrict 5-A and 5-B Test Fish Wheels (1993-2012)

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. Late in the season two local Tanana village fishermen were contracted to operate their fish wheels equipped with live boxes and report their daily catches of fall chum and coho salmon. One fish wheel site was located on the right (north) bank of the Yukon River mainstem in Subdistrict

5-B while the other fish wheel was operated on the left (south) bank in Subdistrict 5-A below the mouth of the Tanana River. The right bank wheel operated from September 14 through October 6, 1993 while the left bank wheel operated from September 15 through October 1, 1993.

The Subdistrict 5-B fish wheel was operated for full seasons from 1994 to 1999. The Subdistrict 5-B fish wheel was not renewed in 2000[20], as similar information was available from the Rapids Test Fish Wheel project upriver. The Subdistrict 5-A fish wheel was operated through 2012 (excluding 2007) with one change in contractor but maintaining the historical fishing site (Fliris 2001). The fish wheel was contracted for summer season operations to assess Chinook and summer chum salmon from 2002–2006. The Subdistrict 5-A fish wheel operations were also used to examine fall chum salmon for coded wire tags (CWT) in 1996–1998 as part of the Toklat River CWT project. Each year the fish wheels were operated on the following time frames: the right bank wheel operated from approximately August 1 through September 15 and monitored the upper Yukon River and Canadian components of the fall chum salmon run while the left bank wheel operated from approximately August 15 through September 30 and monitored the Tanana River fall chum and coho salmon runs. The earliest the left bank fish wheel operated for summer season Tanana River stock assessment was June 14. During summer season the fish wheel was harder to maintain due to the rising Tanana River waters and the debris load that comes out of this system and thereafter only fall season operations were continued (Moore and Daum 2012).

Rampart Fall Chum Salmon Tagging Project (1996-2005)

USFWS operated a mark and recapture project to estimate the abundance of fall chum salmon in the middle Yukon River above the Tanana River confluence from 1996–2005 (Apodaca and Daum 2006). Fish were captured with left and right bank fish wheels at the marking site and a right bank fish wheel as the recovery site (number of wheels varied some years). Fall chum salmon were marked using color-coded spaghetti tags and examined from video recordings at the recovery site. The project operated approximately seven weeks from late July through mid-September and weekly stratum estimates of fall chum salmon were generated for inseason fishery management. Fall chum salmon escapement estimates range from 189,741 (2000) to 1,987,982 (2005) fish with an average of 544,242 fish from 1996–2005 (excluding 2000; Table X). This location equated to the combined total of tributary escapements of fall chum salmon to Chandalar, Sheenjek, Fishing Branch and the mainstem Yukon River at the Canadian border and harvests that occurred within the study area.

A cooperative, interagency radio telemetry project (NMFS and USFWS) was conducted from 1996 to 1999 to determine run characteristics of fall chum salmon returning to the upper Yukon River basin. 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 sites on the Yukon River. In 1997, work focused on preparing for a full-scale telemetry study by installing remote tracking stations 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 full radio tagging programs operated in 1998 and 1999. The Chandalar was the dominant stock each year followed

[20] Busher, W. H. 2000. 2000 Yukon Area fall season data notebook. Alaska Department of Fish and Game, Division of Commercial Fisheries. Unpublished Subdistrict 5-B Test Fish Wheel Data. Fairbanks.

by the Sheenjek, and the mainstem Yukon River at the U.S.-Canada border was also one of the larger components. Different timing patterns were observed for the upper Porcupine River stocks and the Kluane stock in the mainstem Yukon River component. Movement rates of fish traveling to the Chandalar and Sheenjek rivers was slower than the stocks headed to the upper portion of the drainages on both the upper Porcupine River and the mainstem Yukon River.

The tracking stations were also used as part of a cooperative USFWS-ADF&G study to determine the movement patterns and spawning distribution of radio-tagged sheefish in the upper Yukon River. USFWS and various partnerships with ADF&G have also conducted studies using the tower array for broad whitefish in the middle Yukon River, Sheefish in the Nowitna River drainage, whitefishes of the Tanana River, Sheefish in the Innoko River drainage, chum salmon in the Kashunuk River, and most currently the Bering cisco work in the upper Yukon Flats.

All the tagging fish wheels associated with the mark-recapture project including those operated in the Rapids and those operated as tag recovery sites near the village of Rampart were also used to calculate CPUE for fall chum salmon (Zuray 2016). The tagging fish wheels although set up to target salmon also provided some migration information for non-salmon species of Bering cisco, sheefish, broad and humback whitefish. Additional fish wheels were contracted in Beaver and Circle in 2001 and 2002 and Stevens Village in 2002 to test some assumptions for the mark-recapture project but the data was also used to calculate fall chum salmon CPUE as additional inseason run assessment tools.

Rampart Rapids Fishwheel Video Monitoring (1999 – 2015)

From 1999 to 2015 Stan Zuray with assistance from the USFWS Fairbanks Office developed and ran a video capture system that allowed for the immediate release of all species of migrating fish from the fishwheel after being counted by video camera at Rampart Rapids (Yukon River mile 731). Objective was to address the increasing concerns over traditional live box held fish tagging and counting, and devise an alternative method of monitoring catch using video. Livebox catch per unit effort data had been collected for all species of migrating fish by the USFWS at this same project site and fish wheel since 1996.

In 2002 after project requests by both State and Federal management to try to develop a less expensive method to count fall chum moving into the upper Yukon (than the USFWS Rampart Fall Chum Salmon Tagging Project) a formula was developed that took into account water current and other factor at the fish wheel. This eventually produced a 10 year estimate for fall chum closer to the post season run reconstruction estimate than the Tagging Project and allowed that project to end in 2005. This data was produced using consistent specifications that would allow for project repetition at any time in the future using the 20 year database for comparisons.

Project also produced data and information on fall chum arrival times, water temperatures, diel catch patterns, water turbidity and fish friendly fishwheel construction features along with providing a platform for a large number of Federal, State and independent projects to operate over its years.

Rapids Student Data Collection Project (2001 -2013)

This project was run by Stan and Kathleen Zuray with help from USFWS Fairbanks personnel and independent researchers at Rampart Rapids (Yukon River mile 731) from 2001 to 2013. The objectives were to collect Chinook salmon sex, length, weight, girth (SLWG), genetic, and Ichthyophonus disease prevalence data. Chum salmon were also visually inspected for flesh color and related fat content, and an accurate fall chum arrival date determined each year aiding fishermen and fall chum run assessment projects in the area. Salmon used were caught in subsistence fisheries nearby and sampled by students traveling to area fish camps. Students were selected weekly from the local areas and overseen by trained older technicians. Over the duration of the project almost 10,000 Chinook salmon were sampled for size with a majority of those also sampled for Ichthyophoniasis disease and sex. A paper was published in 2012 by the American Fisheries Society using this data describing characteristics of the disease (Zuray et al. 2012).

The project was started to address fishermen's concerns that the average size of Chinook salmon was declining and a disease was significantly present in them. Existing data on Ichthyophonus in the Yukon River was very limited and it was difficult to say anything meaningful about disease concerns. Database development and project methods were specifically designed to be repeatable in the future should the project end. The project was discontinued in 2013 due to increasingly restrictive closures of the Chinook subsistence fishery which eliminated the ability to collect randomly sampled data over the entire run.

Beaver Creek Weir (1996-2000)

In 1996, BLM, with the assistance of USFWS, installed a resistance board weir in the upper portion of Beaver Creek (Collin and Kostohrys 1998). 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; collecting age, sex, and length data and genetic samples for stock identification. The project operated from 1996–1997 and 1999–2000 with Chinook salmon passage of 192, 315 128, and 114 respectively. Chum salmon counts were 632, 34, 75 and 12 for the same years of operation respectively with 17 coho salmon observed in 1997.

Sheenjek (Sheenjik) River Sonar (1981-2012)

Fall chum salmon escapement to the Sheenjek River has been estimated by ADF&G using sonar from 1981–2012 (Dunbar 2013). This project was 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 were collected annually. From 1974–1980 an aerial survey component was incorporated to account for the portion missed by operating the sonar late in the run. This drainage is a major contributor to the fall chum salmon run to the Yukon River and has a biological escapement goal (BEG) range of 50,000 to 104,000 fish. Estimates of fall chum salmon escapements have ranged from 14,229 (1999) to 561,863 (2005) with an average of 97,856 fish from 1974–2012 (Table X).

Black River Weir (1995-1997)

The Council of Athabascan Tribal Governments (CATG) attempted a weir program to estimate sa1mon passage 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 plan was to be operational from early August until late September to enumerate fall chum and coho salmon. Unfortunately, high water levels prevented the deployment of the weir in both 1995 and 1996. In 1997, plans were made to move weir materials further upstream but due to budgetary and personnel problems this was not accomplished.

Fort Yukon Test Fish Wheels (1995-1996)

Two test fish wheels were operated by the Council of Athabascan Tribal Governments (CATG) in the Yukon River near the community of Fort Yukon. Specific objectives were to determine the timing and relative magnitude of 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 right (north) bank of the Yukon River, below the most upstream mouth of the Porcupine River. The second fish wheel was located on the left (south) bank of the Yukon River several miles upstream of Fort Yukon and the Porcupine River confluence. Catch rates for the right bank fish wheel in both years were variable and unpredictable, likely indexing both Porcupine River and upper Yukon River stocks. Results from the left bank wheel in 1995 appeared to correlate well with upper Yukon River bound 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[21].

Information for this project is on file with ADF&G.

6.2.8 District 6

Tanana River Sub-Basin

The Tanana River sub-basin includes the entire Tanana River drainage. The approximate mainstem drainage length of the Tanana River is 440 miles from its headwaters to its terminus at river mile 695 of the Yukon River. Fisheries on the Tanana River are managed as a terminal harvest area and do not contain any Canadian-origin stocks.

USFWS Habitat Restoration Projects 2002-2018.

In Alaska, the US Fish and Wildlife Service has partnered with private landowners, the State of Alaska, non-profits, tribes, universities, federal agencies, and others to maintain and/or restore habitats for native fish and wildlife via four programs: Fish Passage Program, Coastal Program, Partners for Fish & Wildlife Program, and the National Fish Habitat Partnership. We pay up to 50% of project costs and provide informal advice on the design and location of potential projects and capacity for on-the-ground project implementation and monitoring. A fish passage project improves the ability of fish or other aquatic species to move by reconnecting habitat that has been fragmented by barriers. Appendix I19 lists a summary of habitat restoration projects in the Alaska portion of the Yukon River drainage. The vast majority of projects fall within the Tanana River drainage, with several occurring elsewhere within the Yukon River drainage.

Nenana River Reconnaissance (ongoing)

Aerial surveys exist in the Nenana River drainage dating back to 1973 primarily in the Seventeen Mile Slough area for Chinook and coho salmon though chum salmon counts were also noted. In 1996 the coverage of the Nenana River drainage was increased with funding originating from the Bering Sea Fishermen's Association (BSFA) through a competitive grant process. BSFA received

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[21] Ihlenfeldt-McNay, N. 1997. 1997 Yukon River fall season data notebook. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Unpublished Data. Fairbanks.

federal funding to conduct salmon restoration, enhancement, and research activities within the Arctic-Yukon-Kuskokwim region of Alaska.

During the 1996 fall field season, the goal of the Nenana River reconnaissance project was to gain a better understanding of the contribution of 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 fisheries.

Between 17 September and 14 October, 1996 (Headlee 1997) and 22 September and 10 October, 1997 (VanHatten 1998) TCC conducted adult salmon surveys on the Nenana River drainage. 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, 70 chum, 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 Seventeen 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 and 259 fall chum salmon were observed in the 13 creek or river spawning areas surveyed.

BSFA continued conducting surveys through 2010 (except 2007) and ADF&G has continued helicopter surveys during the fall season since then primarily for coho salmon (Table X).

In 1997 the Tri-Valley School in Healy Alaska operated a coho salmon weir in Lignite Springs, a tributary of the Nenana River and provided the daily counts, sex, weight and length of the fish passage to ADF&G.

Chena River Assessment (ongoing)

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 (CFMDD) began an assessment program using mark-recapture techniques to improve the estimated escapement of Chinook salmon. This program was continued by the Division of Sport Fish 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.

A counting tower has been operated since 1993 to enumerate Chinook salmon escapement and to also provide information on summer chum salmon. In some years the project was extended with Division of Commercial Fisheries support to more completely cover summer chum salmon migration. Years in which high water was an issue mark-recapture estimates were generated for Chinook salmon in 1995–1996, 2000 and 2002, and there are were no estimates generated in 2005 or 2011. Counting typically begins in early July and continues 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. Accuracy of tower count estimates is heavily dependent on water visibility during the counting period. Many years (40%) of tower counts have been incomplete estimates due to visibility issues. In 2014 a transition to sonar operations was conducted and in 2015 both sonar and the tower were used in concert. The sonar is primarily used during periods of low visibility and tower counts are used when feasible as using sonar does not allow for species apportionment and a mixture model is applied to the sonar counts.

The minimum aerial survey biological escapement goal for the Chena River is 1,700 Chinook salmon. The biological escapement goal range for the Chena River escapement base on the tower/sonar location is 2,800–5,700 Chinook salmon (Evenson 2002), while no escapement objectives have been developed for summer chum salmon. Chinook salmon escapement estimates from 1986–2016 range from 1,859 (2013) to 13,390 (1997) fish with an average of 6,444 fish (Stuby and Tyers 2016) (Table X). Summer chum salmon are not counted for the full season however the median passage excluding 2002 and 2003 is 8,621 and the highest count observed is 35,109 (2006) fish.

Salcha River Assessment (ongoing)

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 fisheries management of Chinook and summer chum salmon of this stock. In 1987, the Division of Sport Fish began an assessment program using mark-recapture techniques to improve Chinook salmon escapement estimates. 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 Division of Sport Fish primarily to enumerate Chinook salmon escapement into the Salcha River, but also provides information on summer chum salmon. In some years the project was extended with CFMDD support to more completely cover summer chum salmon migration. BSFA operated the counting tower from 1999–2015. Counting begins in early July and continues to late July or early August. The counting site is located just upstream of the Richardson Highway Bridge, approximately 3.25 miles from the confluence of the Salcha and Tanana rivers. This location is downstream from most of the Chinook and chum salmon spawning grounds. Accuracy of the tower count estimates is heavily dependent on water visibility during the counting period. Incomplete estimates occurred in 1996 due to high water and a mark-recapture estimate was generated; however, no estimate was obtained in 2014. In 2016 the Division of Sport Fish began using sonar in concert with the tower to supplement during times of low visibility.

The minimum aerial survey biological escapement goal for the Salcha River is 2,500 Chinook salmon and 3,500 summer chum salmon. The biological escapement goal range for the Salcha River escapement based on the tower counts is 3,300–6,500 Chinook salmon (Evenson 2002), while no escapement objectives have been developed for summer chum salmon. Chinook salmon escapement estimates from 1987–2015 range from 3,294 (1989) to 18,404 (1997) fish with an average of 8,974 fish (Stuby and Tyers 2016)(Table X). Summer chum salmon are not counted for the full season however the median passage is 27,003 and the highest count observed is 194,933 (2005) fish, for the tower operations from 1993–2015. The Salcha River produces the largest amount of Chinook salmon in the Yukon River drainage from a single terminal tributary.

Goodpaster River Counting Tower (ongoing)

A counting tower has been operated since 2004 to enumerate Chinook salmon escapement in the upper portion of the Goodpaster River located near Tenmile Creek. Baseline aerial surveys were conducted to document spawning locations throughout the drainage beginning downstream of the south fork when Teck-Pogo Mine operations began. Spawning occurs below the tower site but this was the furthest downstream location that a tower was feasible. The counting tower project is operated by staff from TCC and BSFA primarily during the month of July. No salmon escapement objectives have been established for this system. Chinook salmon escapement estimates between 2004–2016 range from 678 (2013) to 4,107 (2009) fish with an average of 1,921 fish (Stuby and Tyers 2016).

Delta River Foot Surveys (ongoing)

Similar to the Toklat River, the Delta River is a glacial stream which flows high and turbid during the summer months, with winter flow primarily from sub-permafrost springs in the lower 1.5 miles of the river. This spring area forms a unique fall chum salmon spawning area. Survey estimates of spawning fall chum salmon have occurred on an annual basis since 1972 in the Delta River. 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 (October through November). The spawning abundance is estimated annually using the area- under-the-curve method, spawning residency data collected by Trasky in 1973 and 1974, or peak survey counts. In years for which weekly survey estimates are incomplete, a migratory time-density model has been developed for expanding the peak survey estimate (Barton 1986). The biological escapement goal range for the Delta River is 6,000 to 13,000 fall chum salmon. Fall chum salmon escapement estimates range from 3,001 (2000) to 33,401 (2015) with a median of 16,534 fish from 1972–2016 (Table X).

Delta Clearwater River Boat Surveys (ongoing)

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 (Stuby and Tyers 2016). In 1994–1998, aerial surveys were conducted in non-navigable portions of the river. The sustainable escapement goal range for the Delta Clearwater River proper is 5,200 to 17,000 coho salmon. Coho salmon escapement estimates range from 632 (1972) to 102,800 (2003) with an average of 15,586 fish from 1972–2016 (Table X).

Yukon and Tanana River Fall Chum Salmon Tagging Study (1979–1980)

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. Fall chum salmon population estimates for the upper Yukon River including the Tanana River were 197,000 (1976) and 412,000 (1977). In 1978 a population estimate for the upper Yukon above the confluence of the Tanana River was 165,000 fall chum salmon. In 1979 and 1980 population estimates for the Tanana River included 676,000 and 384,000 fall chum salmon respectively. Results indicate that fall chum salmon bound for the upper Yukon migrate mostly along the north bank of the Yukon River in the

Galena-Ruby area, while fall chum salmon bond for Tanana River migrate mostly along the south bank. Run timing is earlier for the upper Yukon River stock (Buklis 1981).

Tanana River Mark-Recapture (1995-2007)

A cooperative fall chum salmon stock assessment project by ADF&G, Bering Sea Fishermen's Association (BSFA) and Tanana Chiefs Conference (TCC) was conducted on the Tanana River from 1995–2007 (Cleary and Bromaghin 2001; Cleary and Hamazaki 2008). A 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 fish wheels were used in 1995). Another fish wheel was operated 18 miles downstream from Nenana or approximately 37 miles upstream of the tagging site to recapture tagged fall chum salmon and examine the marked to unmarked ratio (two fish wheels were used from 1995–1998). All fish 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. This project was used to estimate the fall chum salmon run size upstream of the Kantishna River. Estimates of fall chum salmon to the upper Tanana River ranged from 34,844 (2000) to 337,755 (2005) with a median of 123,879 fish from 1995–2007.

Similarly, estimating the Kantishna River component of the fall chum salmon run was added to the project and operated from 1999–2007. A fish wheel was used to capture fall chum salmon located approximately 6 miles upstream of the mouth of the Kantishna River and up to four recapture fish wheels were operated on each the upper Kantishna and Toklat rivers approximately 70 miles from the tagging site. Estimates of fall chum salmon to the Kantishna River ranged from 21,450 (2000) to 107,719 (2005) with an average of 61,392 fish from 1999–2007.

In 1999 an attempt was made to tag coho salmon in both the Tanana and Kantishna rivers along with the fall chum salmon however not enough coho salmon could be reexamined for tags to develop a population estimate.

Tanana River Radio Telemetry Studies (1989, 2007-2008)

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 (Barton 1992). A total of 210 external radio transmitters were deployed on fall chum salmon from mid-August to early October from a site 7 miles downstream of Fairbanks. 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 the total fall chum salmon spawning escapement in the Tanana River 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.

In 2007 and 2008 another study incorporating radio telemetry on fall chum salmon was funded by Alaska Sustainable Salmon Fund with University of Alaska graduate program, USGS, and Tanana Chiefs Conference as cooperators. This project was located farther downstream than the 1989 telemetry study with radio tags being deployed on the Tanana River just upstream of the Kantishna River using the same fish wheel as capture gear in the same location as the 2007 mark recapture project. Unfortunately funds could not be obtained to do the entire Tanana River drainage. Because of tagging issues encountered on the Toklat River 1997 telemetry study, 2007 was a feasibility year testing esophageal (internal) tag types. In 2008 tagging commenced with 407 tags deployed including 35 archival tags which measure temperature and depth of the fish as they migrate. The proportion of fall chum salmon destined for the Delta River was estimated at 11.5% and represented the greatest proportion of tagged fish to any tributary spawning area. On the mainstem Tanana River 21.3% were tracked between the Salcha River confluence and the Little Delta River.

The Tanana River transitions from summer to fall chum salmon components mid-August. Based on the tagging dates and terminus tributary each fish migrated to, there was an observable difference in run timing between the two runs. The summer component selected very different spawning locations typically the right (north) bank systems of the Tanana River which are run off streams with very little glacial influence compared to the left (south) bank tributaries that the fall component utilize, though later in the year these locations reveal clear upwelling waters dominating the flow once the glaciers subside with the onset of winter. Tracking the fish to spawning locations was only a portion of the study to explore the habitat which fall chum salmon were seeking. A UAF graduate student and USGS deployed temperature loggers that were overwintered within the spawning areas of the mainstem floodplain of the Tanana River between Fairbanks and Big Delta.

Information for the 2007 and 2008 project is on file with ADF&G[22].

Tanana River Sonar (1989-1990, 2013-2014)

In 1989 the Legislature appropriated funds 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 downstream of Manley Hot Springs (LaFlamme 1990). The project used technology similar to that employed at the mainstem 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 not reinstituted until 2012 which began with new site selection (Broderson et al. 2016).

A new sonar site was chosen just downstream of Manley Hot Springs slough then again was operated as feasibility using more advanced sonar equipment in 2013 before operating a full season in 2014. Sonar estimates were apportioned to 15,502 Chinook, 165,526 summer chum, 222,627 fall chum, and 61,060 coho salmon in 2014. The project was once again discontinued due to lack of funding.

Tanana River Test Fish Wheels (1984-2011)

The Tanana River is managed as a terminal harvest area and ADF&G funded test fish wheel operations to provide CPUE indexes of relative abundance and timing of stocks that are useful for fishery management. A contract test fish wheel was operated on the right (north) bank near the village of Manley during 1984, 1985, and 1988–1994. The Manley test fish wheel operated from

[22] http://akssf.org/default.aspx?id=2899

approximately June 25 to late September and provided assessment for Chinook, chum and coho salmon. A combination of changes in river hydrology, fish migration pattern, fish wheel susceptibility to debris (drift), and declining budgets resulted in suspension of this test fish project.

A contract test fish wheel was operated from 1988–2011, on the right (north) bank approximately 18 miles below Nenana as a CPUE index of relative abundance and timing of Chinook, chum and coho salmon. This downriver site was chosen as it was below most of the Subdistrict 6-B commercial fishing fleet that were based out of the community of Nenana. This project was operated late June to late September, often with a mid-season break during the low passage transition period between summer and fall chum salmon runs in mid-August. In 2003, this project was transitioned from holding fish in a live box to video and then digital counting of salmon passage based on the technology tested in the Yukon River test fish wheels (Borba 2007). This same fish wheel project was used as the main tag recovery site for the 1995–2007 Tanana River mark-recapture studies.

All of the fish wheels used with Tanana/Kantishna River mark-recapture project (mentioned under that project) also generated fall chum and coho salmon CPUE information. The relative abundance and timing information for fall chum and coho salmon was used for inseason fishery management[23,24].

Toklat River Foot Surveys and Sonar (1974-2005)

The escapement database for Toklat River fall chum salmon consists of annual estimates of total spawning abundance from 1974–2005 and intermittent since then. 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 through 2005, an annual ground survey of the major fall chum salmon spawning area at Toklat Springs had been conducted during peak spawning. The ground survey typically occurs during mid to late October with two people and lasts three to four 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 had established a fall chum salmon minimum escapement goal for the Toklat River of 33,000 spawners. Ground surveys were always preceded by aerial reconnaissance; however, following a downturn in production in this system ADF&G maintains aerial surveys as funding allows to monitor this system (Table X). During BEG escapement goal review based on the reconstruction of the total run size for fall chum salmon conducted through parent year 1999, the BEG was changed to a range of 15,000 to 33,000 fish for the Toklat River. Lacking the historic level of production and consistent means to monitor the system the BEG range was eliminated in 2010.

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 (sonar) techniques, in addition to maintaining the ground surveys made of the Toklat Springs. Although

[23] Sandone, G. J. 1995. Yukon River management area fall commercial fishing season data notebook, 1995. Alaska Department of Fish and Game, Division of Commercial Fisheries, Unpublished Manley Test Fish Wheel Data. Anchorage.

[24] Padilla, A. 2012. 2012 Yukon Area fall season data notebook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Unpublished Nenana Test Fish Wheel Data. Fairbanks.

the two independent estimates of fall chum salmon abundance obtained in 1994 complemented each other remarkably well (Barton 1997), 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 (Barton 1998). 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.

Toklat River Intra-Gravel Water Temperatures (1995-1999)

In conjunction with the foot surveys conducted by ADF&G on the Toklat Springs to enumerate primarily fall chum salmon in the floodplain and coho salmon in Geiger Creek. In order to better understand and collect baseline data for fall chum salmon stocks this project, to collect data on intra-gravel temperatures, was conceived in 1994. Water temperatures were collected from 1995–1999 and project cooperators included TCC, BSFA and ADF&G. Three sites were selected for the full study conducted in 1998–1999 and included the Sushana River, Roadhouse Slough, and Geiger Creek as areas to monitor intra-gravel water temperatures at various depths as well as ambient temperatures from mid-October to the end of April (VanHatten 1999). This time period includes spawning through fry emergence from the gravel. Temperatures were taken at depths of 10 cm, 20, cm, 30 cm, and 40 cm from each of the habitat types to determine the daily accumulation of cumulative thermal units (CTUs) needed for incubation and emergence of salmon in this environment.

Barton Creek Weir (1994-1996)

ADF&G operated a weir on Barton Creek from 1994 to 1996 as a part of the enumeration of fall chum and coho salmon in the Toklat River drainage (Barton 1997, 1998). The weir was installed approximately 0.3 miles upstream from its confluence with the Toklat River. The majority of the coho salmon in the system were thought to migrate to this tributary, but most of the coho salmon moved in after October when the sonar project was annually pulled at the onset of winter. The weir project was discontinued along with the sonar project after the 1996 season.

Toklat River Radio Telemetry (1997)

A radio telemetry feasibility study was conducted on the Toklat River during September and October of 1997 (Holder and Fair 2002). 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 9-28. Originally, all radio tags were to be deployed internally but problems with tag retention resulted in modifying 100 of the 123 tags to an external application. Fish locations were successfully tracked using radio telemetry equipment by boat, a stationary remote tracking station, aerial surveys, and spawning ground foot surveys.. 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%). A 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.

Toklat River Coded Wire Tagging (1992-1998)

The department initiated a pilot study in 1992 on the feasibility of taking fall chum salmon eggs from the Toklat River and rearing them at Clear Hatchery. This study was intended to evaluate the feasibility of conducting a large scale fall chum salmon restoration effort on Toklat River. 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.

After initiation of the project the motivation for conducting a large scale restoration effort decreased with improved escapements to the Toklat River. Spawning ground counts in 1994 and 1 995 were 2.3 and 1.7 times, respectively, above the BEG minimum of 33,000 fall chum salmon. The first adult returns from these releases would have been age-3 salmon in 1995. However no tag recovery effort was initiated due to the small number of age-3 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. Therefore, a tag recovery program was initiated in 1996, and continued through 1998 to evaluate the contribution, timing, and homing of fall chum salmon to the Toklat River in the proximal fisheries and to the spawning grounds. The study consisted of five fall chum salmon sampling components: 1) sampling catches in Districts 1-4, 2) sampling catches in Subdistrict 5-A, on the Yukon River immediately downstream of the Tanana River confluence and downstream of the village of Tanana, 3) sampling catches in Tanana River proper from Subdistrict 6-A fishery centered around the community of Manley, 4) sampling catches from the lower Toklat River coded wire recovery field camp, and 5) sampling catches on the Toklat River 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 17,939 fall chum salmon were randomly sampled and 90 were found to have their adipose fin missing. Of the 88 heads sent to the CWT lab for analysis, 57 were found to contain coded wire tags. In 1998, a total of 12,417 fall chum salmon were randomly sampled and 45 fish were found to have adipose clips and 34 of those contained coded wire tags.

The preliminary data analysis estimated 27%, 35%, and 13% of the fish caught in the Subdistrict 5-A test fish wheel in 1996, 1997, and 1998 respectively, were Toklat River fish. The analysis also estimated the fall chum salmon contribution to the Subdistrict 6-A fisheries was 31% in 1996 and 25% in 1998, in 1997 however the confidence intervals were too large to be useful based on low recoveries at the lower Toklat River recovery site.

Chatanika River Assessment (1980-2005)

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 (Stuby and Evenson 1998). A total of 149 Chinook salmon were captured, tagged, and released. During the recapture event, 159 Chinook salmon were examined for tags and secondary marks and 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 operated a salmon counting tower project during the summer season (approximately July 1 to August 7) to enumerate Chinook and chum salmon from 1998 through 2005 (Brase and Doxey 2006). High water affected counts most of the years (2000–2003 and 2005) and the project was discontinued. The highest tower count during the operating years included 2,444 Chinook salmon and 1,538 chum salmon in July 2004.

Chatanika River - Davidson Ditch Dam (2002)

The Davidson Ditch Diversion Dam is located approximately 1 mile below the junction of Faith and McManus Creeks near Mile 69 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 was a sheet pile structure approximately 100 feet (30 m) long and 4 feet (1.2 m) high and blocked the entire river channel. The flow diversion gates are inoperable and the overflow apron was 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 had trapped sediment behind it since its construction and was believed to be a barrier to upstream fish migration. Only two species of fish (Arctic grayling and sculpin) were 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. Funding was secured by US Fish and Wildlife Service and granted to Yukon River Drainage Fisheries Association to contract the work and the dam was removed in 2002, creating potentially

65 miles (105 km) of upstream fish habitat beyond the dam. After the dam was breached monitoring was conducted and Chinook salmon were observed using Faith Creek above the dam location for rearing in 2005 but no adult salmon have been observed beyond the dam location as monitored by nine years of aerial surveys.

DNR presentation on dam removal: www.rrnw.org/wp-content/uploads/Gross_Elaine.pdf

Wood Creek Adult and Juvenile Assessment (1981-1995)

Wood Creek flows into Glacier Creek which joins Julius Creek which flows into Seventeen mile Slough of the Nenana River. This system is located approximately 12 miles south of the community of Nenana. A weir was operated on Wood Creek from 1981–1989 and 1993–1995 counting primarily coho salmon and a few fall chum salmon. Egg takes were taken from this location and incubated at the Clear Hatchery, then marked and released in Foster Creek a tributary of Wood Creek. Subsequently growth studies were conducted between the hatchery releases and wild stocks (Raymond 1986). Ground surveys were conducted a few years prior to the weir. Helicopter surveys have been conducted for adult coho salmon since 1996 (VanHatten 1998) (Table X).

In 1977 and 1978 fall chum salmon eggs from the Delta River were incubated at the Clear Hatchery and released in Clear Creek which is also a tributary that flows 5 miles into Julius Creek adjacent to Wood Creek (Raymond 1981).

Chum Salmon Habitat and Productivity Research (1996-1997)

To address some of the limiting factors of chum salmon stocks, the U.S. Geological Survey, Biological Resources Division has undertaken intensive monitoring of 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 (Finn et al. 1998). The field research occurred in 1996 and 1997. Due to funding limitations, the study concentrated on sites on the Chena River and Bluff Cabin Slough to represent the summer and fall components of the chum salmon run. The projects resulted in developing successful approaches for estimating the number of eggs delivered to each study site and estimating the fry produced from those eggs. Comparisons to environmental conditions such as (mean water temperature, air temperatures and flow regimes) are needed to assess the winter severity controls to survival. This study attempted to estimate production at several intermediate life stages as well as within study site scale. Estimates from potential egg deposition (PED) to smolt survival, PED to actual egg deposition (AED), and AED to pre-emergent survival rates seamed attainable. The project evaluated the success of estimating intragravel survival through the eyed-egg stage within study site scale. Several years of data would be needed for evaluation of the relationship between survival and environmental factors and further funding of the project was not pursed.

6.3 Potential Future Projects and Areas of Concern

As of the date of publication, the following projects have been identified as contributing to the goals of this plan.

6.3.1 Drainagewide

Coho Salmon Radio Telemetry

Support for a large-scale coho salmon radio telemetry project exists between cooperators ADF&G, USFWS, TCC, BLM and YDFDA however funding for such a large project is difficult to secure. Tagging would occur based out of Russian Mission where the current infrastructure of remote tracking stations is already poised from the recent summer chum salmon project. Radio telemetry projects have occurred on Chinook and chum salmon but not on coho salmon within the Yukon River drainage.

Coho salmon migrate into the Tanana River drainage, within the Koyukuk River drainage with a stock ascending the Porcupine River. Coho salmon are harvested in subsistence, commercial, personal use and sport fisheries throughout the drainage. A Yukon River coho salmon management plan was established in 1999 and only one escapement goal exists within the drainage. A radio telemetry project would gain much needed and more detailed information on stock timing, distribution, and relative abundance to coho salmon spawning areas. Other research projects could be generated from the baseline data provided by this radio telemetry project.

Chinook and Coho Salmon Run Reconstruction

Run reconstructions have been conducted for summer chum salmon, fall chum salmon, and Canadian-origin Chinook salmon. Efforts are ongoing to develop a run reconstruction for the entire Yukon River Chinook salmon run (Alaskan and Canadian stocks combined) Additional studies and data on coho salmon is needed, such as the radio-telemetry program described previously, before development of a coho salmon run reconstruction could proceed.

Middle River Mainstem Sonar Salmon Enumeration

The Tanana Chiefs Conference and Yukon River Inter-Tribal Fish Commission plan to develop a mid-river sonar enumeration project to assess all species of Yukon River salmon. This mainstem project would provide additional inseason population and stock assessment data between the current sonar projects located near Pilot Station (river mile 119) and Eagle (river mile XXXX). Current plans for the sonar are focusing on the District 4 management section of the Yukon River, but could possibly change based on site feasibility surveys and input from the public. The project would have the potential to improve assessment information, specifically, on Tanana River and Canadian-origin stocks. Tanana Chiefs Conference and the Yukon River Inter-Tribal Fish Commission are seeking outside funding to support development and secure capital equipment.

Salmon Stock Identification

Fisheries managers have been seeking an inexpensive, timely, and accurate method for identifying stocks harvested in mixed stock fisheries. Advances in genetic stock identification have gone from post-season to inseason assessments of geographical fish groupings. Advancements in genetic markers continue and costs vary but have been decreasing. Continued development of an inexpensive, accurate, inseason method of identifying stocks could improve management of mixed stock fisheries.

Baseline genetic collections used to assess Canadian-origin stocks for Chinook and chum salmon have been pursued as a higher priority than coho salmon. A list of priority stocks for new collections and restocking of tissues is available from the ADF&G Genetics Conservation Laboratory. USFWS and ADF&G have also expanded genetic composition to include coho salmon

(Flannery and Wenburg 2016). Analysis of genetic samples taken from mixed stock fisheries is only as good as the ability to distinguish between stocks included in the genetic baseline, so it is important to have the best baseline coverage possible from the vast regions of the Yukon Area.

Another use for genetic stock identification has been for tracking Canadian-origin Chinook salmon juveniles as they rear in Alaskan waters; however, only a portion of the drainage has been covered (Daum and Flannery 2012).

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 research could improve salmon management decisions for Yukon River salmon stocks because much, if not all, quantitative salmon escapement information is evaluated based on current understanding of Yukon River salmon life history.

Pathogens and Parasites

Pacific Salmon species are affected by various pathogens and parasites throughout their lifecycle. Yukon River fishermen periodically observe salmon with abnormalities or other symptoms of infection or disease. Establishing a cause and effect relationship between a specific environmental condition, pathogen or parasite, and fish health is very difficult. Typically, these abnormalities are relatively rare. Fishermen are encouraged to contact state or federal agencies to relay their observations and seek information about the source or cause. Often fishermen are asked to take pictures for review or to submit the affected fish to local offices for further investigation by staff specializing in fish pathogens and parasites. A comprehensive list of diseases affecting fish can be found on the Parasites and Diseases section of the ADF&G website at the following link: http://www.adfg.alaska.gov/index.cfm?adfg=disease.diseaselist#fish

A common observation on Yukon River salmon are circular skin lesions and scars along the sides and bottom of their bodies. This is likely the result of lamprey that had been attached to the affected salmon during their marine life stage. Lamprey are a parasitic eel-like fish species that attach to the skin of various fish species and feed on their body fluids. It is unknown what effect lamprey have on Yukon River salmon mortality and production. Frequent observation of lamprey scars and lesions on otherwise healthy adult salmon on or near salmon spawning grounds indicates some salmon that are affected by lamprey can survive through adulthood to reproduce.

Another common observation on Yukon River salmon are sea lice. Sea lice are parasitic species of arthropod found attached near salmon fins and around the mouth and gills. They are a marine parasite and are most frequently observed on adult salmon that have recently transitioned from marine into fresh water during their spawning migration. Although sea lice do not typically kill the host fish, salmon infected by sea lice are more susceptible to fungus or bacterial infection around the affected areas that may result in premature mortality. Similar to lamprey, it is unknown what effect sea lice have on Yukon River salmon mortality and production.

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, marketability, and/or suitability for consumption. One abnormality which has cycled through Chinook salmon is a protozoan parasite which 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 protozoan parasite infection which has been identified in many species of marine and anadromous fishes. It is unclear if this parasite is one or several species. The 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 parasite occurs from "fish" to "fish". A simplistic description of the general 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* parasite as a "resting spore". As the healthy fish digests the infected food, the parasites become motile from the digesting flesh, and from the stomach they penetrate the intestinal barrier and enter the blood stream to infect the host organs and/or muscle. Low numbers of 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. Stress (high cortisol) and increased water temperatures were shown to accelerate *Ichthyophonus* infection (Okamoto et al. 1987; Perry et al. 2004).

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).

The JTC formed a subcommittee to gather information concerning *Ichthyophonus*. Prevalence of *Ichthyophonus* was tracked from 1999 through 2010 and was on the decline beginning in 2005 after a peak in 2003 (JTC 2011). The JTC recommends a trigger level of 25% prevalence be used to prioritize *Ichthyophonus* research within future R&E call for proposals. Two baseline sampling sites were discussed for continued monitoring, either Emmonak from ADF&G’s test fishery or Rapids test fishery operated by a local user. It was decided to use the Rapids site because the fish show more clinical signs that far into the migration however at this time the Rapids project is no longer operating so sampling may default to Emmonak.

Environmental Influences

Abnormal environmental conditions can be observed and documented, but in most cases the impacts on salmon populations and productivity can only be postulated since credible and defensible determinations of such impacts are extremely difficult to make. The size and remoteness of the Yukon River drainage presents logistical and fiscal challenges to comprehensive monitoring and documentation of environmental conditions. Most environmental monitoring programs tend to be localized in or near Yukon River communities in addition to collection of environmental data at various fisheries or other research and assessment programs operated throughout the drainage.

The Yukon River drainage is susceptible to many of the following environmental conditions which generally describe their potential impacts on salmon.

Below normal cold temperatures may reduce instream flows during the winter and lead to "freeze-down" where ice can penetrate the gravel and freeze eggs or alevins. If colder air temperatures lead to below normal water temperatures, it could delay the development of eggs or alevins.

Flood events may affect salmon in several ways. The paths of streams can be quickly altered by flood events that erode streambanks. Instream habitat can be altered by streambank scouring or sedimentation which may affect eggs and alevins in the streambed gravel or emergent fry. While these kinds of events may affect productivity of a single year class of salmon, they are not likely to result in long-term impacts on salmon productivity.

Low snow cover may cause impacts similar to extreme cold temperatures, where the lack of an insulating snow layer over frozen rivers may result in thicker ice formation and possible freeze-down events. Low snow cover may also result in lower water flow in the spring and early summer when melting snowpack typically increases instream flows at the time when salmon fry and smolt are outmigrating downstream. Lower flow during outmigration may reduce available habitat and make young salmon more vulnerable to predation.

Low tributary water flows during the summer may lead to crowding on the spawning beds. This can result in superimposition of spawning redds where subsequent spawners disturb or dig up redds and eggs that have already been deposited. High abundance and densities of spawning salmon during periods of low water flow and higher water temperatures can also lead to depleted dissolved oxygen and mortality events in extreme cases. In combination with extended periods of clear and warm weather, low tributary water flows may also result higher than normal water temperatures which can stress migrating or spawning adult salmon and result in mortality or reduced spawning success.

Earthquakes, while rare, have the potential to affect salmon in several ways. Earthquakes may cause mortality of developing eggs or alevins in streambed gravel by mechanical disturbance (Noerenberg and Ossiander 1964). There are some brief periods of egg development that are are very sensitive to disturbance. Significant shifting/shaking of streambed gravel may cause it to settle or compact resulting in eggs or alevins becoming crushed or trapped. In extreme cases, earthquakes also have the power to reshape entire landscapes and cause long-term disruptions to salmon habitats in many ways such as uplifting or subsidence, landslides, and disruptions to groundwater flow (Waller 1966).

Wildfires can affect salmon by increased runoff and sediment load from rainfall and snowmelt in areas where groundcover has been burned. Sedimentation/siltation can suffocate eggs and alevins that are incubating and rearing in streambed gravel and reduce the suitability of spawning habitats.

High water temperatures during salmon migration and spawning may cause mortality or reduced spawning success through heat stress of migrating adult salmon. It can also lead to higher prevalence of infections or parasites such as *ichthyophonus*. Warmer water can't hold as much dissolved oxygen which can also lead to localized mortality events. This can be exacerbated by low water flows, as described above.

Erosion is natural process that is always occurring, and water is the primary driver of erosion. Some erosion events may have detrimental effects on salmon populations. Permafrost loss from climate change can reduce soil stability making watersheds more vulnerable to erosion. Increased erosion and extreme erosion events can alter water courses, affect instream flow, and deposit additional sediment into spawning habitats. This may result in increased morality of developing eggs or reduce the suitability of spawning habitats in the long-term.

Beaver dams can have both positive and negative effects on salmon populations. Beaver dams may create barriers that prevent adult salmon from reaching spawning areas or block the downstream migration of fry and smolt. However, beaver dams can also create productive rearing habitat for young sockeye, Chinook, or coho salmon which spend a year or more in fresh water before migrating out to sea.

Development and Human Impacts

Urban and Rural development

Sewer and Landfill Maintenance.

Although not a significant threat at present, concern has been expressed over potential future problems with waste disposal and landfill maintenance. The population has steadily grown in the region along with associated waste. Low-lying villages along with local soil conditions can 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 built on higher ground and rockier soils have better 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, solvents and refrigerants. The RPT has previously noted that there is inadequate public education about proper disposal or storage methods. The Lower Yukon Economic Development Commission has explored options to have hazardous materials shipped out on backhauls of transportation and fuel barges.

Chena River Urban Development

Although quite healthy when compared to other urban river systems, the Chena River could 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. In Big Delta Alaska a unique environment of upwelling ground water which persists on the left bank and supports in particular fall chum and coho spawning. The land has subsurface waters flowing north towards the Tanana River however the Tanana River erodes the existing banks during its normal meandering in doing so spawning habitat is created.

There continues to be bank hardening projects that are detrimental to known salmon spawning and rearing areas in order to save property. Mitigation for loss of spawning habitat due to urbanization is slow to date.

Industrial Development

Timber Harvest

Over the past 120 years, or the time it takes to grow a large white spruce tree in interior of Alaska, Yukon River Basin timber harvest amounts and locations have shifted. During the Klondike gold rush, steamboats on the Yukon River used large amounts of wood harvested from the adjacent riverside forests. In 1900, more than 50 steamboats operated on the Yukon River. The boats consumed one to five cords of wood an hour. A round trip between St. Michael and Dawson cost approximately $15,000 in wood (1,500 cords per trip). Wood was used to build and heat businesses, cabins and homes throughout the Yukon River Basin. Although comparatively large to present day riverside harvests, most of associated timber harvests of that era (1890-1910) were concentrated where steamboats could travel to villages/town (larger rivers were where steamboats could haul freight nearest to gold mining areas), thus generally, not effecting salmon spawning and rearing streams. On the other hand, mining operations of that period were commonly located in the upper reaches and tributaries of alluvial streams, where adult salmon spawn and juvenile salmon rear. To build and fuel these mining operations, timber was harvested adjacent to those salmon streams and likely had significant negative effects on the associated forests, stream conditions, and salmon.

After the wood burning steamship era, small scale harvest of primarily white spruce for home heating and house logs continued at a small scale in the middle and upper Yukon basin. Power generation switched to coal and gas/diesel for fuel, greatly lowering timber harvests. Lower Yukon River Basin villages have and continue to collect much or all of their wood needs from trees drifting down from the middle and upper Yukon River riparian forests, commonly white spruce trees. In most Yukon River villages, a few private individuals do own and operate small sawmills on an as needed basis. Over the past decade, several larger villages have installed commercial grade wood burning boilers for local school and village building use. Most of these timber harvests are from uplands or have stream buffer set-backs, thus not likely effecting salmon spawning and rearing streams.

Timber Harvest in the Tanana Valley (2018). Small to medium sized commercial logging operations have been in existence for many years within this drainage. The largest wood products facility, Northland Wood in Fairbanks, has been in business for 50 years and produces 2-3 million board feet of finished product per year. Most of the harvests have been on state lands within the Tanana Valley State Forest. The primary markets for this timber are local house logs, dried planed lumber, rough-cut lumber, firewood and biomass for wood pellet production.

In the upper Tanana River drainage, the ten-year average for state forest logging is approximately 1.1 million board feet per year. A rough estimate is that 1 acre of land produces 10,000 board feet. Approximately 90,000 board feet per year, during the past 10 years, has been taking place on Tetlin Village Corporation land. The logging in the Tetlin area has been primarily on upland areas. On state lands, logging is evenly split between upland and floodplain sites.

On state forest land, downriver from approximately Johnson slough (western boundary of the Tok Management Area) and extending below Nenana to the Soldier Slough area, annual harvest activity averages 9 million board feet per year evenly split between upland and floodplain sites.

Logging of approximately 100,000 board feet (10 acres) per year during the past 10 years has been taking place on Nenana Village Corporation lands. Approximately 10% has been within the Tanana River flood plain and the remaining 90% has been in upland areas.

Timber Harvest in the mid/upper Yukon River (Galena to Eagle) (2018). Limited logging of white spruce has been taking place in the Upper Yukon Area above and below the Dalton Highway Yukon River bridge for many 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, three communities have increased operations with the installation of biomass wood fired boilers. The village of Fort Yukon is in the process of installing a centralized chip fed wood fired boiler. It is expected to be operational in 2018-19. Total wood harvest would be approximately 30 acres per year, targeting floodplain white spruce and balsam poplar stands on Native corporation lands near the village. Harvests of this commercial size requires an Alaska Forest Resources & Practices Act (FRPA) notification jointly reviewed by the Division of Forestry, Dept. of Environmental Conservation and ADF&G. The village of Tanana installed a series of Garn solid wood fired boilers, harvesting approximately 250 cords per year of driftwood logs out of the Yukon River. Currently, the community is utilizing birch and spruce right of way timber harvested for the extension of the Tofty Road. The third community is Galena which has installed a chip fired boiler similar to the one at Fort Yukon. Approximately 30 acres per year of floodplain white spruce, birch and balsam poplar is harvested on Native corporation lands. Future harvest will take place on adjacent state-owned lands. FRPA notification is required for the Native corporation land harvests.

Mining

The Yukon River Basin, with particular emphasis on its tributary rivers and streams, has been the source of much mineral wealth, primarily gold. Mining activity has occurred in and around most all rivers and creeks in the Yukon River Basin (Higgs, 1995). From the later 1880s to the present, more than forty million troy ounces of gold have been removed from the Yukon River Basin in Alaska. Production peaked in 1909, shortly before the pickaxe and shovel stampers had mined out the easy pickings thus forcing the industry to shift to deeper and low-grade deposits requiring larger machines (e.g. hydraulic giants, dredges, drag lines) and large investments. Production started to increase again in 1923, after the Alaska Railroad from the Port of Seward to Fairbanks was opened, dramatically lowering transportation and production costs and enabling the introduction of new and larger mining equipment (e.g. bigger dredges, hydraulic giants, drag lines, engines), similar to the effect on upper Yukon River mining operations when the White Pass Railroad from Skagway to Whitehorse opened in 1900.

"The major rivers in the Alaska portion of the Yukon River drainage important to salmon production include the Andreafsky, Atchuelinguk, Anvik, Innoko, Kaltag, Nulato, Rodo, Tozitna, Gisasa, Hogatza, Alatna, Koyukuk, Chandalar, Sheenjeck, Porcupine, Black, Fortymile (AWC delisted 2002), Tanana, Kantishna, Toklat, Tolovana, Chatanika, Salcha, Chena, Delta, Goodpaster and others. Numerous tributaries to these rivers contribute substantially to salmon production (Bergstrom et. al., 1996). Many of these same Yukon River tributaries have been and continue to be important to placer mining (Higgs, 1995)."

Similar to other Yukon River Basin mining areas, from 1924 through 1942, major dredging operations occurred in the Tanana River Basin in several salmon spawning rivers (e.g. Chena, Chatanika, Tolavana), though more common and successful in tributaries creeks to salmon spawning streams (e.g. Chena, Chatanika, Tolavana, Salcha, Goodpaster). Overall, more than 8 million troy ounces of gold were produced out of the Fairbanks area districts from 1880–1994.

One example of disruptive actions to salmon habitat occurred with construction of the 90-mile, "Davidson Ditch" in the 1920s, wherein the Chatanika River was dammed and water diverted for use in large-scale dredging activities. The diversion dam, dewatering the upper Chatanika River, prevented migration of adult Chinook salmon from reaching spawning habitat and juveniles from rearing areas below the dam site, and blocked all fish passage upstream of the dam as well. Diversion dams and water removal were a common practice because lack of water was a limiting factor for mining and sluicing gold from placer mining tailings. The Chatanika dam was removed in 2001 and juvenile Chinook salmon were found to occupy much of the newly available 65 miles of stream the following year. Historic and present mine tailings (silt), flushed into the Chatanika River from mining operations, continues to move down stream as observed in other mining areas.

Many other areas of the Tanana River Drainage have and continues to have placer and hard rock mining activity. The tributaries include, the Chena, Salcha, Delta, Chisana, Chatanika, and Goodpaster Rivers, and the Healy and Gold creeks. In the Lower Tanana River Drainage, extensive mining occurred in the Kantishna River drainage. In the Tofty area northwest of Manley Hot Springs, a large hard rock mine is being developed (Tower Hill's Money Knob prospect). The heavily mined Forty-mile River drainage was removed from the ADFG anadromous waters catalog in 2002.

Mining methods and mine tailings management effects on the salmon habitat has greatly improved over time. For the past 20 to 30 years, present mining operations have for the most part, not had a significant negative effect on salmon or salmon habitat. Though limited, there have been several historic mining areas rehabilitated (e.g. Nome Creek – BLM) and all present mines are required to reclaim as best they can. Alaska Statute 27.19.020 a reclamation standard as, "A mining operation shall be conducted in a manner that prevents unnecessary and undue degradation of land and water resources, and the mining operation shall be reclaimed as contemporaneously as practicable with the mining operation to leave the site in a stable condition"

Present day gold mining activities in the US Yukon River drainage include, numerous small independent placer mining operations (approximately 300-400), two large corporate hard-rock projects, Fort Knox and Pogo, and dozens of smaller hard rock mining efforts. The smaller placer and/or suction dredge operations are spread across the Yukon River Basin, tending to be small stream oriented.

Fort Knox Gold Mine is located on state and private lands, approximately 15 miles northeast of Fairbanks, in the upper headwaters of the Fish Creek Valley, a Chena River tributary. The project is an open-pit mine which started in 1996 and is anticipated to continue past 2025.

Pogo Mine is located on state land in the upper Goodpaster River drainage, about 38 miles northeast of Delta Junction, and 85 miles east-southeast of Fairbanks. In January of 2005 underground mine development began, resulting in the first gold pour in February of 2006. The deposit has currently yielded more than 3 million ounces of gold. Pogo is permitted to operate through 2019, but additional ore reserves have been located and mining will likely continue beyond 2025.

Suction dredging is a popular form of recovering gold from the numerous placer streams in Alaska. Various sizes of suction dredges are used, these vary from "recreational" models that utilize a 18HP or less motor, a 6 inches or smaller intake hose with a 1/8 inch intake screen to "commercial operations" with large, heavy dredges with 8 inch and 10 inch intake hoses, driven by powerful engines, and capable of processing large amounts of material in a single day. Recreational suction dredging does require permitting (ADFG habitat), but is allowed in salmon spawning areas May 15 through July 15, and longer when adjacent to salmon rearing habitat.

Current annual statewide gold production is near a million ounces worth about a billion dollars.

The amount of salmon habitat disrupted/lost due historic placer mining and associated activities in the Yukon River drainage would be difficult to impossible quantify. The scope of land area and stream miles disturbed or amount of tailing/waste material flushed downstream by mining operations is surely vast but poorly documented. Insufficient or no data on salmon populations numbers and locations were not collected prior to or during the majority of historic mining operations (pre-1980s). The first 75 years (1900 -1975) of mining in Alaska was pursued with little knowledge or regard for the environment, salmon or salmon habitat.

"Modern researchers have studied mining impacts on salmon habitat. Current placer mining techniques when designed and used properly can minimize these impacts. Past (pre-1980s) or previously unregulated mining practices may have contributed significantly to negative impacts on the environment. Any mining practice that involved overburden removal or sluicing would contribute to periodic siltation and turbidity in many salmon streams. However, more notable impacts could come from large-scale operations of draglines, scrapers, hydraulicking, and dredging (Higgs, 1995).

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. Land surrounding Nenana has been designated for agricultural use, but to date no significant agricultural development has occurred. 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. High water events could also cause heavy siltation and streambank erosion.

Boat Use

The RPT expressed interest and concern for boat use and potential impacts on salmon. Concerns include potential impacts on salmon migration and spawning beds and potential impacts to riverine habitat from bank erosion caused by wake action or pollution.

Reconnaissance of Small Tributaries Throughout the Basin

Due to the vast size and remoteness of the Yukon River drainage, the department has historically 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 Chinook, chum, and coho salmon production. Documenting use in these smaller tributaries by juvenile and adult salmon is important for maintaining these habitats for salmon use and assessing their contribution to overall salmon production.

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 previously identified by the RPT included waste water, village garbage dumps, and petroleum spills or leakage. Turbidity caused by excessive sediment discharge from mining operations degrades water quality and spawning habitat. Additionally, fuel spills, other hazardous materials, and sewage problems associated with mining or other industrial operations 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. The RPT previously suggested investigating 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 mainstem 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 affect 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 has 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[25,26]. These contaminants accumulate in certain tissues or organs of fish and affect the health of the fish or of people or other animals that 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 was observed in salmon tissue.

The Alaska Department of Environmental Conservation (DEC), in conjunction with the Alaska Department of Health and Social Services and other state, federal, and international agencies, continues testing of Alaska seafood for any potential impacts resulting from the 2011 Fukushima nuclear disaster in Japan. Testing performed 2014–2016 showed no detectable levels of Fukushima-related radionuclides thereby confirming the quality and health of Alaska seafood has not been impacted by the nuclear disaster[27].

Marine Interceptions

The vulnerability of Yukon River salmon stocks to marine interceptions is informed by knowledge of overall distribution and migration patterns of these stocks during their marine residence. While marine-derived data for Yukon River salmon have been limited, conceptual models of Yukon River salmon marine migration and distribution patterns have been developed from decades of tagging studies, scale pattern analysis and genetic stock composition for pink, chum, Chinook, and coho salmon (Myers et al. 2009; Myers et al. 2010). Pink salmon emigrate from the Yukon River in their first year, rear in nearshore waters of the eastern Bering Sea during their first summer at sea, overwinter in the North Pacific Ocean and Gulf of Alaska, return the following spring/summer to the Bering Sea, and spawn in the Yukon River that summer. Fall and summer runs of Yukon River chum salmon emigrate from the river in their first year, rear in nearshore waters of the eastern Bering Sea during their first summer at sea, spend 2–4 years as immatures in the North Pacific

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[25] Alaska Department of Environmental Conservation, Office of the State Veterinarian. Fish Monitoring Program. Total Mercury in Alaska's Fish 2001–2016. Available from: http://dec.alaska.gov/eh/docs/vet/fish/metalsresults/totalmercuryinalaskanfish.pdf. (accessed May 25, 2017).

[26] Alaska Department of Environmental Conservation, Office of the State Veterinarian. Contaminants in Alaska's Fish. Available from: http://dec.alaska.gov/eh/vet/FMP.html. (accessed May 25, 2017).

[27] Alaska Department of Environmental Conservation, Division of Environmental Health. Fukushima Radiation Concerns in Alaska. Available from: http://dec.alaska.gov/eh/Radiation/index.html (accessed May 25, 2017).

Ocean and Gulf of Alaska, migrate back through the Bering Sea in the spring/summer they mature, and spawn in natal tributaries. Chinook salmon emigrate typically in their second year (though first and third year smolt are present in small proportions), rear in nearshore waters of the eastern Bering Sea during their first summer at sea, spend their marine residency as immatures in the Bering Sea (1–6 years), and then return to the river to spawn when they mature. Coho salmon emigrate typically in their third year (though other freshwater life history patterns appear in small proportions), rear in nearshore waters of the eastern Bering Sea during their first summer at sea, overwinter in the North Pacific Ocean and Gulf of Alaska, return to the Bering Sea the following summer, and migrate into the Yukon River tributaries to spawn the same year. Consequently, Yukon River Chinook salmon could be vulnerable to marine interceptions in Bering Sea/Aleutian Islands fisheries, while other Yukon salmon species may be vulnerable to fisheries in the Bering Sea/ Aleutian Islands, North Pacific Ocean and Gulf of Alaska.

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. In order of decreasing salmon harvest they were: 1) Japanese high-seas mothership and land-based salmon gillnet fisheries; 2) high-seas squid gillnet fisheries in the North Pacific Ocean of Japan, the Republic of Korea, and the Republic of China (Taiwan); 3) foreign groundfish fisheries of the Bering Sea and Gulf of Alaska; 4) joint- venture groundfish fisheries of the Bering Sea and the Gulf of Alaska; and 5) the groundfish trawl fishery by many nations in international waters of the Bering Sea (the "Doughnut Hole").

Other marine commercial fisheries operate in the Bering Sea/Aleutian Islands and North Pacific/Gulf of Alaska where Yukon River salmon occur. Those that catch few if any salmon include: 1) U.S. longline fisheries for Pacific halibut, Pacific cod, and other groundfish; 2) U.S. pot fisheries for Pacific cod and other groundfish, and Dungeness, king, and Tanner crab; and 3) U.S. purse seine and gillnet fisheries for Pacific herring (JTC, 1993). Notable marine fisheries that catch salmon and potentially Yukon River stocks include: 1) salmon fisheries in the South Alaska Peninsula (known as Area M), 2) U.S. groundfish trawl fisheries in the Gulf of Alaska and 3) U.S. groundfish trawl fisheries in the Bering Sea/Aleutian Islands.

Chum salmon harvested 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. Decades of research using a variety of methods have attempted to clarify the contribution of Western Alaskan stocks to chum salmon harvested in the Area M fishery, all with considerable limitations in the data resolution provided and caveats associated with study design. Eventually, genetic stock identification (GSI) studies provided an accurate picture of stock composition, although stocks from different streams were often pooled together due to genetic similarity.

An initial GSI analysis (1993–1996) of June Area M chum salmon harvest identified the Northwest Alaska reporting group as predominant. The Northwest Alaska reporting group included Yukon River summer, Kotzebue Sound, Norton Sound, Kuskokwim River, Bristol Bay and North Alaska Peninsula chum salmon stocks. This reporting group was estimated to annually contribute from 38% to 60% in the Shumigan Islands and South Unimak fisheries combined (Seeb et al. 1997). The Yukon River fall chum salmon stock complex comprised a small component or were absent in the chum salmon harvest samples collected from the Area M June fishery.

This previous GSI study was followed by a comprehensive program to sample commercial and subsistence chum and sockeye salmon fisheries in marine and coastal areas of Western Alaska, known as the Western Alaska Salmon Stock Identification Program (WASSIP). WASSIP was unprecedented in its magnitude and scope to address concerns for stock of origin in fisheries like Area M, and included genetic stock composition data from 2007 through 2009. Genetic stock discrimination allowed for modest refinement of reporting groups, though summer Yukon River stocks were still grouped with other Coastal Western Alaska (CWAK) stocks from Norton Sound, Kuskokwim River, and Bristol Bay. WASSIP distinguished Yukon fall chum salmon as a distinct reporting group named Upper Yukon. For the Area M June fishery, the CWAK reporting group was dominant in the catch, representing approximately 52–61%, while the Upper Yukon reporting group represented <1–2%. In the Area M post-June fishery, CWAK represented 2–4% of the catch while Upper Yukon represented 0%. Despite the large percent of the June fishery containing CWAK chum salmon stocks, the actual harvest rate estimated by the study was quite small at 2–7% for CWAK. The harvest rate estimated for Upper Yukon was <1% for the June fishery. Low harvest rates identified for CWAK stocks underline the large total magnitude of CWAK population. It should also be noted that the Yukon River summer chum salmon harvest would be expected to be a fraction of the total CWAK harvest given the large populations of summer chum salmon in Norton Sound, Kuskokwim River, and Bristol Bay. The general conclusion of this comprehensive study indicated that though Yukon River chum salmon are harvested in the Area M fishery, the impact was small during study years. (Munro et al. 2012)

The two other notable marine fisheries that catch salmon are the U.S. groundfish trawl fisheries in the Gulf of Alaska (GOA) and the Bering Sea/Aleutian Islands (BSAI), which primarily target pollock and cod. The North Pacific Fishery Management Council (NPFMC) develops recommendations for fishery regulations and the National Marine Fisheries Service (NMFS) manages both fisheries. In both of these fisheries salmon are regulated as a prohibited species that are caught as bycatch and cannot be sold. Salmon are identified in these fisheries as Chinook and non-Chinook salmon, though the non-Chinook salmon category is approximately 99.6% chum salmon. Since the vast majority of non-Chinook salmon bycatch is comprised of chum salmon, for the purposes of this report it will be referred to as chum salmon bycatch.

Salmon bycatch is generally larger in the BSAI compared to the GOA groundfish fishery, particularly for chum salmon and for historical catches of Chinook salmon. The most recent 10-year average (2007–2016) Chinook and chum salmon bycatch in the GOA groundfish fishery were approximately 24,000 and 2,500 respectively. The most recent 10-year average (2007–2016) Chinook and chum salmon bycatch in the BSAI fishery were approximately 31,100 and 133,300 respectively. Noteworthy large salmon bycatch in the GOA groundfish fishery included 54,700 Chinook salmon in 2010 and 9,500 chum salmon in 2003. Noteworthy large salmon bycatch in the BSAI groundfish fishery included 130,000 Chinook salmon in 2007 and 715,600 chum salmon in 2005.

As would be expected based on marine migration patterns, genetic analyses of GOA salmon bycatch revealed essentially no Yukon Chinook salmon and very few Western Alaska summer (2–3%) and Yukon River Fall (<1%) chum salmon (Guthrie et al. 2016 and 2017a; Kondzela et al. 2016 and 2017), yet western Alaskan origin salmon made up a significant contribution to the BSAI salmon bycatch. From 2011–2015 BSAI chum salmon bycatch included 14–18% Coastal Western Alaska stocks (Yukon summer run, Norton Sound, Kuskokwim, and Bristol Bay stocks combined), and 2–9% Yukon River fall run stocks (Kondzela et al. 2016 and 2017). Typically, the vast majority of BSAI chum salmon bycatch are of Asian origin. During the same years BSAI Chinook salmon bycatch included 40–68% Coastal Western Alaska stocks (lower Yukon River, Norton Sound, Kuskokwim, and Bristol Bay stocks combined), 1–3% middle Yukon River Stocks, and 2–5% Canadian Yukon River stocks (Guthrie et al. 2017b). Though about half or more of the BSAI Chinook salmon bycatch were of Western Alaskan origin, the overall impact of this harvest was relatively small when considered in relation to population size and natural mortality occurring prior to spawning migrations. It has been estimated that the impact rate of BSAI groundfish bycatch on the Coastal Western Alaska and Canadian Yukon River Chinook salmon stocks averaged <3% and <2%, respectively, from 1991–2012 (peak annual impact was 7.5% and 4% respectively (Ianelli and Stram 2015)).

A variety of regulatory measures have been used to limit salmon bycatch in the GOA and BSAI groundfish fisheries. Escalating numbers of Chinook salmon captured as bycatch in the BSAI pollock fishery in 2006 and 2007, which led to the peak impact rates of 7.5% and 4% for Coastal Western Alaska and Canadian Yukon stocks respectively, prompted further review of alternative management measures used to limit the bycatch of Chinook salmon (NMFS 2009a; NMFS 2009b). Following these reviews, the NPFMC recommended Amendment 91 (https://alaskafisheries.noaa.gov/rules-notices/search) be added to the BSAI Groundfish Fisheries Management Plan for the Bering Sea pollock fishery. Amendment 91 was implemented by NMFS during the 2011 fishing season and established a bycatch hard-cap of 60,000 Chinook salmon and a performance cap of 47,591 Chinook salmon for vessels participating in a bycatch Incentive Plan Agreements (IPA). Under Amendment 91, Chinook salmon bycatch quotas are allocated to each season and sector of the fishery based on the bycatch cap, historical Chinook salmon bycatch, and pollock harvest allocations. Sectors that exceed their proportion of the performance cap in any three years of a 7 consecutive year period will have their hard cap permanently reduced to their proportion of the performance cap. Amendment 110 was added in 2016 to provide additional Chinook salmon bycatch avoidance measures, particularly during periods of low abundance of western Alaska Chinook salmon. Among other modifications, amendment 110 lowered the 60,000 hard cap for Chinook salmon bycatch to 45,000 and lowered the 47,591 performance cap to 33,318 following years when the combined in-river run size of Unalakleet, Upper Yukon, and Kuskokwim River stock groups fall below 250,000 fish.

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).

Even after snowmachines became the dominant use for transportation dog teams were maintained to support activities such as general transportation, trapping, wood and water hauling, and racing. Between 1991 and 2008 the number of sled dogs and the number of people involved in dog mushing in rural Yukon River communities has declined by more than 50% (Andersen and Scott 2010). Data on the use of dogs show a general increase in the use of dogs for sprint racing in 2008 compared to 1991, and an overall decrease in the use of dogs for utilitarian purposes such as trap line transportation.

From 1998-2015, estimates of dog populations in 32 rural Yukon River drainage communities have averaged about 5,000 dogs. There are regional differences between the lower and upper Yukon Areas with respect to dogs. There is more prevalence of sled dogs including larger numbers per kennel in the Upper Yukon Area than in the Lower Yukon Area. Declines in numbers of dogs are most drastic in the Upper Yukon Area and fairly stable for the Lower Yukon Area.

When salmon resources are abundant, most people do not voice opposition to the accepted subsistence use of feeding salmon to dogs. However, during years when salmon abundance is limited and only provides for limited commercial fishing or is inadequate for all subsistence uses, people have voiced opposition to feeding salmon to dogs, saying human subsistence needs should be met before salmon are fed to dogs. This concern is highest for Chinook salmon harvested for subsistence use. The Alaska Board of Fisheries (BOF) addressed this issue multiple times through the 1990's. After taking no action initially, a policy statement was adopted into regulation stating Chinook salmon harvested for subsistence were to be used primarily for human consumption; however, concern about feeding Chinook salmon to dogs remained. In 2001 the BOF adopted regulations that prohibited targeting Chinook salmon for dog food and prohibited feeding dried Chinook salmon to dogs, with the exceptions that whole fish unfit for human consumption, Chinook salmon scraps, and Chinook salmon under 16-inches in length may be fed to dogs. Additionally, after July 10 in the Koyukuk River drainage, July 20 in the Tanana River drainage, and August 10 in Subdistrict 5-D upstream if Circle City, Chinook salmon taken incidental to chum salmon subsistence fishing may be fed to dogs.

6.3.2 Coastal

There are no potential future projects described for the Coastal District

6.3.3 District 1

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 pink salmon go relatively unused for subsistence is that Chinook and summer chum salmon are larger, easier to catch and process, and most importantly of all, richer and better tasting than pink salmon. Pink salmon 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 pink salmon for human consumption, while small numbers are cut and dried for use as dog food by some lower Yukon River fishermen.

Pink salmon returns to the Yukon River, have a distinct even-year vs. odd-year abundance pattern. In even-numbered years (2010, 2012, 2014, 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, the west and east forks of the Andreafsky River, and are documented as spawning in the Anvik River as well.

Pink salmon spawning abundance is poorly documented. Pink salmon returns are enumerated by the USFWS weir located 22 miles up the east fork of the Andreafsky River. This project documented annual counts of 74,682 and 58,995 pink salmon in 2012 and 2014, respectively. The mid-point of the pink salmon passage at the weir is July 18 from 1986–2015 (excluding 2001). These counts however must be considered very conservative estimates because weir picket spacing allows large numbers of smaller pink salmon to pass through the weir uncounted. Pink salmon counts in 2013 and 2015 were 589 and 783 respectively. Although substantial runs in their own right, Yukon River pink salmon returns have never generated much processor interest.

In January 2016 the Board of Fisheries adopted a pink salmon management plan for the Yukon River. The plan provides for commercial harvest of Yukon River pink salmon during even year pink runs based on inseason run assessment information. It establishes a pink salmon commercial fishing season from June 15 through July 31 using gillnets with 4.75-inch or less mesh size. It directs the department to provide for commercial pink salmon harvest opportunity provided pink salmon abundance is adequate to provide for subsistence and other uses and summer chum salmon escapement goals will be achieved. To date no directed pink salmon commercial harvest has been taken under the plan with a pink salmon commercial harvest in 2016 of 4,501 taken incidental to chum salmon directed commercial fishing.

6.3.4 District 2

Atchuelinguk (Chulinak) River Assessment

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 mainstem Yukon 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 was noted as a concern in 1998 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 population 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. It is generally accepted that populations are not as substantial as the nearby Andreafsky River. Aerial surveys were recommended to be conducted during peak salmon spawning times, and if further investigation is warranted, a tower or weir may be operated for a few years to determine the magnitude of Chinook, summer chum and possibly coho salmon escapements. Aerial surveys were subsequently conducted in 2011, 2012 and 2015. The highest counts observed in 2015 included 423 Chinook, 2,608 summer chum salmon and an unspecified number of pink salmon.

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. Appendix I20 contains a list of Yukon area salmon processors and buyers. No sales of fish in the round have occurred in District 3 since 1995. In 1998 there remained a buyer (Maserculiq Fish Processors-MFP) in the upper half of District 2 in the vicinity of Marshall. The buyer (Boreal Fisheries) based near Pitka's Point just below St. Mary's retired in 2017 and a new buyer (Fish People) initiated limited operations out of St Mary's late in the 2017 season. Because of transportation costs, volatility of the markets and the reduced quality of fish as they migrate up river most of the buying power exists in District 1 where there is currently only one buyer (Yukon Delta Fish Marketing Co-op). This is also reduced from three major buyers present in 1998.

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 fishermen have 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:

Table 6.1.–Average number of individual CFEC permits fished in Districts 1, 2, and 3, in five year increments, from 1990–2014.

5-year Averages	District 1	District 2	District 3	Total
1990–1994	451	256	17	676
1995–1999	444	232	3	641
2000–2004	357	217	0	552
2005–2009	335	214	2	517
2010–2014	272	204	0	455

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 processor capacity continues to erode, it may become more difficult for the remaining operations to continue.

6.3.5 District 3

Innoko River Assessment

The Innoko River primarily enters the Yukon River at river mile 274 below the village of Holy Cross, 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 1900's 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 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 less extensive and less disruptive to salmon habitat. If current levels of environmental monitoring and enforcement are maintained, this activity should not threaten salmon stocks.

Very little information is available 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 survey was conducted by the USFWS 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, California and Tolstoi creeks (USFWS trip reports dated 8/19/96 and 7/23/97 by B. Flannery).

The information gap on salmon in the Innoko River should be investigated. The first step would be 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.

6.3.6 District 4

The majority of summer chum salmon spawning occurs within and downstream of the Koyukuk River. Assessing abundance and timing of Chinook and summer chum salmon utilizing the middle portion of the Yukon River sub-basin is important to ensure adequate escapement to sustain future runs.

Viability of Subdistrict 4-A Value Added Fishery

The longstanding market concern for Subdistrict 4-A fishermen is the lack of additional commercial salmon fisheries other than the summer chum salmon roe fishery. Chinook salmon do occur incidentally in the roe fishery, but the Chinook salmon roe is not mature and 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 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 eliminate potential 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.

A previous concern for this area was the lack of a commercial guideline harvest range (GHR) for fall chum and coho salmon. The BOF in 2001 provided for a fall chum salmon allocation by annexing Subdistrict 4-A into the existing GHR of Subdistrict 4-B and 4-C of 5,000–40,000 In 2004 the BOF amended the low end of the range to include zero. With the exception of 1979, harvests in Subdistricts 4-B and 4-C were well below their allocation, therefore establishing a District 4 GHR would least affect other district allocations. Since this time commercial openings in Subdistrict 4-A have only occurred in 2008 and 2012 with little harvest. Deterioration of local fishing gear after the roe markets were lost and rebuilding of markets has contributed to the lack of a commercial fishery in this region particularly in the fall season. Coho salmon guideline harvest ranges do not exists as their harvest is considered incidental during the fall chum salmon fishery and allocations during coho salmon directed harvests are based on time, not numbers of fish. No documented sales of coho salmon in Subdistrict 4-A have occurred.

Subdistrict 4-A fishermen would have to figure out how to catch fall chum and coho salmon for commercial sale. Traditionally, fall chum and coho salmon are harvested for subsistence with short drift gillnets on the left bank of the Yukon River. However, commercial fishing is only allowed with set gillnets or fish wheels, and good fishing sites for these gear types are generally limited to the right bank. Therefore, fishermen would have to adjust their fishing pattern to comply with commercial regulations. Local knowledge suggested that coho salmon migrate on the left bank. In consideration for coho salmon directed fishing in this area the Kaltag test fishery was developed to aide in testing the feasibility for directing harvests on coho salmon. Coho salmon represented a small proportion of the overall catch with the dominant species being fall chum salmon.

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 flesh. While this would certainly add value to the product, it would 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 right (north) and left (south) banks of the Yukon River mainstem, respectively. Commercial fishing is concentrated in and around the large village and former Air Force base of Galena and the smaller village of Ruby. The fishery once had markets for both roe and fish in the round from all four salmon species. However, their fishery continued to erode 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 regardless of species. Fishing and processing operations in rural western Alaska, including the Yukon Area, have always been low volume operations relative to other areas of the state. The tremendous growth worldwide of farmed and hatchery salmon production coupled with Alaska's 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 are generally more expensive than the competition in wholesale markets.

Although Galena and Ruby fishermen have a summer and fall season fishery, given current market conditions their low volume harvest guidelines limit fishermen and processors. This has led 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 season and they have had to ship product to Fairbanks by small plane since processors could not afford to operate tenders as in the past. Small amounts of commercial activity occurred in 1999 and 2003. The last commercial openings in Subdistricts 4-B and 4-C was in 2005, which was record fall chum salmon year, but zero commercial harvest occurred in this area.

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 to begin mining on Bear Creek, which flows into Caribou Creek, a tributary of the lower Hogatza River. A 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. 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 salmon (live and dead) in the Clear Creek drainage as compared to 10,562 (live/dead) in the Caribou Creek drainage. This aerial survey also documented low numbers of salmon spawning in Caribou Creek below Bear Creek (leading to concerns 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.

Ambler Road

The Ambler Road project is a proposed 211-mile roadway extending from the Dalton Highway west along the southern edge of the Brooks Range and ending on the south bank of the Ambler River. The road is designed to be an industrial access road to the Ambler Mining District, providing surface transportation for the purposes of increased exploration, mine development, and mine operations. It is proposed as a controlled access road for industrial and commercial traffic. The road will cross both BLM and NPS lands, and two proposed alignments are being considered for crossing the Gates of the Arctic National Park and Preserve. The proposed routes were chosen, in part, to limit crossings to narrow flood plains when possible, and would require 29 bridges and a number of culverts. Waterway crossings include the Koyukuk River, Wild River, John River, E.F. Henshaw Creek, Alatna River, S.F. Bedrock Creek, Kogoluktuk River, Square Creek, Halfman Creek, Huffman Creek, Mauneluk River, Coal Creek, Krumpet Creek, Beaver Creek, Reed River, Kobuk River, Ambler River, Shungnak River, Ruby Creek, and a number of unnamed streams. There are 9 communities which are located within 100 miles of the proposed road development: Bettles, Evanville, Alatna, Allakaket, Ambler, Shungnak, Kobuk, Hughes, and Huslia. These Koyukuk River and Upper Kobuk River communities are reliant upon fish species, especially salmon; recent information on the harvest composition and per capita harvest levels is available for each community.

Harvest levels vary from year to year depending on a variety of factors, including weather, resource abundance, and regulations, among other reasons; however, household harvest data provide a good index of the role of different resources in subsistence economies. Harvest information for the 2011 study year exists for the Koyukuk River communities of Bettles, Evansville, Alatna, and Allakaket. Bettles and Evansville residents harvested between 4 lb and 7 lb of salmon per person; salmon accounted for up to 14% of the total subsistence harvest by these residents. In Alatna and Allakaket, harvests were even greater—27 lb and 152 lb of salmon per capita, composing 10 to 29% of the total subsistence harvest. In 2014, Hughes residents harvested 157 lb of salmon per person, accounting for 44% of the total estimated harvest. The upper Kobuk River communities of Ambler, Shungnak, and Kobuk were surveyed for the 2012 study year. Fish species collectively accounted for over one-third of Ambler's total estimated harvest of wild resources, including 33 lb of salmon per person. During the same year, Shungnak residents harvested 56 lb of salmon species per capita, accounting for 15% of the total subsistence harvest. In Kobuk, fishers harvested 92 lb of salmon per capita. Fish collectively composed over one-half of the total estimated harvest, with salmon contributing 30% of the total estimated harvest.

6.3.7 District 5

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).

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-l 970s 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) reported 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.

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 this system is producing salmon at lower levels than prior to gold mining activities.

Potential projects include; stock restoration, riparian enhancement, channel and floodplain modification, and fish habitat structures.

Timber Harvest

Limited logging of white spruce has been taking place in the Upper Yukon 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.

Viability of District 5 Commercial Salmon Fishery.

The commercial fishery in District 5 used to have both a summer and fall season fishery, with most recent year commercial activity limited to the fall season. Chinook salmon in July and fall chum salmon in August and September were the targeted species although summer season harvest has not occurred in this area since 2008. However, summer chum and coho salmon are primarily 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 (left bank) and in Subdistrict 5-B, the (right bank below the confluence of the Tanana River) and both banks of the Yukon River upstream to Garnet Island. Fishermen from Fairbanks, Tanana, Manley, and Nenana operate from fish camps along the Yukon River or from their villages and are serviced by processors in Manley, Nenana, and/or Fairbanks. Within District 5, these two Subdistricts contain the majority of commercial 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 commercial effort than Subdistricts 5-A and 5-B which is generally reflected by lower harvests. In recent years overall buying effort has waned as wholesale salmon and salmon roe prices have declined. Tender services have declined and fishermen often haul their catch up to the Dalton Highway Bridge to meet 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. Prior to the Chinook salmon decline and restrictions, only three fishermen were using their commercial permits in this area. No Chinook salmon have been sold from this area since the declines in the run size (2000-2001 and since 2004) and no fall chum salmon have been sold from the area since 1997.

District 5 fishermen have also registered as catcher-sellers with 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. This entrepreneurial spirit is to be commended, while 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 personal use, especially if tender support is lacking, which is another indicator of the low cash value of the fishery.

New or expanded markets in District 5 Chinook, summer chum, fall chum, and coho salmon commercial fisheries would be needed to increase commercial effort and interest. 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.

6.3.8 District 6

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 90th 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, personal use, 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 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 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; Lambert 1998). 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.

Chena River Woody Debris project

The forty-five miles of river downstream of the dam has been starved of thousands of trees since the dam was installed. The operation of the dam has also changed the character of the lower river causing barriers to fish passage into several sloughs as the river has become deeper and less braided. Also, a current/ongoing project is being done by the University of Alaska Fairbanks/USGS Cooperative Fish and Wildlife Research Unit to assess large woody debris in the Chena River and use by juvenile Chinook salmon a description of this project should be captured in this section or elsewhere. In the segment discussing Urban Development we would suggest the Chena River is adversely impacted by a variety of problems.

Nenana River Habitat Restoration project

Existing salmon stream is being flooded by a channel of 17 Mile Slough (Nenana River), a glacial fed system. A habitat restoration project would restore spawning habitat and spawning runs. Stream contains runs of chinook, coho, summer and fall chum salmon. The method to address the breeching of the salmon spawning drainage, by the glacial water would entail: A field engineered intrusion water blockage system consisting of locally available downed wood material (logs), wire, cable, reinforced visqueen and sand bags.

6.4 RPT Project Review Criteria

New projects being proposed for inclusion in the potential project list must conform to the Mission Goals and Strategies section of the plan describe in Section 4.2. Appendix C lists the project review criteria in detail. The highest priority projects are those that address depleted wild stocks or rehabilitating habitat. Creating new common property fisheries will be of a lower priority. Consideration of impacts to wild stocks will be given and may be grounds for not supporting proposals. Alaska policies on fish health, genetics, and socioeconomics will be fully considered. Consideration of alternative actions will be considered to amend or replace proposals. Sustainability of projects does not just refer to biological sustainability; it includes project sustainability or funding support. The intended life of a project will affect the feasibility of a project. Short-term projects could be feasible with one-time funding, but long-term projects will need long-term support.

Project proposals for inclusion in the CSP will be considered at the RPT annual meeting. They can be proposed by the general public, the Yukon River Drainage Fisheries Association, any other Yukon River fisheries representative user group, or ADF&G. Additionally, the RPT may see a need and generate a potential project plan at their meeting.

The RPT is guided by regulation in its review of PNP hatchery permit applications and permit alteration requests as described in Section 1.1.7. The other permit type the RPT is required to review is the hatchery site suitability Fish Resource Permit. The RPT has no authority regarding any other permit type; however, this does not preclude the RPT from providing input during a public review of another type of permitting.

The RPT will consider the following questions when project proposals are brought before it for review and recommendations:

1. Will the project make a significant contribution to the common-property fisheries?

The RPT will consider and make its recommendations on each species to be produced if there is a reasonable opportunity for common property harvest consistent with the average common property fishery exploitation rate for that species. For a site to be suitable for private nonprofit hatchery development there must be capability to generate common property harvest.

Considerations pertinent to determining the potential common property benefits include:

Does the application contain significant omissions or error in assumptions? If so, the use of more accurate assumptions might indicate decreased benefits to common property fisheries. Pertinent assumptions might include those relating to (1) interception (harvest) rates in common property fisheries and (2) survivals of green eggs to adults.

If returns cannot provide at significant common property benefit in the traditional fisheries, is there an adequate terminal area where new fisheries could be created for the desired common property benefit without endangering the wild stock?

If the application provides insufficient information for adequate RPT evaluation, the team will request additional information. If they conclude that basic production and harvest assumptions are not realistic, they will recommend that changes in the proposed projects be incorporated by the applicant.

2. Does the project allow for continued protection of wild stocks?

Any judgment as to the acceptability of impacts on natural stocks from an enhancement project should be made on the actual and potential size of the affected wild stocks, and also on the extent of benefits from enhancement and alternative enhancement opportunities in the area that may have less impact on natural stocks. Considerations include:

- Can management or harvest strategies be developed to allow harvest of enhanced returns while protecting natural stocks?
- Does the affected stock actually or potentially support a commercial, sport, personal use, and/or subsistence fishery?
- Does the affected stock have unique characteristics or are there special circumstances (e.g., a unique early run of coho)?
- Will resultant increases in the affected stock have a potential negative effect on another important stock (i.e. coho salmon juveniles are known to prey on juvenile pink and chum salmon, etc.)?

3. Is the project compatible with the Comprehensive Plan?

The goals and objectives of the Comprehensive Plan identify ongoing and proposed projects that are compatible with management strategies for the wild stocks. Thus, the goals, objectives, and recommendations contained in the plan provide a basis for evaluating all projects. The proposed project should also be compatible with management concerns and guidelines set forth in the plan and with specific recommendations concerning strategies and projects.

The RPT, in its recommendation to the commissioner, will take all of these factors into consideration in determining the project`s compatibility with the comprehensive plan.

4. Does the project make the most appropriate use of the site's potential?

A number of opportunities for restoration and enhancement projects exist in the Yukon River region. If the plan goals and objectives, as well as substantial public benefits, are to be achieved, enhancement and restoration projects must be developed to their fullest potential with appropriate species using the best available technology. In many instances, investigation will show one strategy to be more effective than others. Within a given strategy, it will be important that the proposed project will develop the site appropriately and to its full potential.

Given technical feasibility, the RPTs determination of the appropriate development of a site will be based on such factors as the magnitude of its water supply, harvest potentials, manageability, and potentials to address user needs. The applicant, in the application and presentation to the RPT, should demonstrate adequate plans for the site and the capabilities to carry them out. If the applicant does not show adequate planning and documentation, the RPT cannot judge the proposed project's ability to satisfy any criteria or determine whether the proposed project would result in public benefit. An applicant should demonstrate with documentation to the RPT an ability to develop the site properly and to its full potential. This documentation should include plans for implementation and full development of long- and short-term production goals and objectives, and an adequate description of plans for incubation and/or rearing.

6.5 RPT Recommendation

The RPT will formulate a recommendation based on its review of the application and forward it to the commissioner. The RPT's recommendation should not be construed as denoting the decision to be made by the commissioner. ADF&G staff, as well as interested members of the public, may also provide reviews and recommendations to the commissioner. The commissioner may uphold or reject the recommendations of the RPT after reviewing all the merits and potential problems associated with the proposal.

Since the RPT needs adequate review time prior to considering an application, it will generally require that applications and attendant materials be received by the RPT members at least 2 weeks before the meeting at which the application is to be considered. It may also request additional information during the initial review if information contained in the application is inadequate. A representative from the corporation making the application will be expected to make a presentation of the proposal at the RPT meeting.

Alaska statutes and regulations specifically grant the RPT an opportunity to review a permit suspension or revocation. However, revocation by the commissioner would occur only as a very last, unavoidable course of action. It is more desirable to identify problems early and attempt to remedy them. Existing procedures provide for an annual evaluation of operating projects. The annual report and/or AMP supplies information on the project's performance and RPT review of annual reports and/or AMPs may be considered part of ongoing planning duties. This departmental and RPT review allows for monitoring of project performance.

If ADF&G has determined that a project's performance is inadequate and that a permit suspension or revocation is being considered, the commissioner will notify the RPT, and the RPT will be provided with an opportunity to make a recommendation on the proposed action. In evaluating any PNP operation that is referred to the RPT by the commissioner, the RPT will use the specific performance criteria in their review, evaluation, and recommendation to the commissioner. The criteria are established in 5 AAC 40.860. The RPT, in this evaluation, will also consider any mitigating circumstances that were beyond the control of the project operators.

Contribution to the fisheries of the Yukon River region will be the ultimate measure of project performance; however, it is not easy to define this criterion in measurable terms or to delineate what actions should be taken if the criterion is not met. Furthermore, the buildup of production at any project may be slow, so that the ultimate success or failure may not be determined for many years. As experience with these restoration and rehabilitation projects is gained, the performance criteria should be reviewed and refined as needed. There is additional project review criteria for consideration in addition to those listed above.

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APPENDIX A: TERMS AND DEFINITIONS

Appendix A1.–Terms and definitions.

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 born in fresh water, migrate and feed at sea, and return to fresh water to spawn.
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 marine aquatic or intertidal habitat.
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 halibut and rockfish.
biomass	the combined weight of a group of organisms; for example, a school of herring.
broodstock	salmon contributing eggs and milt for supplemental culture purposes.
CF	Division of Commercial Fisheries
coded wire tag (CWT)	magnetically detectable pinhead-sized tag implanted in the nose of a young fish for identification as an adult.
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 CSP or other RPT product or recommendation.
comprehensive salmon plan	a statutorily mandated, strategic plan for perpetuation and increase of salmon resources on a regional basis.
conservative	use carefully, avoiding waste or negative change
criteria	accepted measures or rules for evaluation of programs, project proposals, and operations.
customary and traditional	The noncommercial, long-term, and consistent taking, use, and reliance upon fish in a specific area and the use patterns of that fish that have been established over a reasonable period of time taking into consideration the availability of the fish.

customary trade	The limited noncommercial exchange, for minimal amounts of cash, as restricted by the appropriate board, of fish resources.
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.
epilimnion	layer of water overlying the thermocline of a lake and subject to action of the wind.
escapement	salmon that pass through the fisheries to return upstream to a spawning ground or to be used as brood stock and cost recovery in a hatchery.
euphotic zone	constituting the upper layers of a body of water into which sufficient light penetrates to permit growth of green plants.
exvessel 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 4 baskets on a single axle and is driven by river current or other means.
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 RPT, 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, including water quality.
hatchery	facility in which people collect, fertilize, incubate, and rear fish under authority of an ADF&G issued hatchery permit.
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.
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.
mixed stock fishery	harvest of salmon at a location and time during which several stocks are intermingled. Harvest of more than 1 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).
otolith	calcified ear bones of fish that offer future environmental marking promise. Manipulation of water temperature can 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. Required status to hold a hatchery permit in Alaska.
present condition	average catch for the last 5 years.

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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.
Propagative research	
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)	AS 16.10.380. Statutorily authorized organization comprised of representatives of fisheries user groups organized for the purpose of enhancing salmon production.
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, fish culture, 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	Chinook (king) *Oncorhynchus tshawytscha* Chum (dog) *Oncorhynchus keta* Coho (silver) *Oncorhynchus kisutch* Pink (humpy or humpback) *Oncorhynchus gorbuscha* Sockeye (red) *Oncorhynchus nerka*

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salmon stock	population of salmon identified with a specific water system, or portion thereof. Salmon of a single species that are produced from a single geographic location and are of the same genetic origin.
seine (purse)	a floating net designed to surround fish that can be closed at the bottom by means of a free-running line through 1 or more rings attached to the lead line.
seine (beach)	a floating net designed to surround fish that is set from and hauled to the beach.
seine (hand purse)	floating net designed to surround fish that can be closed at the bottom by pursing the lead line; pursing may only be done by hand power, and a free-running line through 1 or more rings attached to the lead line is not allowed.
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 schools of 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.
supplemental production	salmon produced by method other than natural spawning using enhancement and/or rehabilitation methods.

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terminal fishery	area where a terminal fishery harvest could be conducted.
thermal band	several closely grouped and equidistantly spaced thermal rings that visually blend together at low magnification (<100K).
thermal cycle	occurrence of 1 ambient and 1 treated water event at a pre-identified temperature differential and combination of hours; 1 thermal cycle produces 1 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; generally identifies a specific release 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 1 cycle. Microscopic viewing at high magnification (>100K) is required to resolve ring structure. A hatch mark 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 pre-hatch 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.

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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.
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, dam, or other device by which the stream migrations of salmon (or other fish) may be stopped or funneled through 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 are not being enhanced.
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.

APPENDIX B: STEPS IN THE FORMATION OF A REGIONAL AQUACULTURE ASSOCIATION

Appendix B1.–Steps in the formation of a Regional Aquaculture Association.

Typical steps in the formation of a regional aquaculture association

1. Incorporators inform fisheries user groups of proposed development of RAA through advertised meetings; letters and word of mouth
2. First meeting held by incorporators to publicly discuss RAA formation and implications
3. Second meeting held to develop draft Articles of Incorporation, By-laws; and regional boundaries
4. Incorporators solicit nominations for Board of Directors of RAA
5. Board of Directors organizes and conducts first meeting and adopts Articles of Incorporation, and By-laws
6. Board of Directors files Articles of Incorporation with State of Alaska Division of Corporations
7. Board of Directors submits By-laws, letters of support, other required information, and cover letter to the Commissioner of ADF&G
8. Commissioner of ADF&G authorizes the RAA and designates the region.

Source: Adapted from Joint Northern/Southern Southeast Regional Planning Team. 2004. Comprehensive salmon enhancement plan for Southeast Alaska: Phase III. Unpublished document obtained from Lorraine Vercessi, ADF&G PNP Hatchery Program Coordinator, Juneau.

APPENDIX C: CONSIDERATIONS FOR FISHERY ENHANCEMENT PLANNING

Appendix C1.–Considerations for fishery enhancement planning.

GENERAL PROJECT REVIEW CRITERIA

FISHERY CONCERNS

1. Is supplemental salmon production needed and desirable?

    a. What is the socioeconomic impact on local residents and fishermen?
    b. Do the public and user groups want a restoration or enhancement project in that location?
    c. Will the project fulfill a substantial portion of the region's goals?

SITE LOCATIONS

1. Can the restoration or enhancement project be implemented?
    a. Is the land available for use, and will the landowners consent to the project?
    b. What is the likelihood of the permit applications being approved or disapproved?
    c. Is the site area suitable and of sufficient size for the proposed project?
    d. Will the site require special biological and/or engineering studies and surveys (i.e., land, soil, water, and organisms)?
    e. Will the project be compatible with existing and future development in the area (i.e., potential habitat conflicts)?
2. Can the proposed project be operated and maintained?
    a. How accessible and logistically difficult will the project be to operate/maintain (i.e., access by road, air, or sea and distance from supply point)?
    b. Winter access and supply problems (i.e., bay ice conditions)?
3. Is the water supply adequate and suitable?
    a. Adequate flow year around for intended operations?
    b. Are water quality and seasonal temperature regimes within acceptable parameters?
    c. Are exclusive water rights available, and can water quality be maintained.
    d. Will future land/habitat uses conflict with quality or quantity of the water supply?
4. Can brood fish be obtained and held?
    a. Are local brood fish stocks available and in sufficient number at the right time?
    b. Is brood fish disease history known and are disease problems anticipated?
    c. Can brood fish be protected from the fishery and held in estuary or other holding area for ripening?
5. Can fry production be reared?
    a. Is the estuary suitable for saltwater rearing pens (i.e., protected from seas, sufficient depth, salinities, temperature, fouling organisms, etc.)?
    b. Can rearing be accomplished with land-based facilities (water and facility requirements)?
6. What is the capacity of the estuary and bay for additional salmon rearing?
    a. Are food organisms abundant and available at time of release?
    b. Will abundance of predatory and competitor species severely limit survival of hatchery fish?
    c. Are estuarine and bay conditions suitable for good fry survival?
7. Can adult returns from projects be readily evaluated?
    a. Will returning fish be mixed with other stocks?
    b. What type and quantity of evaluation effort will be required to assess project success?

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FEASIBILITY CONCERNS

1. Are cost/benefit ratios and Net Present Value (NPV) acceptable and justifiable?
2. Are there specific or special economic impacts, benefits, and costs involved?
3. If implemented, will the restoration or enhancement project distract from other worthwhile or perhaps more feasible projects and facilities for the region?

FRESHWATER PROJECT REVIEW CRITERIA

FISHERY STATUS

1. Is it a depressed fishery?
2. Has the fish population been decimated or eliminated?

FRESHWATER HABITAT ASSESSMENT

1. Lakes should be 5 acres in size or larger, at least 8 feet deep.
2. Predator/competitor concerns must be identified.
3. Available spawning area should be identified/estimated.
4. Water quality characteristics.
    - D.O., Temp., Alkalinity, Conductivity
    - Morphodaphic Index—richer lakes are stocked prior to poorer lakes.

ACCESS

1. Will it create new fisheries (has to have the potential)?
2. Accessible to the fishing public?

EFFECT ON MANAGEMENT

1. New projects should not complicate existing fisheries management plans.

LAKE STOCKING GUIDELINES

1. ADF&G guidelines should be adhered to with any new projects.

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MARINE/SALTWATER FISHERIES PROJECT REVIEW CRITERIA

Regarding supplemental production from an enhancement project (e.g., hatchery):

1. What are the potential effects on management plans with the implementation of the enhancement project?
2. What effects will the proposed production, by species, have on present management schemes?
3. What effects will the enhanced stocks (and their harvest) have on natural stocks in the area?
4. Can returns be harvested to provide "significant" common property benefits in traditional fisheries?
5. Is there an adequate terminal area where new fisheries could be created to affect the desired common property benefit?
6. Does the project as proposed allow for the continued protection of natural stocks?
    a. Can management or harvest strategies be developed to allow harvest or enhanced returns while protecting natural stocks?
    b. Is there a segregated area for harvest that will provide adequate cost recovery without significantly impacting wild stocks?
    c. Does the affected wild stock actually or potentially support a commercial, sport, and/or subsistence fishery?
    d. Does the affected stock have unique characteristics or are there special circumstances (e.g., a unique early run of coho)?
    e. What is the degree of risk and the probable degree of loss to the natural stocks?
7. Does the enhancement proposal make the most appropriate use of the sites potential?
8. Does the proposed project pose any disruption to existing fisheries?
9. Genetics consideration that donor broodstock be taken from an appropriate stock as close to the area as possible, and that adequate numbers and run composition are included in donor broodstock.
10. Pathology consideration that donor broodstock have an acceptable disease history for the proposed project.

ELEMENTS OF BENEFIT /COST ANALYSIS

Steps for undertaking projects identified in this plan will incorporate variables such as the facilities and equipment, cost of operations, and the financing.

<u>FEASIBILITY OF A PROJECT</u>

In determining the feasibility of a project, the team may consider the following questions:

1. Are benefit/cost ratios and Net Present Value acceptable?
2. What special economic impacts, benefits, and costs are involved?
3. If a hatchery or other facility is constructed, will it detract from other more worthwhile projects in the region?
4. Will the cost for an annual hatchery or other facility operation and maintenance decrease funding available for other projects in the region?

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COST OF A PROJECT

The cost of a project can generally be segregated into 3 major categories, depending upon the nature and the scope of the task. These are as follows:

1. Facility and Equipment
   a. Site section, including studies of alternative areas.
   b. Site acquisition.
   c. Construction costs, including planning fees.
   d. Equipment acquisition.
2. Operations
   a. Cost of labor, utilities, fish feed, personnel, and maintenance costs.
   b. Administrative.
   c. Project evaluation costs.
3. Financing
   a. Available funding sources.
   b. Source of continuing revenue for long term operations

Economic benefits to most groups directly affected by specific projects are easier to identify. However, the economics benefits of an enhanced fishery to subsistence, sport and personal use fishermen are very subjective and therefore difficult to assign a dollar value. The dollar impact to this group may not vary significantly from project to project and, when compared to the total economic benefit/cost ratio, may not have a significant effect on the overall analysis.

ECONOMIC BENEFITS TO COMMERCIAL FISHERMEN AND PROCESSORS

The economic benefits to these 2 groups can be expressed in dollar terms throughout the analysis of 2 major components; the anticipated increase product available for catch and the dollar value of the catch increase. Regardless of the nature of the project, however, the amount of product available depends on the annual adult salmon rate of return and the annual catch rate, expressed in terms of pounds of product.

VARIABLES TO CONSIDER IN DETERMINING THE PRODUCT VALUE

The value of the caught product includes a scrutiny of the following variables:

1. Type of product

2. Anticipated market price, including the effect of world supply and demand on the market price

3. Cost of catching and processing the product

In order to prepare a benefit/cost analysis for hatchery stock development, a spreadsheet which provides in detail the variables required to determine the quantity of catchable product, value of the catch, impact multipliers, and cost information relating the development of fish hatcheries should be developed. For more information, contact the ADF&G PNP Hatchery Program Coordinator.

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STOCK APPRAISAL TOOL

Adapted from the Comprehensive Salmon Enhancement Plan for Southeast Alaska: Phase III [28]

The ADF&G genetic policy states that

> "Stocks cannot be introduced to sites where the introduced stock may have significant interaction or impact on significant or unique wild stocks." (Davis et al. 1985, Sec. II.A)

The Stock Appraisal Tool identifies the criteria to be used by the regional planning teams and ADF&G biologists when evaluating the significance of a wild stock that may potentially interact with a hatchery release. The Stock Appraisal Tool attempts to inject as much objectivity as possible into determining the significance of a potentially impacted stock. In this context *significance* is defined as the importance of a stock in maintaining the overall viability and sustainability of the wild salmon resource as well as the importance of the stock in meeting fishery needs. *Significance* is more complex than simple production numbers. Some of our most viable fisheries depend on aggregates of wild stocks, each of which is not very large. Diversity among wild stocks is a key factor in maintaining production capacity and the potential to maximize harvest opportunities over time. Stock significance should be considered in developing appropriate straying studies or other assessments of the potential impact of a project on naturally occurring stocks.

The Stock Appraisal Tool is modeled after one developed by Hatchery Scientific Review Group, for use in the Pacific Northwest (HSRG Recommendations 2002). Their version looks at 4 stock characteristics: wildness, uniqueness, isolation, and viability. Our version splits viability into *population size* and *population trend*, and adds a criterion that addresses the human use pattern. In the Pacific Northwest version, a numerical rating scale is used, which is possible because of the availability of a much greater amount of data on a smaller number of stocks compared with those in Alaska. In the Alaska model each of the 6 characteristics has a nonnumeric gradient ranging from the quality that would indicate less significance (left side of the scale) to the quality that would indicate more significance (right side of the scale). The combined assessments of the 6 characteristics provide a qualitative estimate of significance. Admittedly this is not a perfect method. However, it does provide a consistent framework upon which to make professional judgments about the significance of wild stocks in the neighborhood of a proposed project. When this assessment is documented, it provides a record of part of the project development process. A determination of *stock significance* must be based on existing knowledge. This would include any data from ADF&G, federal agencies, other agencies, and local knowledge.

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[28] Joint Northern/Southern Southeast Regional Planning Team. 2004. Comprehensive salmon enhancement plan for Southeast Alaska: Phase III. Unpublished document obtained from Lorraine Vercessi, ADF&G PNP Hatchery Program Coordinator, Juneau.

I. Wildness

Introduced .... Native

The *wildness* spectrum includes the degree of impact from previous stocking, as well as the likelihood of impacts from existing enhancement projects. It is important to remember that all species of salmon have a relatively low baseline propensity to pioneer, and that the same level of influx from an enhancement project should not compromise wildness, if an appropriate stock was used for the enhancement project and the wild stock escapement is large enough to absorb a low number of strays.

II. Uniqueness

Typical of other stocks in the area .... Has unique characteristics

Based on the best existing knowledge, is there anything unique about the life history or other biological characteristics of the stock, and to what extent are these characteristics irreplaceable? A stock that shares some characteristics with local stocks that are not shared with other, more distant stocks would occupy an intermediate point on the *uniqueness* scale.

III. Isolation

One of several stocks in the area .... Solitary

To what extent could a stock be considered part of a metapopulation? In other words, is it part of a *big gene bank* that through normal processes could mitigate for low levels of gene influx from an enhancement project?

IV. Population Size

Small spawning aggregate ……. ……. ……….. ……….. ……... ……..Very large stock

Large stocks serve as large reservoirs of genetic diversity and are important for the sustainability of the total resource. Small stocks are more susceptible than large ones to adverse environmental conditions (e.g., unfavorable marine conditions) that could result in reduced population viability. Large populations are buffered from such effects, and, as conditions improve, could become sources for recovery by providing a source of strays. Large populations may be critically important for maintaining species over wide geographic ranges by acting as the source populations for eventual recolonization when site-specific extinctions occur due to earthquakes, landslides, glaciers, etc. (Alex Wertheimer, NMFS Auke Bay Laboratory, personal communication).

Some of the region's largest stocks are also very important in maintaining existing fisheries. Fisheries monitoring data should be used to determine the importance of a stock in maintaining fisheries.

V. Population Trend

Escapement stable or increasing .... ……….Escapement declining

The escapement trend of a population can be a measure of the stock's potential to thrive as a gene pool, and the potential to withstand an exogenous impact. A method for determining the escapement trend of a spawning population is outlined below (Baker et al. 1996).

-continued-

Data requirements

- To calculate *long-term mean escapement*: A 10-year span of observations using the same survey method is needed. Observations must be made during at least half of the years between the first and the most recent observations.
- To calculate *short-term mean escapement*: Within the last 5-year period, at least 3 years of observations are needed.

Trend definitions

- *Increasing*: The short-term mean escapement is more than 50% greater than long-term mean escapement.
- *Stable*: Short-term mean escapement is ± 50% of the long-term mean escapement.
- *Declining*: Short-term mean escapement is less than 50% but greater than 20% of long-term mean escapement.
- *Precipitously declining*: Short-term mean escapement is less than 20% of long-term mean escapement.
- *Unknown*: Data requirement is not met.

Having sufficient data to answer all the questions regarding a spawning aggregate may prove to be the exception, rather than the rule. Addressing the genetic significance of small spawning populations remains a topic for future research.

VI. Fishery Support

Contributes to multistock harvest …. ……… …………. ……supports targeted fishery

The first 5 criteria address biological or population characteristics that may call for increased awareness of potential enhanced/wild interaction. The final criterion takes into consideration the human-use pattern of a stock. A stock may be important for cultural or economic reasons, thereby increasing its overall rating of significance. For example, in this category a small sockeye stock near a village in Southeast Alaska may be situated on the right side of the scale, whereas a similar sized population in Bristol Bay may be situated on the left side of the scale. Another example might be a large transboundary river stock such as sockeye salmon from the Stikine River, where directed use by different parties (i.e., U.S./Canada) results in the significance of the stock in terms of management moving to the right side of the scale.

APPENDIX D: ROADMAP FOR HATCHERY PERMITTING AND PROCESS

Appendix D1.–Roadmap for hatchery permitting and process.

Aquaculture Association Pre-Project Planning

1. Determine location of hatchery facility.
2. Test water quality and flow rates (1 year worth of data necessary in some cases).
    a. Seek to secure water rights. (Must have at least temporary use authority to submit hatchery permit.)
3. Determine species to be reared and probable broodstock source.
4. Determine release site if not hatchery location and water quality data for site.
5. Request Management Feasibility Analysis (MFA) from ADF&G. An MFA request includes the location of the facility; the species desired for hatchery production; the run timing, by species; and incubation and rearing levels desired (by species) at start-up and at full capacity. ADF&G has 90 days to complete the MFA, which will include estimate of potential contributions to the common property fishery, potential size and location of a special harvest area, special management considerations or the need for additional studies, potential broodstock sources, assessment of production potentials for each species, and additional factors considered relevant to the proposed hatchery operation.
6. Determine financial feasibility of program (short and long-term funding sources).
7. Provide detailed statement of operational goals, objectives, and plans for hatchery permit application.
8. PNP Aquaculture Association formally adopts planned program.

Note: Some of the above items can be worked on simultaneously. PNP coordinator and/or area management biologist may provide assistance in preparing an application or conducting related activities.

PNP Application Process

9. Submit PNP application (must include the completed MFA).
10. PNP Coordinator formally accepts application as complete; a 135-day minimum time period further broken down into 2 phases for processing application begins.
11. Hatchery Permit Application Review – Schedule A (60 days)[29]

    Division of Commercial Fisheries technical staff (i.e., geneticist, pathologist, fish culturist) reviews application and either submits comments to the PNP coordinator or requests additional information.

    a. Department management and regional staff review the application and either submit comments to PNP coordinator or request additional information.
    b. RPT reviews the application for compatibility with regional Comprehensive Salmon Plan and sends a recommendation to the commissioner (goals, significant and unique stock designation).
    c. Basic management plan (BMP) is drafted by department area staff, the applicant, and the PNP coordinator working together.
12. Issuance of Private Nonprofit Hatchery Permit – Schedule B (75 days)

-continued-

[29] If additional information is requested from the applicant by the PNP coordinator at any time during the review and approval process set out in 5 AAC 40.190, Schedule A, the remainder of the 60-day time period will be suspended until the requested information is received by the PNP coordinator and determined to be sufficient.

Public participation, finalization, and decision.

a. Public hearing is scheduled and 30-day notice is published; completed application (includes the MFA) and draft BMP are provided.
b. Public hearing is held; process concludes 15 days after oral hearing is held. ADF&G is to respond to specific objections (oral or written) within 10 working days after receipt.
c. BMP is finalized by applicant and PNP coordinator.

If additional information is requested from the applicant by the PNP coordinator at any time during the review and approval process set out in 5 AAC 40.190, Schedule A, the remainder of the 60-day time period will be suspended until the requested information is received by the PNP coordinator and determined to be sufficient.

Review and Determination

13. The commissioner will review the application before rendering a decision (75 days). [30]
14. Application package submitted to the commissioner for review will include the recommendations from the regional planning team, recommendations resulting from ADF&G's review, and the results of the public hearing regarding the proposed facility.
15. PNP Permit is either issued or denied by the commissioner.

Other Considerations and/or Permits

Permits/agencies in this section are dependent upon the needs of the individual site and will vary. Not all permits/agencies may be listed. Items in this section can be worked on parallel to or in conjunction with the hatchery permit application.

Financing secured (Dept. of Commerce or other)

Dept. of Natural Resources (Water reservations/in-stream flow, Tideland Leases)

Dept. of Environmental Conservation (Domestic and hatchery discharge permits)

Dept. of Fish and Game (Habitat permits)

Army Corp of Engineers

U.S. Forest Service

U.S. Park Service

U.S. Bureau of Land Management

Commercial Fisheries Entry Commission Special Harvest Area Entry Permit

[30] See Review and Determination regulations, 5 AAC 40.220, for commissioner's considerations.

APPENDIX E: PNP HATCHERY PERMIT APPLICATION

APPLICATION

PRIVATE NONPROFIT SALMON HATCHERY PERMIT

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

COMMERCIAL FISHERIES DIVISION

P.O. Box 115526

JUNEAU, ALASKA 99811-5526

GENERAL INSTRUCTIONS

1. Fill in the blanks on the form provided.
2. Where necessary to fully answer a particular question, attach additional pages marked with the corresponding appendix number in the application.
3. Applications Must Be Typed.
4. Applications must be signed by the legally authorized representative of the corporate applicant.
5. The application should be sent to the following address:

   STATE OF ALASKA

   DEPARTMENT OF FISH AND GAME

   COMMERCIAL FISHERIES DIVISION

   P.O. Box 115526

   JUNEAU, ALASKA 99811-5526

   ATTENTION: PNP HATCHERY PROGRAM COORDINATOR
6. Requests for assistance in preparation of the application or related activities should be directed to the PNP Hatchery Program Coordinator. Such requests will be honored to the extent available staff time and funds permit.
7. This application must be accompanied by a management feasibility analysis (MFA) prepared by the department in accordance with 5 AAC 40.130.
8. The application must be accompanied by a $100 nonrefundable application fee, in accordance with AS 16.10.400.

(Rev. 10/2011)

APPLICATION

PRIVATE NONPROFIT SALMON HATCHERY PERMIT

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

I. IDENTIFICATION OF APPLICANT

A. Private Nonprofit Corporation

Name____

Address____

____

Phone____

(Please attach a copy of Articles of Incorporation for the above nonprofit corporation organized in accordance with Alaska Statute 10.20)

B. Individual Completing This Form

Name____

Address____

____

Phone____

C. Relation to Above Nonprofit Corporation

____

____

II. STATEMENT OF APPLICANT'S GOALS AND OBJECTIVES

Explain why you have decided to apply for a hatchery permit and what you generally expect to accomplish by the operation of the proposed hatchery.

III. PRODUCTION GOALS AND HATCHERY SITE INFORMATION

A. Egg Capacities by species	Millions of eggs required for hatchery at start-up at capacity

B. Location Description

1. Site (stream and/or lake name, ADF&G stream number, and exact geographical coordinates)

____

____

____

2. Site Physical Description (attach topographic map and photographs of proposed site).

a. Topography

____

____

____

b. Geology

____

____

____

c. Soils

____

____

____

C. Current Land Use and Ownership Status

1. Have the land or usage rights been acquired?

2. What is (will be) the legal form of any usage rights?

3. List the additional state and federal permits needed by the applicant to build and operate the proposed hatchery. Examples may include: U.S. Army Corps of Engineers Permit; Department of Natural Resources Water Use, Land Use, and Tidelands Lease Permits; and U.S. Forest Service Land Use Permit.

Use Permits (land and water)

D. Water Supply

The water quantity, minimum and Maxim temperatures, and the amounts of silt loading will be critical factors in the evaluation of water supply adequacy. Care should be exercised in the evaluation of these questions.

1. Source (e.g., lake, stream, well, spring). Have the water usage rights been acquired?

2. Water source characteristic (e.g., substrate, size of drainage area, gradient, ground water characteristics).

3. Water quality characteristics (in every case, cite the qualifications of the individual making the assessment and the method(s) used).

a. Recommended parameters to measure for evaluating potential hatchery water supply. Either fill out the table below or attach a copy of the water quality analysis conducted.

Water Qualities	Standards	Levels for the hatchery water source
Alkalinity	at least 20 mg/L as caCO_3	
Ammonia (unionized)	<0.0125 mg/L	
Arsenic	<0.05 mg/L	
Barium	<5.0 mg/L)	
Cadmium	<0.0005 mg/L (< 100 mg/L alkalinity <0.005 mg/L ($\geq$ 100 mg/L alkalinity)	
Carbon dioxide	<1.0 mg/L	
Chloride	<4.0 mg/L	
Copper	<0.006 mg/L (< 100 mg/L alkalinity) <0.03 mg/L ($\geq$ 100 mg/L alkalinity)	
Dissolved oxygen	>8.0 mg/L	
Hydrogen sulfide	<0.003 mg/L	
Iron	<0.1 mg/L	
Lead	<0.02 mg/L	
Magnesium	<15 mg/L	
Mercury	<0.0002 mg/L	
Nickel	<0.01 mg/L	
Nitrate (NO_3)	<1.0 mg/L	
Nitrate (NO_2)	<0.1 mg/L	
Nitrogen (N_2)	<110% total gas pressure (<103% nitrogen gas)	
Petroleum (oil)	<0.001 mg/L	
pH	6.5 - 8.0	
Potassium	<5.0 mg/L	
Salinity	<5.0 ppt	
Selenium	<0.01 mg/L	
Silver	<0.003 mg/L (fresh water) <0.003 mg/L (salt water)	
Sodium	<75.0) mg/L	
Sulfate SO_4^{-2}	<50.0 mg/L	
Total dissolved solids	<400.0 mg/L	
Total settleabel solids	<80.0 mg/L (25 JTU)	
Zinc	<0.005 mg/L	

Note: Synergistic and antagonistic chemical reactions must be considered when evaluating a water source against these criteria.

b. Attach a temperature profile (minimum of one year of data) of the hatchery water source. Also, provide vertical profiles if a lake water source is proposed.

See attached Appendix _____________.

c. List monthly levels of dissolved oxygen in the hatchery water source. If a lake source, provide seasonal oxygen profiles.

See attached Appendix_____________.

d. If a lake source, provide information on surface area, depth, and water storage capacity.

See attached Appendix_____________.

e. Describe the silt load (include consideration of possible seasonal high water).

---

4. Water Flow Data

This information should be based on the equivalent of long-term USGS stream gauge data (10 years or more data) or the U.S. Forest Service Water Resources Atlas synthetic hydrograph model.

a. Attach a seasonal profile, including yearly minimum and maximum flows.

See attached Appendix_____________.

b. List a historical range of water flow conditions, if available.

See attached Appendix_____________.

5. Water Distribution System

Describe the water distribution system in at least the following dimensions:

a. Type, size, elevation and locations of water intake, screening, and water use/reuse system.

---

b. Size, length, and type of pipe, insulation, and distribution system. Include elevations of water surfaces at each point in the system from intake through incubation and rearing to fish ladder or other discharge.

See attached Appendix____________.

c. If a hydroelectric generation system will be used, will effluent from this system be used in the hatchery? If so, describe plans to address possible problems with gas supersaturation.

____

____

____

d. Describe provisions for an emergency water system in the event of primary wate system failure.

____

____

____

6. Water Treatment System

Describe any water treatment facilities that you will employ to meet minimal water quality standards (influent or effluent).

____

____

____

7. Annual Water Budget

Attach a graph showing seasonal variation in flow required for eyeing, incubation, freshwater rearing, freshwater lens in saltwater pens, adult holding, and fishladder operations.

See attached Appendix__________.

IV. HATCHERY DESIGN AND CONSTRUCTION INFORMATION

A. Biocriteria for Design and Construction

Describe the critical operational assumptions and objectives which determine the design size and capacity of the proposed hatchery. Specific reference should be made to the following (for reference, a table of CFMD assumptions for salmon survival is provided, Table 1):

BROOD STOCK - SPECIES______________________________

1. Eggs per female spawner______________________________
2. Brood stock requirements at 1:1 sex ratio______________________________
3. Green egg requirements______________________________
4. Estimated holding mortality______________________________, _____%

HATCHERY FACILITY

5. Eyed eggs (_____% loss from green egg stage)______________________________
6. Eyed egg density per incubation unit______________________________
7. Total number of incubation units______________________________
8. Number of cabinets per unit______________________________
9. Water requirements at ____L/min/unit=______________________________L/min

10 Water requirements with_______% loss=______________________________L/min

FRESHWATER REARING UNITS

11 Number of emerging fry (______% loss from eyed stage)______________________________

12 Initial fry weight at_____/kg=______________________________kg

13 Final Fry weight at _____/kg=______________________________kg

14 Initial freshwater fry rearing space required at ________kg/m^3 ____________________m^3

15 Final freshwater fry rearing space required at______kg/m^3 ____________________ m^3

16 Maximum number of rearing units (_____m by_____m by_____m= ____________________

17 Maximum water requirements at _____kg/L/min and 10% loss____________________L/min

18 Number of exchanges per hour (R-value) per raceway______________________________

MARINE REARING UNITS

19. Number of fry/fingerling/or smolts______________________________
20. Initial weight at _____/kg =______________________________kg
21. Final weight at _____/kg =______________________________kg
22. Initial rearing space required at ________kg/m^3 =______________________________ m^3
23. Final rearing space required at ______kg/m^3 ______________________________ m^3
24. Maximum number of rearing units (_____m by_____m by_____m=_____________ m^3)

PROJECTED RETURN

25. Number of returning fish at _____% ocean survival =__________________________

A. Biocriteria for Design and Construction (continued)

BROOD STOCK - SPECIES____

1. Eggs per female spawner____
2. Brood stock requirements at 1:1 sex ratio___________________________________
3. Green egg requirements____
4. Estimated holding mortality__________________________________, _____%

HATCHERY FACILITY

5. Eyed eggs (_____% loss from green egg stage)______________________________
6. Eyed egg density per incubation unit______________________________________
7. Total number of incubation units____
8. Number of cabinets per unit____
9. Water requirements at ____L/min/unit=______________________________L/min
10. Water requirements with______% loss=_____________________________L/min

FRESHWATER REARING UNITS

11. Number of emerging fry (_____% loss from eyed stage)________________________
12. Initial fry weight at_____/kg=____kg
13. Final Fry weight at _____/kg=_______________________________________kg
14. Initial freshwater fry rearing space required at _______kg/m^3 ________________ m^3
15. Final freshwater fry rearing space required at______kg/m^3 ________________ m^3
16. Maximum number of rearing units (_____m by_____m by_____m= ________________
17. Maximum water requirements at _____kg/L/min and 10% loss________________L/min
18. Number of exchanges per hour (R-value) per raceway__________________________

MARINE REARING UNITS

19. Number of fry/fingerling/or smolts_______________________________________
20. Initial weight at _____/kg=____kg
21. Final weight at _____/kg=____kg
22. Initial rearing space required at _______kg/m^3 =___________________________ m^3
23. Final rearing space required at ______kg/m^3 ___________________________ m^3
24. Maximum number of rearing units (_____m by_____m by_____m=____________ m^3)

PROJECTED RETURN

25. Number of returning fish at _____% ocean survival =______________________

A. Biocriteria for Design and Construction (continued)

BROOD STOCK - SPECIES____

1. Eggs per female spawner____
2. Brood stock requirements at 1:1 sex ratio_____________________________________
3. Green egg requirements____
4. Estimated holding mortality_________________________________, _____%

HATCHERY FACILITY

5. Eyed eggs (______% loss from green egg stage)_____________________________
6. Eyed egg density per incubation unit_____________________________________
7. Total number of incubation units____
8. Number of cabinets per unit____
9. Water requirements at ____L/min/unit=________________________________L/min
10 Water requirements wiith_______% loss=_______________________________L/min

FRESHWATER REARING UNITS

11 Number of emerging fry (______% loss from eyed stage)______________________
12 Initial fry weight at_____/kg=____kg
13 Final Fry weight at _____/kg=____kg
14 Initial freshwater fry rearing space required at ________kg/m^3 ____________________ m^3
15 Final freshwater fry rearing space required at______kg/m^3 ____________________ m^3
16 Maximum number of rearing units (_____m by_____m by_____m= ___________________
17 Maximum water requirements at _____kg/L/min and 10% loss___________________L/min
18 Number of exchanges per hour (R-value) per raceway_________________________

MARINE REARING UNITS

19. Number of fry/fingerling/or smolts____
20. Initial weight at _____/kg=____kg
21. Final weight at _____/kg=____kg
22. Initial rearing space required at ________kg/m^3 =________________________________ m^3
23. Final rearing space required at ______kg/m^3 _______________________________ m^3
24. Maximum number of rearing units (_____m by_____m by_____m=_____________ m^3)

PROJECTED RETURN

25. Number of returning fish at _____% ocean survival =_________________________

Table 1. Salmon survival goals at various life stages and fecundities[1] to use in budget documents and hatchery planning.

	Hatchery				Lake	Marine
Species	Green to eyed egg	Eyed Egg to emergent fry	Emergent fry to fingerling	Fingerling to smolt	Fry/fingerling to smolt	Survival to adult
Chum	.90 (.90)[2]	.95 (.855)[3]				.007 (.006)
	.90 (.90)	.95 (.855)	.90 (.770)[4]			.02 (.015)
Pink	.90 (.90)	.95 (.855)[3]				.007 (.006)
	.90 (.90)	.95 (.855)	.90 (.770)[4]			.02 (.015)
Coho	.90 (.90)	.95 (.855)[5]			.10 (.086)	.10 (.009)
	.90 (.90)	.95 (.855)	.90 (.770)[6]		.20 (.154)	.10 (.015)
	.90 (.90)	.95 (.855)	.90 (.770)	.80 (.616)[7]		.10 (.062)
Chinook	.90 (.90)	.95 (.855)[5]			.10 (.086)	.03 (.003)
	.90 (.90)	.95 (.855)	.90 (.770)[6]		.20 (.154)	.03 (.005)
	.90 (.90)	.95 (.855)	.90 (.770)	.80 (.616)[7]		.03 (.018)
Sockeye	.90 (.90)	.95 (.855)[5]			.10 (.086)	.10 (.009)
	.90 (.90)	.95 (.855)	.90 (.770)[6]		.20 (.154)	.10 (.015)
	.90 (.90)	.95 (.855)	.90 (.770)	.80 (.616)[7]		.10 (.062)

[1] Fecundities by species (eggs per female spawner): Chum - 2,200; Pink - 1,600; Coho - 2,800; Chinook - 6,500; Sockeye - 3,000
[2] Cumulative survivals in parenthesis.
[3] Fry to ocean.
[4] Fingerling to ocean.
[5] Fry to lake/stream.
[6] Fingerling to lake/stream.
[7] Smolt to ocean.

B. General Description

Attach a written description of the proposed facility. This description should represent a solid concept of the proposed hatchery design. Also include preliminary sketches and drawings of at least the following in an appendix.

1. Incubation and rearing site plan.
2. Hatchery floor plan.
3. Water supply system.
4. Incubation/operation building.
5. Facility layout.

The site plan should include a plan view of all facilities at a scale of 1:100 or larger, a USGS 1:63360 scale topographical map showing the entire watershed and all facility locations, and a NOAA marine chart of the largest scale available showing all tidewater-based facilities and local data.

See Attached Appendix _____.

C. Proposed Construction Timetable

Prepare a timetable for the construction period which indicates the critical milestones for the project.

See attached Appendix ______.

V. BROOD STOCK

A. Initial Donor Stock

1. Identification of source.
   Indicate stream name, ADF&G number or geographic coordinates, and salmon species for each proposed donor stock.

   a. Species ______________________________

      Stream name ______________________________

      ADF&G number or geographic coordinates ______________________________

   b. Species ______________________________

      Stream name ______________________________

      ADF&G number or geographic coordinates ______________________________

   c. Species______________________________

      Stream name______________________________

      ADF&G number or geographic coordinates______________________________

   d. Species______________________________

      Stream name______________________________

      ADF&G number or geographic coordinates______________________________

If more sources are being requested, attach an additional list.

2. Capture techniques and holding facilities at the donor stream.

   a. Capture techniques
      Describe in detail the capture techniques you will use to harvest adults and take eggs. Please provide a map identifying the exact location of the holding facilities.

____

____

____

____

____

   b. Holding facilities
      Describe the holding facilities to be used for donor stock spawners (include schematics).List the loading rate [kg fish/ (L/min)] and density (kg fish/mg^3).

____

____

____

3. Transportation
   Discuss method planned for transporting live fish and/or eggs

4. Spawning and fertilization
   Discuss the spawning, fertilization, and disinfection procedures and the procedure for estimating percent fertilization.

B. Brood Stock Returning to Hatchery

1. Capture techniques and holding facilities at the hatchery.
   a. Capture Techniques
      Describe in detail the techniques you will use to capture and ripen adults and take eggs.

   b. Holding facilities
      Describe the holding facilities to be used for hatchery brood stock spawners (include schematics) and give the loading rate [kg fish/ (L/min)] and density (kg fish/mg^3).

2. Transportation
   Discuss method planned for transporting live fish and/or eggs (if different from those described in Part A).

3. Spawning and fertilization

Discuss the spawning and fertilization procedures (if different from those described in Part A).

VI. INCUBATION AND REARING PLAN

A. Incubators and Rearing Units

Describe the type of incubators and rearing facilities to be used.

B. Egg Handling

Describe the method by which you plan to handle the eggs from the spawning process through planting them in incubators.

C. Chemical Treatment

What chemicals and concentrations will be used for controlling fungus on eggs until the eyed stage?

D. Enumerations

Describe the method(s) to be used in estimating numbers of green eggs, eyed eggs, and fry.

E. Rearing Plans

Describe any plans to rear the salmon including type of food.

____

____

____

F. Disease Control

Describe plans for preventing or controlling disease during rearing.

____

____

____

VII. RELEASE PLAN

A. Release Site(s)

1. Give exact location and description of proposed release site(s), including maps.

____

____

____

____

____

____

2. List proposed number and age of each species to be released at each site.

____

____

____

____

B. Transportation

Discuss the methods planned for transporting live fish from the hatchery to the release site(s).

____

____

____

VIII. STAFFING

A. Technical Advisors

Attach information about each technical advisor to the nonprofit corporation, indicating that person's name, address, role and responsibilities, and a brief statement of technical qualifications.

B. Design and Construction

Attach a list of the names and qualifications of persons or corporations responsible for final design and construction of proposed facilities.

See attached Appendix_____.

C. Administrative Personnel

List the administrative personnel who will support this facility when operational.

Personnel Assigned (Titles)	Percentage of Time
1.________________________________	____________
2.________________________________	____________
3.________________________________	____________

D. Operating Personnel

List the operating personnel who will be assigned to this facility when operational.

Personnel Assigned (Titles)	Percentage of Time
1.________________________________	____________
2.________________________________	____________
3.________________________________	____________
4.________________________________	____________
5.________________________________	____________
6.________________________________	____________
7.________________________________	____________
8________________________________	____________
9.________________________________	____________
10.________________________________	____________

IX. FINANCIAL PLAN

An estimate of hatchery construction and operating costs should be detailed here. These estimates would provide an indication of the cost recovery requirements of the proposed facility on an annual basis. Acceptance of this application by the Department of Fish and Game in no way implies agreement by the Department of Commerce and Economic Development to commit state loan funds for this project.

See attached Appendix _________.

X. BASIC MANAGEMENT PLAN

The preparation of a draft Basic Management Plan will be completed prior to the public hearing. The applicant will be expected to work closely with ADF&G staff in developing the Basic Management Plan (see 5 AAC 40.820).

XI. DECLARATION AND SIGNATURE

I declare that the information given in this application is, to my knowledge, true, correct, and complete.

____ ______________

Name of Applicant

____ ______________

Signature of Applicant Date Signed

APPENDIX F: GENETIC POLICY AND BACKGROUND

Alaska Department of Fish and Game
Genetic Policy

1985

Followed by a copy of the

Background of the Genetic Policy of the Alaska
Department of Fish and Game

1989

Alaska Department of Fish and Game
Genetic Policy
by
Genetic Policy Review Team

Bob Davis – ADF&G, FRED, Chairman

Other Team Members:

Brian Allee – PWSAC, Cordova
Don Amend – SSRAA, Ketchikan
Bruce Bachen – NSRAA, Sitka
Bill Davidson – SJC, Sitka
Tony Gharrett – UAJ, Juneau
Scott Marshall – ADF&G, Comm. Fish
Alex Wertheimer – NMFS, Auke Bay Lab

Approved:

Don W. Collinsworth, Commissioner
Alaska Department of Fish and Game
6/11/85

INTRODUCTION

Alaska's valuable salmon industry relies on production from wild systems and, increasingly, on fish produced by aquaculture programs. The importance of maintaining healthy wild stocks and implementing successful enhancement activities underlies the need for an effective genetic policy. The genetic guidelines created to steer Alaska's aquaculture efforts were established in the mid-70's and have been reviewed to ensure that they reflect current knowledge, and goals. A revised genetic policy has been established that contains guidelines, supporting information and recommendations.

The genetic policy contains restrictions that will serve to protect the genetic integrity of important wild stocks. Certainly in Alaska where wild stocks are the mainstay of the commercial fishery economy, it is necessary to protect these stocks through careful consideration of the impacts of enhancement activities. Another important aspect of the genetic policy is the orientation towards increasing the productivity of enhancement programs in the state. Adherence to the guidelines will help maintain adequate genetic variability ensuring that the enhanced stock will be able to adapt to changing environmental conditions. The policy also includes considerations for selective breeding for desirable characteristics.

Due to the limited amount of information available on the genetic impacts of salmon enhancement on wild stocks, much of the basis for these guidelines is theoretical or based on work done with other species. Consequently, the most important considerations used in writing the guidelines are presented as a mechanism for illustrating the intent of the policy. An understanding of the rationale behind the policy is imperative to its effective application to individual cases under the very diverse conditions found in Alaska. The importance of the genetic guidelines will continue to increase as aquaculture activities expand their production. This policy represents a consensus of opinion and should continue to be periodically reviewed to ensure that the guidelines are consistent with current knowledge. By doing so, we will be able to meet the goal of greater fish production through enhancement while maintaining healthy wild stocks.

POLICY STATEMENT

I. Stock Transport

Interstate: Live salmonids, including gametes, will, not be imported from sources outside the state. Exceptions may be allowed for trans-boundary rivers.

Inter-regional: Stocks will not be transported between major geographic areas: Southeast, Kodiak Island, Prince William Sound, Cook Inlet, Bristol Bay, AYK and Interior.

Regional: Acceptability of transport within regions will be judged on the following criteria.

Phenotypic characteristics of the donor stock must be shown to be appropriate for the proposed fish culture regions and the goals set in the management plan.

No distance is set or specified for transport within a region. It is recognized that transplants occurring over greater distances may result in increased straying and reduce the likelihood of a successful transplant. Although the risk of failure affects the agency transporting the fish, transplants with high probability of failure will be denied. Proposals for long distance transport should be accompanied by adequate justification for non-local stock.

II. Protection of Wild Stocks

Gene flow from hatchery fish straying and intermingling with wild stocks may have significant detrimental effects on wild stocks. First priority will be given to protection of wild stocks from possible harmful interactions with introduced stocks. Stocks cannot be introduced to sites where the introduced stock may have significant interaction or impact on significant or unique wild stocks.

Significant or unique wild stocks must be identified on a regional and species basis so as to define sensitive and non-sensitive areas for movement of stocks.

Stock Rehabilitation and Enhancement

A watershed with a significant wild stock can only be stocked with progeny from the indigenous stocks.

Gametes may be removed, placed in a hatchery, and subsequently returned to the donor system at the appropriate life history state (eyed egg, fry or fingerling). However, no more than one generation of separation from the donor system to stocking of the progeny will be allowed.

Drainage’s should be established as wild stock sanctuaries on a regional and species basis. These sanctuaries will be areas in which no enhancement activity is permitted except gamete removal for broodstock development. Use of such reservoirs for broodstock should be considered on a case-by-case basis, and sliding egg take removal schedules applied to such systems should be conservative.

Fish releases at sites where no interaction with, or impact on significant or unique wild stocks will occur, and which are not for the purposes of developing, rehabilitation of, or enhancement of a stock (e.g., releases for terminal harvest or in landlocked lakes) will not produce a detrimental genetic effect. Such releases need not be restricted by genetic concerns.

III. Maintenance of Genetic Variance

Genetic diversity among hatcheries

A single donor stock cannot be used to establish or contribute to more than three hatchery stocks.

Off-site releases for terminal harvest rather than development or enhancement of a stock need not be restricted by III.A.1, if such release sites are selected so that they do not impact significant wild stocks, wild stock sanctuaries, or other hatchery stocks.

Genetic diversity within hatcheries and from donor stocks

A minimum effective population (Ne) of 400 should be used for broodstock development and maintained in hatchery stocks. However, small population sizes may be unavoidable with Chinook and steelhead.

To ensure all segments of the run have the opportunity to spawn, sliding egg take scales for donor stock transplants will not allocate more than 90% of any segment of the run for broodstock.

GUIDELINES AND JUSTIFICATIONS

I. Stock Transport

A. Interstate: It is generally accepted that population of salmonids which have existed over many generations in a given watershed have evolved traits that make them adapted for survival in that environment. The greater the distance that a population is transferred from its native environment or the greater the difference in environmental conditions between the donor and stream, the less likely the genetic characteristics of the population will fit the new environment. If the fitness of the population is indeed reduced in the new environment, then the probability of the transport succeeding would be affected. In addition, interbreeding of a transferred stock with indigenous stocks could transfer gene traits that would reduce the fitness of the native populations. In many states, discrete stocks cannot be identified because excessive movement and interbreeding have already occurred. The State of Alaska, therefore, desires to protect and develop local stocks by restricting the movement of live fish or eggs into the state. There are, however, several trans-boundary rivers penetrating British Columbia, Canada, that flow into the state of Alaska. In some instances, donors from these stocks might fit a well-designed management plan.

B. Inter-regional: The environment can vary greatly from one region to another in a state as large as Alaska. For similar reasons given in I.A. above, the transfer of fish from one region to another is restricted. Consideration may be given to regional border areas, especially when no suitable donor stock is available within a region.

C. Regional: Although it is recognized that indigenous stocks are best for donor stock development, there have been numerous successful transplants, especially if the environment at the new site is similar to that of the donor stock and distance between the sites is not great. There is insufficient scientific data to predict how far or how diverse the environment must be before a negative impact will occur. However, it is believed that within a region site matching opportunities may be available. As site matching characteristics decrease and transplant distance increases within the regional borders greater justification is required for the proposed transplant. The following should be considered when selecting a donor stock.

Matching: Phenotypic characteristics of the donor stock should be matched to the environment at the site and to the management goals. Water chemistry and temperature profiles should be considered. Island stocks should be matched to other islands or to short rivers of comparable characteristics where possible. Time of spawning and fry emergence should be matched or compensated with the hatchery temperature required. Any deviations should be addressed and justified in the permit application or the annual management plan.

Migration Routes: The probable migration routes and potential user groups should be identified. The applicant must determine a probable migration route based on the migration route of the proposed stock and characteristics (topography) of the transplant site. Coded wire tagging of hatchery releases can determine the accuracy of migration route predictions as well as assess possible impact on local stocks.

II. Protection of Wild Stocks

A. <u>Prevention of detrimental effects of gene flow from hatchery fish straying and interbreeding with wild fish.</u>

Straying of hatchery fish released at the hatchery or off-station can potentially impact the fitness of wild fish populations through interbreeding of wild and hatchery fish. This assumes that hatchery and wild fish are adapted to different environments and either would presumably be less fit in the environment of the other and that hybrids would be less fit for either environment. Wild stocks have presumably been rigorously adapted to their native environment. Because of the large number of loci involved in the adaptation, many "successful" combinations of genetic information are possible along with the enormous number of "unsuccessful" combinations. Hybridization between discrete populations may produce a stock that has reduced fitness and therefore reduced production. Hatchery fish have been subjected to selection pressure for survival within artificial culture regimes, and may also have been originally derived from another stock adapted to totally different conditions than the impacted wild stock. Continued influx of hatchery fish together with the return of hybrids may alter the wild gene pool, reduce stock fitness, and thus threaten the survival of the wild population.

An alternative perspective is that hatchery strays will have little genetic impact on wild stocks. The influx of new genetic material through straying is a natural process in the development and expansion of salmon populations. If adaptation of the natural population is indeed very specific and selection is intense, then selection will favor and maintain the genetic complex of the wild populations. If adaptation is less specific and less intensive, then the genetic impacts from gene flow are insignificant. It is true that some straying occurs among adjacent wild populations and in most cases has occurred for a long enough time that such populations are quite similar genetically. However, situations in which transplanted stocks are not analogous, as transplanted stocks would be less similar and gene flow would have a more profound effect. It is also true that the impact of introgression into the wild gene pool of genes from fish transplanted from a radically different environment may be limited by natural selection. Again the situations of concern do not necessarily lie near this extreme; hybrids and strays may be fit enough to dilute or replace the wild genome. Inherent homeostatic mechanisms for gene expression may compensate for some genetic influx.

The magnitude of straying relative to the size of the wild run is the most important criterion, as massive spawning by hatchery strays may jeopardize a wild population by displacement on spawning habitat and superimposition of redds, as well as, genetic influx. A conservative management approach dictates avoiding release sites where large numbers of hatchery strays can be expected to interact with significant or unique wild stocks. This approach can be achieved by spatial or temporal isolation of the hatchery and wild stock.

B. <u>Regional designation of significant and unique wild stocks.</u>

The magnitude of salmon populations varies between watersheds from intermittent runs maintained by straying to hundreds of thousands of fish. In evaluating the impacts of salmon enhancement projects, consideration must be given to the potential of detrimental effects from straying and intermingling with wild populations and possible resultant loss of wild production. Such consideration must take into account the benefits of the enhancement activity and the significance of the wild stocks impacted. Designation of criteria for runs of fish that are considered significant would greatly expedite the evaluation process. However, "significance" must be defined not only by the magnitude of the run, but also in the context of local importance and utilization. A small sockeye salmon stock near a village in southeast Alaska may be "significant", whereas the same size population may be too small to be considered a manageable entity in Bristol Bay. Because local utilization is an important concern, a regional planning group such as the Salmon Enhancement Regional Planning Teams, should consider what criteria will be used to determine significant stocks within a region and recommend such stock designations.

<u>Stock rehabilitation and enhancement.</u>

1. A watershed with significant wild stocks can only be stocked with progeny from the indigenous stocks. Rehabilitation of a watershed implies that there is insufficient production in habitat that formerly maintained a stock of some magnitude. Unless the indigenous stock has gone to extinction, use of an exogenous stock has potential for genetic damage noted in II. A. This damage will be exacerbated by the imprinting and homing of the transplanted stock to the impacted watershed, and potential displacement of wild juveniles by the exotics stocked in the rearing habitat. Enhancement of habitat not naturally accessible to salmon involves stocking eyed eggs, fry, or fingerlings, thus gaining production from this unutilized

habitat. Where the inaccessible habitat is located above the barriers on watersheds that maintain significant natural populations, stocking nonindigenous populations again has potential for genetic impacts noted in II.A., exacerbated by imprinting and homing of the transplanted stock to the watershed. For both rehabilitation and above barrier stockings, use of the indigenous stock alleviates these concerns.

2. When enhancing a stream using the indigenous stock, the fish used for stocking shall not be removed from the wild system to a hatchery for more than one generation.

Hatchery incubation and rearing select for a limited set of biological and behavioral traits which are not necessarily the most suitable for survival in the wild environment. Because of this potential for such selection, the transfer of hatchery fish to rehabilitate or enhance stocks in depleted or underutilized watersheds runs the risk of altering the genetic character of the wild stock, even if the indigenous stock was the original donor stock for hatchery population. By restricting the separation between the transfer to the hatchery and the stocking to no more than one generation (e.g., eggs taken in a given year are cultured to fry or fingerling release at the hatchery; eggs or fish from the returns to the hatchery of this donor transplant are used for stocking), the risk of negative effects due to selection in the hatchery are minimized.

3. <u>Establishment of wild stock sanctuaries.</u>

As noted in preceding sections, there is concern that hatchery culture of salmon through their freshwater (and in some cases, initial estuarine) life history phases may select for a limited set of biological traits that are not suitable for wild populations. Loss of genetic variability through intensive in-breeding for domestication and desired traits has often resulted in detrimental genetic effects in agronomy and agriculture, such as reduced resistance to disease or adverse environmental conditions. Original wild strains can provide the genetic variability needed to outbreed domestics and alleviate inbreeding depression. Because there is potential for detrimental impacts due to reduction of genetic variability, there is a need to preserve a variety of wild types for future broodstock development and outbreeding for enhancement programs. Designation of watersheds where hatcheries or hatchery plants are not allowed would allow wild stocks within these watersheds to be subjected to natural selection only, within the life history phases cultured at hatcheries. These watersheds would be “gene banks” of wild type genetic variability.

III. Maintenance of Genetic Variance

1. <u>Genetic diversity among hatcheries.</u>

There is general agreement that be introducing and maintaining a wide diversity of wild donor stock populations into the hatchery system that the prospects for long term success of the hatchery program in Alaska will be enhanced. Diversity tends to buffer biological systems against disaster, either natural or man-made. Developing and maintaining hatchery broodstock from a wide variety of donors will buffer the hatchery system against future catastrophes. Agricultural crop production in the U. S. provides a prime example of the dangers of genetic uniformity.

In an effort to increase yield, plant breeders have come to rely on a few highly productive strains. In 1970 approximately 15% of the corn production in the United States was lost to corn blight. The corn blight responsible, a mutant of the normal blight causing fungus, did not attack all strains. Only one strain of corn was vulnerable, but that strain of corn was grown by nearly every farmer in the country. Breeders were able to recover from the corn blight epidemic by replacing Texas cytoplasm with normal cytoplasm. Recovery was rapid because adequate genetic variability was available. There are other examples.

How does this relate to salmonid culture? Salmonid stocks apparently differ in levels of disease resistance, temperature tolerance, acid tolerance, and in their response to artificial selection. It seems imprudent to assume that conditions similar to those found in agriculture will not occur in aquaculture. In addition, the ability to genetically improve hatchery broodstock performance in the future will depend on the availability of genetic variability such as is found among wild salmonid stocks. A hatchery system with a variety of diverse broodstocks will be a valuable resource.

Genetic diversity does not guarantee protection from disaster, but uniformity seems to invite catastrophe. Local failures are inevitable within the hatchery system. It seems prudent to provide the system with a level of insurance by developing and preserving diversity among hatcheries.

Off-site releases for terminal harvest, whether for the commercial fishery or for a put and take sport fishery should have no adverse genetic effect if they are released at sites selected so that they do not impact significant wild stocks, wild stock sanctuaries or other hatchery stocks. The success of this type of release from a genetic standpoint depends on the ability to manage and harvest the return. If returns can not be harvested, increased straying may result which might lead to an impact on wild stocks at a greater than expected distance from the release site.

2. <u>Genetic diversity within hatcheries and from donor stocks.</u>

There is a general consensus among geneticists that fitness (reproductive potential) is enhanced by heterozygosity (genetic variability). Any loss of genetic variation will be accompanied by a concomitant reduction in fitness. Genetic variation allows a population to adapt to a changing environment or to adapt to and colonize a new environment. Available genetic variation determines how rapidly a population will respond to either artificial or natural selection. On the other hand, selection, inbreeding and random genetic drift will reduce genetic variability in a population. Natural selection, that is selection for fitness, is a continuing process and should not be so intense that it has a significant effect in reduction of genetic variation, unless the population is in a new and quite different environment. Artificial selection on the other hand can be very intense, but can either be avoided or designed to assure that possible negative effects to fitness are offset by increased production efficiency due to the selection program, and by more efficient culture techniques. Inbreeding due to the deliberate mating of related individuals can be easily avoided in salmon hatcheries. Undoubtedly, in hatcheries and possibly in natural stocks the most important cause of loss of genetic variation is random genetic drift. In hatcheries reduction of genetic variation caused by inbreeding and genetic drift can easily by avoided by using adequate numbers of spawners.

Random genetic drift in general refers to fluctuations in gene frequency that occur as a result of chance. Such fluctuations occur, especially in small populations, as a result of random sampling among gametes. The amount of change but not the direction of change, can be predicted. The rate of this change is related inversely to effective population size (N_e). The smaller the effective population size the greater the fluctuation in gene frequencies. In small populations random genetic drift can result in inadvertent loss of genetic variability which may significantly reduce the fitness of the population.

Effective population size (N_e) is defined as the size of an idealized population that would lose genetic variability at the same rate as the sample population. An idealized population is one in which there is no mutation or selection, there are equal numbers of males and females, mating is random, etc. Obviously it is very unlikely that any natural population will meet all criteria for an idealized population.

Breeding structure of a population can profoundly affect the rate at which genetic variability is lost. However, we can determine the effective breeding size (N_e) for breeding structures and obtain the rate of inbreeding (ΔF) as

$$(\Delta F) = 1/2\ N_e$$ Δ©ʌ

so the consequences of breeding structure can be related to the loss of variation.

Many breeding structure variations can influence the effective population size. Four seem likely to operate in a salmon hatchery population: (1) numbers of males and females in the breeding population; (2) unequal numbers in successive generations; (3) nonrandom distribution of offspring among families; and (4) overlapping generations. These are discussed in greater detail in Appendix A.

Any of these variations in breeding structure may have a marked effect on N_e . Although it may be impossible to control or even to measure variation in family size it is important to keep in mind the relationship to effective population size. Breeding plans that would aggravate or increase the variation of family size should be avoided. The effect of overlapping populations is to increase the effective population number, in that individuals mating in different years contribute to greater diversity. For example, it would take a larger number of pink salmon each year to maintain $N_e = 400$ than it would sockeye salmon.

The factor having the greatest potential effect in the hatchery and over which we have most control is sex ratio. As the formula indicates (Appendix A) the effective population size is affected most by the numbers of the least frequent sex. It is important to consider this in the breeding plan. In salmon, because a male can be used to fertilize the eggs of a large number of females, there is a temptation to do so. This temptation should be moderated by the necessity to maintain an effective population size which will assure that adequate genetic variation is maintained in the population. A minimum effective population (N_e) of 400 should be maintained. At this size the rate of in-breeding will be 0.125 percent per generation which should not have a significant effect on the long term fitness of the population.

In some cases, for example with Chinook and steelhead, small population size may be unavoidable. In such cases a plan should be developed to offset the effects of small population size by infusion of genes from a source outside the hatchery population, such as the original donor source. Help in designing these breeding plans can be obtained from the Principal Geneticist, FRED Division, (absorbed into Commercial Fisheries Division in 1994) Alaska Department of Fish and Game.

While developing hatchery stocks from wild donor sources it is important that the genetic variability in the donor stock be protected. Cropping of the early or late run segments of a donor stock can change the timing of that run, which will reduce genetic variability of the population and may be detrimental to the stock's prospects for long term survival. To prevent such selection, sliding egg take scales for donor stock transplants should allocate no more than 90% of any segment of a run for broodstock.

RESEARCH

The necessity for much of this policy arises from our ignorance of the genetics of wild salmon populations and the effects of their domestication in hatcheries. The policy is based more on extrapolation from other disciplines such as agriculture than from first-hand knowledge of our resource. As a result, the policy is a somewhat conservative interpretation of these data in order to assure the long-term viability of salmon populations. The Committee has identified several areas in which specific knowledge would clarify this policy and contribute to the effectiveness of salmon enhancement. The Committee encourages cooperative research efforts among the university, state, federal and private sectors directed toward the general areas listed below.

1. Development of performance profiles of hatchery stock and potential for genetic improvement. Information about stocks kept in culture will be useful in several ways. If taken in a standard manner, the data will be useful in determining the extent of variability in the species and will aid in the choice of stock to be used for outplanting or transplanting. The information will also be helpful in maximizing the production of a particular facility.
2. Potential for genetic improvement of cultured stocks. A sequel to the cataloging of the variability within and among stocks will be to experimentally assess the potential for genetic improvement by selective breeding. To do this, it is necessary to determine the heritability for traits of interest, which is the part of the phenotypic variability present in a population which results from genetic (heritable) causes as opposed to environmental causes. Traits such as size of adults, age of return and various timing parameters are particularly interesting to industry. Application of artificial selection is responsible for the enormous advances that have been made in agriculture; the potential also exists in aquaculture.

3. Assessment of the effect of introgression of genes from hatchery fish into wild populations. To examine this effect, one must first have an estimate of the rate of straying and the factors that influence straying. Such factors might include transplant distance, run strength, source of the hatchery stock and year-to-year environmental differences. By using a genetically marked stock, one can monitor the flow of "hatchery genes" into other populations. Because the effect of such introgression may develop over time, it is necessary that such an experiment be conducted over several generations. For this kind of study, it may be necessary to develop a means for marking fish cultured at production levels.

   The second part of this problem is to establish the impact of introgression. A range of potential interactions is possible ranging from introgression between 2 unrelated stocks to the introgression of fish subject to the selective pressures of a hatchery back into the wild stock from which they were derived. Research to examine these effects could best be done in an experimental hatchery where hybrid stocks could be produced and all releases marked. Port sampling and stream walking would be necessary to evaluate survival, straying and other phenotypic effects.

4. The effects of inbreeding and maintenance of inbred lines. Accompanying the artificial propagation of a species is the potential for inbreeding, loss of genetic variability and increased homozygosity. Information pertinent to the extent of inbreeding depression that results from various levels of inbreeding is necessary in determining adequate effective population sizes. This is especially important for species for which a large effective population size is difficult to maintain. In addition, this information would permit a judgment on the efficacy of enhancing very small remnant populations. This work could be done both by performing crosses designed to accomplish some level of inbreeding, and by the maintenance of small randomly breeding populations. In both cases, it is important to keep careful controls.

Appendix A

The relationship of breeding structure, effective population size, and rate of inbreeding.

Breeding structure can profoundly affect effective breeding size (N_e) of a population. We can, at least in theory, determine the effective breeding size for many breeding structures and obtain the rate of inbreeding (AF) as

$$AF = 1/2\ N_e$$

directly relating variation in breeding structure to loss of genetic variation. (Falconer. 1981) The following demonstrates the consequence of some breeding structures to effective population size.

Number of males and females: Unequal numbers of males and females in the breeding population reduce effective population size. Sex ratio is related to effective population number (N_e) as

$$N_e = 4NmNf/(Nm = Nf)$$

where Nm and Nf refer to the total number of males and females respectively. The effective population size is strongly influenced by the number of the least frequent sex.

Unequal numbers in successive generations: If the numbers of breeding individuals is not constant in successive generations the mean effective number is the harmonic mean of the number in each generation. Over generations the effective number is approximately,

$$1/Ne = 1/t(1/N1 + 1/N2 + 1/N3 + \ldots\ldots\ldots 1/Nt).$$

The generation that has the smallest number will have the largest effect.

Nonrandom distribution of offspring among families: When there is large variation in family size the next generation is made up of the progeny of a smaller than expected number of parents. This can be related to loss of genetic variation through effective population number as

$$N_e = 4N/(Vk + 2)$$

where Vk refers to the variance in family size. When variation of family size Vk is equal to 2, then N = N. When the number of males and females are unequal, the variance of family size may be unequal in the 2 sexes and

$$N_e = 8N(Vkm + Vkf + 4)$$

where Vkm and Vkf are the variance of family size for males and females respectively.

Overlapping generations: In species other than pink generations are not discrete, they are overlapping. When generations overlap the effective population size is

$$N_e = 4NcL\ (Vkm + 2)$$

When where L is the generation time and Nc is the number of individuals born in a year, that is the cohort size. The cohort size Nc is related to the total number (Nt) by Nc = Nt/E and E is the mean age at death. As before Vkm is the variation of family size. The effect of unequal sex ratio and unequal numbers in successive generations on population size can be easily estimated. On the other hand it will be difficult or perhaps impossible to estimate the variance of family size. Nevertheless, we should keep in mind the relationships of family size and overlapping generations. Overlapping generations will in general increase the effective population number in that individuals mating in different years contribute to greater diversity. Variance of family size can radically reduce effective population size. Procedures that contribute to variance of family size or separation of year classes should be avoided.

Background of the Genetics Policy of the Alaska Department of Fish and Game

by
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INTRODUCTION

The salmon industry of Alaska is dependent on production of salmon from wild populations. In the early 1970s, a system of public and private nonprofit hatcheries was created for the rehabilitation and enhancement of salmon populations. This came about largely because of several years of very low returns of salmon to many areas of Alaska. This depression of wild stocks was coupled with increases in knowledge of incubation and rearing requirements of salmon. However, the importance of the wild stocks of salmon to the state economy was recognized as paramount. It was also understood that the development and operation of a hatchery system could, if not done with care, have a detrimental impact on wild salmon populations. There has never been any intent to replace wild populations with hatchery fish. The intention is to augment wild production and, perhaps, even reduce fishing pressure on wild systems. A provisional genetic policy was developed in 1975 by the Department of Fish and Game (ADF&G) to protect wild stocks from enhancement activities. It has been revised twice (1978 and 1985). The revisions have extended the policy by developing guidelines that provide for the application of genetic principals to the development and management of broodstock for the hatchery system. The revisions also clarify the rationale for the policy guidelines, and reduce ambiguity in the policy. Protection of wild stocks remains the principal objective of the genetic policy.

Our goal is to discuss the genetic policy and the genetic principles on which it is based. We also will discuss some of the problems encountered in trying to implement the policy.

Finally, we will review the policy in an attempt to determine if, in its present form, it achieves the objectives for which it was developed.

PROBLEM

Genetic impacts to wild, indigenous fish stocks becomes a possibility when man decides to (a) transport fish from one locale and release them in another, and (b) when man decides to create by artificial means (hatcheries) fish to supplant those produced by nature. It is important to recognize that to conduct these activities does not automatically mean that genetic impact to wild stocks will follow. The attention man gives to preventing impact will determine whether any impact ensues. While not a topic for discussion here, it should be mentioned that the most clearly demonstrable genetic impact to wild salmon has been produced by commercial harvest.

What are the potential genetic hazards to wild fish populations brought by transport associated with enhancement? There are two. The first hazard is with the effects of gene flow between fish stocks. Gene flow occurs naturally between local stocks of the same species, but our concern is that fish released either at a hatchery or off-station may stray and interbreed with local wild stocks. If these stray fish are poorly adapted to the environment, the fitness of the local stocks potentially can be impacted. It is presumed that wild stocks have been adapted by natural selection to their native environment. Interbreeding with hatchery fish or transplanted wild fish, because these have adapted to a different environment, could reduce the fitness of the local stock. Although we are primarily interested in protection of wild fish stocks, the same dangers exist for hatchery brood stocks.

The second area of concern is with maintaining adequate genetic diversity both within and between fish populations. There are two components to the diversity in a species. There is the variation within each stock and also the diversity among stocks. Both of these components are important to the well-being of the species.

GENETIC CONCERNS

The science of Population Genetics has been developed over the past 70 years. It is true that there is little, if any, direct information on the genetic impacts of salmon enhancement on wild salmon stocks. However, there is a large body of theoretical and experimental work; the experimental work has been based on a wide variety of plants and animals other than fish. We have applied that body of knowledge to the development of the genetic policy.

<u>What We Know</u>

Genetic Variability and Fitness:

Our approach to policy development has been based on principles of population genetics theory. Population genetics deals with diversity, phenotypic diversity but, especially, with that portion of diversity that is caused by difference in genotype among individuals. A great deal of effort in population genetics is expended in determining the amount of genetic variation that exists both within and between natural populations. Genetic variability is the raw material which allows a population to adapt to its environment. Genetic variation, in addition, seems to increase the physiological stability of individuals and populations. In addition to genetic variability, a central factor in salmon population genetics is population structure. Salmon stocks home with remarkable precision to their “home” stream to spawn. Behavioral barriers to gene flow result in a significant degree of genetic diversity among salmon stocks. The amount of diversity is dependent on a number of factors, such as time since stocks separated and amount of gene flow between stocks. The amount of gene flow may be related to distance between stocks, or other impediments to migration.

Fitness can be defined as the probability that an individual will survive from conception to reproduction. However, we are primarily interested in the average fitness of the population or stock. It is very difficult to measure the total fitness of an individual because of the complexity of the trait. Anything that can increase or decrease the chance of an individual’s survival to maturity affects the fitness of that individual and, therefore, the average fitness of the population to which it belongs. Any loss of genetic variation results in a loss of fitness, but any gain in genetic variation may or may not improve fitness.

<u>What We Think We Know</u>

It follows from what we know about population genetics theory that wild stocks must be approximately in genetic equilibrium. Being in genetic equilibrium means that though the population is constantly subject to natural selection tending to increase fitness, the gene frequencies remain relatively stable and fitness does not improve. The reason this is the case is that additive genetic variance (that portion of genetic variance that will respond to selection) will, over time, have been removed from the population by natural selection. (This has been called the “Red Queen” hypothesis after the character in Alice In Wonderland who said it was necessary to run as fast as they could to stay where they were.) Therefore, a wild stock at any particular location is assumed to be close to maximum fitness and, therefore, the stock best adapted for that location. We assume also that transplanted salmon will not home as accurately to the new location, at least initially, as native salmon. Homing of some transplanted salmon has improved rapidly over the first few generations at a new location. This lends support to our assumption.

Finally, genetic distance and geographic distance are assumed to be correlated. Although salmon home with a remarkable degree of accuracy, there is some straying. Chances are that they stray into nearby streams with greater regularity than into more distant streams. It is not unreasonable, therefore, to assume that gene flow between neighboring stocks would result in genetic similarity. Having made that assumption, we have to recognize that there will be exceptions to this general rule. Life history characteristics, environmental features, and geological formations can effectively block gene flow between stocks that are geographically close.

Given these assumptions, we might also consider factors that would enter into an objective consideration of any proposed enhancement project. What is the environment to which salmon adapt? We should recognize that the environment of a salmon population is extremely complex. First, their environment encompasses both freshwater and marine habitats. Both environments vary spatially as well as temporally. In addition, it seems clear that salmon populations are characterized by a great deal of plasticity. Most salmon stocks are able to physiologically adapt to a wide variety of environmental conditions. Further, much mortality in salmon populations is due to pure chance or phenotypic difference rather than genetic selection. "Much differential survival and fertility is purely accidental – an animal may survive because it happens to be in the right place at the right time. This is especially true of organisms that produce a great excess of progeny of which only a few survive to maturity" (Crow and Kimura, An Introduction to Population Genetic Theory, 1970. Harper and Row, New York). Many of the assumptions on which we base our policy decisions are tied to the notion that the genetic composition of indigenous wild salmon is determined primarily by selection. The value of these assumptions is not necessarily negated by the understanding that many differences between stocks have arisen by chance, and environment can perpetuate phenotypic differences without the populations undergoing genetic change. Our basic assumptions represent the most conservative approach to policy; however, we must recognize that these unknowns exist.

SOLUTION

The genetic policy is the solution to the problem of development of a salmon enhancement program while protecting wild salmon populations. As stated earlier, the genetic policy was developed in 1975 to protect wild stocks from possible detrimental effects of artificial propagation and management practices. However, since public and private nonprofit hatcheries have come on-line and proven successful, additional guidelines have been added to protect hatchery and enhanced stocks. The policy was reviewed and revised in 1978, and again in 1985. The purpose of the genetic policy is still to protect wild stocks. The following describes pertinent genetic considerations and how these have influenced the development of the genetic policy.

From the beginning of enhancement efforts, there has been a recognized need for controls on the movement of salmon stocks. The Fish Transport Permit (FTP) was developed to provide control of fish transport. In order for anyone to transport, possess, export from the state, or release fish into the waters of the state, they must hold an FTP issued by the Commissioner of ADF&G. Each FTP is reviewed and commented on by selected staff of ADF&G.

Control of fish transport is the only method available for limiting gene flow into fish stocks that need to be protected. Indiscriminate movement of stocks can result in decreased genetic diversity among stocks. Development of criteria for the genetic review of FTP applications has been a problem since the permit was established. Specific knowledge of salmon population genetics and the genetic impacts of salmon enhancement on wild stocks is limited. Consequently, the genetic policy is based more on information from agriculture genetics and population genetics of other species than on knowledge of our own salmon resources. The result is a policy containing guidelines that are rather flexible. We have tried to develop nonambiguous criteria for judging fish transport permits. The policy suggests that because our knowledge is limited, we should apply the policy and presumably evaluate the FTPs conservatively. An attempt to act conservatively gives the appearance of being arbitrary and begs the comment that the policy is too ambiguous. Unfortunately, the present level of our knowledge forces us to be somewhat ambiguous in our guidelines. Conservative application of the genetic policy can occur only if we set somewhat arbitrary limits based on what we know about the genetics of populations.

APPLYING GENETIC POLICY

When stocks are moved, wild salmon are subjected to increased danger of genetic impact. Direct genetic impact requires first that gene flow occur from the transplanted stock to the indigenous wild stock and, second, requires that the fitness of the wild stock be reduced. Simple, starch gel electrophoresis of tissue proteins can often detect whether or not gene flow has occurred between two salmon stocks. But to prove genetic impact conclusively, it is necessary to demonstrate that the fitness of the indigenous wild stock has been reduced. Fitness is measured in terms of production of biomass by the stock, and any change in fitness must be a measure of that change in production ascribable only to gene substitution. Numerous environmental variables, both biotic and abiotic, also influence production by the stock, and so it borders on the impossible to measure any change in fitness (production) due to gene flow. Year-to-year variation in production due to this set of other variables masks any reduction in fitness that could be expected over a period of time. Hence, changes in fitness of salmon stocks due to interbreeding have never been measured. So it follows that direct genetic impact due to interbreeding has never been demonstrated in salmon.

The genetic policy has been developed to provide guidelines that will allow development of a hatchery/enhancement program while minimizing the potential for genetic impacts on wild stocks to an acceptable level. Stock interaction must allow for the long-term retention of natural communities under conditions that provide the potential for continuing evolution.

Significant Stocks

Salmon populations vary in size from intermittent runs, which may be maintained by straying, to runs of hundreds of thousands of fish. It seems reasonable that all salmon populations are not of equal importance. The effect of a salmon enhancement project depends to some degree on the relative value of the stock that might be impacted. The concept of significant stocks arose out of such considerations. Early versions of the policy (1975 and 1978) distinguished between introductions into systems with large indigenous stocks and into systems with few or no indigenous fish. The earlier policies made no attempt to set limits on population size but clearly had introduced the concept of significant stocks. The 1985 review and revision of the genetic policy was initiated because of a need to remove ambiguity and increase consistency in application of the policy. Members of the review committee were unable to define the term, “significant stock,” but did develop an approach to the problem. The committee felt that, while the size of the population is important, “significance” must be defined not only by the magnitude of the run, but also in context of local importance and utilization. The committee suggested as well that “Because local utilization is an important concern, a regional planning group such as the Salmon Enhancement Regional Planning Teams should consider what criteria will be used to determine significant stocks within a region and recommend such stock designations.” At this time, these suggestions have not been implemented.

Genetic and Geographic Distance

The idea that genetic distance and geographic distance are correlated has also been used in developing and applying the genetic policy. We are led to this idea by two facts of salmon biology. Salmon stocks home to their own spawning grounds with some accuracy and adapt to that particular environment. This tends to cause some degree of genetic separation between stocks. However, there must be background levels of straying occurring between local salmon stocks. The fact that salmon species will repopulate barren streams is evidence that salmon stray; however, straying may also lead to reduced fitness of a recipient stock.

Background levels of straying occur between neighboring, thus genetically similar, stocks. We become concerned when stocks that have been transported from distant locales stray because they are not genetically similar to local stocks. The chance that strays from one stock will interbreed with another is dependent on the distance between the two stocks. It would seem to follow that, other things being equal, two stocks that are separated by a short distance will be more alike genetically than two stocks that are separated by a greater distance. Every stock will have its own sphere of influence, circumscribed by the straying of its members. The influence of each stock will decrease with distance from its home stream.

Changes of location on the globe result in changes in the environment. That is, in general, environment also changes as a function of distance. This, coupled with the fact that natural selection works to adapt a stock to its environment, lends support to the assumption that genetic differences between stocks separated by a great distance are larger than genetic differences between neighboring stocks.

This relationship between genetic similarity and distance leads to two conclusions: First, local stocks transplanted to a site will have less genetic impact on indigenous populations because of their genetic similarity than stocks transplanted from a greater distance; and, second, stocks local to an area are best suited for transplant within the area or for development of a brood stock at a site within the area.

Salmon stocks have a genetic sphere of influence because of their life history characteristics. All stocks interact genetically with those around them. This concept has governed the way the genetic policy has been applied. It seems obvious as well that each hatchery or enhanced population will also have a genetic sphere of influence. The larger the production of the wild stock, hatchery stock, or enhanced stock, the greater its influence will be on surrounding stocks.

The effect of these genetic spheres of influence is that decisions made in the past seem bound to limit options for future projects. Consider what it means when all stocks influence and, in turn, are influenced by those around them. Transplanted stocks will impact the genetic composition of stocks adjacent to the release site. Because we assume that wild stocks are in approximate equilibrium, we must assume also that any genetic impact caused by a stock adapted to a different environment (a transplanted stock) will result in some loss of fitness to the indigenous wild stock. The reduction may not be critical; it is impossible to know. It is conceivable that the indigenous wild stock will derive some benefit from the introduction of genetic variation. The result would probably depend on the amount of gene flow that occurs. The amount of gene flow would depend, in turn, on ability to manage the enhanced stock so that straying of returns would be minimized. It would also depend on the degree of genetic difference between stocks and the reproductive success of the straying fish. This aspect of salmon population genetics is not understood. This problem reemphasizes the need to apply the genetic policy conservatively.

Transplants will modify to some degree the genetic composition of local stocks. When remote stocks are transplanted to areas with significant wild stocks, the wild stocks in this locale are changed to some degree genetically, and their status must be reconsidered. Future options may have been limited.

<u>Multiple Use of Stocks</u>

It is important to build stock diversity into the hatchery system. Salmon stocks differ in levels of disease resistance, temperature tolerance, acid tolerance, and in response to artificial selection. Stock diversity will tend to buffer the hatchery system against both natural and man-made disasters. Further, the ability to genetically improve hatchery brood stock performance in the future depends on the availability of genetic variability. Such variability would be present in a hatchery system with a variety of diverse brood stocks.

There is an apparent conflict between the need for stock diversity in the hatchery system and the need to start up individual hatcheries as economically as possible. It is more economical in the short run to develop a hatchery brood stock from excess eggs of an existing brood stock than from a wild source. And, it is difficult to place a monetary value on the long-term value of stock diversity. The genetic policy limits to three the number of hatchery brood stocks that can be established from a single donor. It does not limit the number of release sites for terminal harvest. This limit on multiple use of stocks balances the need for short-term economy and the need to establish and maintain genetic diversity. It will limit the spread of a single stock.

CONCLUSION

Can the genetic policy in its present form be applied in a way that will achieve the objectives for which it was developed? The answer is yes. Although there is an inherent risk to wild stocks from the development and operation of a hatchery/enhancement program, this risk can be managed by reducing the genetic impact on wild stocks to an acceptable level. The need is not to avoid all genetic change, but to allow for the long-term retention of natural communities under conditions that would provide for continuing evolution. To achieve this goal, we have to apply the genetic policy conservatively. This means that if we know, for example, that genetic similarity decreases with distance and our decisions are not to be ambiguous, we must set arbitrary limits on distance a stock can be transported. An effective genetic policy must allow for implementing successful enhancement activities while protecting and maintaining healthy wild stocks. There are only two primary genetic concerns in protecting wild stocks and implementing a successful enhancement program. The first concern is possible genetic impacts due to gene flow into wild or enhanced stocks. The second concern is the loss of genetic variation within or among stocks. We are obviously concerned with both wild and enhanced stocks. However, Alaska's valuable salmon industry is founded on production from wild stocks, and wild stocks are the source of genetic variation for development of enhanced stocks; therefore, our primary concern is wild stocks. Both gene flow and loss of genetic variation can potentially cause the reduction of total fitness in wild stocks and hatchery broodstocks. The genetic policy addresses these problems in its three main topic areas. The topics addressed are Stock Transport, Protection of Wild Stocks, and the Maintenance of Genetic Variance. The genetic policy addresses the genetic concerns adequately. The policy describes the genetic concerns and presents guidelines that protect wild stocks from impacts of enhancement activities, as well as protecting hatchery brood stocks and enhanced stocks from the problems associated with loss of genetic variation.

The only problems with the policy are those of perception. It is our hope that this paper will serve to promote a better understanding of the policy. One important task remains to be accomplished: The Genetic Policy Review Committee (1985) outlined an approach to the problem of defining significant and unique wild stocks. Any designation of stocks as significant or nonsignificant will be arbitrary. However, some means of defining these terms is critical to the successful application of the genetic policy and must be found.

APPENDIX G: 5 AAC 39.222. POLICY FOR THE MANAGEMENT OF SUSTAINABLE SALMON FISHERIES

(a) The Board of Fisheries (board) and Department of Fish and Game (department) recognizes that

(1) while, in the aggregate, Alaska's salmon fisheries are healthy and sustainable largely because of abundant pristine habitat and the application of sound, precautionary, conservation management practices, there is a need for a comprehensive policy for the regulation and management of sustainable salmon fisheries;

(2) in formulating fishery management plans designed to achieve maximum or optimum salmon production, the board and department must consider factors including environmental change, habitat loss or degradation, data uncertainty, limited funding for research and management programs, existing harvest patterns, and new fisheries or expanding fisheries;

(3) to effectively assure sustained yield and habitat protection for wild salmon stocks, fishery management plans and programs require specific guiding principles and criteria, and the framework for their application contained in this policy.

(b) The goal of the policy under this section is to ensure conservation of salmon and salmon's required marine and aquatic habitats, protection of customary and traditional subsistence uses and other uses, and the sustained economic health of Alaska's fishing communities.

(c) Management of salmon fisheries by the state should be based on the following principles and criteria:

(1) wild salmon stocks and the salmon's habitats should be maintained at levels of resource productivity that assure sustained yields as follows:

(A) salmon spawning, rearing, and migratory habitats should be protected as follows:

(i) salmon habitats should not be perturbed beyond natural boundaries of variation;

(ii) scientific assessments of possible adverse ecological effects of proposed habitat alterations and the impacts of the alterations on salmon populations should be conducted before approval of a proposal;

(iii) adverse environmental impacts on wild salmon stocks and the salmon's habitats should be assessed;

(iv) all essential salmon habitat in marine, estuarine, and freshwater ecosystems and access of salmon to these habitats should be protected; essential habitats include spawning and incubation areas, freshwater rearing areas, estuarine and nearshore rearing areas, offshore rearing areas, and migratory pathways;

(v) salmon habitat in fresh water should be protected on a watershed basis, including appropriate management of riparian zones, water quality, and water quantity;

(B) salmon stocks should be protected within spawning, incubating, rearing, and migratory habitats;

(C) degraded salmon productivity resulting from habitat loss should be assessed, considered, and controlled by affected user groups, regulatory agencies, and boards when making conservation and allocation decisions;

(D) effects and interactions of introduced or enhanced salmon stocks on wild salmon stocks should be assessed; wild salmon stocks and fisheries on those stocks should be protected from adverse impacts from artificial propagation and enhancement efforts;

(E) degraded salmon spawning, incubating, rearing, and migratory habitats should be restored to natural levels of productivity where known and desirable;

(F) ongoing monitoring should be conducted to determine the current status of habitat and the effectiveness of restoration activities;

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(G) depleted salmon stocks should be allowed to recover or, where appropriate, should be actively restored; diversity should be maintained to the maximum extent possible, at the genetic, population, species, and ecosystem levels;

(2) salmon fisheries shall be managed to allow escapements within ranges necessary to conserve and sustain potential salmon production and maintain normal ecosystem functioning as follows:

(A) salmon spawning escapements should be assessed both temporally and geographically; escapement monitoring programs should be appropriate to the scale, intensity, and importance of each salmon stock's use;

(B) salmon escapement goals, whether sustainable escapement goals, biological escapement goals, optimal escapement goals, or inriver run goals, should be established in a manner consistent with sustained yield; unless otherwise directed, the department will manage Alaska's salmon fisheries, to the extent possible, for maximum sustained yield;

(C) salmon escapement goal ranges should allow for uncertainty associated with measurement techniques, observed variability in the salmon stock measured, changes in climatic and oceanographic conditions, and varying abundance within related populations of the salmon stock measured;

(D) salmon escapement should be managed in a manner to maintain genetic and phenotypic characteristics of the stock by assuring appropriate geographic and temporal distribution of spawners as well as consideration of size range, sex ratio, and other population attributes;

(E) impacts of fishing, including incidental mortality and other human-induced mortality, should be assessed and considered in harvest management decisions;

(F) salmon escapement and harvest management decisions should be made in a manner that protects non-target salmon stocks or species;

(G) the role of salmon in ecosystem functioning should be evaluated and considered in harvest management decisions and setting of salmon escapement goals;

(H) salmon abundance trends should be monitored and considered in harvest management decisions;

(3) effective management systems should be established and applied to regulate human activities that affect salmon as follows:

(A) salmon management objectives should be appropriate to the scale and intensity of various uses and the biological capacities of target salmon stocks;

(B) management objectives should be established in harvest management plans, strategies, guiding principles, and policies, such as for mixed stock fishery harvests, fish disease, genetics, and hatchery production, that are subject to periodic review;

(C) when wild salmon stocks are fully allocated, new fisheries or expanding fisheries should be restricted, unless provided for by management plans or by application of the board's allocation criteria;

(D) management agencies should have clear authority in statute and regulation to

(i) control all sources of fishing mortality on salmon;

(ii) protect salmon habitats and control non-fishing sources of mortality;

(E) management programs should be effective in

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(i) controlling human-induced sources of fishing mortality and should incorporate procedures to assure effective monitoring, compliance, control, and enforcement;

(ii) protecting salmon habitats and controlling collateral mortality and should incorporate procedures to assure effective monitoring, compliance, control, and enforcement;

(F) fisheries management implementation and outcomes should be consistent with regulations, regulations should be consistent with statutes, and effectively carry out the purpose of this section;

(G) the board will recommend to the commissioner the development of effective joint research, assessment, and management arrangements with appropriate management agencies and bodies for salmon stocks that cross state, federal, or international jurisdictional boundaries; the board will recommend the coordination of appropriate procedures for effective monitoring, compliance, control, and enforcement with those of other agencies, states, or nations;

(H) the board will work, within the limits of its authority, to assure that

(i) management activities are accomplished in a timely and responsive manner to implement objectives, based on the best available scientific information;

(ii) effective mechanisms for the collection and dissemination of information and data necessary to carry out management activities are developed, maintained, and utilized;

(iii) management programs and decision-making procedures are able to clearly distinguish, and effectively deal with, biological and allocation issues;

(I) the board will recommend to the commissioner and legislature that adequate staff and budget for research, management, and enforcement activities be available to fully implement sustainable salmon fisheries principles;

(J) proposals for salmon fisheries development or expansion and artificial propagation and enhancement should include assessments required for sustainable management of existing salmon fisheries and wild salmon stocks;

(K) plans and proposals for development or expansion of salmon fisheries and enhancement programs should effectively document resource assessments, potential impacts, and other information needed to assure sustainable management of wild salmon stocks;

(L) the board will work with the commissioner and other agencies to develop effective processes for controlling excess fishing capacity;

(M) procedures should be implemented to regularly evaluate the effectiveness of fishery management and habitat protection actions in sustaining salmon populations, fisheries, and habitat, and to resolve associated problems or deficiencies;

(N) conservation and management decisions for salmon fisheries should take into account the best available information on biological, environmental, economic, social, and resource use factors;

(O) research and data collection should be undertaken to improve scientific and technical knowledge of salmon fisheries, including ecosystem interactions, status of salmon populations, and the condition of salmon habitats;

(P) the best available scientific information on the status of salmon populations and the condition of the salmon's habitats should be routinely updated and subject to peer review;

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(4) public support and involvement for sustained use and protection of salmon resources should be sought and encouraged as follows:

(A) effective mechanisms for dispute resolution should be developed and used;

(B) pertinent information and decisions should be effectively disseminated to all interested parties in a timely manner;

(C) the board's regulatory management and allocation decisions will be made in an open process with public involvement;

(D) an understanding of the proportion of mortality inflicted on each salmon stock by each user group, should be promoted, and the burden of conservation should be allocated across user groups in a manner consistent with applicable state and federal statutes, including AS 16.05.251 (e) and AS 16.05.258 ; in the absence of a regulatory management plan that otherwise allocates or restricts harvests, and when it is necessary to restrict fisheries on salmon stocks where there are known conservation problems, the burden of conservation shall be shared among all fisheries in close proportion to each fisheries' respective use, consistent with state and federal law;

(E) the board will work with the commissioner and other agencies as necessary to assure that adequately funded public information and education programs provide timely materials on salmon conservation, including habitat requirements, threats to salmon habitat, the value of salmon and habitat to the public and ecosystem (fish and wildlife), natural variability and population dynamics, the status of salmon stocks and fisheries, and the regulatory process;

(5) in the face of uncertainty, salmon stocks, fisheries, artificial propagation, and essential habitats shall be managed conservatively as follows:

(A) a precautionary approach, involving the application of prudent foresight that takes into account the uncertainties in salmon fisheries and habitat management, the biological, social, cultural, and economic risks, and the need to take action with incomplete knowledge, should be applied to the regulation and control of harvest and other human-induced sources of salmon mortality; a precautionary approach requires

(i) consideration of the needs of future generations and avoidance of potentially irreversible changes;

(ii) prior identification of undesirable outcomes and of measures that will avoid undesirable outcomes or correct them promptly;

(iii) initiation of any necessary corrective measure without delay and prompt achievement of the measure's purpose, on a time scale not exceeding five years, which is approximately the generation time of most salmon species;

(iv) that where the impact of resource use is uncertain, but likely presents a measurable risk to sustained yield, priority should be given to conserving the productive capacity of the resource;

(v) appropriate placement of the burden of proof, of adherence to the requirements of this subparagraph, on those plans or ongoing activities that pose a risk or hazard to salmon habitat or production;

(B) a precautionary approach should be applied to the regulation of activities that affect essential salmon habitat.

(d) The principles and criteria for sustainable salmon fisheries shall be applied, by the department and the board using the best available information, as follows:

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(1) at regular meetings of the board, the department will, to the extent practicable, provide the board with reports on the status of salmon stocks and salmon fisheries under consideration for regulatory changes, which should include

(A) a stock-by-stock assessment of the extent to which the management of salmon stocks and fisheries is consistent with the principles and criteria contained in the policy under this section;

(B) descriptions of habitat status and any habitat concerns;

(C) identification of healthy salmon stocks and sustainable salmon fisheries;

(D) identification of any existing salmon escapement goals, or management actions needed to achieve these goals, that may have allocative consequences such as the

(i) identification of a new fishery or expanding fishery;

(ii) identification of any salmon stocks, or populations within stocks, that present a concern related to yield, management, or conservation; and

(iii) description of management and research options to address salmon stock or habitat concerns;

(2) in response to the department's salmon stock status reports, reports from other resource agencies, and public input, the board will review the management plan, or consider developing a management plan, for each affected salmon fishery or stock; management plans will be based on the principles and criteria contained in this policy and will

(A) contain goals and measurable and implementable objectives that are reviewed on a regular basis and utilize the best available scientific information;

(B) minimize the adverse effects on salmon habitat caused by fishing;

(C) protect, restore, and promote the long-term health and sustainability of the salmon fishery and habitat;

(D) prevent overfishing; and

(E) provide conservation and management measures that are necessary and appropriate to promote maximum or optimum sustained yield of the fishery resource;

(3) in the course of review of the salmon stock status reports and management plans described in (1) and (2) of this subsection, the board, in consultation with the department, will determine if any new fisheries or expanding fisheries, stock yield concerns, stock management concerns, or stock conservation concerns exist; if so, the board will, as appropriate, amend or develop salmon fishery management plans to address these concerns; the extent of regulatory action, if any, should be commensurate with the level of concerns and range from milder to stronger as concerns range from new and expanding salmon fisheries through yield concerns, management concerns, and conservation concerns;

(4) in association with the appropriate management plan, the department and the board will, as appropriate, collaborate in the development and periodic review of an action plan for any new or expanding salmon fisheries, or stocks of concern; action plans should contain goals, measurable and implementable objectives, and provisions, including

(A) measures required to restore and protect salmon habitat, including necessary coordination with other agencies and organizations;

(B) identification of salmon stock or population rebuilding goals and objectives;

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(C) fishery management actions needed to achieve rebuilding goals and objectives, in proportion to each fishery's use of, and hazards posed to, a salmon stock;

(D) descriptions of new or expanding salmon fisheries, management concern, yield concern, or conservation concern; and

(E) performance measures appropriate for monitoring and gauging the effectiveness of the action plan that are derived from the principles and criteria contained in this policy;

(5) each action plan will include a research plan as necessary to provide information to address concerns; research needs and priorities will be evaluated periodically, based on the effectiveness of the monitoring described in (4) of this subsection;

(6) where actions needed to regulate human activities that affect salmon and salmon's habitat that are outside the authority of the department or the board, the department or board shall correspond with the relevant authority, including the governor, relevant boards and commissions, commissioners, and chairs of appropriate legislative committees, to describe the issue and recommend appropriate action.

(e) Nothing in the policy under this section is intended to expand, reduce, or be inconsistent with, the statutory regulatory authority of the board, the department, or other state agencies with regulatory authority that impacts the fishery resources of the state.

(f) In this section, and in implementing this policy,

(1) "allocation" means the granting of specific harvest privileges, usually by regulation, among or between various user groups; "allocation" includes quotas, time periods, area restrictions, percentage sharing of stocks, and other management measures providing or limiting harvest opportunity;

(2) "allocation criteria" means the factors set out in AS 16.05.251 (e) considered by the board as appropriate to particular allocation decisions under 5 AAC 39.205, 5 AAC 75.017, and 5 AAC 77.007;

(3) "biological escapement goal" or "(BEG)" means the escapement that provides the greatest potential for maximum sustained yield; BEG will be the primary management objective for the escapement unless an optimal escapement or inriver run goal has been adopted; BEG will be developed from the best available biological information, and should be scientifically defensible on the basis of available biological information; BEG will be determined by the department and will be expressed as a range based on factors such as salmon stock productivity and data uncertainty; the department will seek to maintain evenly distributed salmon escapements within the bounds of a BEG;

(4) "burden of conservation" means the restrictions imposed by the board or department upon various users in order to achieve escapement, rebuild, or in some other way conserve a specific salmon stock or group of stocks; this burden, in the absence of a salmon fishery management plan, will be generally applied to users in close proportion to the users' respective harvest of the salmon stock;

(5) "chronic inability" means the continuing or anticipated inability to meet escapement thresholds over a four to five year period, which is approximately the generation time of most salmon species;

(6) "conservation concern" means concern arising from a chronic inability, despite the use of specific management measures, to maintain escapements for a stock above a sustained escapement threshold (SET); a conservation concern is more severe than a management concern;

(7) "depleted salmon stock" means a salmon stock for which there is a conservation concern;

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(8) "diversity", in a biological context, means the range of variation exhibited within any level of organization, such as among genotypes within a salmon population, among populations within a salmon stock, among salmon stocks within a species, among salmon species within a community, or among communities within an ecosystem;

(9) "enhanced salmon stock" means a stock of salmon that is undergoing specific manipulation, such as hatchery augmentation or lake fertilization, to enhance its productivity above the level that would naturally occur; "enhanced salmon stock" includes an introduced stock, where no wild salmon stock had occurred before, or a wild salmon stock undergoing manipulation, but does not include a salmon stock undergoing rehabilitation, which is intended to restore a salmon stock's productivity to a higher natural level;

(10) "escapement" means the annual estimated size of the spawning salmon stock; quality of the escapement may be determined not only by numbers of spawners, but also by factors such as sex ratio, age composition, temporal entry into the system, and spatial distribution within the salmon spawning habitat;

(11) "expanding fishery" means a salmon fishery in which effective harvesting effort has recently increased significantly beyond historical levels and where the increase has not resulted from natural fluctuations in salmon abundance;

(12) "expected yields" mean levels at or near the lower range of recent historic harvests if they are deemed sustainable;

(13) "genetic" means those characteristics (genotypic) of an individual or group of salmon that are expressed genetically, such as allele frequencies or other genetic markers;

(14) "habitat concern" means the degradation of salmon habitat that results in, or can be anticipated to result in, impacts leading to yield, management, or conservation concerns;

(15) "harvestable surplus" means the number of salmon from a stock's annual run that is surplus to escapement needs and can reasonably be made available for harvest;

(16) "healthy salmon stock" means a stock of salmon that has annual runs typically of a size to meet escapement goals and a potential harvestable surplus to support optimum or maximum sustained yield;

(17) "incidental harvest" means the harvest of fish, or other species, that is captured in addition to the target species of a fishery;

(18) "incidental mortality" means the mortality imposed on a salmon stock outside of directed fishing, and mortality caused by incidental harvests, interaction with fishing gear, habitat degradation, and other human-related activities;

(19) "inriver run goal" means a specific management objective for salmon stocks that are subject to harvest upstream of the point where escapement is estimated; the inriver run goal will be set in regulation by the board and is comprised of the SEG, BEG, or OEG, plus specific allocations to inriver fisheries;

(20) "introduced stock" means a stock of salmon that has been introduced to an area, or portion of an area, where that stock had not previously occurred; an "introduced salmon stock" includes a salmon stock undergoing continued enhancement, or a salmon stock that is left to sustain itself with no additional manipulation;

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(21) "management concern" means a concern arising from a chronic inability, despite use of specific management measures, to maintain escapements for a salmon stock within the bounds of the SEG, BEG, OEG, or other specified management objectives for the fishery; a management concern is not as severe as a conservation concern;

(22) "maximum sustained yield" or "(MSY)" means the greatest average annual yield from a salmon stock; in practice, MSY is achieved when a level of escapement is maintained within a specific range on an annual basis, regardless of annual run strength; the achievement of MSY requires a high degree of management precision and scientific information regarding the relationship between salmon escapement and subsequent return; the concept of MSY should be interpreted in a broad ecosystem context to take into account species interactions, environmental changes, an array of ecosystem goods and services, and scientific uncertainty;

(23) "mixed stock fishery" means a fishery that harvests fish from a mixture of stocks;

(24) "new fishery" means a fishery that new units of effort or expansion of existing effort toward new species, areas, or time periods, results in harvest patterns substantially different from those in previous years, and the difference is not exclusively the result of natural fluctuations in fish abundance;

(25) "optimal escapement goal" or "(OEG)" means a specific management objective for salmon escapement that considers biological and allocative factors and may differ from the SEG or BEG; an OEG will be sustainable and may be expressed as a range with the lower bound above the level of SET, and will be adopted as a regulation by the board; the department will seek to maintain evenly distributed escapements within the bounds of the OEG;

(26) "optimum sustained yield" or "(OSY)" means an average annual yield from a salmon stock considered to be optimal in achieving a specific management objective other than maximum yield, such as achievement of a consistent level of sustained yield, protection of a less abundant or less productive salmon stock or species, enhancement of catch per unit effort in sport fishery, facilitation of a non-consumptive use, facilitation of a subsistence use, or achievement of a specific allocation;

(27) "overfishing" means a level of fishing on a salmon stock that results in a conservation or management concern;

(28) "phenotypic characteristics" means those characteristics of an individual or group of salmon that are expressed physically, such as body size and length at age;

(29) "rehabilitation" means efforts applied to a salmon stock to restore it to an otherwise natural level of productivity; "rehabilitation" does not include an enhancement, which is intended to augment production above otherwise natural levels;

(30) "return" means the total number of salmon in a stock from a single brood (spawning) year surviving to adulthood; because the ages of adult salmon (except pink salmon) returning to spawn varies, the total return from a brood year will occur over several calendar years; the total return generally includes those mature salmon from a single brood year that are harvested in fisheries plus those that compose the salmon stock's spawning escapement; "return" does not include a run, which is the number of mature salmon in a stock during a single calendar year;

(31) "run" means the total number of salmon in a stock surviving to adulthood and returning to the vicinity of the natal stream in any calendar year, composed of both the harvest of adult salmon plus the escapement; the annual run in any calendar year, except for pink salmon, is composed of several age classes of mature fish from the stock, derived from the spawning of a number of previous brood years;

-continued-

(32) "salmon" means the five wild anadromous semelparous Pacific salmon species *Oncorhynchus sp.*, except steelhead and cutthroat trout, native to Alaska as follows:

(A) Chinook or king salmon (*O. tschawytscha*);

(B) sockeye or red salmon (*O. nerka*);

(C) coho or silver salmon (*O. kisutch*);

(D) pink or humpback salmon (*O. gorbuscha*); and

(E) chum or dog salmon (*O. keta*);

(33) "salmon population" means a locally interbreeding group of salmon that is distinguished by a distinct combination of genetic, phenotypic, life history, and habitat characteristics, comprised of an entire stock or a component portion of a stock; the smallest uniquely identifiable spawning aggregation of genetically similar salmon used for monitoring purposes;

(34) "salmon stock" means a locally interbreeding group of salmon that is distinguished by a distinct combination of genetic, phenotypic, life history, and habitat characteristics or an aggregation of two or more interbreeding groups which occur within the same geographic area and is managed as a unit;

(35) "stock of concern" means a stock of salmon for which there is a yield, management, or conservation concern;

(36) "sustainable escapement goal" or "(SEG)" means a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated or managed for; the SEG is the primary management objective for the escapement, unless an optimal escapement or inriver run goal has been adopted by the board; the SEG will be developed from the best available biological information; and should be scientifically defensible on the basis of that information; the SEG will be determined by the department and will take into account data uncertainty and be stated as either a "SEG range" or "lower bound SEG"; the department will seek to maintain escapements within the bounds of the SEG range or above the level of a lower bound SEG;

(37) "sustainable salmon fishery" means a salmon fishery that persists and obtains yields on a continuing basis; characterized by fishing activities and habitat alteration, if any, that do not cause or lead to undesirable changes in biological productivity, biological diversity, or ecosystem structure and function, from one human generation to the next;

(38) "sustained yield" means an average annual yield that results from a level of salmon escapement that can be maintained on a continuing basis; a wide range of average annual yield levels is sustainable; a wide range of annual escapement levels can produce sustained yields;

(39) "sustained escapement threshold" or "(SET)" means a threshold level of escapement, below which the ability of the salmon stock to sustain itself is jeopardized; in practice, SET can be estimated based on lower ranges of historical escapement levels, for which the salmon stock has consistently demonstrated the ability to sustain itself; the SET is lower than the lower bound of the BEG and lower than the lower bound of the SEG; the SET is established by the department in consultation with the board, as needed, for salmon stocks of management or conservation concern;

(40) "target species" or "target salmon stocks" means the main, or several major, salmon species of interest toward which a fishery directs its harvest;

(41) "yield" means the number or weight of salmon harvested in a particular year or season from a stock;

-continued-

(42) "yield concern" means a concern arising from a chronic inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs; a yield concern is less severe than a management concern, which is less severe than a conservation concern;

(43) "wild salmon stock" means a stock of salmon that originates in a specific location under natural conditions; "wild salmon stock" may include an enhanced or rehabilitated stock if its productivity is augmented by supplemental means, such as lake fertilization or rehabilitative stocking; "wild salmon stock" does not include an introduced stock, except that some introduced salmon stocks may come to be considered "wild" if the stock is self-sustaining for a long period of time;

(44) "action point" means a threshold value for some quantitative indicator of stock run strength at which an explicit management action will be taken to achieve an optimal escapement goal.

History: Eff. 9/30/2000, Register 155; am 11/16/2000, Register 156; am 6/22/2001, Register 158; am 6/10/2010, Register 194

Authority: AS 16.05.251

APPENDIX H: SUMMARY OF YUKON RIVER COMPREHENSIVE SALMON PLAN PUBLIC INPUT

Appendix H1.–Summary of Yukon River comprehensive salmon plan public input.

Date	Location	Meeting
4/29/2016	Anchorage	Yukon River CSP Scoping Workshop
6/14/2016	Fairbanks	Yukon River Regional Planning Team
11/4/2016	Fairbanks	Yukon River Regional Planning Team
1/19-20/2017	Anchorage	Yukon River Regional Planning Team
3/9-10/2017	Fairbanks	Yukon River Regional Planning Team
4/20/2017	Fairbanks	Yukon River CSP outreach meeting
4/21/2017	Fairbanks	Yukon River Regional Planning Team
5/23/2017	Alakanuk	Community outreach meeting
5/24/2017	Saint Mary's	Community outreach meeting
5/25/2017	Hooper Bay	Community outreach meeting
5/26/2017	Russian Mission	Community outreach meeting
6/13/2017	Allakaket	Community outreach meeting
6/15/2017	Fort Yukon	Community outreach meeting
8/9/2017	Galena	Community outreach meeting
8/14/2017	Nenana	Community outreach meeting
8/16/2017	Minto	Community outreach meeting
10/4-5/2017	Fairbanks	Yukon River Regional Planning Team
12/18-19/2017	Anchorage	Yukon River Regional Planning Team

COMMUNITY OUTREACH MEETINGS

Alakanuk CSP Meeting. May 23, 2017
Attendees: George, John, Marvin Paul, Raymond, Sifton Bob, Ken George, Shelby Edmond, Allen, Charles, Doris, Ron
Facilitator: Chris Stark

Three-hour meeting in Tribal Council lodge 12-3pm.
The first hour was used to walk attendees through the agenda and answering questions as we went. Handouts and verbal descriptions were used to describe the Regional Comprehensive Salmon Planning process, the statewide regional CSP's and associated RPT/RAA's, the Yukon River regional planning team (RPT) membership and purpose, statewide hatchery locations, Alaska salmon enhancement and specifically Chinook salmon hatchery production, and the present status of Yukon River salmon stocks. Many attendee questions were centered on basic Chinook salmon biology, high seas by-catch and harvest characteristics (run timing, fish quality).

Comments: all attendees suggest that subsistence is the highest priority/need and that those needs are not being met, however, would like to have harvests like they were in the 1980's and 1990's. Sharing with everyone on the Yukon River was very important. Several attendees expressed concerns with ADFG mismanagement – most believe there must be better ways to share management regulations and methods with fishermen – and to share information in a timely manner with fishermen so as to be more useful.
Suggestions and ideas included; more village visits by managers and/or inclusion with management decision making with specifics on best harvest timing (attendees desire for earlier fishing which would help fish preservation quality), larger mesh size (would like to have 8 inch mesh nets), access to a suite of mesh size nets so they can fish with legal size mesh when required (it is to expensive to buy multiple nets, floats, lead lines). Some would like gas money for subsistence fishing (this assistance is available in some Yukon villages). Fishing openers could be longer to increase efficiency and not be so late in the run timing to make fishing worthwhile due the cost of fishing (gas) and declining catch (rates).

Most attendees understand the reasons for the Chinook salmon restrictions but feel that much of the social structure built around fishing has been diminished and is now being lost to some extent. Several expressed their disappointment with ADFG management, have continued belief that the US high seas fisheries are not being honest with by-catch reporting, and under reporting of foreign fishing fleets salmon interception and other illegal high seas fishing. Many had distrust of Pilot station counting, "big fish were going uncounted because they swim deeper/outside the sonar range." Three fishermen were clearly opposed to hatchery fish (not natural) or traditional, most had no opinion on enhancement or hatcheries, two were interested in learning more and would like to see some examples of Chinook salmon hatchery production. One elder suggested that they no longer feel that management is listening so they (the fishermen) just don't say anything anymore.

Eleven surveys were filled out and collected.

Saint Mary's CSP Meeting. May 24, 2017
Attendees: Bill Alstrom, Richard Alstrom, Mike M. Joe Jr., Christopher Beans
Facilitator: Chris Stark

Three hour meeting in uptown Tribal Council lodge 2-5 pm - cold, windy, snow/rainy weather was likely the reason for the low attendance as meeting notice flyers were well distributed (tribal halls, AC store, schools) and about a dozen fishermen confirmed to be coming earlier in the day did not show up.

The first hour was spent going over the agenda items and answering questions on Chinook salmon harvest, high seas by-catch, harvest characteristics (Canadian vs. US run timing, fish quality, access) and management of Yukon salmon harvest and escapement. Handouts and verbal descriptions were used to describe the Regional Salmon Planning process, the statewide regional CSP's, regional planning team membership and purpose, statewide hatchery locations, Alaska salmon and Chinook salmon hatchery production potential, and the present status of Yukon River salmon stocks.

Comments: all attendees expressed concern for subsistence harvests not being enough for the people and how the loss of commercial fishing hurts subsistence fishing and traditional practices. Attendees did not believe in Pilot Station Chinook estimates. Some concerns expressed that 6-nch mesh nets are killing larger Chinook, which get tangled (net in mouth) then drop out. Concern was expressed about the Andreafsky River weir not allowing fish to pass naturally or unobstructed. Sharing the fish resource with everyone on the Yukon River is very important to the continued health of the fish and people who use them.

Suggestions: allow retention of dip-net caught kings (maybe just the small or male kings or some size limit for retention of smaller fish), allow some LYTF test fish to be given to St. Mary's village (as was done in 2016), do some test fishing with net of 6.5 and 7 inch mesh with the intention of lowering the chum catch as chum salmon are clogging the nets. Start fishing earlier so fish can be higher quality and better preserved. Longer fishing periods would help with the cost of fishing. No comments for or against hatchery fish but if there was one it should be in the Andreafsky River but did acknowledge that Andreafsky Chinook salmon were not the preferred Chinook due their soft flesh, red color and late run timing making preservation difficult. Would like to see the school be more involved (the school presently has some field classes and boats/teachers who lead summer school). Suggested that increasing numbers of outside (non-local) users were not good and was becoming a real conflict for locals. Beavers are blocking streams with their dams more than they use to, so need to remove dams.

Three surveys were filled out at the meeting, 3 more were filled out later in the evening at the Bingo hall.

Hooper Bay CSP Meeting. May 25, 2017
Attendees: Albert Simon, Martha Simon, Lillian Gamp, Ronely Kraganek, Lester Wilde, Jonathan Smith, Lawrence Carl, Dennis O'Brien, Joseph Bell, William Tinker, Ethan Hoche, Victor W. Lake, Edgar Smith, Craig Friday
Officials of Paimiut, Native Village of Hooper Bay, Yukon Kuskokwim RAC, Sea lion Corp., City of Hooper Bay)
Facilitator: Chris Stark

Two hour meeting at the Hooper Bay Village Council Office 2-4 pm.
The first hour was spent describing to attendees the agenda and answering general CSP process questions. Attendee questions were addressing information needs on Chinook salmon ocean migration, high seas by-catch, in-river harvest characteristics (run timing, fish quality) and local Hooper Bay environmental concerns (Hooper Bay gravel extraction, barge traffic/noise, siltation of Bay and rivers). Some time was spent describing dams and mining in Alaska and Canada and potential effects on Yukon salmon and the CSP. Handouts and verbal descriptions were used to describe the Regional Salmon Planning process, the statewide regional CSP's, hatcheries in Alaska, Chinook hatchery production in Alaska and Canada, the role of the RPT and the CSP.

Comments: All attendees expressed concern for subsistence harvests not being met for many years and the loss of fishing capacity. Several expressed a desire for their area to have access to commercial salmon fishing. Several attendees expressed interest in finding more information about the Black River salmon (a common fishing location for Hooper Bay residence). The Black River was suggested as a potential hatchery site as was Canada or upper US Yukon River (Tanana/Fairbanks). Some concern for the increasing number of beavers in the area causing environmental damage.

Eleven surveys were filled out during the meeting, several attendees had already filled out the survey when administered by Lester Wilde weeks earlier.

Russian Mission CSP Meeting. May 26, 2017
Attendees: Theodore Stefanoff, Katie , Anastasia Larson, Basil Larson, and roughly 50 adults and 50 kids/teenagers
Facilitator: Chris Stark

A full day meeting was held Village School main hall, as part of a larger Russian Mission gathering. A one-hour presentation on CSP and RPT was given to approximately 50 adults and 50 kids/teenagers during the People to be Heard segment of the village meeting. Several other persons also gave informational presentations during this afternoon session, including YRDFA Daniel Stickman on a BIA planning program and several AVCP staff gave health care information and water quality presentations.

The CSP and RPT hour was focused on describing to attendees the purpose of the Comprehensive Salmon Plan, the role of the RPT/RAA, going over the main points of the agenda and answering questions. A PPP was used but handouts and verbal descriptions were primarily source used to describe the Regional Salmon Planning process, the statewide regional

CSP’s, regional planning team membership and purpose, statewide hatchery locations, Alaska salmon and specifically Chinook salmon hatchery production, and the present status of Yukon River Salmon stocks. Many questions were centered on Chinook salmon biology, hatchery salmon effects on Yukon River salmon decline, high seas by-catch and local salmon harvest access issues.

Due the size of the crowd and the short time available, the information gathering survey was given verbally with the city clerk recording the results. Adults (and kids in a separate vote) were asked to pick one of four levels of harvest for each harvest category for each species. Sport fishing was suggested as not something Russian Mission fishermen participate in so was not pursued in the survey. The corresponding desired harvest(s) results from the adults who responded to the survey are in brackets adjacent the species and harvest type. The kids and teenagers voted for most all categories, especially the highest, are not reported here. Whether or not fishermen felt enhanced fish production for Chinook salmon was of interest was ask as a yes or no question. (No 10, Yes 2, No Opinion 15).

Meeting Materials list:

- Meeting Agenda and public notice flyer (J. Klein)
- Yukon River Regional Planning Team – Information Gathering (user harvest goal survey)
- Overview of the Regional Planning Team and Comprehensive Salmon Plan Process (S. Rabung)
- Restoration, Rehabilitation, Enhancement Project Examples (S. Rabung)
- Salmon Fishery Enhancement in Alaska 4/20/2017 (S. Rabung)
- Regional Planning Teams (S. Rabung)
- In Statute: Regional Salmon Plans (S. Rabung)
- Yukon River CSP: Public Outreach Plan (3-10-2017 RPT)
- ADFG – Yukon Fishing Districts 1-6 Maps (notebook and poster size)
- Yukon River CSP updated Chapters 4 and 6 (5-20-2017 RPT)
- Subsistence Harvest Ranges – Yukon Regional Planning Team (5-20-2017 - C. Brown)
- Yukon River Comprehensive Salmon Plan For Alaska (1998)

Allakaket CSP Meeting. June 13, 2017

Attendees: Steve Bergman, Elsie Bergman, Walter Bergman, Donovan Nickoli, Harold David Sr., Harding Sam, D. Shawn Bergman, Johnson Moses, Andy Simon Sr., Megan Henry, Veronica Bergman, Catherine Henzie, Vincent Bergman, Albert Bergman, Jimmie Lee Simon, Elizabeth Strassburg, Beattus Moses Jr., Gilbert Vent Sr., Jonathan Henzie, Chrystal Bergman, George Linus, Lavonne Moses

Officials of Allakaket Council, Tribal Administration, Alatna Council, Sam Rabung (ADFG)

Facilitator: Chris Stark (BSFA)

Two hour meeting in Allakaket Tribal Council Hall 12-2 pm

Over lunch provided by BSFA, Chris and Sam described the effort to update the 1998 Yukon River CSP, why it is being updated and potential outcomes. Handouts and verbal descriptions were used to describe the CSP process, the statewide regional CSP's and their associated RPT/RAA's. The Yukon River regional planning team (RPT) membership (e.g. local RPT member Simon Pollock) and the RPT 's purpose and relationship to enhancement regulations were also addressed. Alaska salmon enhancement methods or types of enhancement were given with specific examples of present Alaskan hatchery Pink and Chum Salmon production.

Comments: Many attendee questions were centered on basic Chinook salmon biology, high seas by-catch and harvest characteristics (run timing, fish quality). Most express interest in enhancement effort in the Koyokuk River as there are few Chinook caught there historically. All attendees suggest that subsistence is the highest priority and an interest in local management of natural resources. A few attendees expressed concerns with ADFG Chinook Salmon management. In general, attendees understood the reasons for the recent Chinook salmon restrictions but feel that much of the cultural traditions built around fishing has been diminished which in turn is affecting the village social structure.

Suggestions and ideas included: some suggested beaver dam removal or stream clearing/salmon access issues. A few fishermen were hopeful for better management in the coming years, better salmon returns, and were opposed to hatchery fish as they are not natural or traditional. Several attendees would be interested in examples of Chinook salmon hatchery production and where the fish could be raised (locally, in a larger facility or elsewhere, or at remote sites (egg boxes)).

Twelve surveys were filled out and collected.

Fort Yukon CSP Meeting. June 15, 2017

Attendees: Paul Shewfelt, Richard James-Dickie, Duane Solomon, Phillip Solomon, Raymond Solomon, Mardo Solomon, Robert Solomon, Billy Adams, Abraham Peter, Mike Peter, Virginia Englishshoe, Ronald Englishshoe, Annie Peter, Walter Peter, Gerald Alexander, Richard Carroll Jr., Marybeth Solomon, Steve Ginnis, Bonnie Ginnis, Gary Lawrence, Julie Mahler

Sam Rabung (ADFG)

Facilitators: Chris Stark (BSFA), Michele Henzler (BSFA)

Two and a half hour meeting in Tribal Council Hall 12-2:30 pm

The first hour was a lively exchange between attendees and presenters (Sam, Chris) concerning Fort Yukon resident's salmon fishing problems and concerns. The general issue was harvest sharing and fairness relative to lower Yukon River commercial Chinook Salmon harvests. The presenters eventually explained the purpose of the CSP plan, how the plan is structured, the legal functions, the use of and generalized locations where hatcheries could be placed. Handouts and verbal descriptions were used to describe the Yukon River Comprehensive Salmon Planning (CSP) process, the statewide regional CSP's and associated RPT/RAA's, the Yukon River regional planning team (local RPT member Andrew Firman) membership and their purpose. A brief overview of statewide hatchery locations, Alaska salmon enhancement efforts and status of Yukon River salmon stocks was also presented.

Comments: There were many Fort Yukon area salmon harvest issues and CSP harvest goal questions/concerns. How would the goals be affected and who gets the enhanced fish? Several attendees questioned how Yukon Canadian Chinook Salmon and Whitehorse hatchery stock were involved, as those were the fish Fort Yukon fishermen depend on and related concerns (e.g. what causes the small physical size and low returns of hatchery Chinook Salmon). How does the CSP plan address Canadian involvement? Sam clarified that the CSP does not involved Canada.

Many attendees stated their distrust of ADFG management of natural/wild stocks and expressed their belief that upper river users have not been getting their fair share of the salmon and express deep concerns about hatcheries. What how do hatchery fish effect wild fish? Most attendees suggested that subsistence is the only Yukon priority, that lower Yukon River commercial fishing does them no good and that subsistence needs have not been met for decades. Sharing with everyone on the Yukon River was stated as the highest priority. Several attendees expressed concerns with commercial fishing effects on wild salmon, pondered if hatchery fish would worsen that issue. Some suggested over harvesting in the high seas and in river commercial fishery being the likely cause for Fort Yukon fishing problems.

Suggestions and ideas included; down river folks and managers need to recognize that the up river folks always get the short end of the stick, it has never been fair. Some would prefer federal management, as has happened on the Kuskokwim River fisheries. Subsistence should be the only Yukon fishing priority as history shown there are problems of fairness. Most attendees understood the reasons and causes for the recent subsistence Chinook salmon restrictions but feel that Fort Yukon fishermen have been the most restricted.

Eleven surveys were filled out and collected.

Galena CSP Meeting. August 9, 2017

Attendees: Nicole R. Gregory, Fred Huntington Sr., Bobby Frankson, Howard Beasley, Freda D Beasley, Kento Moos

Sam Rabung (ADFG),

Facilitators: Chris Stark (BSFA), Michele Henzler (BSFA)

Two hour meeting in Louden Tribal Hall 12-2 pm

The first hour was spent describing to attendees the agenda and answering general CSP process questions. Handouts and verbal descriptions were used to describe the CSP development process. Attendee's questions were centered on Chinook salmon production and biology, in-river harvest characteristics, harvest sharing fairness and local environmental environmental concerns (flooding, beaver dams, roads, lower river interception, water pollution, etc.). Some time was spent describing dams and mining in Alaska and Canada and potential effects on Yukon salmon and the CSP. Handouts were also used to describe the statewide regional CSP's, Alaskan Pink and Chum Salmon hatchery production and some Chinook hatchery production in Alaska and Yukon Territories, the role of the RPT and the outreach timelines for the Yukon CSP.

This CSP outreach meeting followed a Yukon River Inter-tribal Fish Commission (YRITFC) meeting held the day before which likely affected this CSP outreach meeting attendance. CSP outreach meeting attendees suggested holding meetings with similar agendas be held on the same day. The facilitators and ADFG staff were not aware of the YRITFC meeting.

Nenana CSP Meeting. August 14, 2017

Attendees: Doug Ostlund, Dennis Argall, Timothy McManus, Victor Lord, Gerald Riley, Gerry Bean, Larry Ketzler, Jesse Holms, Gilbert Huntington, Donald Charlie, Gale Vick, Dorothy Shockley, Jude Henzler, Grace Henzler

Facilitators: Chris Stark (BSFA), Michele Henzler (BSFA)

Two and a half hour meeting in Mitch Demientieff Tribal Hall 12-2:30 pm

The first hour was used to explain to attendees the purpose of the CSP plan, how the plan works, the main focus being on enhancement and setting harvest goals. Handouts and verbal descriptions were used to describe the Regional Comprehensive Salmon Planning process, the statewide regional CSP's and associated RPT/RAA's, the Yukon River regional planning team (RPT) membership and purpose, statewide hatchery locations, Alaska salmon enhancement and specifically Chinook salmon hatchery production, and the present status of Yukon River salmon stocks.

Comments: It was suggested by an attendee that folks not fill out the surveys because the information may be used against them. Several attendees expressed concern with management of natural/wild stocks in Alaska and elsewhere, and expressed their doubts about Yukon hatcheries success. (e.g. Clear Creek Hatchery was unsuccessful/closed in 1997). Several attendees stated that their subsistence needs are not being met. Everyone agreed that sharing with everyone living on the Yukon River was of highest priority. Several attendees expressed concerns with ADFG mismanagement and commercial fishing effects on local fishing problems. Most were very happy with their 2017 salmon harvests however.

Most attendees somewhat agreed with and understood the need for recent Chinook salmon harvest restrictions but feel that much of the Tanana River fishing culture has been lost in the process. Several express continued belief that the US high seas fisheries are a big harvester (under reported) and harvest by Area M fishing intercepts Yukon salmon continues as does illegal foreign high seas fishing. There was little interest in enhancement and most attendees were opposed to hatcheries.

Suggestions and ideas included: attendees suggest that the Yukon Salmon stocks are coming back, so would like salmon management to continue with the conservative efforts and to be sure escapement goals are always met by limiting the harvest until the salmon fully recover so that fishing can go back to unrestricted management like the 1980/1990's.

Four surveys were filled out and collected.

Minto CSP Meeting. August 16, 2017

Attendees: Clifford Charlie (1st Chief), David Baker (council member), Wayne Smoke, Harry Riley, Eric Wizer, Valerie Tusuk, Keith Charlie (Tribal Adm., Council member), Floyd Charlie, Joyce Frank, Timothy Gibson, Charlie Titus Jr. (Tribal council), Vanessa Joseph, Ann Williams, Ruth Titus, Andrew Jimmy, Josh Wizer, Richard Frank, Vera Wizer, Andrianna Charlie, Madison Charlie, Wilma David, Melanie Titus, Gale Vick, Dorothy Shockley, Jude Henzler, Grace Henzler

Facilitators: Chris Stark (BSFA), Michele Henzler (BSFA)

Two and a half hour meeting at the Minto Tribal Hall 12-2:30 pm, Lunch Provided.

The first hour was used to explain to attendees the purpose of the CSP plan, how the plan works, the use and where hatcheries could be placed, and many fishing questions/concerns. Handouts and verbal descriptions were used to describe the Regional Comprehensive Salmon Planning process, the statewide regional CSP's and associated RPT/RAA's, the Yukon River regional planning team (RPT) membership and purpose, statewide hatchery locations, Alaska salmon enhancement and specifically Chinook salmon hatchery production, and the present status of Yukon River salmon stocks.

Comments: Minto village residents harvest few salmon and more whitefish than most Yukon River based villages due their location. Many attendees were concerned with management of wild salmon and how hatchery fish being available to them. How do hatchery fish affect wild fish and how are they kept separate? All attendees suggest that subsistence is the highest priority as there are no commercial operations nearby. Sharing with everyone in the village and relatives/friends in Fairbanks was noted as important.

Suggestions and ideas included; concern was expressed as to the use of the survey data. ADFG should be directed to assure subsistence harvests are not controlled or impacted by commercial fisheries. There are problems of fairness, if commercial fishing happens then subsistence fishing should be un-restricted. There were no local habitat or rehabilitation projects suggested as few salmon pass by their area.

Seven surveys were filled out and collected.

Meeting Materials list:

- Meeting Agenda and public notice flyer (J. Klein)
- Yukon River Regional Planning Team – Information Gathering (user harvest goal survey)
- Overview of the Regional Planning Team and Comprehensive Salmon Plan Process (S. Rabung)
- Restoration, Rehabilitation, Enhancement Project Examples (S. Rabung)
- Salmon Fishery Enhancement in Alaska 4/20/2017 (S. Rabung)
- Regional Planning Teams (S. Rabung)
- In Statute: Regional Salmon Plans (S. Rabung)
- Yukon River CSP: Public Outreach Plan (3-10-2017 RPT)

- ADFG – Yukon Fishing Districts 1-6 Maps (notebook and poster size)
- Yukon River CSP updated Chapters 4 and 6 (5-20-2017 RPT)
- Subsistence Harvest Ranges – Yukon Regional Planning Team (5-20-2017 - C. Brown)
- Yukon River Comprehensive Salmon Plan For Alaska (1998)

SURVEY

Yukon River Regional Planning Team
INFORMATION GATHERING

What are your salmon harvest goals? Please think about your household needs and include anyone else you gather and supply fish for.

The following sentence was generated by the Regional Planning Team. Please consider it when answering the following questions about your subsistence, commercial and sport fishing.

"Desired harvest goals for subsistence are based on when there were abundant salmon runs and unrestricted harvests."

Where do you live or fish?____

Number of Fish

Harvest goal (subsistence Chinook salmon): ______________________________

Harvest goal (commercial Chinook salmon): ______________________________

Harvest goal (sport fish Chinook salmon): ______________________________

Harvest goal (subsistence chum salmon): ______________________________

Harvest goal (commercial chum salmon): ______________________________

Harvest goal (sport fish chum salmon): ______________________________

Harvest goal (subsistence coho salmon): ______________________________

Harvest goal (commercial coho salmon): ______________________________

Harvest goal (sport fish coho salmon): ______________________________

What are important rivers, streams or lakes in your area? Please identify them:

What types of projects do you think could restore salmon habitat, rehabilitate a depressed salmon stock to increase or rebuild it to historical abundance or enhance a salmon stock beyond what could be naturally produced in its natural habitat?

If salmon was restored to a tributary or river you know, what do you think it could produce?

Please mail back to: Jill Klein, RPT Chair, C/O Bering Sea Fishermen's Association, 431 West 7th Ave. Suite 204, Anchorage, AK 99501

APPENDIX I: DATA TABLES

Appendix I1.–Life cycles of Yukon River drainage salmon.

Life stage	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	Late winter
	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

Appendix I2.–Guideline harvest ranges and midpoints for commercial harvest of Chinook, summer chum, and fall chum salmon, Yukon Area, Alaska, 2017.

	Chinook Salmon Guideline Harvest Range [a]					
District or	Lower		Midpoint		Upper	
Subdistrict	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
5-B, 5-C	2,400	3.6	2,600	2.6	2,800	2.2
5-D	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 Guideline Harvest Range [b]					
District or	Lower		Midpoint		Upper	
Subdistrict	Numbers	Percent	Numbers	Percent	Numbers	Percent
1 and 2	251,000	62.9	503,000	62.9	755,000	62.9
3	6,000	1.6	12,500	1.6	19,000	1.6
4-A [c]	113,000	28.2	225,500	28.2	338,000	28.2
4-B, 4-C	16,000	3.9	31,500	3.9	47,000	3.9
5B, 5-C, 5-D	1,000	0.3	2,000	0.3	3,000	0.3
6	13,000	3.2	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 Guideline Harvest Range [e]					
District or	Lower		Midpoint		Upper	
Subdistrict	Numbers	Percent	Numbers	Percent	Numbers	Percent
1, 2, and 3	60,000	82.5	140,000	71.2	220,000	68.6
4	5,000	6.9	22,500	11.4	40,000	12.5
5-B, 5-C	4,000	5.5	20,000	10.2	36,000	11.2
5-D	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
Subdistrict 5-A range of 0 to 4,000 pounds of roe. [f]						

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[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.

[f] Subdistrict 5-A was removed from the guideline harvest ranges for Chinook and summer chum salmon and a separate guideline harvest range of 0 to 4,000 pounds of fall chum salmon roe was established in November 1998.

Appendix I3.–Chinook salmon total utilization in numbers of fish by district, area, and country, Yukon River drainage, 1961–2017.

	District 1					District 2			
Year	Subsistence [a,b]	Commercial [c]	Personal Use [d]	Test Fish Sales	Total	Subsistence	Commercial [c]	Test Fish Sales	Total
1961		84,466			84,466		29,026		29,026
1962		67,099			67,099		22,224		22,224
1963		85,004			85,004		24,221		24,221
1964		67,555			67,555		20,246		20,246
1965		89,268			89,268		23,763		23,763
1966		70,788			70,788		16,927		16,927
1967		104,350			104,350		20,239		20,239
1968		79,465			79,465		21,392		21,392
1969		71,688			71,688		14,756		14,756
1970		56,648			56,648		17,141		17,141
1971		86,042			86,042		19,226		19,226
1972		70,052			70,052		17,855		17,855
1973		56,981			56,981		13,859		13,859
1974		71,840			71,840		17,948		17,948
1975		44,585			44,585		11,315		11,315
1976		62,410			62,410		16,556		16,556
1977		69,915			69,915		16,722		16,722
1978	5,246	59,006			64,252	3,964	32,924		36,888
1979	2,879	75,007			77,886	4,268	41,498		45,766
1980	3,669	90,382			94,051	3,674	50,004		53,678
1981	2,282	99,506			101,788	3,580	45,781		49,361
1982	2,311	74,450			76,761	2,109	39,132		41,241
1983	6,263	95,457			101,720	9,065	43,229		52,294
1984	4,624	74,671			79,295	7,172	36,697		43,869
1985	3,071	90,011			93,082	3,468	48,365		51,833
1986	5,275	53,035			58,310	6,483	41,849		48,332
1987	7,278	76,643	0		83,921	9,866	47,458		57,324
1988	3,938	56,120	67	989	61,114	3,823	35,120	68	39,011
1989	4,565	61,570	286	794	67,215	7,147	33,166	59	40,372
1990	6,619	51,199	450	1,063	59,331	9,546	33,061	152	42,759
1991	5,925	56,332		485	62,742	7,617	39,260	113	46,990
1992	5,141	74,212		930	80,283	7,074	38,139	0	45,213

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Appendix I3.–Page 2 of 15 (Chinook Harvest).

	District 1					District 2			
Year	Subsistence [a, b]	Commercial [c]	Personal Use [d]	Test Fish Sales	Total	Subsistence	Commercial [c]	Test Fish Sales	Total
1993	10,408	49,286		1,408	61,102	11,513	37,293	164	48,970
1994	6,540	62,241		1,561	70,342	8,956	41,692	70	50,718
1995	5,960	76,106		2,078	84,144	9,037	41,458	74	50,569
1996	3,646	56,642		1,698	61,986	7,780	30,209	0	37,989
1997	7,550	66,384		2,791	76,725	9,350	39,363	20	48,733
1998	7,242	25,413		878	33,533	9,455	16,806	48	26,309
1999	6,848	37,161		1,049	45,058	10,439	27,133	156	37,728
2000	5,891	4,735		275	10,901	9,935	3,783	322	14,040
2001	7,089	-		0	7,089	13,442	-	0	13,442
2002	5,603	11,089		494	17,186	8,954	11,440	34	20,428
2003	6,332	22,709		619	29,660	9,668	14,220	61	23,949
2004	5,880	28,403		722	35,005	9,724	24,145	70	33,939
2005	5,058	16,694		310	22,062	9,156	13,413	0	22,569
2006	5,122	23,748		817	29,687	8,039	19,843	0	27,882
2007	6,059	18,616		792	25,467	10,553	13,306	57	23,916
2008	6,163	2,530		0	8,693	8,826	2,111	0	10,937
2009	4,125	90		0	4,215	6,135	226	0	6,361
2010	5,856	5,744		0	11,600	8,676	4,153	0	12,829
2011	6,255	36		0	6,291	8,069	46	0	8,115
2012	4,313	0		0	4,313	6,881	0	0	6,881
2013	1,634	0		0	1,634	1,104	0	0	1,104
2014	1,356	0		0	1,356	616	0	0	616
2015	1,919	0		0	1,919	1,185	0	0	1,185
2016	2,786	0		0	2,786	3,159	0	0	3,159
2017		168		0	168		0	0	0
2012-2016 Average	2,402	0		0	2,402	2,589	0	0	2,589
2007-2016 Average	4,047	2,702		79	6,827	5,520	1,984	6	7,510

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	District 3			Lower Yukon Area Subtotals				
Year	Subsistence	Commercial	Total	Subsistence	Commercial	Personal Use [d]	Test Fish Sales	Total
1961		4,368	4,368		117,860			117,860
1962		4,687	4,687		94,010			94,010
1963		7,020	7,020		116,245			116,245
1964		4,705	4,705		92,506			92,506
1965		3,204	3,204		116,235			116,235
1966		3,612	3,612		91,327			91,327
1967		3,618	3,618		128,207			128,207
1968		4,543	4,543		105,400			105,400
1969		3,595	3,595		90,039			90,039
1970		3,705	3,705		77,494			77,494
1971		3,490	3,490		108,758			108,758
1972		3,841	3,841		91,748			91,748
1973		3,204	3,204		74,044			74,044
1974		3,480	3,480		93,268			93,268
1975		4,177	4,177		60,077			60,077
1976		4,148	4,148		83,114			83,114
1977		3,965	3,965		90,602			90,602
1978	3,902	2,916	6,818	13,112	94,846			107,958
1979	3,325	5,018	8,343	10,472	121,523			131,995
1980	4,818	5,240	10,058	12,161	145,626			157,787
1981	4,011	4,023	8,034	9,873	149,310			159,183
1982	3,359	2,609	5,968	7,779	116,191			123,970
1983	4,910	4,106	9,016	20,238	142,792			163,030
1984	4,394	3,039	7,433	16,190	114,407			130,597
1985	3,342	2,588	5,930	9,881	140,964			150,845
1986	4,305	901	5,206	16,063	95,785			111,848
1987	4,708	2,039	6,747	21,852	126,140	0		147,992
1988	4,547	1,767	6,314	12,308	93,007	67	1,057	106,439
1989	4,778	1,645	6,423	16,490	96,381	286	853	114,010
1990	4,093	2,341	6,434	20,258	86,601	450	1,215	108,524
1991	3,187	2,344	5,531	16,729	97,936		598	115,263
1992	4,991	1,819	6,810	17,206	114,170		930	132,306

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	District 3			Lower Yukon Area Subtotals				
Year	Subsistence	Commercial	Total	Subsistence	Commercial	Personal Use [d]	Test Fish Sales	Total
1993	6,592	1,501	8,093	28,513	88,080		1,572	118,165
1994	6,124	1,114	7,238	21,620	105,047		1,631	128,298
1995	5,419	-	5,419	20,416	117,564		2,152	140,132
1996	6,783	0	6,783	18,209	86,851		1,698	106,758
1997	6,311	-	6,311	23,211	105,747		2,811	131,769
1998	4,514	0	4,514	21,211	42,219		926	64,356
1999	7,715	538	8,253	25,002	64,832		1,205	91,039
2000	3,914	-	3,914	19,740	8,518		597	28,855
2001	6,361	-	6,361	26,892	0		0	26,892
2002	4,139	-	4,139	18,696	22,529		528	41,753
2003	5,002	-	5,002	21,002	36,929		680	58,611
2004	4,748	-	4,748	20,352	52,548		792	73,692
2005	5,131	-	5,131	19,345	30,107		310	49,762
2006	5,374	315	5,689	18,535	43,906		817	63,258
2007	4,651	190	4,841	21,263	32,112		849	54,224
2008	5,855	-	5,855	20,844	4,641		0	25,485
2009	2,924	-	2,924	13,184	316		0	13,500
2010	4,299	-	4,299	18,831	9,897		0	28,728
2011	4,134	-	4,134	18,458	82		0	18,540
2012	2,362	-	2,362	13,556	0		0	13,556
2013	444	-	444	3,182	0		0	3,182
2014	48	–	48	2,020	0		0	2,020
2015	447	–	447	3,551	0		0	3,551
2016	900	–	900	6,845	0		0	6,845
2017		–	0	0	168		0	168
2012-2016 Average	840	–	840	5,831	0		0	5,831
2007-2016 Average	2,606	190	2,625	12,173	4,705		85	16,963

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	District 4				District 5				
Year	Subsistence	Commercial	Commercial Related [e]	Total	Subsistence	Commercial [c]	Commercial Related [e]	Personal Use [d]	Total
1961									
1962									
1963									
1964									
1965									
1966									
1967									
1968									
1969									
1970									
1971									
1972									
1973									
1974		685	0	685		2,663	0		2,663
1975		389	0	389		2,872	0		2,872
1976		409	0	409		3,151	0		3,151
1977		985	0	985		4,162	0		4,162
1978	5,549	608	0	6,157	10,405	3,079	0		13,484
1979	7,203	1,989	0	9,192	11,997	3,389	0		15,386
1980	11,053	1,521	0	12,574	17,684	4,891	0		22,575
1981	4,432	1,347	0	5,779	13,300	6,374	0		19,674
1982	5,077	1,087	0	6,164	12,859	5,385	0		18,244
1983	9,754	601	0	10,355	16,780	3,606	0		20,386
1984	7,650	961	0	8,611	14,989	3,669	0		18,658
1985	7,425	664	0	8,089	15,090	3,418	0		18,508
1986	9,530	502	0	10,032	15,944	2,733	0		18,677
1987	7,914	1,524	0	9,438	17,556	3,758	0	1,706	23,020
1988	9,515	3,159	0	12,674	17,200	3,436	0	1,435	22,071
1989	9,074	2,790	0	11,864	20,336	3,286	0	1,877	25,499
1990	11,122	3,536	2	14,660	14,589	3,353	12	1,693	19,647
1991	11,100	2,446	1,136	14,682	16,429	3,810	16		20,255
1992	8,291	1,651	743	10,685	17,691	3,852	3		21,546

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	District 4				District 5				
Year	Subsistence	Commercial	Commercial Related [e]	Total	Subsistence	Commercial [c]	Commercial Related [e]	Personal Use [d]	Total
1993	10,936	1,349	228	12,513	21,365	3,008	0		24,373
1994	10,327	2,216	227	12,770	18,760	3,739	5		22,504
1995	9,474	262	237	9,973	16,866	3,242	0		20,108
1996	8,193	45	92	8,330	15,727	2,497	260		18,484
1997	12,006	1,450	7	13,463	18,049	3,678	0		21,727
1998	15,801	-	-	15,801	14,802	517	0		15,319
1999	11,238	1,437	0	12,675	14,330	2,604	0		16,934
2000	6,264	-	-	6,264	8,854	-	-		8,854
2001	10,152	-	-	10,152	13,566	-	-		13,566
2002	9,456	-	-	9,456	13,401	771	0		14,172
2003	12,771	562	0	13,333	19,191	1,134	0		20,325
2004	16,269	-	-	16,269	15,666	1,546	0		17,212
2005	13,964	-	-	13,964	17,424	1,469	0		18,893
2006	12,022	-	-	12,022	15,924	1,839	0		17,763
2007	11,831	0	0	11,831	19,165	1,241	0		20,406
2008	10,619	0	0	10,619	11,626	-	-		11,626
2009	9,514	0	0	9,514	8,917	-	-		8,917
2010	12,888	0	0	12,888	10,397	-	-		10,397
2011	9,893	-	-	9,893	10,493	-	-		10,493
2012	7,662	0	0	7,662	6,466	-	-		6,466
2013	2,901	0	0	2,901	4,541	-	-		4,541
2014	132	0	0	132	288	–	–		288
2015	771	0	0	771	1,849	–	–		1,849
2016	6,015	0	0	6,015	7,096	–	–		7,096
2017		0	0	0		–	–		0
2012-2016 Average	3,496	0	0	3,496	4,048	–	–		4,048
2007-2016 Average	7,223	0	0	7,223	8,084	1,241	0		8,208

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	District 6						Upper Yukon Area Subtotals					
Year	Subsistence	Commercial [c]	Comm. Related [e]	Personal Use	Test Fish Sales	Total	Subsistence	Commercial	Comm. Related [e]	Personal Use	Test Fish Sales	Total
1961								1,804	0			1,804
1962								724	0			724
1963								803	0			803
1964								1,081	0			1,081
1965								1,863	0			1,863
1966								1,988	0			1,988
1967								1,449	0			1,449
1968								1,126	0			1,126
1969								988	0			988
1970								1,651	0			1,651
1971								1,749	0			1,749
1972								1,092	0			1,092
1973								1,309	0			1,309
1974		1,473	0					4,821	0			4,821
1975		500	0					3,761	0			3,761
1976		1,102	0					4,662	0			4,662
1977		1,008	0					6,155	0			6,155
1978	1,231	635	0			1,866	17,185	4,322	0			21,507
1979	1,333	772	0			2,105	20,533	6,150	0			26,683
1980	1,826	1,947	0			3,773	30,563	8,359	0			38,922
1981	2,085	987	0			3,072	19,817	8,708	0			28,525
1982	2,443	981	0			3,424	20,379	7,453	0			27,832
1983	2,706	911	0			3,617	29,240	5,118	0			34,358
1984	3,599	867	0			4,466	26,238	5,497	0			31,735
1985	7,375	1,142	0			8,517	29,890	5,224	0			35,114
1986	3,701	950	0			4,651	29,175	4,185	0	0		33,360
1987	4,096	3,338	0			7,434	29,566	8,620	0	1,706		39,892
1988	4,884	762	0	623	24	6,293	31,599	7,357	0	2,058	24	41,038
1989	2,546	1,741	0	453	440	5,180	31,956	7,817	0	2,330	440	42,543
1990	2,618	1,757	399	451	833	6,058	28,329	8,646	413	2,144	833	40,365
1991	2,515	686	386	0	91	3,678	30,044	6,942	1,538	0	91	38,615
1992	2,438	572	181	0	32	3,223	28,420	6,075	927	0	32	35,454

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Year	District 6 Subsistence	District 6 Commercial [c]	District 6 Comm. Related [c]	District 6 Personal Use	District 6 Test Fish Sales	District 6 Total	Upper Yukon Area Subtotals Subsistence	Upper Yukon Area Subtotals Commercial	Upper Yukon Area Subtotals Comm. Related [c]	Upper Yukon Area Subtotals Personal Use	Upper Yukon Area Subtotals Test Fish Sales	Upper Yukon Area Subtotals Total
1993	1,672	1,113	332	426	0	3,543	33,973	5,470	560	426	0	40,429
1994	2,370	2,135	471	0	0	4,976	31,457	8,090	703	0	0	40,250
1995	1,779	1,660	1,087	399	0	4,925	28,119	5,164	1,324	399	0	35,006
1996	1,177	278	169	215	0	1,839	25,097	2,820	521	215	0	28,653
1997	2,712	1,966	762	313	0	5,753	32,767	7,094	769	313	0	40,943
1998	1,919	882	81	357	0	3,239	32,522	1,399	81	357	0	34,359
1999	1,624	402	288	331	0	2,645	27,192	4,443	288	331	0	32,254
2000	983	-	-	75	0	1,058	16,101	0	0	75	0	16,176
2001	2,327	-	-	122	0	2,449	26,045	0	0	122	0	26,167
2002	1,067	836	230	126	0	2,259	23,924	1,607	230	126	0	25,887
2003	2,145	1,813	0	204	0	4,162	34,107	3,509	0	204	0	37,820
2004	1,388	2,057	0	201	0	3,646	33,323	3,603	0	201	0	37,127
2005	1,828	453	0	138	0	2,419	33,216	1,922	0	138	0	35,276
2006	1,229	84	0	89	0	1,402	29,175	1,923	0	89	0	31,187
2007	1,717	281	0	136	0	2,134	32,713	1,522	0	136	0	34,371
2008	605	0	0	126	0	731	22,850	0	0	126	0	22,976
2009	1,285	0	0	127	0	1,412	19,716	0	0	127	0	19,843
2010	1,143	0	0	162	0	1,305	24,428	0	0	162	0	24,590
2011	1,367	0	0	89	0	1,456	21,753	0	0	89	0	21,842
2012	627	0	0	71	0	698	14,755	0	0	71	0	14,826
2013	367	0	0	42	0	409	7,809	0	0	42	0	7,851
2014	283	0	0	1	0	284	703	0	0	1	0	704
2015	440	0	0	5	0	445	3,060	0	0	5	0	3,065
2016	816	0	0	57	0	873	13,927	0	0	57	0	13,984
2017		0	0		0		0	0	0	0	0	0
2012-2016 Average	507	0	0	35	0	542	8,051	0	0	35	0	8,086
2007-2016 Average	865	28	0	82	0	975	16,171	152	0	82	0	16,405

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	Alaska Yukon River Totals						
Year	Subsistence	Commercial	Commercial Related [e]	Personal Use	Test Fish Sales	Sport Fish [f]	Total
1961	21,488	119,664	0				141,152
1962	11,110	94,734	0				105,844
1963	24,862	117,048	0				141,910
1964	16,231	93,587	0				109,818
1965	16,608	118,098	0				134,706
1966	11,572	93,315	0				104,887
1967	16,448	129,656	0				146,104
1968	12,106	106,526	0				118,632
1969	14,000	91,027	0				105,027
1970	13,874	79,145	0				93,019
1971	25,684	110,507	0				136,191
1972	20,258	92,840	0				113,098
1973	24,317	75,353	0				99,670
1974	19,964	98,089	0				118,053
1975	12,867	63,838	0				76,705
1976	17,806	87,776	0				105,582
1977	17,581	96,757	0			156	114,494
1978	30,297	99,168	0			523	129,988
1979	31,005	127,673	0			554	159,232
1980	42,724	153,985	0			956	197,665
1981	29,690	158,018	0			769	188,477
1982	28,158	123,644	0			1,006	152,808
1983	49,478	147,910	0			1,048	198,436
1984	42,428	119,904	0			351	162,683
1985	39,771	146,188	0			1,368	187,327
1986	45,238	99,970	0			796	146,004
1987	51,418	134,760	0	1,706		502	188,386
1988	43,907	100,364	0	2,125	1,081	944	148,421
1989	48,446	104,198	0	2,616	1,293	1,063	157,616
1990	48,587	95,247	413	2,594	2,048	544	149,433
1991	46,773	104,878	1,538	0	689	773	154,651
1992	45,626	120,245	927	0	962	431	168,191

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Year	Alaska Yukon River Totals						
	Subsistence	Commercial	Commercial Related [e]	Personal Use	Test Fish Sales	Sport Fish [f]	Total
1993	62,486	93,550	560	426	1,572	1,695	160,289
1994	53,077	113,137	703	0	1,631	2,281	170,829
1995	48,535	122,728	1,324	399	2,152	2,525	177,663
1996	43,306	89,671	521	215	1,698	3,873	139,284
1997	55,978	112,841	769	313	2,811	2,174	174,886
1998	53,733	43,618	81	357	926	654	99,369
1999	52,194	69,275	288	331	1,205	1,023	124,316
2000	35,841	8,518	0	75	597	276	45,307
2001	52,937	0	0	122	0	679	53,738
2002	42,620	24,136	230	126	528	486	68,126
2003	55,109	40,438	0	204	680	2,719	99,150
2004	53,675	56,151	0	201	792	1,513	112,332
2005	52,561	32,029	0	138	310	483	85,521
2006	47,710	45,829	0	89	817	739	95,184
2007	53,976	33,634	0	136	849	960	89,555
2008	43,694	4,641	0	126	0	409	48,870
2009	32,900	316	0	127	0	863	34,206
2010	43,259	9,897	0	162	0	474	53,792
2011	40,211	82	0	89	0	474	40,856
2012	28,311	0	0	71	0	345	28,727
2013	10,991	0	0	42	0	166	11,199
2014	2,723	0	0	1	0	0	2,724
2015	6,611	0	0	5	0	13	6,629
2016	20,772	0	0	57	0		20,829
2017	0	168	0	0	0		168
2012-2016 Average	13,882	0	0	35	0	131	14,022
2007-2016 Average	28,345	4,857	0	82	85	412	33,739

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	Canada: Mainstem Yukon						Canada	
	Non-Commercial						Porcupine	Total
Year	Domestic	Aboriginal	Sport [g]	Test fish [h]	Commercial	Subtotal	Aboriginal	Canadian
1961		9,300			3,446	12,746	500	13,246
1962		9,300			4,037	13,337	600	13,937
1963		7,750			2,283	10,033	44	10,077
1964		4,124			3,208	7,332	76	7,408
1965		3,021			2,265	5,286	94	5,380
1966		2,445			1,942	4,387	65	4,452
1967		2,920			2,187	5,107	43	5,150
1968		2,800			2,212	5,012	30	5,042
1969		957			1,640	2,597	27	2,624
1970		2,044			2,611	4,655	8	4,663
1971		3,260			3,178	6,438	9	6,447
1972		3,960			1,769	5,729		5,729
1973		2,319			2,199	4,518	4	4,522
1974	406	3,342			1,808	5,556	75	5,631
1975	400	2,500			3,000	5,900	100	6,000
1976	500	1,000			3,500	5,000	25	5,025
1977	531	2,247			4,720	7,498	29	7,527
1978	421	2,485			2,975	5,881		5,881
1979	1,200	3,000			6,175	10,375		10,375
1980	3,500	7,546	300		9,500	20,846	2,000	22,846
1981	237	8,879	300		8,593	18,009	100	18,109
1982	435	7,433	300		8,640	16,808	400	17,208
1983	400	5,025	300		13,027	18,752	200	18,952
1984	260	5,850	300		9,885	16,295	500	16,795
1985	478	5,800	300		12,573	19,151	150	19,301
1986	342	8,625	300		10,797	20,064	300	20,364
1987	330	6,069	300		10,864	17,563	51	17,614
1988	282	7,178	650		13,217	21,327	100	21,427
1989	400	6,930	300		9,789	17,419	525	17,944
1990	247	7,109	300		11,324	18,980	247	19,227
1991	227	9,011	300		10,906	20,444	163	20,607
1992	277	6,349	300		10,877	17,803	100	17,903

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	Canada: Mainstem Yukon						Canada	
	Non-Commercial						Porcupine	Total
Year	Domestic	Aboriginal	Sport [g]	Test fish [h]	Commercial	Subtotal	Aboriginal	Canadian
1993	243	5,576	300		10,350	16,469	142	16,611
1994	373	8,069	300		12,028	20,770	428	21,198
1995	300	7,942	700		11,146	20,088	796	20,884
1996	141	8,451	790		10,164	19,546	66	19,612
1997	288	8,888	1,230		5,311	15,717	811	16,528
1998	24	4,687	-	737	390	5,838	99	5,937
1999	213	8,804	177	-	3,160	12,354	114	12,468
2000	-	4,068	-	761	-	4,829	50	4,879
2001	89	7,421	146	767	1,351	9,774	370	10,144
2002	59	7,139	128	1,036	708	9,070	188	9,258
2003	115	6,121	275	263	2,672	9,446	173	9,619
2004	88	6,483	423	167	3,785	10,946	292	11,238
2005	99	6,376	436	-	4,066	10,977	394	11,371
2006	63	5,757	606	-	2,332	8,758	314	9,072
2007	-	4,175	2	617	-	4,794	300	5,094
2008	-	2,885	-	513	1	3,399	314	3,713
2009	17	3,791	125	-	364	4,297	461	4,758
2010	-	2,455	1	-	-	2,456	250	2,706
2011	-	4,550	40	-	4	4,594	290	4,884
2012	-	2,000	0	-	0	2,000	200	2,200
2013	0	1,902	0	-	2	1,904	242	2,146
2014	19	100	–	–	–	119	3	122
2015	–	1,000	–	–	–	1,000	204	1,204
2016	–	2,768	–	–	1	2,769	177	2,946
2017	–					0		0
2012-2016 Average	10	1,554	0	–	1	1,558	165	1,724
2007-2016 Average	12	2,563	28	565	62	2,733	244	2,977

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	Yukon River Drainage (Alaska/Canada) Totals							Total Alaska Yukon Area		
Year	Subsistence [i]	Commercial	Commercial Related [e]	Personal Use	Alaska Test Fish	Sport Fish	Total	Coastal District	Alaska Total	Yukon Area Total
1961	31,288	123,110					154,398		141,152	141,152
1962	21,010	98,771					119,781		105,844	105,844
1963	32,656	119,331					151,987		141,910	141,910
1964	20,431	96,795					117,226		109,818	109,818
1965	19,723	120,363					140,086		134,706	134,706
1966	14,082	95,257					109,339		104,887	104,887
1967	19,411	131,843					151,254		146,104	146,104
1968	14,936	108,738					123,674		118,632	118,632
1969	14,984	92,667					107,651		105,027	105,027
1970	15,926	81,756					97,682		93,019	93,019
1971	28,953	113,685					142,638		136,191	136,191
1972	24,218	94,609					118,827		113,098	113,098
1973	26,640	77,552					104,192		99,670	99,670
1974	23,787	99,897					123,684		118,053	118,053
1975	15,867	66,838					82,705		76,705	76,705
1976	19,331	91,276					110,607		105,582	105,582
1977	20,388	101,477				156	122,021		114,494	114,494
1978	33,203	102,143				523	135,869	488	129,988	130,476
1979	35,205	133,848				554	169,607		159,232	159,232
1980	55,770	163,485				1,256	220,511		197,665	197,665
1981	38,906	166,611				1,069	206,586		188,477	188,477
1982	36,426	132,284				1,306	170,016		152,808	152,808
1983	55,103	160,937				1,348	217,388		198,436	198,436
1984	49,038	129,789				651	179,478		162,683	162,683
1985	46,199	158,761				1,668	206,628		187,327	187,327
1986	54,505	110,767				1,096	166,368		146,004	146,004
1987	57,868	145,624		1,706		802	206,000	3,621	188,386	192,007
1988	51,467	113,581		2,125	1,081	1,594	169,848	1,588	148,421	150,009
1989	56,301	113,987		2,616	1,293	1,363	175,560	16	157,616	157,632
1990	56,190	106,571	413	2,594	2,048	844	168,660		149,433	149,433
1991	56,174	115,784	1,538	0	689	1,073	175,258		154,651	154,651
1992	52,352	131,122	927	0	962	731	186,094	1,451	168,191	169,642

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	Yukon River Drainage (Alaska/Canada) Totals							Total Alaska Yukon Area		
Year	Subsistence [i]	Commercial	Commercial Related [e]	Personal Use	Alaska Test Fish	Sport Fish	Total	Coastal District	Alaska Total	Yukon Area Total
1993	68,447	103,900	560	426	1,572	1,995	176,900	1,429	160,289	161,718
1994	61,947	125,165	703	0	1,631	2,581	192,027	825	170,829	171,654
1995	57,573	133,874	1,324	399	2,152	3,225	198,547	2,085	177,663	179,748
1996	51,964	99,835	521	215	1,698	4,663	158,896	2,365	139,284	141,649
1997	65,965	118,152	769	313	2,811	3,404	191,414	1,139	174,886	176,025
1998	59,280	44,008	81	357	926	654	105,306	391	99,369	99,760
1999	61,325	72,435	288	331	1,205	1,200	136,784	1,111	124,316	125,427
2000	40,720	8,518	0	75	597	276	50,186	563	45,307	45,870
2001	61,584	1,351	0	122	0	825	63,882	2,882	53,738	56,620
2002	51,042	24,844	230	126	528	614	77,384	1,122	68,126	69,248
2003	61,781	43,110	0	204	680	2,994	108,769	1,850	99,150	101,000
2004	60,705	59,936	0	201	792	1,936	123,570	2,038	112,332	114,370
2005	59,430	36,095	0	138	310	919	96,892	848	85,521	86,369
2006	53,844	48,161	0	89	817	1,345	104,256	883	95,184	96,067
2007	59,068	33,634	0	136	849	962	94,649	1,198	89,555	90,753
2008	47,406	4,642	0	126	0	409	52,583	1,492	48,870	50,362
2009	37,169	680	0	127	0	988	38,964	905	34,206	35,111
2010	45,964	9,897	0	162	0	475	56,498	1,300	53,792	55,092
2011	45,051	86	0	89	0	514	45,740	769	40,856	41,625
2012	30,511	0	0	71	0	345	30,927	2,104	28,727	30,831
2013	13,135	2	0	42	0	166	13,345	1,542	11,199	12,741
2014	2,845	0	0	1	0	0	2,846	563	2,724	3,287
2015	7,815	0	0	5	0	13	7,833	966	6,629	7,595
2016	23,717	1	0	57	0	0	23,775	886	20,829	21,715
2017		168	0	0	0	0	168		168	168
2012-2016 Average	15,605	1	0	35	0	105	15,745	1,212	14,022	15,234
2007-2016 Average	31,268	4,894	0	82	85	387	36,716	1,173	33,739	34,911

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Note: En dash indicates no commercial fishing activity occurred. Blank cells indicate insufficient information to generate average.

[a] Subsistence harvest estimates not available by district until 1978.

[b] Does not include coastal subsistence harvest in Hooper Bay and Scammon Bay.

[c] Includes department test fish sales prior to 1988 and estimates of illegal sales.

[d] Prior to 1987 and in 1991, 1992, and 1994, personal use was considered part of subsistence. Between 1987 and 1990, personal use fishing was defined by the fisherman's location of residence versus fishing location. In 1992, the Fairbanks nonsubsistence area was created as the only personal use area in the Yukon River drainage.

[e] Commercial related refers to the estimated harvest of female chinook salmon to produce roe sold.

[f] Estimated sport fish harvest for Alaskan portion of the Yukon River drainage. The majority of sport fish harvest occurs in the Tanana River drainage (District 6).

[g] Canadian sport fish harvest unknown prior to 1980.

[h] Canadian Chinook test fishery is conducted for management purposes, the fish harvested are retained and given to Aboriginal or Domestic users, but are not reported under those categories.

[i] Includes Alaskan subsistence harvest and Canadian Domestic, test fish, and Aboriginal harvests.

Appendix I4.–Summer chum salmon total utilization in numbers of fish by district, area, and country, Yukon River drainage, 1961-2017.

	District 1					District 2			
Year	Subsistence [a, b]	Commercial [c]	Personal Use [d]	Test Fish Sales	Total	Subsistence	Commercial [c]	Test Fish Sales	Total
1961		0					0		
1962		0					0		
1963		0					0		
1964		0					0		
1965		0					0		
1966		0					0		
1967		9,453			9,453		1,425		1,425
1968		12,995			12,995		1,407		1,407
1969		56,886			56,886		5,080		5,080
1970		117,357			117,357		19,649		19,649
1971		93,928			93,928		6,112		6,112
1972		114,234			114,234		20,907		20,907
1973		221,644			221,644		63,402		63,402
1974		466,004			466,004		74,152		74,152
1975		418,323			418,323		99,139		99,139
1976		273,204			273,204		99,190		99,190
1977		250,652			250,652		105,679		105,679
1978	30,897	393,785			424,682	21,684	227,548		249,232
1979	16,144	369,934			386,078	23,276	172,838		196,114
1980	15,972	391,252			407,224	13,681	308,704		322,385
1981	11,310	507,158			518,468	14,218	351,878		366,096
1982	18,452	249,516			267,968	18,442	182,344		200,786
1983	24,679	451,164			475,843	27,396	248,092		275,488
1984	28,459	292,676			321,135	26,996	236,931		263,927
1985	24,349	247,486			271,835	19,795	188,099		207,894
1986	38,854	381,127			419,981	41,496	288,427		329,923
1987	30,760	222,898	0		253,658	33,134	174,876		208,010
1988	28,934	645,322	416	2,876	677,548	28,787	424,461	711	453,959
1989	52,844	544,373	381	3,408	601,006	39,703	343,032	930	383,665
1990	36,999	146,725	256	2,186	186,166	28,453	131,755	752	160,960

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	District 1					District 2			
Year	Subsistence [a, b]	Commercial [c]	Personal Use [d]	Test Fish Sales	Total	Subsistence	Commercial [c]	Test Fish Sales	Total
1991	27,790	140,470		1,373	169,633	20,703	175,149	703	196,555
1992	33,239	177,329		1,918	212,486	24,731	147,129	0	171,860
1993	33,986	73,659		1,379	109,024	25,297	19,332	490	45,119
1994	32,145	42,332		2,769	77,246	22,907	12,869	443	36,219
1995	34,990	142,266		5,672	182,928	27,190	83,817	401	111,408
1996	27,289	92,506		7,309	127,104	28,426	30,727	0	59,153
1997	27,248	59,915		2,557	89,720	26,971	18,242	33	45,246
1998	26,888	21,270		2,935	51,093	26,280	6,848	84	33,212
1999	20,169	16,181		799	37,149	24,137	11,702	37	35,876
2000	24,079	3,315		561	27,955	25,331	3,309	87	28,727
2001	22,771	-		0	22,771	26,303	-	0	26,303
2002	24,107	6,327		164	30,598	23,554	4,027	54	27,635
2003	19,701	3,579		37	23,317	16,773	2,583	82	19,438
2004	20,620	13,993		217	34,830	25,931	5,782	0	31,713
2005	27,695	23,965		134	51,794	24,277	8,313	0	32,590
2006	27,881	21,816		456	50,153	31,655	25,543	0	57,198
2007	24,209	106,790		10	131,009	23,507	69,432	0	92,939
2008	22,767	67,459		80	90,306	24,291	58,139	0	82,430
2009	23,998	71,335		0	95,333	21,089	86,571	0	107,660
2010	25,172	102,267		0	127,439	23,738	80,948	0	104,686
2011	28,590	163,439		0	192,029	24,692	103,071	0	127,763
2012	35,370	150,800		1,274	187,444	32,566	57,049	1,138	90,753
2013	28,516	207,871		2,304	238,691	32,499	171,272	0	203,771
2014	23,894	198,240		0	222,134	26,134	229,107	0	255,241
2015	21,641	172,639		2,494	196,774	24,557	181,447	0	206,004
2016	26,701 [b]	293,522		380	320,603	27,197 [b]	228,267	0	255,464
2017		345,395		1,819	347,214		47,770	0	47,770
2012-2016 Average	27,224	204,614		1,290	233,129	28,591	173,428	228	202,247
2007-2016 Average	26,086	153,436		654	180,176	26,027	126,530	114	152,671

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	District 3			Lower Yukon Area Subtotals				
Year	Subsistence	Commercial	Total	Subsistence	Commercial [c]	Personal Use [d]	Test Fish Sales	Total
1961		0			0			
1962		0			0			
1963		0			0			
1964		0			0			
1965		0			0			
1966		0			0			
1967		57	57		10,935			10,935
1968		68	68		14,470			14,470
1969		0	0		61,966			61,966
1970		0	0		137,006			137,006
1971		50	50		100,090			100,090
1972		527	527		135,668			135,668
1973		463	463		285,509			285,509
1974		1,721	1,721		541,877			541,877
1975		0	0		517,462			517,462
1976		9,802	9,802		382,196			382,196
1977		3,412	3,412		359,743			359,743
1978	1,706	27,003	28,709	54,287	648,336			702,623
1979	9,531	40,015	49,546	48,951	582,787			631,738
1980	5,727	44,782	50,509	35,380	744,738			780,118
1981	7,430	54,471	61,901	32,958	913,507			946,465
1982	5,840	4,086	9,926	42,734	435,946			478,680
1983	4,609	14,600	19,209	56,684	713,856			770,540
1984	7,351	1,087	8,438	62,806	530,694			593,500
1985	3,687	1,792	5,479	47,831	437,377			485,208
1986	12,238	442	12,680	92,588	669,996			762,584
1987	12,176	3,501	15,677	76,070	401,275	0		477,345
1988	14,609	13,965	28,574	72,330	1,083,748	416	3,587	1,160,081
1989	12,824	7,578	20,402	105,371	894,983	381	4,338	1,005,073
1990	9,521	643	10,164	74,973	279,123	256	2,938	357,290

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Year	District 3 Subsistence	District 3 Commercial	District 3 Total	Lower Yukon Area Subtotals Subsistence	Lower Yukon Area Subtotals Commercial [c]	Lower Yukon Area Subtotals Personal Use [d]	Lower Yukon Area Subtotals Test Fish Sales	Lower Yukon Area Subtotals Total
1991	5,545	8,912	14,457	54,038	324,531		2,076	380,645
1992	9,599	65	9,664	67,569	324,523		1,918	394,010
1993	7,538	463	8,001	66,821	93,454		1,869	162,144
1994	8,492	35	8,527	63,544	55,236		3,212	121,992
1995	12,143	-	12,143	74,323	226,083		6,073	306,479
1996	11,368	1,534	12,902	67,083	124,767		7,309	199,159
1997	10,316	-	10,316	64,535	78,157		2,590	145,282
1998	6,472	0	6,472	59,640	28,118		3,019	90,777
1999	5,748	0	5,748	50,054	27,883		836	78,773
2000	3,687	-	3,687	53,097	6,624		648	60,369
2001	1,309	-	1,309	50,383	-		0	50,383
2002	2,506	-	2,506	50,167	10,354		218	60,739
2003	5,858	-	5,858	42,332	6,162		119	48,613
2004	2,958	-	2,958	49,509	19,775		217	69,501
2005	5,766	-	5,766	57,738	32,278		134	90,150
2006	3,534	116	3,650	63,070	47,475		456	111,001
2007	2,056	1	2,057	49,772	176,223		10	226,005
2008	2,971	-	2,971	50,029	125,598		80	175,707
2009	1,146	-	1,146	46,233	157,906		0	204,139
2010	1,341	-	1,341	50,251	183,215		0	233,466
2011	2,733	-	2,733	56,015	266,510		0	322,525
2012	8,690	-	8,690	76,626	207,849		2,412	286,887
2013	4,692	-	4,692	65,707	379,143		2,304	447,154
2014	3,748	–	3,748	53,776	427,347		0	481,123
2015	3,127	–	3,127	49,325	354,086		2,494	405,905
2016	3,053 [b]	–	3,053	56,951	521,789		380	579,120
2017		–	0	0	393,165		1,819	394,984
2012-2016 Average	4,662	–	4,662	60,477	378,043		1,518	440,038
2007-2016 Average	3,356	1	3,356	55,469	279,967		768	336,203

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	District 4					District 5				
Year	Subsistence [e]	Commercial	Commercial Related [f]	Anvik River [g]	Total	Subsistence [e]	Commercial	Commercial Related [f]	Personal Use [d]	Total
1961		0	0				0	0		
1962		0	0				0	0		
1963		0	0				0	0		
1964		0	0				0	0		
1965		0	0				0	0		
1966		0	0				0	0		
1967		0	0				0	0		
1968		0	0				0	0		
1969		0	0				0	0		
1970		0	0				0	0		
1971		0	0				0	0		
1972		0	0				0	0		
1973		0	0				0	0		
1974		27,866	0		27,866		6,831	0		6,831
1975		165,054	0		165,054		12,997	0		12,997
1976		211,307	0		211,307		774	0		774
1977		169,541	0		169,541		1,274	0		1,274
1978	93,139	364,184	16,920		474,243	20,423	4,892	605		25,920
1979	81,838	169,430	35,317		286,585	22,869	8,608	1,009		32,486
1980	117,305	147,560	135,824		400,689	8,594	456	0		9,050
1981	48,452	59,718	270,727		378,897	27,259	1,236	49		28,544
1982	57,967	3,647	254,072		315,686	9,770	213	21		10,004
1983	46,713	6,672	248,716		302,101	22,087	42	1,856		23,985
1984	49,230	1,009	277,061		327,300	31,488	645	47		32,180
1985	59,839	12,007	415,476		487,322	26,996	700	0		27,696
1986	53,020	300	465,235		518,555	21,833	690	0	0	22,523
1987	48,911	29,991	179,809		258,711	20,544	362	44	4,262	25,212
1988	86,623	24,051	466,023		576,697	28,960	722	363	567	30,612
1989	40,935	18,554	491,690		551,179	12,981	154	373	295	13,803
1990	26,534	12,364	210,186		249,084	9,817	11	660	641	11,129

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	District 4					District 5				
Year	Subsistence [e]	Commercial	Commercial Related [f]	Anvik River [g]	Total	Subsistence [e]	Commercial	Commercial Related [f]	Personal Use [d]	Total
1991	35,269	6,381	303,263		344,913	24,164	4	31		24,199
1992	35,812	2,659	208,737		247,208	12,612	102	328		13,042
1993	20,076	27	42,930		63,033	11,086	0	0		11,086
1994	27,504	3,611	145,423	22,573	199,111	11,830	229	235		12,294
1995	25,084	8,873	490,970	54,744	579,671	7,655	107	209		7,971
1996	16,425	0	425,607	84,633	526,665	11,509	0	336		11,845
1997	24,230	2,062	109,061	13,548	148,901	4,520	137	0		4,657
1998	18,046	-	-	-	18,046	2,314	96	14		2,424
1999	15,339	1,267	0	-	16,606	2,276	115	0		2,391
2000	7,046	-	-	-	7,046	3,641	-	-		3,641
2001	4,588	-	-	-	4,588	2,856	-	-		2,856
2002	15,971	-	-	-	15,971	5,610	6	0		5,616
2003	17,513	62	0	-	17,575	5,545	0	0		5,545
2004	14,959	-	-	-	14,959	3,411	25	0		3,436
2005	12,350	-	-	-	12,350	6,800	0	0		6,800
2006	14,997		-	-	-	11,830	20	0		11,850
2007	16,256	7,304	0	-	23,560	8,881	0	0		8,881
2008	13,517	23,746	0	-	37,263	3,537	-	-		3,537
2009	14,958	4,589	0	-	19,547	5,298	-	-		5,298
2010	11,720	44,207	0	-	55,927	3,555	-	-		3,555
2011	13,166	-	-	-	13,166	7,709	-	-		7,709
2012	21,555	108,222	0	-	129,777	4,892	-	-		4,892
2013	13,761	100,507	0	-	114,268	11,417	-	-		11,417
2014	9,981	96,385	0	–	106,366	3,108	–	–		3,108
2015	9,777	–	–	–	9,777	3,745	–	–		3,745
2016	13,502 [b]	–	–	–	13,502	4,958 [b]	–	–		4,958
2017		157,831	–	–	157,831		–	–		0
2012-2016 Average	13,715	115,736	0	–	74,738	5,624	–	–	–	5,624
2007-2016 Average	13,819	67,849	0	–	52,315	5,710	0	0	–	5,710

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	District 6						Upper Yukon Area Subtotals					
Year	Subsistence [e]	Commercial	Commercial Related [f]	Personal Use	Test Fish Sales	Total	Subsistence [e]	Commercial	Commercial Related [f]	Personal Use [d]	Test Fish Sales	Total
1961		0	0					0	0			
1962		0	0					0	0			
1963		0	0					0	0			
1964		0	0					0	0			
1965		0	0					0	0			
1966		0	0					0	0			
1967		0	0					0	0			
1968		0	0					0	0			
1969		0	0					0	0			
1970		0	0					0	0			
1971		0	0					0	0			
1972		0	0					0	0			0
1973		0	0					0	0			0
1974		13,318	0			13,318		48,015	0			48,015
1975		14,782	0			14,782		192,833	0			192,833
1976		6,617	0			6,617		218,698	0			218,698
1977		4,317	0			4,317		175,132	0			175,132
1978	3,534	34,814	8,236			46,584	117,096	403,890	25,761			546,747
1979	2,312	18,491	3,891			24,694	107,019	196,529	40,217			343,765
1980	6,426	35,855	3,282			45,563	132,325	183,871	139,106			455,302
1981	8,960	32,477	1,987			43,424	84,671	93,431	272,763			450,865
1982	6,942	21,597	1,517			30,056	74,679	25,457	255,610			355,746
1983	23,696	24,309	18			48,023	92,496	31,023	250,590			374,109
1984	23,106	56,249	335			79,690	103,824	57,903	277,443			439,170
1985	23,078	66,913	1,540			91,531	109,913	79,620	417,016			606,549
1986	14,896	50,483	2,146			67,525	89,749	51,473	467,381			608,603
1987	25,153	10,610	450			36,213	94,608	40,963	180,303	4,262		320,136
1988	8,686	40,129	1,646	1,242	0	51,703	124,269	64,902	468,032	1,809		659,012
1989	7,868	42,115	4,871	1,215	6,267	62,336	61,784	60,823	496,934	1,510	6,267	627,318
1990	4,285	11,127	3,706	930	5,325	25,373	40,636	23,502	214,552	1,571	5,325	285,586

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	District 6						Upper Yukon Area Subtotals					
Year	Subsistence [e]	Commercial	Commercial Related [f]	Personal Use	Test Fish Sales	Total	Subsistence [e]	Commercial	Commercial Related [f]	Personal Use [d]	Test Fish Sales	Total
1991	5,069	18,197	5,695	-	1,858	30,819	64,502	24,582	308,989	0	1,858	399,931
1992	9,504	5,029	2,199	-	49	16,781	57,928	7,790	211,264	0	49	277,031
1993	6,793	3,041	664	674	0	11,172	37,955	3,068	43,594	674	0	85,291
1994	7,026	21,208	10,226	-	0	38,460	46,360	25,048	178,457	0	0	249,865
1995	11,661	24,711	12,717	780	0	49,869	44,400	33,691	558,640	780	0	637,511
1996	7,486	22,360	24,530	905	0	55,281	35,420	22,360	535,106	905	0	593,791
1997	3,824	14,886	10,401	391	0	29,502	32,574	17,085	133,010	391	0	183,060
1998	6,004	397	173	84	0	6,658	26,364	493	187	84	0	27,128
1999	2,654	124	24	382	0	3,184	20,269	1,506	24	382	0	22,181
2000	1,111	-	-	30	0	1,141	11,798	-	-	30	0	11,828
2001	412	-	-	146	0	558	7,856	-	-	146	0	8,002
2002	512	3,198	19	175	0	3,904	22,093	3,204	19	175	0	25,491
2003	2,914	4,461	0	148	0	7,523	25,972	4,523	0	148	0	30,643
2004	1,793	6,610	0	231	0	8,634	20,163	6,635	0	231	0	27,029
2005	2,014	8,986	0	152	0	11,152	21,164	8,986	0	152	0	30,302
2006	1,010	44,621	0	262	0	45,893	27,837	44,641	0	262	0	57,743
2007	1,896	14,674	0	184	0	16,754	27,033	21,978	0	184	0	49,195
2008	1,311	1,842	0	138	0	3,291	18,365	25,588	0	138	0	44,091
2009	1,253	7,777	0	308	0	9,338	21,509	12,366	0	308	0	34,183
2010	422	5,466	0	319	0	6,207	15,697	49,673	0	319	0	65,689
2011	825	8,651	0	439	0	9,915	21,700	8,651	0	439	0	30,790
2012	678	3,504	0	321	0	4,503	27,125	111,726	0	321	0	139,172
2013	1,094	5,937	0	138	0	7,169	26,272	106,444	0	138	0	132,854
2014	731	6,912	0	235	0	7,878	13,820	103,297	0	235	0	117,352
2015	252	4,770	0	220	0	5,242	13,774	4,770	0	220	0	18,764
2016	96 [b]	4,020	0	176 [b]	0	4,292	18,556	4,020	0	176	0	22,752
2017		4,300	0		0	4,300	0	162,131	0	0	0	162,131
2012-2016 Average	570	5,029	0	218	0	5,817	19,909	66,051	0	218	0	86,179
2007-2016 Average	856	6,355	0	248	0	7,459	20,385	44,851	0	248	0	65,484

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	Alaska Yukon River Totals							Total Alaska Yukon Area	
Year	Subsistence	Commercial	Commercial Related [f]	Personal Use	Test Fish Sales	Sport Fish [h]	Total	Coastal District	Yukon Area Total
1961	305,317	0	0				305,317		305,317
1962	261,856	0	0				261,856		261,856
1963	297,094	0	0				297,094		297,094
1964	361,080	0	0				361,080		361,080
1965	336,848	0	0				336,848		336,848
1966	154,508	0	0				154,508		154,508
1967	206,233	10,935	0				217,168		217,168
1968	133,880	14,470	0				148,350		148,350
1969	156,191	61,966	0				218,157		218,157
1970	166,504	137,006	0				303,510		303,510
1971	171,487	100,090	0				271,577		271,577
1972	108,006	135,668	0				243,674		243,674
1973	161,012	285,509	0				446,521		446,521
1974	227,811	589,892	0				817,703		817,703
1975	211,888	710,295	0				922,183		922,183
1976	186,872	600,894	0				787,766		787,766
1977	159,502	534,875	0			316	694,693		694,693
1978	171,383	1,052,226	25,761			451	1,249,821	16,809	1,266,630
1979	155,970	779,316	40,217			328	975,831		975,831
1980	167,705	928,609	139,106			483	1,235,903		1,235,903
1981	117,629	1,006,938	272,763			612	1,397,942		1,397,942
1982	117,413	461,403	255,610			780	835,206		835,206
1983	149,180	744,879	250,590			998	1,145,647		1,145,647
1984	166,630	588,597	277,443			585	1,033,255		1,033,255
1985	157,744	516,997	417,016			1,267	1,093,024		1,093,024
1986	182,337	721,469	467,381	0		895	1,372,082		1,372,082
1987	170,678	442,238	180,303	4,262		846	798,327	29,668	827,995
1988	196,599	1,148,650	468,032	2,225	3,587	1,037	1,820,130	31,230	1,851,360
1989	167,155	955,806	496,934	1,891	10,605	2,132	1,634,523	2,341	1,636,864
1990	115,609	302,625	214,552	1,827	8,263	472	643,348		643,348

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	Alaska Yukon River Totals							Total Alaska Yukon Area	
Year	Subsistence	Commercial	Commercial Related [f]	Personal Use	Test Fish Sales	Sport Fish [h]	Total	Coastal District	Yukon Area Total
1991	118,540	349,113	308,989	0	3,934	1,037	781,613		781,613
1992	125,497	332,313	211,264	0	1,967	1,308	672,349	16,695	689,044
1993	104,776	96,522	43,594	674	1,869	564	247,999	20,798	268,797
1994	109,904	80,284	178,457	0	3,212	350	372,207	14,903	387,110
1995	118,723	259,774	558,640	780	6,073	1,174	945,164	17,360	962,524
1996	102,503	147,127	535,106	905	7,309	1,946	794,896	22,235	817,131
1997	97,109	95,242	133,010	391	2,590	662	329,004	15,711	344,715
1998	86,004	28,611	187	84	3,019	421	118,326	1,362	119,688
1999	70,323	29,389	24	382	836	555	101,509	13,461	114,970
2000	64,895	6,624	0	30	648	161	72,358	13,177	85,535
2001	58,239	-	0	146	0	82	58,467	13,916	72,383
2002	72,260	13,558	19	175	218	384	86,614	14,796	101,410
2003	68,304	10,685	0	148	119	1,638	80,894	13,968	94,862
2004	69,672	26,410	0	231	217	203	96,733	8,262	104,995
2005	78,902	41,264	0	152	134	435	120,887	14,357	135,244
2006	90,907	92,116	0	262	456	583	184,324	24,171	208,495
2007	76,805	198,201	0	184	10	245	275,445	16,121	291,566
2008	68,394	151,186	0	138	80	371	220,169	18,120	238,289
2009	67,742	170,272	0	308	0	174	238,496	12,797	251,293
2010	65,948	232,888	0	319	0	1,183	300,338	22,425	322,763
2011	77,715	275,161	0	439	0	294	353,609	18,305	371,914
2012	103,751	319,575	0	321	2,412	271	426,330	23,241	449,571
2013	91,979	485,587	0	138	2,304	1,423	581,431	23,135	604,566
2014	67,596	530,644	0	235	0	374	598,849	19,304	618,153
2015	63,099	358,856	0	220	2,494	194	424,863	20,468	445,331
2016	75,507	525,809	0	176	380		601,872	11,844 [b]	613,716
2017	0	555,296	0		1,819		557,115		557,115
2012-2016 Average	80,386	444,094	0	218	1,518	566	526,669	19,598	546,267
2007-2016 Average	75,854	324,818	0	248	768	503	402,140	18,576	420,716

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Note: En dash indicates no commercial fishing activity occurred. Blank cells indicate insufficient information to generate average.

[a] Subsistence harvest estimates not available by district until 1978. Harvests prior to 1977 were estimated because catches of salmon Other than Chinook salmon were not differentiated by species.

[b] Does not include coastal subsistence harvest in Hooper Bay and Scammon Bay.

[c] Includes department test fish sales prior to 1988 and estimates of illegal sales.

[d] Prior to 1987 and in 1991, 1992, and 1994, personal use was considered part of subsistence. Between 1987 and 1990, personal use fishing was defined by the fisherman's location of residence versus fishing location. In 1992, the Fairbanks nonsubsistence area was created as the only personal use area in the Yukon River drainage.

[e] In 1978 and 1979, the commercial related harvest was subtracted from the subsistence harvest because it was assumed this harvest was included in the reported subsistence harvest. From 1980 through 1987, the District 4 subsistence harvest was also reduced to account for commercial related harvests being reported in the subsistence harvest. It was calculated that 80.2% of the reported subsistence harvest (excluding Innoko and Koyukuk River catches) was commercial related. Beginning in 1989, subsistence surveys attempted to document subsistence only fishing catches and commercial related use separately

[f] In Districts 4, excluding the Anvik River, 5, and 6, commercial related refers to the estimated number of females and incidental males harvested to produce roe sold. Beginning in 2006, the numbers of females harvested are included in the total commercial harvest.

[g] Only roe has been sold in the Anvik River commercial fishery. The commercial related harvest shown is the estimated number of females harvested to produce roe sold.

[h] Estimated sport fish harvest for all chum salmon (assumes majority of chums caught during summer season) in Alaskan portion of the drainage. A majority of the sport fish harvest occurs in the Tanana River drainage (District 6).

Appendix I5.–Fall chum salmon total utilization in numbers of fish by district, area, and country, Yukon River drainage, 1961-2017.

	District 1					District 2			
Year	Subsistence [a,b]	Commercial [c]	Personal Use [d]	Test Fish Sales [e]	Total	Subsistence [a]	Commercial [c]	Test Fish Sales [e]	Total
1961		42,461			42,461				
1962		53,116			53,116				
1963									
1964		8,347			8,347				
1965		22,936			22,936				
1966		69,836			69,836				
1967		36,451			36,451				
1968		49,857			49,857				
1969		128,866			128,866				
1970		200,306			200,306		4,858		4,858
1971		188,533			188,533				
1972		136,711			136,711		12,898		12,898
1973		173,783			173,783		45,304		45,304
1974		176,036			176,036		53,540		53,540
1975		158,183			158,183		51,666		51,666
1976		105,851			105,851		21,212		21,212
1977		131,758			131,758		51,994		51,994
1978		127,947			127,947		51,646		51,646
1979	15,788	109,406			125,194	14,662	94,042		108,704
1980	7,433	106,829			114,262	12,435	83,881		96,316
1981	15,540	167,834			183,374	11,770	154,883		166,653
1982	10,016	97,484			107,500	9,511	96,581		106,092
1983	8,238	124,371			132,609	10,341	85,645		95,986
1984	8,885	78,751			87,636	11,394	70,803		82,197
1985	13,275	129,948			143,223	11,544	40,490		52,034
1986	9,000	59,352			68,352	13,483	51,307		64,790
1987	18,467	-	0	-	18,467	13,454	-	-	13,454
1988	5,475	45,317	5	639	51,436	8,600	31,861	16	40,477
1989	4,914	77,876	18	3,641	86,449	10,015	97,906	348	108,269
1990	5,335	27,337	60	2,068	34,800	6,187	37,173	96	43,456
1991	3,935	59,724		2,455	66,114	5,628	102,628	96	108,352
1992	5,216	-		-	5,216	7,382	-	-	7,382

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	District 1					District 2			
Year	Subsistence [a,b]	Commercial [c]	Personal Use [d]	Test Fish Sales [e]	Total	Subsistence [a]	Commercial [c]	Test Fish Sales [e]	Total
1993	7,770	-		-	7,770	3,094	-	-	3,094
1994	4,887	-		-	4,887	4,151	-	-	4,151
1995	4,698	79,378		1,121	85,197	3,317	90,831	0	94,148
1996	4,147	33,629		1,717	39,493	5,287	29,651	0	34,938
1997	3,132	27,483		867	31,482	4,680	24,326	0	29,006
1998	3,163	-		-	3,163	4,482	-	-	4,482
1999	6,502	9,987		1,149	17,638	4,594	9,703	22	14,319
2000	5,294	-		-	5,294	1,425	-	-	1,425
2001	3,437	-		-	3,437	3,256	-	-	3,256
2002	1,881	-		-	1,881	1,618	-	-	1,618
2003	2,139	5,586		0	7,725	2,901	-	-	2,901
2004	2,067	660		0	2,727	2,421	-	-	2,421
2005	2,889	130,525		87	133,501	3,257	-	-	3,257
2006	3,902	101,254		0	105,156	4,015	39,905	0	43,920
2007	4,390	38,852		0	43,242	3,472	35,826	0	39,298
2008	2,823	67,704		0	70,527	3,522	41,270	0	44,792
2009	1,917	11,911		0	13,828	1,563	12,072	0	13,635
2010	3,202	545		0	3,747	1,419	270	0	1,689
2011	3,434	127,735		0	131,169	2,578	100,731	0	103,309
2012	7,622	139,842		74	147,538	3,332	129,284	92	132,708
2013	3,673	106,588		121	110,382	4,878	106,274	0	111,152
2014	4,072	51,829		30	55,931	5,817	59,138	0	64,955
2015	5,877	100,562		50	106,489	6,258	74,214	0	80,472
2016	4,585	226,576		668	231,829	4,476	213,225	0	217,701
2017									
2012-2016 Average	5,166	125,079		189	130,434	4,952	116,427	18	121,398
2007-2016 Average	4,160	87,214		94	91,468	3,732	77,230	9	80,971

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	District 3			Lower Yukon Area Subtotals				
Year	Subsistence [a]	Commercial	Total	Subsistence [a]	Commercial [c]	Personal Use [d]	Test Fish Sales [e]	Total
1961					42,461			42,461
1962					53,116			53,116
1963								
1964					8,347			8,347
1965					22,936			22,936
1966		1,209	1,209		71,045			71,045
1967		1,823	1,823		38,274			38,274
1968		3,068	3,068		52,925			52,925
1969		1,722	1,722		130,588			130,588
1970		3,285	3,285		208,449			208,449
1971					188,533			188,533
1972		1,313	1,313		150,922			150,922
1973					219,087			219,087
1974		552	552		230,128			230,128
1975		5,590	5,590		215,439			215,439
1976		4,250	4,250		131,313			131,313
1977		15,851	15,851		199,603			199,603
1978		11,527	11,527		191,120			191,120
1979	2,443	25,955	28,398	32,893	229,403			262,296
1980	2,320	13,519	15,839	22,188	204,229			226,417
1981	3,043	19,043	22,086	30,353	341,760			372,113
1982	1,659	5,815	7,474	21,186	199,880			221,066
1983	2,863	10,018	12,881	21,442	220,034			241,476
1984	2,233	6,429	8,662	22,512	155,983			178,495
1985	2,290	5,164	7,454	27,109	175,602			202,711
1986	2,155	2,793	4,948	24,638	113,452			138,090
1987	3,287	0	3,287	35,208	-	0	-	35,208
1988	1,747	2,090	3,837	15,822	79,268	5	655	95,750
1989	1,023	15,332	16,355	15,952	191,114	18	3,989	211,073
1990	2,056	3,715	5,771	13,578	68,225	60	2,164	84,027
1991	615	9,213	9,828	10,178	171,565		2,551	184,294
1992	2,358	-	2,358	14,956	-		-	14,956

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Year	District 3 Subsistence [a]	District 3 Commercial	District 3 Total	Lower Yukon Area Subtotals Subsistence [a]	Commercial [c]	Personal Use [d]	Test Fish Sales [e]	Total
1993	1,449	-	1,449	12,313	-		-	12,313
1994	862	-	862	9,900	-		-	9,900
1995	1,672	-	1,672	9,687	170,209		1,121	181,017
1996	2,706	-	2,706	12,140	63,280		1,717	77,137
1997	787	-	787	8,599	51,809		867	61,275
1998	1,561	-	1,561	9,206	-		-	9,206
1999	415	-	415	11,511	19,690		1,171	32,372
2000	598	-	598	7,317	-		-	7,317
2001	700	-	700	7,393	-		-	7,393
2002	164	-	164	3,663	-		-	3,663
2003	738	-	738	5,778	5,586		0	11,364
2004	298	-	298	4,786	660		0	5,446
2005	1,304	-	1,304	7,450	130,525		87	138,062
2006	480	-	480	8,397	141,159		0	149,556
2007	925	-	925	8,787	74,678		0	83,465
2008	1,821	-	1,821	8,166	108,974		0	117,140
2009	937	-	937	4,417	23,983		0	28,400
2010	1,325	-	1,325	5,946	815		0	6,761
2011	354	-	354	6,366	228,466		0	234,832
2012	637	-	637	11,591	269,126		166	280,883
2013	1,764	-	1,764	10,315	212,862		121	223,298
2014	2,457	-	2,457	12,346	110,967		30	123,343
2015	1,388	-	1,388	13,523	174,776		50	188,349
2016	989	-	989	10,050	439,801		668	450,519
2017								
2012-2016 Average	1,447		1,447	11,565	241,506		207	253,278
2007-2016 Average	1,260		1,260	9,151	164,445		104	173,699

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Year	District 4				District 5				
	Subsistence [a,f]	Commercial	Commercial Related [g]	Total	Subsistence [a,f]	Commercial	Commercial Related [g]	Personal Use [d]	Total
1961		0 [h]		0					
1962		0 [h]		0					
1963		0 [h]		0					
1964		0 [h]		0					
1965		381 [h]		381					
1966		0 [h]		0					
1967		0 [h]		0					
1968		0 [h]		0					
1969		722 [h]		722					
1970		1,146 [h]		1,146					
1971		1,061 [h]		1,061					
1972		1,254 [h]		1,254					
1973		13,003 [h]		13,003					
1974		9,213	0	9,213		23,551	0		23,551
1975		13,666	0	13,666		27,212	0		27,212
1976		1,742	0	1,742		5,387	0		5,387
1977		13,980	0	13,980		25,730	0		25,730
1978		10,988	1,721	12,709		21,016	5,220		26,236
1979	34,697	48,899	3,199	86,795	102,695	47,459	8,097		158,251
1980	18,923	27,978	4,752	51,653	75,861	41,771	605		118,237
1981	17,120	12,082	2,853	32,055	104,612	87,856	5,719		198,187
1982	20,152	3,894	167	24,213	71,786	13,593	42		85,421
1983	32,246	4,482	1,963	38,691	105,103	43,993	0		149,096
1984	28,937	7,625	2,215	38,777	98,376	24,060	57		122,493
1985	22,750	24,452	2,525	49,727	117,125	25,338	0		142,463
1986	26,126	2,045	0	28,171	87,729	22,053	395		110,177
1987	41,467	-	-	41,467	141,335 [i]	-	-	15,750	157,085
1988	16,958	15,662	1,421	34,041	84,209	16,989	0	1,762	102,960
1989	24,540	11,776	3,407	39,723	112,001	18,215	3,989	3,294	137,499
1990	19,241	4,989	3,177	27,407	90,513	7,778	1,198	3,723	103,212
1991	20,875	3,737	2,354	26,966	74,002	27,355	4,759		106,116
1992	21,232	-	-	21,232	45,701	-	-		45,701

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	District 4				District 5				
Year	Subsistence [a,f]	Commercial	Commercial Related [g]	Total	Subsistence [a,f]	Commercial	Commercial Related [g]	Personal Use [d]	Total
1993	10,832	-	-	10,832	43,764	-	-		43,764
1994	13,325	-	-	13,325	66,396	3,630	0		70,026
1995	14,057	2,924	5,807	22,788	57,594	9,778	20,255		87,627
1996	16,786	2,918	0	19,704	63,473	11,878	9,980		85,331
1997	11,734	2,458	0	14,192	55,258	2,446	1,474		59,178
1998	7,898	-	-	7,898	31,393	-	-		31,393
1999	9,174	681	0	9,855	53,580	-	-		53,580
2000	1,759	-	-	1,759	9,920	-	-		9,920
2001	3,352	-	-	3,352	20,873	-	-		20,873
2002	1,549	-	-	1,549	10,976	-	-		10,976
2003	9,750	1,315	0	11,065	28,270	-	-		28,270
2004	7,797	-	-	7,797	40,670	0	0		40,670
2005	9,405	-	-	9,405	51,663	0	0		51,663
2006	6,335	-	-	6,335	52,158	10,030	0		62,188
2007	8,576	-	-	8,576	53,731	427	0		54,158
2008	7,412	0	0	7,412	57,258	4,556	0		61,814
2009	7,382	-	-	7,382	38,083	-	-		38,083
2010	6,788	-	-	6,788	44,334	-	-		44,334
2011	7,260	-	-	7,260	51,885	1,246	0		53,131
2012	18,055	811	0	18,866	54,350	2,419	0		56,769
2013	15,191	-	-	15,191	76,098	1,041	0		77,139
2014	15,936	-	-	15,936	51,197	1,264	0		52,461
2015	13,274	-	-	13,274	50,260	1,048	0		51,308
2016	9,874	-	-	9,874	58,598	7,542	0		66,140
2017									
2012-2016 Average	14,466	811		14,628	58,101	2,663	0		60,763
2007-2016 Average	10,975	406		11,056	53,579	2,443	0		55,534

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	District 6						Upper Yukon Area Subtotals					
Year	Subsistence [a,f]	Commercial	Commercial Related [g]	Personal Use [d]	Test Fish Sales [e]	Total	Subsistence [a,d,f]	Commercial	Commercial Related [g]	Personal Use [d]	Test Fish Sales [e]	Total
1961								0	0			0
1962								0	0			0
1963								0	0			0
1964								0	0			0
1965								381	0			381
1966								0	0			0
1967								0	0			0
1968								0	0			0
1969								722	0			722
1970								1,146	0			1,146
1971								1,061	0			1,061
1972								1,254	0			1,254
1973								13,003	0			13,003
1974		26,884	0			26,884		59,648	0			59,648
1975		18,692	0			18,692		59,570	0			59,570
1976		17,948	0			17,948		25,077	0			25,077
1977		18,673	0			18,673		58,383	0			58,383
1978		13,259	3,687			16,946		45,263	10,628			55,891
1979	44,596	34,185	7,170			85,951	181,988	130,543	18,466			330,997
1980	50,261	19,452	67			69,780	145,045	89,201	5,424			239,670
1981	23,013	25,989	3,619			52,621	144,745	125,927	12,191			282,863
1982	19,014	6,820	550			26,384	110,952	24,307	759			136,018
1983	31,069	34,089	1,105			66,263	168,418	82,564	3,068			254,050
1984	22,670	20,564	56			43,290	149,983	52,249	2,328			204,560
1985	36,963	42,352	0			79,315	176,838	92,142	2,525			271,505
1986	24,973	1,892	182			27,047	138,828	25,990	577			165,395
1987	124,587 [j]	-	-	3,316		127,903	307,389	-	-	19,066		326,455
1988	34,597	21,844	1,806	2,114	27,008	87,369	135,764	54,495	3,227	3,876	27,008	224,370
1989	58,654	49,090	7,353	1,770	16,984	133,851	195,195	79,081	14,749	5,064	16,984	311,073
1990	44,568	43,182	7,793	1,393	7,060	103,996	154,322	55,949	12,168	5,116	7,060	234,615
1991	40,469	28,195	16,253	0	1,385	86,302	135,346	59,287	23,366	0	1,385	219,384
1992	25,713	15,721	3,301	0	1,407	46,142	92,646	15,721	3,301	0	1,407	113,075

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	District 6						Upper Yukon Area Subtotals					
Year	Subsistence [a,f]	Commercial	Commercial Related [g]	Personal Use [d]	Test Fish Sales [e]	Total	Subsistence [a,d,f]	Commercial	Commercial Related [g]	Personal Use [d]	Test Fish Sales [e]	Total
1993	9,853	-	-	163		10,016	64,449	-	-	163		64,612
1994	33,597	1	4,368	0		37,966	113,318	3,631	4,368	0		121,317
1995	49,168	67,855	6,262	863		124,148	120,819	80,557	32,324	863		234,563
1996	36,467	10,266	7,308	356		54,397	116,726	25,062	17,288	356		159,432
1997	19,550	-	-	284		19,834	86,542	4,904	1,474	284		93,204
1998	14,370	-	-	2		14,372	53,661	-	-	2		53,663
1999	15,471	-	-	262		15,733	78,225	681	0	262		79,168
2000	310	-	-	1		311	11,989	-	-	1		11,990
2001	3,526	-	-	10		3,536	27,751	-	-	10		27,761
2002	3,202	-	-	3		3,205	15,727	-	-	3		15,730
2003	12,986	4,095	0	394		17,475	51,006	5,410	0	394		56,810
2004	8,953	3,450	0	230		12,633	57,420	3,450	0	230		61,100
2005	22,946	49,637	0	133		72,716	84,014	49,637	0	133		133,784
2006	16,925	23,353	0	333		40,611	75,418	33,383	0	333		109,134
2007	29,893	15,572	0	173		45,638	92,200	15,999	0	173		108,372
2008	16,135	5,735	0	181		22,051	80,805	10,291	0	181		91,277
2009	16,079	1,286	0	78		17,443	61,544	1,286	0	78		62,908
2010	11,391	1,735	0	3,209		16,335	62,513	1,735	0	3,209		67,457
2011	14,376	9,267	0	347		23,990	73,521	10,513	0	347		84,381
2012	15,302	17,336	0	410		33,048	87,707	20,566	0	410		108,683
2013	11,631	24,148	0	383		36,162	102,920	25,189	0	383		128,492
2014	12,798	3,368	0	278		16,444	79,931	4,632	0	278		84,841
2015	9,345	15,646	0	80		25,071	72,879	16,694	0	80		89,653
2016	5,165	18,053	0	283		23,501	73,637	25,595	0	283		99,515
2017												
2012-2016 Average	10,848	15,710	0	287		26,845	83,415	18,535	0	287		102,237
2007-2016 Average	14,212	11,215	0	542		25,968	78,766	13,250	0	542		92,558

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	Alaska Yukon River Totals						Canada: Yukon Area Totals					
							Mainstem Yukon River				Porcupine	
Year	Subsistence [a,d,f,k]	Commercial [c]	Commercial Related [g]	Personal Use [d]	Test Fish Sales [e]	Total	Domestic	Aboriginal	Commercial	Subtotal	Aboriginal	Total
1961	101,772	42,461	0			144,233		3,800	3,276	7,076	2,000	9,076
1962	87,285	53,116	0			140,401		6,500	936	7,436	2,000	9,436
1963	99,031	0	0			99,031		5,500	2,196	7,696	20,000	27,696
1964	120,360	8,347	0			128,707		4,200	1,929	6,129	6,058	12,187
1965	112,283	23,317	0			135,600		2,183	2,071	4,254	7,535	11,789
1966	51,503	71,045	0			122,548		1,430	3,157	4,587	8,605	13,192
1967	68,744	38,274	0			107,018		1,850	3,343	5,193	11,768	16,961
1968	44,627	52,925	0			97,552		1,180	453	1,633	10,000	11,633
1969	52,063	131,310	0			183,373		2,120	2,279	4,399	3,377	7,776
1970	55,501	209,595	0			265,096		612	2,479	3,091	620	3,711
1971	57,162	189,594	0			246,756		150	1,761	1,911	15,000	16,911
1972	36,002	152,176	0			188,178		0	2,532	2,532	5,000	7,532
1973	53,670	232,090	0			285,760		1,129	2,806	3,935	6,200	10,135
1974	93,776	289,776	0			383,552	466	1,636	2,544	4,646	7,000	11,646
1975	86,591	275,009	0			361,600	4,600	2,500	2,500	9,600	11,000	20,600
1976	72,327	156,390	0			228,717	1,000	100	1,000	2,100	3,100	5,200
1977	82,771	257,986	0			340,757	1,499	1,430	3,990	6,919	5,560	12,479
1978	84,239	236,383	10,628			331,250	728	482	3,356	4,566	5,000	9,566
1979	214,881	359,946	18,466			593,293	2,000	11,000	9,084	22,084		22,084
1980	167,233	293,430	5,424			466,087	4,000	3,218	9,000	16,218	6,000	22,218
1981	175,098	467,687	12,191			654,976	1,611	2,410	15,260	19,281	3,000	22,281
1982	132,138	224,187	759			357,084	683	3,096	11,312	15,091	1,000	16,091
1983	189,860	302,598	3,068			495,526	300	1,200	25,990	27,490	2,000	29,490
1984	172,495	208,232	2,328			383,055	535	1,800	22,932	25,267	4,000	29,267
1985	203,947	267,744	2,525			474,216	279	1,740	35,746	37,765	3,500	41,265
1986	163,466	139,442	577			303,485	222	2,200	11,464	13,886	657	14,543
1987	342,597	-	-	19,066		361,663	132	3,622	40,591	44,345	135	44,480
1988	151,586	133,763	3,227	3,881	27,663	320,120	349	1,882	30,263	32,494	1,071	33,565
1989	211,147	270,195	14,749	5,082	20,973	522,146	100	2,462	17,549	20,111	2,909	23,020
1990	167,900	124,174	12,168	5,176	9,224	318,642	0	3,675	27,537	31,212	2,410	33,622
1991	145,524	230,852	23,366	0	3,936	403,678	0	2,438	31,404	33,842	1,576	35,418
1992	107,602	15,721	3,301	0	1,407	128,031	0	304	18,576	18,880	1,935	20,815

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	Alaska Yukon River Totals						Canada: Yukon Area Totals					
								Mainstem Yukon River				
Year	Subsistence [a,d,f,k]	Commercial [c]	Commercial Related [g]	Personal Use [d]	Test Fish Sales [e]	Total	Domestic	Aboriginal	Commercial	Subtotal	Porcupine Aboriginal	Total
1993	76,762	-	-	163	-	76,925	0	4,660	7,762	12,422	1,668	14,090
1994	123,218	3,631	4,368	0	0	131,217	0	5,319	30,035	35,354	2,654	38,008
1995	130,506	250,766	32,324	863	1,121	415,580	0	1,099	39,012	40,111	5,489	45,600
1996	128,866	88,342	17,288	356	1,717	236,569	0	1,260	20,069	21,329	3,025	24,354
1997	95,141	56,713	1,474	284	867	154,479	0	1,238	8,068	9,306	6,294	15,600
1998	62,867	-	-	2	-	62,869	0	1,795	0	1,795	6,159	7,954
1999	89,736	20,371	0	262	1,171	111,540	0	3,234	10,402	13,636	6,000	19,636
2000	19,306	-	-	1	-	19,307	0	2,927	1,319	4,246	5,000	9,246
2001	35,144	-	-	10	-	35,154	3	3,077	2,198	5,278	4,594	9,872
2002	19,390	-	-	3	-	19,393	0	3,167	3,065	6,232	1,860	8,092
2003	56,784	10,996	0	394	0	68,174	0	1,493	9,030	10,523	382	10,905
2004	62,206	4,110	0	230	0	66,546	0	2,180	7,365	9,545	205	9,750
2005	91,464	180,162	0	133	87	271,846	13	2,035	11,931	13,979	4,593	18,572
2006	83,815	174,542	0	333	0	258,690	0	2,521	4,096	6,617	5,179	11,796
2007	100,987	90,677	0	173	0	191,837	0	2,221	7,109	9,330	4,500	13,830
2008	88,971	119,265	0	181	0	208,417	0	2,068	4,062	6,130	3,436	9,566
2009	65,961	25,269	0	78	0	91,308	0	820	293	1,113	898	2,011
2010	68,459	2,550	0	3,209	0	74,218	0	1,523	2,186	3,709	2,078	5,787
2011	79,887	238,979	0	347	0	319,213	0	1,000	5,312	6,312	1,851	8,163
2012	99,298	289,692	0	410	166	389,566	0	700	3,205	3,905	3,118	7,023
2013	113,235	238,051	0	383	121	351,790	18	500	3,369	3,887	2,283	6,170
2014	92,277	115,599	0	278	30	208,184	19	546	2,485	3,050	1,983	5,033
2015	86,402	191,470	0	80	50	278,002	35	1,000	2,862	3,897	556	4,453
2016	83,687	465,396	0	283	668	550,034	0	1,000	1,745	2,745	3,005	5,750
2017												
2012-2016 Average	94,980	260,042	0	287	207	355,515	14	749	2,733	3,497	2,189	5,686
2007-2016 Average	87,916	177,695	0	542	104	266,257	7	1,138	3,263	4,408	2,371	6,779

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	Yukon River Drainage (Alaska/Canada) Totals						Total Alaska Yukon Area		
Year	Subsistence [l]	Commercial	Commercial Related [g]	Personal Use [d]	Alaska Test Fish	Total	Coastal District	Alaska Total	Yukon Area Total
1961	107,572	45,737	0			153,309	0	144,233	144,233
1962	95,785	54,052	0			149,837	0	140,401	140,401
1963	124,531	2,196	0			126,727	0	99,031	99,031
1964	130,618	10,276	0			140,894	0	128,707	128,707
1965	122,001	25,388	0			147,389	0	135,600	135,600
1966	61,538	74,202	0			135,740	0	122,548	122,548
1967	82,362	41,617	0			123,979	0	107,018	107,018
1968	55,807	53,378	0			109,185	0	97,552	97,552
1969	57,560	133,589	0			191,149	0	183,373	183,373
1970	56,733	212,074	0			268,807	0	265,096	265,096
1971	72,312	191,355	0			263,667	0	246,756	246,756
1972	41,002	154,708	0			195,710	0	188,178	188,178
1973	60,999	234,896	0			295,895	0	285,760	285,760
1974	102,878	292,320	0			395,198	0	383,552	383,552
1975	104,691	277,509	0			382,200	0	361,600	361,600
1976	76,527	157,390	0			233,917	0	228,717	228,717
1977	91,260	261,976	0			353,236	0	340,757	340,757
1978	90,449	239,739	10,628			340,816	665	331,250	331,915
1979	227,881	369,030	18,466			615,377	0	593,293	593,293
1980	180,451	302,430	5,424			488,305	0	466,087	466,087
1981	182,119	482,947	12,191			677,257	0	654,976	654,976
1982	136,917	235,499	759			373,175	0	357,084	357,084
1983	193,360	328,588	3,068			525,016	0	495,526	495,526
1984	178,830	231,164	2,328			412,322	0	383,055	383,055
1985	209,466	303,490	2,525			515,481	0	474,216	474,216
1986	166,545	150,906	577			318,028	0	303,485	303,485
1987	346,486	40,591	0	19,066		406,143	0	361,663	361,663
1988	154,888	164,026	3,227	3,881	27,663	353,685	5,489	320,120	325,609
1989	216,618	287,744	14,749	5,082	20,973	545,166	156	522,146	522,302
1990	173,985	151,711	12,168	5,176	9,224	352,264	0	318,642	318,642
1991	149,538	262,256	23,366	0	3,936	439,096	0	403,678	403,678
1992	109,841	34,297	3,301	0	1,407	148,846	206	128,031	128,237

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	Yukon River Drainage (Alaska/Canada) Totals						Total Alaska Yukon Area		
Year	Subsistence [l]	Commercial	Commercial Related [g]	Personal Use [d]	Alaska Test Fish	Total	Coastal District	Alaska Total	Yukon Area Total
1993	83,090	7,762	0	163	-	91,015	120	76,925	77,045
1994	131,191	33,666	4,368	0	0	169,225	347	131,217	131,564
1995	137,094	289,778	32,324	863	1,121	461,180	354	415,580	415,934
1996	133,151	108,411	17,288	356	1,717	260,923	392	236,569	236,961
1997	102,673	64,781	1,474	284	867	170,079	0	154,479	154,479
1998	70,821	0	0	2	-	70,823	34	62,869	62,903
1999	98,970	30,773	0	262	1,171	131,176	204	111,540	111,744
2000	27,233	1,319	0	1	-	28,553	89	19,307	19,396
2001	42,818	2,198	0	10	-	45,026	559	35,154	35,713
2002	24,417	3,065	0	3	-	27,485	284	19,393	19,677
2003	58,659	20,026	0	394	0	79,079	146	68,174	68,320
2004	64,591	11,475	0	230	0	76,296	320	66,546	66,866
2005	98,105	192,093	0	133	87	290,418	70	271,846	271,916
2006	91,515	178,638	0	333	0	270,486	187	258,690	258,877
2007	107,708	97,786	0	173	0	205,667	234	191,837	192,071
2008	94,475	123,327	0	181	0	217,983	386	208,417	208,803
2009	67,679	25,562	0	78	0	93,319	158	91,308	91,466
2010	72,060	4,736	0	3,209	0	80,005	186	74,218	74,404
2011	80,887	244,291	0	347	0	325,525	315	319,213	319,528
2012	99,998	292,897	0	410	166	393,471	11	389,566	389,577
2013	116,036	241,420	0	383	121	357,960	149	351,790	351,939
2014	94,825	118,084	0	278	30	213,217	252	208,184	208,436
2015	87,993	194,332	0	80	50	282,455	198	278,002	278,200
2016	87,692	467,141	0	283	668	555,784	762	550,034	550,796
2017									
2012-2016 Average	97,309	262,775	0	287	207	360,577	274	355,515	355,790
2007-2016 Average	90,935	180,958	0	542	104	272,539	265	266,257	266,522

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Note: Unless otherwise indicated, blank cells indicate years in which no information was collected or harvest numbers were insufficient to generate summary information. Endash indicates no commercial fishing activity occurred, includes commercial related or test fish sales.

[a] Subsistence harvest estimates not available by district until 1978.

[b] Does not include coastal subsistence harvest in Hooper Bay and Scammon Bay.

[c] Includes department test fish sales prior to 1988.

[d] Prior to 1987 and in 1991, 1992, and 1994, personal use was considered part of subsistence. Between 1987 and 1990, personal use fishing was defined by the fisherman's location of residence versus fishing location. In 1992, the Fairbanks nonsubsistence area was created as the only personal use area in the Yukon River drainage.

[e] The number of salmon sold by ADF&G test fisheries.

[f] From 1978 through 1988, the commercial related harvest was subtracted from the subsistence harvest in Districts 4, 5, and 6 because it was assumed that this harvest was included in the reported subsistence harvest during that time period. Beginning in 1989, subsistence surveys attempted to document subsistence only fishing catches and commercial related use separately.

[g] Estimated number of females harvested to produce roe sold.

[h] These numbers were added from original Annual Management Reports January 13, 2006; however, they are not in the fish ticket programs.

[i] Includes an estimated 95,768 fall chum salmon illegally sold in District 5.

[j] Includes an estimated 119,168 fall chum salmon illegally sold in District 6

[k] Minimum estimates from 1961-1978 because subsistence surveys were conducted prior to the end of the fishing season and catches of fish other than Chinook salmon were not differentiated by species.

[l] Includes Alaska Yukon River subsistence and Canadian Domestic and Aboriginal harvests.

Appendix I6.–Coho salmon total utilization in numbers of fish by district, area, and country, Yukon River drainage, 1961-2017.

	District 1					District 2			
Year	Subsistence [a,b]	Commercial [c]	Personal Use [d]	Test Fish Sales [e]	Total	Subsistence [a]	Commercial [c]	Test Fish Sales [e]	Total
1961		2,855			2,855		0		0
1962		22,926			22,926		0		0
1963		5,572			5,572		0		0
1964		2,446			2,446		0		0
1965		350			350		0		0
1966		19,254			19,254		0		0
1967		9,925			9,925		0		0
1968		13,153			13,153		0		0
1969		13,989			13,989		0		0
1970		12,632			12,632		0		0
1971		12,165			12,165		0		0
1972		21,705			21,705		506		506
1973		34,860			34,860		1,781		1,781
1974		13,713			13,713		176		176
1975		2,288			2,288		200		200
1976		4,064			4,064		17		17
1977		31,720			31,720		5,319		5,319
1978	1,142	16,460			17,602	598	5,835		6,433
1979	3,184	11,369			14,553	1,132	2,850		3,982
1980	1,808	4,829			6,637	4,801	2,660		7,461
1981	3,769	13,129			16,898	3,736	7,848		11,584
1982	11,192	15,115			26,307	10,229	14,179		24,408
1983	3,590	4,595			8,185	6,072	2,557		8,629
1984	6,095	29,472			35,567	7,066	43,064		50,130
1985	3,246	27,676			30,922	4,834	17,125		21,959
1986	2,725	24,824			27,549	9,140	21,197		30,337
1987	6,396	-	0	-	6,396	6,894	-	-	6,894
1988	4,389	36,028	0	407	40,824	7,104	34,758	18	41,880
1989	5,077	22,987	59	1,685	29,808	5,039	38,402	120	43,561
1990	3,301	12,160	8	1,194	16,663	6,344	16,405	30	22,779
1991	1,808	54,095		2,094	57,997	3,297	40,898	86	44,281
1992	5,426	-		-	5,426	6,587	-	-	6,587

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	District 1					District 2			
Year	Subsistence [a,b]	Commercial [c]	Personal Use [d]	Test Fish Sales [e]	Total	Subsistence [a]	Commercial [c]	Test Fish Sales [e]	Total
1993	2,343	-		-	2,343	1,695	-	-	1,695
1994	3,272	-		-	3,272	3,881	-	-	3,881
1995	2,251	21,625		193	24,069	2,142	18,488	0	20,630
1996	2,445	27,705		1,728	31,878	3,475	20,974	0	24,449
1997	1,823	21,450		498	23,771	2,424	13,056	0	15,480
1998	2,171	-		-	2,171	2,297	1	0	2,298
1999	1,730	855		236	2,821	2,793	746	0	3,539
2000	1,067	-		-	1,067	2,351	-	-	2,351
2001	1,274	-		-	1,274	1,440	-	-	1,440
2002	1,295	-		-	1,295	1,233	-	-	1,233
2003	1,260	9,757		0	11,017	1,586	-	-	1,586
2004	1,175	1,583		0	2,758	1,500	-	-	1,500
2005	976	36,533		0	37,509	1,110	-	-	1,110
2006	1,177	39,323		0	40,500	2,459	14,482	0	16,941
2007	2,265	21,720		0	23,985	2,347	21,487	0	23,834
2008	1,211	13,946		0	15,157	1,997	19,246	0	21,243
2009	847	5,994		0	6,841	1,057	1,582	0	2,639
2010	1,122	1,027		0	2,149	557	1,023	0	1,580
2011	1,127	45,335		0	46,462	823	24,184	0	25,007
2012	3,350	39,757		39	43,146	1,346	29,063	0	30,409
2013	1,224	27,306		1	28,531	1,080	31,458	0	32,538
2014	1,782	54,804		0	56,586	1,769	48,602	0	50,371
2015	2,100	66,029		8	68,137	3,002	54,860	0	57,862
2016	1,233	113,669		11	114,913	1,119	67,208	0	68,327
2017									
2012-2016 Average	1,938	60,313		12	62,263	1,663	46,238		47,901
2007-2016 Average	1,626	38,959		6	40,591	1,510	29,871		31,381

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	District 3			Lower Yukon Area Subtotals				
Year	Subsistence [a]	Commercial	Total	Subsistence [a,b]	Commercial [c]	Personal Use [d]	Test Fish Sales [e]	Total
1961		0	0		2,855			2,855
1962		0	0		22,926			22,926
1963		0	0		5,572			5,572
1964		0	0		2,446			2,446
1965		0	0		350			350
1966		0	0		19,254			19,254
1967		1,122	1,122		11,047			11,047
1968		150	150		13,303			13,303
1969		1,009	1,009		14,998			14,998
1970		0	0		12,632			12,632
1971		0	0		12,165			12,165
1972		0	0		22,211			22,211
1973		0	0		36,641			36,641
1974		0	0		13,889			13,889
1975		0	0		2,488			2,488
1976		0	0		4,081			4,081
1977		538	538		37,577			37,577
1978	223	758	981	1,963	23,053			25,016
1979	74	0	74	4,390	14,219			18,609
1980	91	0	91	6,700	7,489			14,189
1981	510	419	929	8,015	21,396			29,411
1982	675	87	762	22,096	29,381			51,477
1983	917	0	917	10,579	7,152			17,731
1984	740	621	1,361	13,901	73,157			87,058
1985	376	171	547	8,456	44,972			53,428
1986	954	793	1,747	12,819	46,814			59,633
1987	754	-	754	14,044	-	0	-	14,044
1988	1,667	1,419	3,086	13,160	72,205	0	425	85,790
1989	537	3,988	4,525	10,653	65,377	59	1,805	77,894
1990	1,026	918	1,944	10,671	29,483	8	1,224	41,386
1991	1,340	1,905	3,245	6,445	96,898	0	2,180	105,523
1992	1,549	-	1,549	13,562	-		-	13,562

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	District 3			Lower Yukon Area Subtotals				
Year	Subsistence [a]	Commercial	Total	Subsistence [a,b]	Commercial [c]	Personal Use [d]	Test Fish Sales [e]	Total
1993	279	-	279	4,317	-		-	4,317
1994	363	-	363	7,516	-		-	7,516
1995	891	-	891	5,284	40,113		193	45,590
1996	444	-	444	6,364	48,679		1,728	56,771
1997	766	-	766	5,013	34,506		498	40,017
1998	400	-	400	4,868	1		0	4,869
1999	610	-	610	5,133	1,601		236	6,970
2000	94	-	94	3,512	-		-	3,512
2001	0	-	0	2,714	-		-	2,714
2002	115	-	115	2,643	-		-	2,643
2003	711	-	711	3,557	9,757		0	13,314
2004	284	-	284	2,959	1,583		0	4,542
2005	217	-	217	2,303	36,533		0	38,836
2006	83	-	83	3,719	53,805		0	57,524
2007	739	-	739	5,351	43,207		0	48,558
2008	410	-	410	3,618	33,192		0	36,810
2009	321	-	321	2,225	7,576		0	9,801
2010	353	-	353	2,032	2,050		0	4,082
2011	36	-	36	1,986	69,519		0	71,505
2012	556	-	556	5,252	68,820		39	74,111
2013	371	-	371	2,675	58,764		1	61,440
2014	340	-	340	3,891	103,406		0	107,297
2015	428	-	428	5,530	120,889		8	126,427
2016	140	-	140	2,492	180,877		11	183,380
2017								
2012-2016 Average	367	-	367	3,968	106,551		12	110,531
2007-2016 Average	369	-	369	3,505	68,830		6	72,341

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	District 4				District 5				
Year	Subsistence [a]	Commercial	Commercial Related [f]	Total	Subsistence [a]	Commercial	Commercial Related [f]	Personal Use [d]	Total
1961									
1962									
1963									
1964									
1965									
1966									
1967									
1968									
1969									
1970									
1971									
1972									
1973									
1974						1,409	0		1,409
1975						5	0		5
1976						-	-		0
1977						2	0		2
1978	145	32	0	177	970	1	0		971
1979	197	155	0	352	595	-	-		595
1980	7,734	30	0	7,764	561	-	-		561
1981	2,239	-	-	2,239	1,713	-	-		1,713
1982	2,952	15	0	2,967	3,428	-	-		3,428
1983	3,946	-	-	3,946	2,448	-	-		2,448
1984	2,867	1,095	0	3,962	17,467	-	-		17,467
1985	3,949	938	0	4,887	8,098	-	-		8,098
1986	2,458	-	-	2,458	5,870	-	-		5,870
1987	3,479	-	-	3,479	11,842 [g]	-	-	58	11,900
1988	4,714	2	0	4,716	19,755	8	0	103	19,866
1989	4,030	3	0	4,033	7,187	84	0	82	7,353
1990	3,614	-	-	3,614	11,562	-	-	18	11,580
1991	4,451	14	0	4,465	4,931	-	-		4,931
1992	8,429	-	-	8,429	12,376	-	-		12,376

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	District 4				District 5				
Year	Subsistence [a]	Commercial	Commercial Related [f]	Total	Subsistence [a]	Commercial	Commercial Related [f]	Personal Use [d]	Total
1993	1,167	-	-	1,167	5,984	-	-		5,984
1994	3,515	-	-	3,515	4,174	-	-		4,174
1995	1,934	-	-	1,934	2,205	-	-		2,205
1996	2,467	161	0	2,628	6,588	-	-		6,588
1997	3,754	814	0	4,568	3,583	-	-		3,583
1998	2,593	-	-	2,593	2,839	-	-		2,839
1999	2,049	-	-	2,049	4,241	-	-		4,241
2000	1,068	-	-	1,068	4,987	-	-		4,987
2001	2,266	-	-	2,266	7,674	-	-		7,674
2002	1,023	-	-	1,023	2,076	-	-		2,076
2003	5,773	367	0	6,140	3,887	-	-		3,887
2004	4,766	-	-	4,766	1,423	-	-		1,423
2005	2,971	-	-	2,971	2,159	-	-		2,159
2006	1,302	-	-	1,302	3,779	-	-		3,779
2007	2,952	-	-	2,952	3,366	-	-		3,366
2008	1,490	0	0	1,490	3,203	91	-		3,294
2009	3,986	-	-	3,986	2,498	-	-		2,498
2010	1,730	-	-	1,730	3,604	-	-		3,604
2011	2,072	-	-	2,072	1,389	-	-		1,389
2012	3,556	0	0	3,556	3,092	634	0		3,726
2013	4,940	-	-	4,940	1,298	0	0		1,298
2014	3,062	-	-	3,062	2,030	0	0		2,030
2015	1,941	-	-	1,941	2,462	0	0		2,462
2016	826	-	-	826	864	54	0		918
2017									
2012-2016 Average	2,865	0	0	2,865	1,949	138			2,087
2007-2016 Average	2,656	0	0	2,656	2,381	130			2,459

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	District 6						Upper Yukon Area Subtotals					
Year	Subsistence [a]	Commercial	Commercial Related [f]	Personal Use [d]	Test Fish Sales [e]	Total	Subsistence [a]	Commercial	Commercial Related [f]	Personal Use [d]	Test Fish Sales [e]	Total
1961												
1962												
1963												
1964												
1965												
1966												
1967												
1968												
1969								95	0			95
1970								556	0			556
1971								38	0			38
1972								22	0			22
1973								0	0			0
1974		1,479	0			1,479		2,888	0			2,888
1975		53	0			53		58	0			58
1976		1,103	0			1,103		1,103	0			1,103
1977		1,284	0			1,284		1,286	0			1,286
1978	4,709	3,066	0			7,775	5,824	3,099	0			8,923
1979	4,612	2,791	0			7,403	5,404	2,946	0			8,350
1980	5,163	1,226	0			6,389	13,458	1,256	0			14,714
1981	9,261	2,284	0			11,545	13,213	2,284	0			15,497
1982	7,418	7,780	0			15,198	13,798	7,795	0			21,593
1983	6,932	6,168	0			13,100	13,326	6,168	0			19,494
1984	14,785	7,006	0		682	22,473	35,119	8,101	0			43,220
1985	11,761	11,762	0			23,523	23,808	12,700	0			36,508
1986	13,321	441	0			13,762	21,649	441	0			22,090
1987	53,006 [h]	-	-	2,465		55,471	68,327	-	-	2,523		70,850
1988	30,201	13,972	0	1,147	13,295	58,615	54,670	13,982	0	1,250	13,295	83,197
1989	18,841	16,084	0	731	2,140	37,796	30,058	16,171	0	813	2,140	49,182
1990	17,613	11,549	3,255	1,155	1,426	34,998	32,789	11,549	3,255	1,173	1,426	50,192
1991	21,561	6,268	3,506	-	791	32,126	30,943	6,282	3,506	-	791	41,522
1992	17,554	6,556	1,423	-	1,629	27,162	38,359	6,556	1,423	-	1,629	47,967

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	District 6						Upper Yukon Area Subtotals					
Year	Subsistence [a]	Commercial	Commercial Related [f]	Personal Use [d]	Test Fish Sales [e]	Total	Subsistence [a]	Commercial	Commercial Related [f]	Personal Use [d]	Test Fish Sales [e]	Total
1993	4,304	-	-	0		4,304	11,455	-	-	0		11,455
1994	26,489	120	4,331	-		30,940	34,178	120	4,331	-		38,629
1995	18,802	5,826	1,074	417		26,119	22,941	5,826	1,074	417		30,258
1996	14,893	3,803	3,339	198		22,233	23,948	3,964	3,339	198		31,449
1997	11,595	-	-	350		11,945	18,932	814	0	350		20,096
1998	7,472	-	-	9		7,481	12,904	-	-	9		12,913
1999	9,394	-	-	147		9,541	15,684	-	-	147		15,831
2000	5,150	-	-	0		5,150	11,205	-	-	0		11,205
2001	8,966	-	-	34		9,000	18,906	-	-	34		18,940
2002	9,499	-	-	20		9,519	12,598	-	-	20		12,618
2003	10,363	15,119	0	549		26,031	20,023	15,486	0	549		36,058
2004	11,584	18,649	0	233		30,466	17,773	18,649	0	233		36,655
2005	19,538	21,778	0	107		41,423	24,668	21,778	0	107		46,553
2006	10,571	11,137	0	279		21,987	15,652	11,137	0	279		27,068
2007	7,845	1,368	0	135		9,348	14,163	1,368	0	135		15,666
2008	8,428	2,408	0	50		10,886	13,121	2,499	0	50		15,670
2009	7,051	457	285	70		7,863	13,535	457	285	70		14,347
2010	5,555	1,700	0	1,062		8,317	10,889	1,700	0	1,062		13,651
2011	6,842	6,784	0	232		13,858	10,303	6,784	0	232		17,319
2012	9,540	5,335	0	100		14,975	16,188	5,969	0	100		22,257
2013	5,257	7,439	0	109		12,805	11,495	7,439	0	109		19,043
2014	7,911	1,286	0	174		9,371	13,003	1,286	0	174		14,463
2015	8,000	8,811	0	145		16,956	12,403	8,811	0	145		21,359
2016	4,271	20,551	0	266		25,088	5,961	20,605	0	266		26,832
2017												
2012-2016 Average	6,996	8,684	0	159		15,839	11,810	8,822	0	159		20,791
2007-2016 Average	7,070	5,614	29	234		12,947	12,106	5,692	29	234		18,061

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	Alaska Yukon River Totals							Canada: Yukon Territories Totals		
Year	Subsistence [a,b,i]	Commercial [a,c]	Commercial Related [f]	Personal Use [d]	Test Fish Sales [e]	Sport Fish [j]	Total	Mainstem Yukon River [k]	Porcupine Aborginal	Total
1961	9,192	2,855	0				12,047			
1962	9,480	22,926	0				32,406			
1963	27,699	5,572	0				33,271			
1964	12,187	2,446	0				14,633			
1965	11,789	350	0				12,139			
1966	13,192	19,254	0				32,446			
1967	17,164	11,047	0				28,211			
1968	11,613	13,303	0				24,916			
1969	7,776	15,093	0				22,869			
1970	3,966	13,188	0				17,154			
1971	16,912	12,203	0				29,115			
1972	7,532	22,233	0				29,765			
1973	10,236	36,641	0				46,877			
1974	11,646	16,777	0				28,423			
1975	20,708	2,546	0				23,254			
1976	5,241	5,184	0				10,425			
1977	16,333	38,863	0			125	55,321			
1978	7,787	26,152	0			302	34,241			
1979	9,794	17,165	0			50	27,009			
1980	20,158	8,745	0			67	28,970	0	1,500	1,500
1981	21,228	23,680	0			45	44,953	0	500	500
1982	35,894	37,176	0			191	73,261	0		0
1983	23,905	13,320	0			199	37,424	0		0
1984	49,020	81,258	0			831	131,109	0	500	500
1985	32,264	57,672	0			808	90,744	0	250	250
1986	34,468	47,255	0			1,535	83,258	0	300	300
1987	82,371	0	0	2,523		1,292	86,186	0	306	306
1988	67,830	86,187	0	1,250	13,720	2,420	171,407	0	350	350
1989	40,711	81,548	0	872	3,945	1,811	128,887	0	470	470
1990	43,460	41,032	3,255	1,181	2,650	1,947	93,525	0	680	680
1991	37,388	103,180	3,506	0	2,971	2,775	149,820	0	235	235
1992	51,921	6,556	1,423	0	1,629	1,666	63,195	0	495	495

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	Alaska Yukon River Totals							Canada: Yukon Territories Totals		
Year	Subsistence [a,b,i]	Commercial [a,c]	Commercial Related [f]	Personal Use [d]	Test Fish Sales [e]	Sport Fish [j]	Total	Mainstem Yukon River [k]	Porcupine Aboriginal	Total
1993	15,772	-	-	0	-	897	16,669	0	60	60
1994	41,694	120	4,331	0	0	2,174	48,319	2	332	334
1995	28,225	45,939	1,074	417	193	1,278	77,126	0	509	509
1996	30,312	52,643	3,339	198	1,728	1,588	89,808	0	41	41
1997	23,945	35,320	0	350	498	1,470	61,583	2	298	300
1998	17,772	1	0	9	0	758	18,540	0	214	214
1999	20,817	1,601	0	147	236	609	23,410	0	100	100
2000	14,717	-	-	0	-	554	15,271	0	37	37
2001	21,620	-	-	34	-	1,202	22,856	0	0	0
2002	15,241	-	-	20	-	1,092	16,353	26	449	475
2003	23,580	25,243	0	549	0	1,477	50,849	7	523	530
2004	20,732	20,232	0	233	0	1,623	42,820	5	175	180
2005	26,971	58,311	0	107	0	627	86,016	0	11	11
2006	19,371	64,942	0	279	0	1,000	85,592	1	111	112
2007	19,514	44,575	0	135	0	597	64,821	2	500	502
2008	16,739	35,691	0	50	0	341	52,821	0	200	200
2009	15,760	8,033	285	70	0	964	25,112	0	0	0
2010	12,921	3,750	0	1,062	0	944	18,677	0	12	12
2011	12,289	76,303	0	232	0	463	89,287	0	63	63
2012	21,440	74,789	0	100	39	131	96,499	0	10	10
2013	14,170	66,203	0	109	1	266	80,749	0	10	10
2014	16,894	104,692	0	174	0	1,855	123,615	0	133	133
2015	17,933	129,700	0	145	8	593	148,379	0	0	0
2016	8,453	201,482	0	266	11	29	210,241	0	0	0
2017										
2012-2016 Average	15,778	115,373	0	159	12	575	131,897		31	31
2007-2016 Average	15,611	74,522	29	234	6	618	91,020		93	93

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	Yukon River Drainage (Alaska/Canada) Totals							Total Alaska Yukon Area		
Year	Subsistence [a,b,i,l]	Commercial	Commercial Related [f]	Personal Use [d]	Alaska Test Fish [e]	Sport Fish	Total	Coastal District	Alaska Total	Yukon Area Total
1961	9,192	2,855	0				12,047	0	12,047	12,047
1962	9,480	22,926	0				32,406	0	32,406	32,406
1963	27,699	5,572	0				33,271	0	33,271	33,271
1964	12,187	2,446	0				14,633	0	14,633	14,633
1965	11,789	350	0				12,139	0	12,139	12,139
1966	13,192	19,254	0				32,446	0	32,446	32,446
1967	17,164	11,047	0				28,211	0	28,211	28,211
1968	11,613	13,303	0				24,916	0	24,916	24,916
1969	7,776	15,093	0				22,869	0	22,869	22,869
1970	3,966	13,188	0				17,154	0	17,154	17,154
1971	16,912	12,203	0				29,115	0	29,115	29,115
1972	7,532	22,233	0				29,765	0	29,765	29,765
1973	10,236	36,641	0				46,877	0	46,877	46,877
1974	11,646	16,777	0				28,423	0	28,423	28,423
1975	20,708	2,546	0				23,254	0	23,254	23,254
1976	5,241	5,184	0				10,425	0	10,425	10,425
1977	16,333	38,863	0			125	55,321	0	55,321	55,321
1978	7,787	26,152	0			302	34,241	89	34,241	34,330
1979	9,794	17,165	0			50	27,009	0	27,009	27,009
1980	21,658	8,745	0			67	30,470	0	28,970	28,970
1981	21,728	23,680	0			45	45,453	0	44,953	44,953
1982	35,894	37,176	0			191	73,261	0	73,261	73,261
1983	23,905	13,320	0			199	37,424	0	37,424	37,424
1984	49,520	81,258	0			831	131,609	0	131,109	131,109
1985	32,514	57,672	0			808	90,994	0	90,744	90,744
1986	34,768	47,255	0			1,535	83,558	0	83,258	83,258
1987	82,677	0	0	2,523		1,292	86,492	191	86,186	86,377
1988	68,180	86,187	0	1,250	13,720	2,420	171,757	15,672	171,407	187,079
1989	41,181	81,548	0	872	3,945	1,811	129,357	4,299	128,887	133,186
1990	44,140	41,032	3,255	1,181	2,650	1,947	94,205	0	93,525	93,525
1991	37,623	103,180	3,506	0	2,971	2,775	150,055	0	149,820	149,820
1992	52,416	6,556	1,423	0	1,629	1,666	63,690	59	63,195	63,254

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	Yukon River Drainage (Alaska/Canada) Totals							Total Alaska Yukon Area		
Year	Subsistence [a,b,i,l]	Commercial	Commercial Related [f]	Personal Use [d]	Alaska Test Fish [e]	Sport Fish	Total	Coastal District	Alaska Total	Yukon Area Total
1993	15,832	0	0	0	0	897	16,729	40	16,669	16,709
1994	42,026	122	4,331	0	0	2,174	48,653	81	48,319	48,400
1995	28,734	45,939	1,074	417	193	1,278	77,635	152	77,126	77,278
1996	30,353	52,643	3,339	198	1,728	1,588	89,849	92	89,808	89,900
1997	24,243	35,322	0	350	498	1,470	61,883	0	61,583	61,583
1998	17,986	1	0	9	0	758	18,754	349	18,540	18,889
1999	20,917	1,601	0	147	236	609	23,510	74	23,410	23,484
2000	14,754	0	0	0	0	554	15,308	222	15,271	15,493
2001	21,620	0	0	34	0	1,202	22,856	548	22,856	23,404
2002	15,690	17	0	20	0	1,101	16,828	248	16,353	16,601
2003	24,103	25,243	0	549	0	1,484	51,379	292	50,849	51,141
2004	20,907	20,236	0	233	0	1,624	43,000	63	42,820	42,883
2005	26,982	58,311	0	107	0	627	86,027	279	86,016	86,295
2006	19,482	64,942	0	279	0	1,001	85,704	335	85,592	85,927
2007	20,014	44,575	0	135	0	599	65,323	110	64,821	64,931
2008	16,939	35,691	0	50	0	341	53,021	116	52,821	52,937
2009	15,760	8,033	285	70	0	964	25,112	246	25,112	25,358
2010	12,933	3,750	0	1,062	0	944	18,689	124	18,677	18,801
2011	12,352	76,303	0	232	0	463	89,350	55	89,287	89,342
2012	21,450	74,789	0	100	39	131	96,509	93	96,499	96,592
2013	14,180	66,203	0	109	1	266	80,759	287	80,749	81,036
2014	17,027	104,692	0	174	0	1,855	123,748	204	123,615	123,819
2015	17,933	129,700	0	145	8	593	148,379	174	148,379	148,553
2016	8,453	201,482	0	266	11	29	210,241	355	210,241	210,596
2017										
2012-2016 Average	15,809	115,373	0	159	12	575	131,927	223	131,897	132,119
2007-2016 Average	15,704	74,522	29	234	6	619	91,113	176	91,020	91,197

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Note: Unless otherwise indicated, blank cells indicate years in which no information was collected or harvest numbers were insufficient to generate summary information. Endash indicates no commercial fishing activity occurred, includes commercial related and test fish sales.

[a] Subsistence harvest estimates not available by district until 1978.

[b] Does not include coastal subsistence harvest in Hooper Bay and Scammon Bay.

[c] Includes department test fish sales prior to 1988.

[d] Prior to 1987 and in 1991, 1992, and 1994, personal use was considered part of subsistence. Between 1987 and 1990, personal use fishing was defined by the fisherman's location of residence versus fishing location. In 1992, the Fairbanks nonsubsistence area was created as the only personal use area in the Yukon River drainage.

[e] The number of fish sold by ADF&G test fisheries.

[f] Estimated number of females harvested to produce roe sold.

[g] Includes an estimated 5,015 coho salmon illegally sold in District 5.

[h] Includes an estimated 31,276 coho salmon illegally sold in District 6.

[i] Minimum estimates from 1961-1978 because subsistence surveys were conducted prior to the end of the fishing season and catches of fish other than Chinook salmon were not differentiated by species.

[j] Estimated sport fish harvest for Alaskan portion of the Yukon River drainage. A majority of the sport fish harvest occurs in the Tanana River drainage, District 6.

[k] Includes Domestic, commercial, test, sport, and Aboriginal harvest from the Mainstem Yukon River.

[l] Includes Alaska Yukon River subsistence harvest and Canadian Aboriginal harvest.

Appendix I7.–Commercial Fisheries Entry Commission salmon gear permits issued by residence, Yukon Area, 2017.

Lower Yukon Area	Residence	Gillnet (S04Y)
District 1, 2, and 3	Alakanuk	73
	Anchorage/Eagle River	38
	Auke Bay	1
	Bethel	10
	Chevak	1
	Elim	1
	Emmonak	128
	Fairbanks	7
	Holy Cross	5
	Homer	3
	Hooper Bay	2
	Juneau	2
	Kotlik	84
	Kwethluk	1
	Marshall	46
	Mcgrath	1
	Mountain Village	76
	Nenana	1
	Newhalen	1
	Nome	1
	Nunam Iqua	19
	Palmer	2
	Pilot Station	65
	Russian Mission	19
	Saint Marys	81
	Saint Michael	5
	Sand Point	1
	Scammon Bay	40
	Shaktoolik	1
	Sitka	1
	Stebbins	4
District 1, 2, and 3	Stebbins	4
	Wasilla	16
	Out of State	3
Total Lower Yukon Area		743

Upper Yukon Area	Residence	Gillnet (S04P)	Fish wheel (S08P)	Total
District 4, 5, and 6	Anchorage	4	2	6
	Anvik	1	4	5
	Eagle River	0	1	1
	Fairbanks	22	21	43
	Fort Yukon	0	1	1
	Galena	2	6	8
	Grayling	2	4	6
	Hughes	0	1	1
	Kaltag	0	8	8
	Manley Hot Springs	2	5	7
	Nenana	6	13	19
	North Pole	2	3	5
	Nulato	0	9	9
	Rampart	1	0	1
	Ruby	1	4	5
	Salcha	1	0	1
	Stevens Village	0	1	1
	Tanana	1	8	9
	Valdez	0	1	1
	Wasilla	0	3	3
	Schuyler	0	1	1
	Winnebago, IL	0	1	1
	Camano Island, WA	1	0	1
Total Upper Yukon Area		46	97	143
Grand Total Yukon Area				143

Note: Counts are for initial issues only and do not include transfers. Includes interim entry permits but not interim use or test fish permits.

Appendix I8.–Estimated value and fishermen's participation in Yukon Area commercial salmon fishery, 1977–2017.

		Total	
Year	Total Value	Permits Issued	Permits Fished
1977	4,267,466	929	783
1978	5,740,191	928	834
1979	7,171,515	943	840
1980	5,789,752	943	834
1981	10,020,605	954	836
1982	6,675,742	952	820
1983	6,964,229	945	810
1984	5,669,624	940	812
1985	7,019,369	938	817
1986	6,261,115	940	801
1987	7,202,358	938	797
1988	13,379,691	938	844
1989	10,179,350	937	851
1990	6,517,794	936	826
1991	9,552,796	935	826
1992	11,331,871	957	821
1993	5,427,795	946	805
1994	4,786,687	944	762
1995	7,150,405	946	717
1996	4,797,993	944	676
1997	5,889,300	940	693
1998	1,955,891	936	671
1999	5,086,539	938	668
2000	734,239	936	561
2001	-	928	0
2002	1,813,258	930	564
2003	1,953,277	932	584
2004	3,131,606	896	574
2005	2,468,839	893	602
2006	3,687,727	880	610
2007	2,511,840	874	596
2008	1,389,792	869	496
2009	718,953	861	403
2010	1,553,897	843	455
2011	3,442,334	835	446
2012	3,074,045	820	494
2013	3,514,663	807	467
2014	3,156,692	800	482
2015	2,672,084	793	486
2016	5,248,096	788	492
2017	4,319,474	789	476
2012-2016 Average	3,533,116	802	484
2007-2016 Average	2,728,240	829	482

Appendix I9.–Estimated exvessel value of commercial salmon fishery to Lower Yukon Area fishermen, 1967-2017.

	Chinook		Summer chum		Fall chum		Coho				Total
Year	$/lb	Dollars	$/lb	Dollars	$/lb	Dollars	$/lb	Dollars	Pink	Dollars	Dollars
1967	0.19	584,624 [a]	0.05	14,128 [b]	0.05	14,353 [b]	0.07	5,645 [a]			618,750
1968	0.18	502,758 [a]	0.06	17,711 [b]	0.06	23,816 [b]		[c]			544,286
1969	0.19	408,867 [a]	0.08	80,060 [b]	0.08	78,353 [b]	0.08	8,039 [a]			575,319
1970	0.22	380,186 [a]	0.09	204,961 [b]	0.09	140,703 [b]	0.12	10,762 [a]			736,612
1971	0.24	589,903 [a]	0.10	163,347 [b]	0.10	141,400 [b]	0.12	10,073 [a]			904,723
1972	0.24	541,680 [a]	0.11	98,495 [a]	0.11	126,171 [a]	0.13	20,501 [a]			786,847
1973	0.30	544,223 [a]	0.16	310,634 [a]	0.16	276,926 [a]	0.18	46,827 [a]			1,178,610
1974	0.38	839,972 [a]	0.21	739,662 [a]	0.21	362,452 [a]	0.25	24,306 [a]			1,966,391
1975	0.42	555,111 [a]	0.20	672,701 [a]	0.20	323,159 [a]	0.21	3,762 [a]			1,554,732
1976	0.51	928,300 [a]	0.24	596,226 [a]	0.24	236,363 [a]	0.27	7,272 [a]			1,768,162
1977	0.85	1,841,033	0.40	1,007,280	0.45	718,571	0.50	140,914			3,707,798
1978	0.90	2,048,674	0.45	2,071,434	0.47	691,854	0.60	96,823			4,908,785
1979	1.09	2,763,433	0.52	2,242,564	0.68	1,158,485	0.80	83,466			6,247,948
1980	1.04	3,409,105	0.20	1,027,738	0.28	394,162	0.36	17,374			4,848,379
1981	1.20	4,420,669	0.40	2,741,178	0.55	1,503,744	0.60	87,385			8,752,976
1982	1.41	3,768,107	0.40	1,237,735	0.55	846,492	0.69	135,828			5,988,162
1983	1.40	4,093,562	0.34	1,734,270	0.34	591,011	0.35	17,497			6,436,340
1984	1.50	3,510,923	0.26	926,922	0.32	374,359	0.50	256,050			5,068,254
1985	1.50	4,294,432	0.35	1,032,700	0.47	634,616	0.53	176,254			6,138,002
1986	1.63	3,165,078	0.38	1,746,455	0.49	399,321	0.71	211,942			5,522,796
1987	1.98	5,428,933	0.49	1,313,618	–	–	–	–			6,742,551
1988	2.97	5,463,800	0.66	5,001,100	1.01	638,700	1.38	734,400			11,838,000
1989	2.77	5,181,700	0.34	2,217,700	0.50	713,400	0.66	323,300			8,436,100
1990	2.84	4,820,859	0.24	497,571	0.45	238,165	0.66	137,302			5,693,897
1991	3.70	7,128,300	0.36	782,300	0.34	438,310	0.44	300,182			8,649,092
1992	4.12	9,957,002	0.27	606,976	–	0	–	0			10,563,978
1993	2.70	4,884,044	0.38	226,772	–	0	–	0			5,110,816
1994	2.07	4,169,270	0.21	79,206	–	0	–	0			4,248,476
1995	2.09	5,317,508	0.16	241,598	0.15	185,036	0.29	80,019			5,824,161
1996	1.95	3,491,582	0.09	89,020	0.10	48,579	0.26	96,795			3,725,976
1997	2.46	5,450,433	0.10	56,535	0.22	86,526	0.32	79,973			5,673,467
1998	2.51	1,911,370	0.14	26,415	-	-	-	-			1,937,785
1999	3.80	4,950,522	0.10	19,687	0.25	35,639	0.35	3,620			5,009,468
2000	4.57	725,606	0.17	8,633	–	–	–	–			734,239
2001	–	–	–	–	–	–	–	–			0
2002	3.77	1,781,996	0.06	4,342	–	–	–	–			1,786,338
2003	2.37	1,871,202	0.05	1,585	0.15	5,993	0.10	18,168			1,896,948
2004	2.80	3,063,667	0.05	8,884	0.25	1,126	0.05	2,774			3,076,451
2005	3.43	1,952,109	0.05	11,004	0.32	316,698	0.32	83,793			2,363,604
2006	3.94	3,290,367	0.05	23,862	0.20	202,637	0.20	50,299			3,567,165
2007	3.73	1,939,114	0.19	220,715	0.27	144,256	0.39	127,869			2,431,954
2008	4.64	325,470	0.40	326,930	0.55	428,969	0.97	216,777	0.10	0	1,298,146
2009	5.00	20,970	0.50	514,856	0.70	108,778	1.00	52,176	–	–	696,780
2010	5.00	639,230	0.70	823,967	1.00	5,428	1.50	20,535	–	–	1,489,160
2011	5.00 [a]	4,925	0.75	1,301,008	1.00	1,628,329	1.00	472,199	–	–	3,406,461

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Year	Chinook $/lb	Chinook Dollars	Summer chum $/lb	Summer chum Dollars	Fall chum $/lb	Fall chum Dollars	Coho $/lb	Coho Dollars	Pink	Dollars	Total Dollars
2012	–	–	0.75	980,424	1.00	1,385,498	1.25	534,523	–	–	2,900,445
2013	–	–	0.75	1,721,524	0.75	1,154,172	1.10	453,998	–	–	3,329,694
2014	–	–	0.60	1,648,866	0.75	621,975	1.00	706,569	0.07	13,691	2,991,101
2015	–	–	0.60	1,259,908	0.60	762,142	0.70	616,165	0.12	3,691	2,641,906
2016	–	–	0.60	1,903,490	0.68	2,093,052	1.00	1,143,823	0.14	63,663	5,204,028
2017	5.50 [d]	9,922	0.60	1,470,353	0.60	2,038,232	1.00	514,580	-	0	4,033,087
2007-2016 Average	4.67	585,942	0.58	1,070,169	0.73	833,260	0.99	434,463	0.11	20,261	2,638,967
2012–2016 Average	-	–	0.66	1,502,842	0.76	1,203,368	1.01	691,015	0.07	16,209	3,413,435

Note: Endash indicates no commercial fishing activity occurred. Blank cells indicate insufficient information to generate average. Information about commercial harvest prior to 1967 either because fishery did not occur or commercial harvest information is not available by number of fish, average weight, or price per pound so value cannot be calculated

[a] Value calculated from average weight and number of fish commercially harvested published in previous AMR reports

[b] No average weight published from this year in previous AMR reports. Value calculated from an estimated average weight based on historical data and the number of salmon harvested commercially as previously published.

[c] No price per pound information from this year.

[d] Chinook salmon sold in fall season only.

Appendix I10.–Estimated exvessel value of commercial salmon fishery to Upper Yukon Area fishermen, 1974-2017.

	Chinook			Summer chum			Fall chum			Coho		
Year	$/lb	Roe	Dollars	$/lb	Roe	Dollars	$/lb	Roe	Dollars	$/lb	Roe	Dollars
1974	0.50		41,702 [a]	0.15		55,120 [a]	0.13			0.15		
1975	0.92		61,244 [a]	0.17		230,941 [a]	0.14			0.17		
1976	0.74		63,478 [a]	0.19		266,878 [a]	0.16			0.19		
1977	1.37		148,766	0.27	2.66	306,481	0.22		102,170	0.27		2,251
1978	0.87		66,472	0.24		655,738	0.25		103,091	0.24		6,105
1979	1.00		124,230	0.25	3.00	444,924	0.29		347,814	0.25		6,599
1980	0.85		113,662	0.23	2.50	627,249	0.27		198,088	0.29		2,374
1981	1.00		206,380	0.20	3.00	699,876	0.35		356,805	0.35		4,568
1982	1.02		162,699	0.18	2.75	452,837	0.28		53,258	0.37		18,786
1983	1.08		105,584	0.16	1.66	281,883	0.19		128,950	0.31		11,472
1984	0.95		102,354	0.23	1.78	382,776	0.26		103,417	0.24		12,823
1985	0.86		82,644	0.23	1.94	593,801	0.25		178,125	0.33		26,797
1986	0.89		73,363	0.22	2.08	634,091	0.14		30,309	0.21		556
1987	0.79		136,196	0.19	2.22	323,611	-		-	-		-
1988	1.04		142,284	0.23	4.33	1,123,991	0.32		151,300	0.37		34,116
1989	0.84		108,178	0.24	4.41	1,377,117	0.28		223,996	0.35		33,959
1990	0.72		105,295	0.11	4.41	506,611	0.29		174,965	0.34		37,026
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
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
1993	1.06	5.52	113,217	0.35	8.53	203,762	–	–	0	–	–	0
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
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
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
1997	0.97	1.62	110,713	0.07	1.08	96,806	0.17	1.75	7,252	0.20	–	1,062
1998	0.91	2.00	17,285	0.18	1.90	821	–	–	–	–	–	–
1999	1.10	2.11	74,475	0.18	2.25	1,720	0.20	–	876	–	–	0
2000	–	–	–	–	–	–	–	–	–	–	–	–
2001	–	–	–	–	–	–	–	–	–	–	–	–
2002	0.75	1.75	20,744	0.32	2.25	6,176	–	–	–	–	–	–
2003	0.80	–	40,957	0.27	–	6,879	0.10	–	3,398	0.05	–	5,095
2004	0.77	–	38,290	0.27	–	9,645	0.05	–	848	0.06	–	6,372
2005	0.87	–	24,415	0.25	–	13,479	0.14	–	48,159	0.12	–	19,182
2006	1.30	–	32,631	0.16	–	42,988	0.14	–	33,806	0.19	–	11,137
2007	1.33	–	27,190	0.25	2.36	34,421	0.20	–	16,907	0.20	–	1,368
2008	–	–	–	0.25	3.00	65,840	0.27	–	22,089	0.20	–	3,717
2009	–	–	–	0.26	3.00	20,430	0.19	–	1,286	0.15	–	457
2010	–	–	–	0.23	–	61,534	0.23	–	2,761	0.26	–	442
2011	–	–	–	0.26	–	12,966	0.22	–	16,115	0.15	–	6,792

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	Chinook			Summer chum			Fall chum			Coho		
Year	$/lb	Roe	Dollars	$/lb	Roe	Dollars	$/lb	Roe	Dollars	$/lb	Roe	Dollars
2012	–	–	–	0.37	-	137,817	0.19	–	28,355	0.25	–	7,428
2013	–	–	–	0.30	-	152,110	0.16	–	25,744	0.17	–	7,115
2014	–	–	–	0.29	-	154,959	0.25	–	8,156	0.38	–	2,380
2015	–	–	–	0.23	-	7,166	0.14	–	15,683	0.12	–	6,877
2016	–	–	–	0.26	-	6,030	0.14	–	22,477	0.13	–	15,540
2017	–	–	–	0.34	-	274,608	0.22	–	10,888	0.18	–	892
2007-2016 Average	1.33	–	27,190	0.27	2.79	65,327	0.20	–	15,957	0.20	–	5,212
2012–2016 Average	–	–		0.29	–		0.18	–	20,083	0.21	–	7,868

Note: Endash indicates no commercial fishing activity occurred. Blank cells indicate insufficient information to generate average. Information about commercial harvest prior to 1974 is not available by number of fish, average weight, or price per pound so value cannot be calculated.

[a] Value calculated from average weight and number of fish commercially harvested published in previous AMR reports

Appendix I11.–Chinook salmon aerial survey indices for selected spawning areas in the Alaskan portion of the Yukon River drainage, 1961–2017.

	Andreafsky River		Anvik River		Nulato River			Gisasa River
Year	East Fork	West Fork	Drainagewide Total	Index Area [a]	North Fork [b]	South Fork	Both Forks	
1961	1,003		1,226		376 [c]	167	543	266 [c]
1962	675 [c]	762 [c]						
1963								
1964	867	705						
1965		344 [c]	650 [c]					
1966	361	303	638					
1967		276 [c]	336 [c]					
1968	380	383	310 [c]					
1969	274 [c]	231 [c]	296 [c]					
1970	665	574 [c]	368					
1971	1,904	1,682						
1972	798	582 [c]	418					
1973	825	788	222					
1974		285	[c]		55 [c]	23 [c]	78 [c]	161
1975	993	301	1,197		123	81	204	385
1976	818	643	1,153		471	177	648	332
1977	2,008	1,499	1,394		286	201	487	255
1978	2,487	1,062	1,454		498	422	920	45 [c]
1979	1,180	1,134	2,146		1,093	414	1,507	484
1980	958 [c]	1,500	1,330	1,192	954 [c]	369 [c]	1,323 [c]	951
1981	2,146 [c]	231 [c]	807 [c]	577 [c]		791	791	
1982	1,274	851						421
1983			653 [c]	376 [c]	526	480	1,006	572
1984	1,573 [c]	1,993	641 [c]	574 [c]				
1985	1,617	2,248	1,051	720	1,600	1,180	2,780	735
1986	1,954	3,158	1,118	918	1,452	1,522	2,974	1,346
1987	1,608	3,281	1,174	879	1,145	493	1,638	731
1988	1,020	1,448	1,805	1,449	1,061	714	1,775	797
1989	1,399	1,089	442 [c]	212 [c]				
1990	2,503	1,545	2,347	1,595	568 [c]	430 [c]	998 [c]	884 [c]
1991	1,938	2,544	875 [c]	625 [c]	767	1,253	2,020	1,690

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Year	Andreafsky River East Fork	Andreafsky River West Fork	Anvik River Drainagewide Total	Anvik River Index Area	Nulato River North Fork	Nulato River South Fork	Nulato River Both Forks	Gisasa River
1992	1,030 [c]	2,002 [c]	1,536	931	348	231	579	910
1993	5,855	2,765	1,720	1,526	1,844	1,181	3,025	1,385
1994	300 [c]	213 [c]		913 [c]				2,775
1995	1,635	1,108	1,996	1,147	968	681	1,649	410
1996		624	839	709		100 [c]	100	
1997	1,140	1,510	3,979	2,690				144 [c]
1998	1,027	1,249 [c]	709 [c]	648 [c]	507	546	1,053	889 [c]
1999	[c]	870 [c]	950 [c]	950 [c]		[c]	[c]	[c]
2000	1,018	427	1,394	1,394		[c]	[c]	[c]
2001	1,059	565	1,420	1,177	1,116	768	1,884 [d]	1,298 [c]
2002	1,447	917	1,713	1,329	687	897	1,584	506
2003	1,116 [c]	1,578 [c]	973 [c]	973 [c]		[c]	[c]	
2004	2,879	1,317	3,679	3,304	856	465	1,321	731
2005	1,715	1,492	2,421	1,922	323	230	553	958
2006	591 [c]	824	1,886	1,776 [e]	620	672	1,292	843
2007	1,758	976	1,529	1,497	1,928	1078	2,583	593
2008	278 [c]	262 [c]	992 [c]	827 [c]	463	543	922	487
2009	84 [c]	1,678	832	590	1,418	842	2,260	515
2010	537	858	974	721	356	355	711	264
2011	620	1,173	642	501	788	613	1,401	906
2012	[c]	722 [c]	722	451	682	692	1,374	[c]
2013	1,441	1,090	940	656	586	532	1,118	201 [c]
2014	[c]	1,695	1,584	800	[c]	[c]	[c]	[c]
2015	2,167 [c]	1,356 [c]	2,616		999	565	1,564	558
2016	[c]							
2017	[c]	942	1,101		500	443	943	[c]
SEG [f]	2,100-4,900 [g]	640-1,600	1,100-1,700				940-1,900	[g]
Average								
1997–2016	1,180	1,082	1,577	1,234	809	628	1,401	635
2007–2016	984	1,090	1,203	755	903	653	1,492	503
2012–2016	1,804	1,216	1,466	636	756	596	1,352	380

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Note: Aerial survey counts are peak counts only. Survey rating was fair or good unless otherwise noted.

[a] Anvik River Index Area includes mainstem counts between Yellow River and McDonald Creek. The SEG is for the entire drainage.

[b] Nulato River mainstem aerial survey counts below the forks are included with the North Fork.

[c] Incomplete, poor timing and/or poor survey conditions resulting in no aerial survey or inaccurate counts.

[d] In 2001, the Nulato River escapement goal was established for both forks combined.

[e] Index area includes counts from Beaver Creek to McDonald Creek.

[f] Sustainable Escapement Goal.

[g] Aerial escapement goal was discontinued in 2010. A weir-based goal replaced East Fork Andreafsky River aerial survey goal.

Appendix I12.–Chinook salmon escapement counts for selected spawning areas in the Alaska portion of the Yukon River drainage, 1986-2017.

Year	Andreafsky River		Nulato River Tower	Henshaw Creek Weir		Gisasa River Weir		Chena River		Salcha River	
	No. Fish	% Fem.	No. Fish	No. Fish	% Fem.	No. Fish	% Fem.	No. Fish	% Fem. [a]	No. Fish	% Fem. [a]
1986	1,530	23.3 [b]						9,065 [c]	25.4		
1987	2,011	56.1 [b]						6,404 [c]	48.2	4,771 [c]	52.0
1988	1,339	38.7 [b]						3,346 [c]	33.9	4,562 [c]	45.3
1989		13.6						2,666 [c]	45.3	3,294 [c]	43.8
1990		41.6						5,603 [c]	36.3	10,728 [c]	36.2
1991		33.9						3,025 [c]	31.5	5,608 [c]	40.7
1992		21.2						5,230 [c]	21.6	7,862 [c]	36.0
1993		29.9						12,241 [b]	11.7	10,007 [b]	22.9
1994	7,801	35.5 [d]	1,795 [d]			2,888	[d]	11,877 [b]	32.4	18,399 [b]	40.4
1995	5,841	43.7	1,412			4,023	46.0	11,394 [c]	51.7	13,643	48.5
1996	2,955	41.9	756			1,991	19.5	7,153 [c]	26.8	7,570 [c]	26.2
1997	3,186	36.8	4,766			3,764	26.0	13,390	25.6	18,514	43.4
1998	4,034	29.0	1,536			2,414	16.2	4,745	28.4	5,027	26.1
1999	3,444	28.6	1,932			2,644	26.4	6,485	45.6	9,198	47.4
2000	1,609	54.3	908	244	29.7	2,089	34.4	4,694 [c]	21.7	4,595	38.1
2001	1,148	-	- [d]	1,103	36.3	3,052	49.2 [d]	9,696	30.1	13,328	32.5
2002	4,123	21.1	2,696	649	30.8	2,025	20.7	6,967 [c]	27.3	9,000 [e]	30.1
2003	4,336	45.3	1,716 [h]	763	38.4	1,901	38.1	11,100	31.8	15,500 [e]	34.3
2004	8,045	37.3		1,248	21.3	1,774	30.1	9,645	43.9	15,761	54.5
2005	2,239	50.2		1,059	41.4	3,111	34.0		30.6	5,988	47.1
2006	6,463	42.6				3,031	28.2	2,936	32.1	10,679	37.6
2007	4,504	44.7		740	24.9	1,427	39.0	3,806	26.0	6,425	31.0
2008	4,242	34.8		766	27.7	1,738	16.2	3,208	29.0	5,415 [e]	34.1
2009	3,004	46.0		1,637	49.0	1,955	29.3	5,253	40.0	12,774	33.9
2010	2,413	48.6		857	50	1,516	29.0	2,382	20.6	6,135	26.6
2011	5,213	20.2		1,796	33.9	2,692	19.5		22.7	7,200 [e]	36.3
2012	2,517	28.0		922	43.0	1,323	17.0	2,219 [e]	39.1	7,165	50.9
2013	1,998	40.4		772	44.8	1,126	34.1	1,860	40.3	5,465	50.5
2014	5,949	44.2			[d]	1,589	19.2	7,192 [i]	33.1		32.0
2015	5,474	39.7		2,391	40.7	1,319	29.5	6,294	39.0	6,879	37.0
2016	2,676	49.4		1,354	47.5	1,395	27.2	6,665 [i]	22.8	2,675	38.8
2017	[f] 2,970	25.9		677		1,083		[i]		[i]	
BEG [g]								2,800-5,700		3,300-6,500	
Average											
1996–2016	3,789	39	2,044	1,087	37	2,089	28	6,089	31	8,765	38
2007–2016	3,799	40		1,248	40	1,608	26	4,320	31	6,681	37
2012–2016	3,723	40		1,360	44	1,350	25	4,846	35	5,546	42

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Note: Aerial survey counts are peak counts only. Survey rating was fair or good unless otherwise noted.

[a] In years when only carcass surveys were conducted, proportions of males and females were adjusted based on the average of ratios of unbiased estimates from mark–recapture experiments to estimates from carcass samples over those years when mark–recapture studies were conducted. In years when mark–recapture experiments were conducted, proportions of males and females were estimated as the ratio of the abundance estimate of each gender to the abundance estimate of all fish.

[b] Tower counts.

[c] Mark–recapture population estimate.

[d] No estimate due to extreme high water conditions.

[e] Estimate includes an expansion for missed counting days based on average run timing. Minimum documented abundances from successful counting days were 4,644 in 2002, 11,758 in 2003, and 5,415 in 2008.

[f] Data are preliminary.

[g] Biological Escapement Goals (BEG) established by the Alaska Board of Fisheries, January 2001.

[h] Weir counts.

[i] Due to high water, DIDSON sonar was used and preliminary species apportionment was estimated using average run timing.

Appendix I13.–Summer chum salmon escapement counts for the selected spawning areas in the Alaskan portion of the Yukon River drainage, 1973–2017.

	Andreafsky River			Anvik River		Rodo River	Kaltag Creek	Nulato River		
	East Fork		West Fork					South Fork	North Fork [a]	Mainstem
Year	Aerial [b]	Sonar, Tower, or Weir Counts [c]	Aerial [b]	Tower & Aerial [d]	Sonar	Aerial [b]	Tower	Aerial [b]	Aerial [b]	Tower
1973	10,149 [e]		51,835	249,015						
1974	3,215 [e]		33,578	411,133		16,137		29,016	29,334	
1975	223,485		235,954	900,967		25,335		51,215	87,280	
1976	105,347		118,420	511,475		38,258		9,230 [e]	30,771	
1977	112,722		63,120	358,771		16,118		11,385	58,275	
1978	127,050		57,321	307,270		17,845		12,821	41,659	
1979	66,471		43,391	-	277,712	-		1,506	35,598	
1980	36,823 [e]		114,759	-	482,181	-		3,702 [e]	11,244 [e]	
1981	81,555	152,665	-	-	1,479,582	-		14,348	-	
1982	7,501 [e]	181,352	7,267 [e]	-	444,581	-		-	-	
1983	-	113,328	-	-	362,912	-		1,263 [e]	19,749	
1984	95,200 [e]	72,598	238,565	-	891,028	-		-	-	
1985	66,146	-	52,750	-	1,080,243	24,576		10,494	19,344	
1986	83,931	152,730	99,373	-	1,085,750	-		16,848	47,417	
1987	6,687 [e]	45,221 [f]	35,535	-	455,876	-		4,094	7,163	
1988	43,056	68,937 [f]	45,432	-	1,125,449	13,872		15,132	26,951	
1989	21,460 [e]	-	-	-	636,906	-		-	-	
1990	11,519 [e]	-	20,426 [e]	-	403,627	1,941 [e]		3,196 [e, g]	1,419 [e]	
1991	31,886	-	46,657	-	847,772	3,977		13,150	12,491	
1992	11,308 [e]	-	37,808 [e]	-	775,626	4,465		5,322	12,358	
1993	10,935 [e]	-	9,111 [e]	-	517,409	7,867		5,486	7,698	
1994	-	200,981 [g]	-	-	1,124,689	-	47,295	-	-	148,762 [g]
1995	-	172,148	-	-	1,339,418	12,849	77,193	10,875	29,949	236,890
1996	-	108,450	-	-	933,240	4,380	51,269	8,490 [e]	-	129,694
1997	-	51,139	-	-	605,751	2,775 [e]	48,018	-	-	157,975
1998	-	67,720	-	-	487,300	-	8,113	-	-	49,140
1999	-	32,587	-	-	437,355	-	5,339	-	-	30,076
2000	2,094 [e]	24,785	18,989 [e]	-	196,350	-	6,727	-	-	24,308

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	Andreafsky River			Anvik River		Rodo River	Kaltag Creek	Nulato River		
	East Fork		West Fork					South Fork	North Fork [a]	Mainstem
Year	Aerial [b]	Sonar, Tower, or Weir Counts [c]	Aerial [b]	Tower & Aerial [d]	Sonar	Aerial [b]	Tower	Aerial [b]	Aerial [b]	Tower
2001	-	2,134 [g]	-	-	224,059	-	-	-	-	-
2002	-	44,194	-	-	459,058	-	13,583	-	-	72,232
2003	-	22,461	-	-	256,920	-	3,056	-	-	19,590 [g]
2004	-	64,883	-	-	365,354	-	5,247	-	-	-
2005	-	20,127	-	-	525,392	-	22,093	-	-	-
2006	3,100 [e]	102,260	617	-	605,487	-	-	7,772	11,658	-
2007	-	69,642	-	-	459,038	-	-	21,825	15,277	-
2008	9,300	57,259	25,850	-	374,933	-	-	12,070	10,715	-
2009	736	8,770	3,877	-	193,098	621	-	2,120	567	-
2010	1,982	72,893	24,380	-	396,174	-	-	1,891	1,038	-
2011	12,889	100,473	10,020	-	642,529	6,011	-	9,454	8,493	-
2012	-	56,680	-	-	484,091	15,606	-	20,600	14,948	-
2013	10,965	61,234	9,685	-	577,876	-	-	13,695	13,230	-
2014	-	37,793	-	-	399,796	-	-	-	-	-
2015	6,004	48,809	2,836	36,871	374,968	3,685	-	4,102	9,525	-
2016	-	50,362	-	-	337,821	-	-	-	-	-
2017	-	55,532	11,655	38,191	415,139	-	-	4,890	7,885	-
2012-2016 Average	8,485	50,976	6,261	36,871	434,910	9,646	-	12,799	12,568	
Escapement Objective [h]	>40		>116		350-700				>53	

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	Henshaw Creek	Gisasa River		Hogatza River		Tozitna River	Chena River		Salcha River	
				Clear & Caribou Cr.	Clear Creek					
Year	Weir	Aerial [b]	Weir	Aerial [b]	Tower	Weir and Aerial [b]	Aerial [b]	Tower	Aerial [b]	Tower
1973							79 [e]		290	
1974		22,022				1,823	4,349		3,510	
1975		56,904		22,355		3,512	1,670		7,573	
1976		21,342		20,744		725 [e]	685		6,484	
1977		2,204 [e]		10,734		761 [e]	610		677 [e]	
1978		9,280 [e]		5,102		2,262	1,609		5,405	
1979		10,962		14,221		-	1,025 [e]		3,060	
1980		10,388		19,786		580	338		4,140	
1981		-		-		-	3,500		8,500	
1982		334 [e]		4,984 [e]		874	1,509		3,756	
1983		2,356 [e]		28,141		1,604	1,097		716 [e]	
1984		-		184 [e]		-	1,861		9,810	
1985		13,232		22,566		1,030	1,005		3,178	
1986		12,114		-		1,778	1,509		8,028	
1987		2,123		5,669 [e]		-	333		3,657	
1988		9,284		6,890		2,983	432		2,889 [e]	
1989		-		-		-	714 [e]		1,574 [e]	
1990		450 [e]		2,177 [e]		36	245 [e]		450 [e]	
1991		7,003		9,947		93	115 [e]		154 [e]	
1992		9,300		2,986		794	848 [e]		3,222	
1993		1,581		-		970	168	5,483	212	5,809
1994		6,827	51,116 [g]	8,247 [i]		-	1,137	9,984	4,916	39,450
1995		6,458	136,886	-	116,735	4,985	185 [e]	3,519 [g]	934 [e]	30,784
1996		-	158,752	27,090 [i]	100,912	2,310	2,061	12,810 [g]	9,722	74,827
1997		686 [e]	31,800	1,821 [e]	76,454	428 [e]	594 [e]	9,439 [g]	3,968 [e]	35,741
1998		-	21,142	120 [e]	212 [g]	7 [e]	24 [e]	5,901	370 [e]	17,289
1999		-	10,155	-	11,283	-	520	9,165	150	23,221
2000	24,457	-	11,410	-	19,376	480	105	3,515	228	20,516

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Year	Henshaw Creek	Gisasa River		Hogatza River		Tozitna River	Chena River		Salcha River	
				Clear & Caribou Cr.	Clear Creek					
	Weir	Aerial [b]	Weir	Aerial [b]	Tower	Weir and Aerial [b]	Aerial [b]	Tower	Aerial [b]	Tower
2001	34,777	-	17,946	-	3,674	12,527	2	4,773	-	14,900
2002	25,249	-	33,481	-	13,150	18,789	-	1,021 [g]	78	27,012 [j]
2003	21,400	-	25,999	-	6,159	8,487	-	573 [g]	-	-
2004	86,474	-	37,851	-	15,661	25,003	-	15,163 [g]	-	47,861
2005	237,481	-	172,259	-	26,420	39,700	219	16,873 [g]	4,320	194,933
2006	-	1,000	261,306	-	29,166 [j]	22,629	469	35,109 [g]	152	113,960
2007	44,425	-	46,257	-	6,029 [j]	8,470	-	4,999	4 [e]	13,069
2008	96,731	20,470	36,938	-	-	9,133	37	1,300 [g]	0 [e]	2,213 [g]
2009	156,933	1,060	25,904	3,981	-	8,434	-	16,516	-	31,035
2010	105,398	1,096	47,669	840	-	-	-	7,561	-	22,185
2011	248,247	13,228	95,796	3,665	-	11,351	-	-	-	66,564 [k]
2012	292,082	- [e]	83,423	23,022	-	11,045	-	6,882	-	46,252
2013	285,008	9,300 [e]	80,055	-	-	-	-	21,372	-	60,981
2014	- [e]	-	32,523	-	-	-	-	13,303 [e]	-	- [e]
2015	238,529	5,601	42,747	6,080	-	-	-	8,620	0 [e]	12,812
2016	286,780	-	66,670	-	-	-	-	6,493 [g]	-	2,897 [g]
2017	360,687	-	73,584	-	-	-	-	21,156 [g]	-	29,093 [g]
2012-2016 Average	275,600	7,451	61,084	14,551	-	-	-	11,334	-	30,736
Escapement Objective				>17					>3.5	

Note: Unless otherwise noted blank cells indicate years prior to the project being operational. Dashes "-" indicates years in which no information was collected.

[a] Includes mainstem counts below the confluence of the North and South Forks, unless otherwise noted.

[b] Aerial survey counts are peak counts only, survey rating is fair or good unless otherwise noted.

[c] East Fork Andreafsky passage estimated with: sonar 1981–1984, tower counts 1986–1988; weir counts from 1994 to present. The project did not operate in 1985 and 1989–1993.

[d] From 1972 to 1979 counting tower operated; escapement estimate listed is the tower counts plus expanded aerial survey counts below the tower.

[e] Incomplete survey and/or poor survey timing or conditions resulted in minimal or inaccurate count.

[f] Mainstem counts below the confluence of the North and South Forks of the Nulato River included in the South Fork counts.

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

[h] Biological (Andreafsky) or Sustainable (Anvik) Escapement Goal.

[i] Bureau of Land management helicopter survey.

[j] Project operated as a video monitoring system.

[h] Estimate includes an expansion for missed counting days based on average run timing. Minimum documented abundance from successful counting days was 30,411 (SE not reported).

Appendix I14.–Fall chum salmon abundance estimates or escapement estimates for selected spawning areas in Alaskan portions of the Yukon River Drainage, 1971-2017.

	Alaska								
		Tanana River Drainage						Upper Yukon River Drainage	
Year	Yukon River Mainstem Sonar Estimate	Toklat River [a]	Kantishna River Abundance Estimate [b]	Delta River [c]	Bluff Cabin Slough [d]	Upper Tanana River Abundance Estimate [e]	Tanana River Estimate [f]	Chandalar River [g]	Sheenjek River [h]
1971									
1972				5,384					
1973				10,469					
1974		41,798		5,915					89,966 [i]
1975		92,265		3,734 [j]					173,371 [i]
1976		52,891		6,312 [j]					26,354 [i]
1977		34,887		16,876 [j]					45,544 [i]
1978		37,001		11,136					32,449 [i]
1979		158,336		8,355					91,372 [i]
1980		26,346 [k]		5,137	3,190				28,933 [i]
1981		15,623		23,508	6,120				74,560 [m]
1982		3,624		4,235	1,156 [l]				31,421 [m]
1983		21,869		7,705	12,715 [l]				49,392 [m]
1984		16,758		12,411	4,017 [l]				27,130 [m]
1985		22,750		17,276 [j]	2,655				152,768 [m, n]
1986		17,976		6,703 [j]	3,458 [l]			59,313	84,207 [n, o]
1987		22,117		21,180	9,395 [l]			52,416	153,267 [n, o]
1988		13,436		18,024	4,481			33,619	45,206 [o]
1989		30,421		21,342 [j]	5,386			69,161	99,116 [o]
1990		34,739		8,992 [j]	1,632 [l]			78,631	77,750 [o]
1991		13,347		32,905 [j]	7,198 [l]				86,496 [p]
1992		14,070		8,893 [j]	3,615				78,808
1993		27,838		19,857	5,550				42,922
1994		76,057		23,777 [j]	2,277				150,565
1995	1,156,278	54,513 [k]		20,587	19,460 [l]	268,173	230,643	323,586	241,855
1996		18,264		19,758 [j]	7,074 [j]	134,563	132,922	230,450	246,889
1997	579,767	14,511		7,705 [j]	5,707 [j]	71,661	88,641	211,914	80,423 [q]
1998	375,222	15,605		7,804 [j]	3,549 [j]	62,384	82,475	83,899	33,058
1999	451,505	4,551	27,199	16,534 [j]	7,559 [j]	97,843	109,309	92,685	14,229

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		Alaska							
		Tanana River Drainage						Upper Yukon River Drainage	
Year	Yukon River Mainstem Sonar Estimate	Toklat River [a]	Kantishna River Abundance Estimate [b]	Delta River [c]	Bluff Cabin Slough [d]	Upper Tanana River Abundance Estimate [e]	Tanana River Estimate [f]	Chandalar River [g]	Sheenjek River [h]
2000	273,206	8,911	21,450	3,001 [j]	1,595	34,844	55,983	71,048	30,084 [r]
2001	408,961	6,007 [s]	22,992	8,103 [j]	1,808	96,556 [t]	116,012	112,664	53,932
2002	367,886	28,519	56,719	11,992 [j]	3,116 [l]	109,970	163,421	94,472	31,642
2003	923,540	21,492	87,359	22,582 [j]	10,600	193,418	263,302	221,343	44,047 [u]
2004	633,368	35,480	76,163	25,073 [j]	10,270	123,879	187,409	169,848	37,878
2005	1,894,078	17,779 [k]	107,719	28,132 [j]	11,964	337,755	372,758	526,838	561,863 [n, v, w]
2006	964,238		71,135	14,055 [j]		202,669	233,193	254,778	160,178 [n, v]
2007	740,195		81,843	18,610 [j]		320,811	357,016	243,805	65,435 [n, v]
2008	636,525			23,055 [j]	1,198		264,200	178,278	50,353 [n, v, x]
2009	274,227 [y]			13,492 [j]	2,900				54,126 [n, v, x]
2010	458,103			17,933 [j]	1,610			167,532	22,048
2011	873,877			23,639 [j]	2,655			298,223	97,976 [n, v, x]
2012	778,158			9,377 [l]				205,791	104,701 [n, v, x]
2013	865,295			31,955 [j]	5,554			252,710	
2014	706,630			32,480 [l]	4,095			221,421	
2015	669,483			33,401 [l]	6,020			164,486	
2016 [z]	994,760	16,885 [d]		21,913 [l]	4,936			295,023	
2017	1,829,931							509,115	
Escapement [aa]	300,000	15,000 [ab]		6,000		46,000 [ac]	61,000	74,000	50,000
Objective	600,000	33,000		13,000		103,000	136,000	152,000	104,000
Average									
1971–2016	737,554 [ad]	30,808	61,398	15,807	5,427	158,040	189,806	181,305	91,598
2007–2016	747,003 [ad]	–	81,843	22,586	3,621	320,811	310,608	225,252	65,773
2012–2016	802,865	–	–	25,825	5,151	–	–	227,886	104,701

Note: Yukon River mainstem sonar historical estimates were revised in 2016, using selectivity parameters.

[a] 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.

[b] Fall chum salmon abundance estimate for the Kantishna and Toklat River drainages is based on a mark-recapture program. Number of tagging and recovery wheels changed over the years.

[c] Estimates are a total spawner abundance, using migratory time density curves and stream life data, unless otherwise indicated.

[d] Aerial survey count, unless otherwise indicated.

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[e] Fall chum salmon abundance estimate for the upper Tanana River drainage is based on a mark-recapture program. Number of tagging and recovery wheels changed over the years.

[f] Tanana River abundance estimates prior to 1995 can be found in Eggers (2001) but are based on Upper Tanana plus Toklat River escapement. Estimates from 1995-1998 are based on the relationship of the Upper Tanana to the Kantishna river abundance estimates, and 2008-2012 are based on the relationship of the Tanana estimate (1995-2007) with the Delta River escapements. The estimate in 2013 and 2014 are based on regression with Mainstem Yukon 1995-2012 (excluding 2005). The harvests from the Tanana River fisheries are removed to estimate escapement

[g] Single-beam sonar estimate for 1986 to 1990, split-beam sonar estimate 1995 to 2006. DIDSON in since 2007, project was aborted in 2009. Counts were expanded to represent the remainder of the run after the project was terminated for the season in 1995 to present.

[h] Single-beam sonar estimate beginning in 1981, split-beam sonar estimate 2002 to 2004, DIDSON from 2005 to 2012.

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

[j] Population estimate generated from replicate foot surveys and stream life data (area under the curve method).

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

[l] Peak foot survey, unless otherwise indicated.

[m] Project started late, estimated escapements expanded for portion missed using average run timing curves based on Chandalar (1986-1990) and Sheenjek (1991-1993) rivers.

[n] Sonar counts include both banks in 1985-1987, 2005-2009, and 2011-2012.

[o] Expanded estimates for period approximating second week August through fourth week September, using annual Chandalar River run timing data (1986-1990)

[p] Total abundance estimates are for the period approximating second week August through fourth week of September (1991 to present). Comparative escapement estimates before 1986 are considered more conservative; approximating the period end of August through September.

[q] Data interpolated due to high water from 29 August until 3 September 1997, during buildup to peak passage.

[r] Project ended early (September 12) because of low water.

[s] Minimal estimate because Sushana River was breached by the main channel and uncountable.

[t] Low numbers of tags deployed and recovered resulted in an estimate with an extremely large confidence interval (95% CI +/- 41,072).

[u] Project ended on peak daily passages due to late run timing, estimate was expanded based on run timing (87%) at Rampart.

[v] In addition to the historical right bank count, the left bank was enumerated with DIDSON (right bank count for 2005-2009 and 2011 was 266,963, 106,397, 39,548, 35,912, 28,480, and 49,080 respectively, not including expansions by bank.

[w] Project ended while still counting >10,000 fish per day, estimate was expanded based on run timing (73%) at Rampart.

[x] Run timing was late and counts were expanded to represent the remainder of the run after the project was terminated for the season.

[y] Pilot Station sonar project encountered record low water levels during the fall season causing difficulties with species apportionment and catchability. Fall chum salmon estimate is suspected of being conservative and should not be used in averages or run reconstructions.

[z] Data are preliminary.

[aa] Escapement Goal (EG) includes individual tributary BEGs and drainagewide SEG from 2011.

[ab] Escapement goal discontinued in 2010.

[ac] The BEG for the Tanana River as a whole is 61,000 to 136,000. However it includes the Toklat plus and the Upper Tanana which was broke out for comparison to the upper Tanana River abundance estimates.

[ad] Does not include 2009.

Appendix I15.–Coho salmon passage estimates or escapement estimates for selected spawning areas in the Alaskan portion of the Yukon River drainage, 1972–2017.

	Yukon River Mainstem Sonar	Nenana River Drainage				Upper Tanana River Drainage		
Year	Estimate [a]	Lost Slough	Nenana Mainstem [b]	Wood Creek	Seventeen Mile Slough	Delta Clearwater River [c]	Clearwater Lake and Outlet	Richardson Clearwater River
1972						632 (b)	417 (f)	454 (f) [d]
1973						3,322 (u)	551 (u)	375 (u)
1974		1,388 (f)			27 (f)	3,954 (h) [d]	560 (f)	652 (h)
1975		827 (f)			956 (f)	5,100 (b)	1,575 (b)	
1976		118 (f)			281 (f)	1,920 (b)	1,500 (b)	80 (f) [d]
1977		524 (f) [d]		310 (g)	1,167 (f)	4,793 (b)	730 (b)	327 (f)
1978		350 (f)		300 (g)	466 (f)	4,798 (b)	570 (b)	
1979		227 (f)			1,987 (f)	8,970 (b)	1,015 (b)	372 (f)
1980		499 (f) [d]		1,603 (g)	592 (f)	3,946 (b)	1,545 (b)	611 (f)
1981		274 (f)		849 (w) [e]	1,005 (f)	8,563 (u) [f]	459 (f)	550 (f)
1982				1,436 (w) [e]	(f)	8,365 (g) [f]		
1983		766 (f)		1,042 (w)	103 (f)	8,019 (b) [f]	253 (f)	88 (f)
1984		2,677 (f)		8,826 (w)	(f)	11,061 (b)	1,368 (f)	428 (f)
1985		1,584 (f)		4,470 (w)	2,081 (f)	5,358 (b)	750 (f)	
1986		794 (f)		1,664 (w)	218 (b)	10,857 (b)	3,577 (f)	146 (f) [d]
1987		2,511 (f)		2,387 (w)	3,802 (f)	22,300 (b)	4,225 (b)	
1988		348 (f)		2,046 (w)		21,600 (b)	825 (b)	
1989				412 (w)	824 (f) [d]	11,000 (b)	1,600 (b)	483 (f)
1990		688 (f)	1,308 (f)		(h) [d]	8,325 (b)	2,375 (b)	
1991		564 (f)	447 (f)		52 (f)	23,900 (b)	3,150 (b)	
1992		372 (f)			490 (f)	3,963 (b)	229 (b)	500 (f)
1993		350 (f)	419 (f)	666 (w) [g]	581 (h)	10,875 (b)	3,525 (b)	
1994		944 (h)	1,648 (h)	1,317 (w) [h]	2,909 (h)	62,675 (b)	3,425 (b)	5,800 (f)
1995	119,893	4,169 (f)	2,218 (h)	500 (w)	1,512 (h)	20,100 (b)	3,625 (b)	
1996		2,040 (h)	2,171 (h)	201 (u) [d]	3,668 (g/b)	14,075 (b)	1,125 (b) [d]	
1997	118,065	1,524 (h)	1,446 (h)	[i]	1,996 (h)	11,525 (b)	2,775 (b)	
1998	146,365	1,360 (h) [d]	2,771 (h) [d]	[i]	1,413 (g/b)	11,100 (b)	2,775 (b)	

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Year	Yukon River Mainstem Sonar Estimate [a]	Nenana River Drainage: Lost Slough	Nenana River Drainage: Nenana Mainstem [b]	Nenana River Drainage: Wood Creek	Nenana River Drainage: Seventeen Mile Slough	Upper Tanana River Drainage: Delta Clearwater River [c]	Upper Tanana River Drainage: Clearwater Lake and Outlet	Upper Tanana River Drainage: Richardson Clearwater River
1999	76,174	1,002 (h) [d]	745 (h) [d]	370 (h)	662 (h) [d]	10,975 (b)		
2000	206,365	55 (h) [d]	68 (h) [d]	[i]	879 (h) [d]	9,225 (b)	1,025 (b)	2,175 (h)
2001	160,272	242 (h)	859 (h)	699 (h)	3,753 (h)	27,500 (b)	4,425 (b)	1,531 (f)
2002	137,077	0 (h)	328 (h)	935 (h)	1,910 (h)	38,625 (b)	5,900 (b)	874 (f)
2003	280,552	85 (h)	658 (h)	3,055 (h)	4,535 (h)	102,800 (b)	8,800 (b)	6,232 (h)
2004	207,844	220 (h)	450 (h)	840 (h)	3,370 (h)	37,550 (b)	2,925 (b)	8,626 (h)
2005	194,622	430 (h)	325 (h)	1,030 (h)	3,890 (h)	34,293 (b)	2,100 (b)	2,024 (h)
2006	163,889	194 (h)	160 (h)	634 (h)	1,916 (h)	16,748 (b)	4,375 (b)	271 (h)
2007	192,406	63 (h)	520 (h)	605 (h)	1,733 (h)	14,650 (b)	2,075 (b)	553 (h)
2008	145,378	1,342 (h)	1,539 (h)	578 (h)	1,652 (h)	7,500 (b)	1,275 (b)	265 (h)
2009	240,779 [j]	410 (h)		470 (h)	680 (h)	16,850 (b)	5,450 (b)	155 (h)
2010	177,724	1,110 (h)	280 (h)	340 (h)	720 (h)	5,867 (b)	813 (b)	1,002 (h)
2011	149,533	369 (h)			912 (h)	6,180 (b)	2,092 (b)	575 (h)
2012	130,734		106 (h)		405 (h)	5,230 (b)	396 (h)	515 (h)
2013	110,515	721 (h)		55 (h)	425 (h)	6,222 (b)	2,221 (h)	647 (h)
2014	283,421	333 (h)	378 (h)	649 (h)	886 (h)	4,285 (b)	434 (h)	1,941 (h)
2015	121,193	242 (h)	1,789 (h)	1,419 (h)	3,890 (h)	19,533 (b)	1,621 (h)	3,742 (h)
2016 [k]	168,297	334 (h)	1,680 (h)	1,327 (h)	2,746 (h)	6,767 (b)	1,421 (h)	1,350 (h)
2017	166,320							
SEG [l]						5,200-17,000		
Averages								
1971–2016	166,865 [j]	682	835	1,420	1,498	14,004	2,056	1,251
2007–2016	164,356 [j]	547	899	680	1,405	9,308	1,780	1,075
2012–2016	162,832	408	988	863	1,670	8,407	1,219	1,639

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Note: Only peak counts presented. Survey rating is fair to good, unless otherwise noted. Denotations of survey methods include: (b)=boat, (f)=fixed wing, (g)=ground/foot, (h)=helicopter, and (u)=undocumented. Yukon River mainstem sonar historical estimates were revised in 2016, using selectivity parameters.

[a] Passage estimates for coho salmon are incomplete. The sonar project is terminated prior to the end of the coho salmon run.

[b] Index area includes mainstem Nenana River between confluence's of Lost Slough and Teklanika River.

[c] Index area is lower 17.5 miles of system.

[d] Poor survey.

[e] Weir was operated at the mouth of Clear Creek (Shores Landing).

[f] Expanded estimate based on partial survey counts and historic distribution of spawners from 1977 to 1980.

[g] Weir project terminated on October 4, 1993. Weir normally operated until mid to late October.

[h] Weir project terminated September 27, 1994. Weir normally operated until mid-October.

[i] No survey of Wood Creek due to obstructions in creek.

[j] Pilot Station sonar project encountered record low water levels during the fall season causing difficulties with species apportionment and catchability. Coho salmon are suspected of being over estimated therefore this value should not be used in averages or run reconstructions.

[k] Data preliminary.

[l] Sustainable escapement goal (SEG) established January 2004, (replaces BEG of greater than 9,000 fish established March, 1993) based on boat survey counts of coho salmon in the lower 17.5 river miles during the period October 21 through 27.

Appendix I16.–Escapement, rebuilding and interim goals for Canadian origin Chinook and fall chum salmon stocks, 1985–2017.

	Canadian Origin Stock Targets					
	Chinook Salmon		Fall Chum Salmon			
					Fishing Branch	
Year	Mainstem Escapement Goal	Stabilization/ Rebuilding/ Interim Goals	Mainstem Escapement Goal	Stabilization/ Rebuilding/ Interim Goals	Escapement Goal	Interim Goal
1985	33,000-43,000					
1986	33,000-43,000					
1987	33,000-43,000		90,000-135,000		50,000-120,000	
1988	33,000-43,000		90,000-135,000		50,000-120,000	
1989	33,000-43,000		90,000-135,000		50,000-120,000	
1990	33,000-43,000	18,000	80,000		50,000-120,000	
1991	33,000-43,000	18,000	80,000		50,000-120,000	
1992	33,000-43,000	18,000	80,000	51,000	50,000-120,000	
1993	33,000-43,000	18,000	80,000	51,000	50,000-120,000	
1994	33,000-43,000	18,000	80,000	61,000	50,000-120,000	
1995	33,000-43,000	18,000	80,000		50,000-120,000	
1996	33,000-43,000	28,000	80,000	65,000	50,000-120,000	
1997	33,000-43,000	28,000	80,000	49,000	50,000-120,000	
1998	33,000-43,000	28,000	80,000		50,000-120,000	
1999	33,000-43,000	28,000	80,000		50,000-120,000	
2000	33,000-43,000	28,000	80,000		50,000-120,000	
2001	33,000-43,000	28,000	80,000		50,000-120,000	
2002	33,000-43,000	28,000	80,000	60,000	50,000-120,000	
2003 [a]	33,000-43,000	28,000 [b]	80,000	65,000	50,000-120,000	15,000
2004	33,000-43,000	28,000	80,000	65,000	50,000-120,000	13,000
2005	33,000-43,000	28,000	80,000	65,000	50,000-120,000	24,000
2006	33,000-43,000	28,000	80,000		50,000-120,000	28,000
2007	33,000-43,000		80,000		50,000-120,000	34,000
2008	33,000-43,000	45,000 [c]	80,000		50,000-120,000	22,000-49,000 [d]
2009	33,000-43,000	45,000 [c]	80,000		50,000-120,000	22,000-49,000 [d]
2010	33,000-43,000	42,500-55,000 [e]	80,000	70,000-104,000 [f]	50,000-120,000	22,000-49,000 [d]
2011	33,000-43,000	42,500-55,000 [f]	80,000	70,000-104,000 [f]	50,000-120,000	22,000-49,000 [d]
2012	33,000-43,000	42,500-55,000 [f]	80,000	70,000-104,000 [f]	50,000-120,000	22,000-49,000 [d]
2013	33,000-43,000	42,500-55,000 [f]	80,000	70,000-104,000 [f]	50,000-120,000	22,000-49,000 [d]
2014	33,000-43,000	42,500-55,000 [f]	80,000	70,000-104,000 [f]	50,000-120,000	22,000-49,000 [d]
2015	33,000-43,000	42,500-55,000 [f]	80,000	70,000-104,000 [f]	50,000-120,000	22,000-49,000 [d]
2016	33,000-43,000	42,500-55,000 [f]	80,000	70,000-104,000 [f]	50,000-120,000	22,000-49,000 [d]
2017	33,000-43,000	42,500-55,000 [f]	80,000	70,000-104,000 [f]	50,000-120,000	22,000-49,000 [d]

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Note: All single numbers are considered minimums.

[a] Treaty was signed by governments in December 2002.

[b] In 2003 the Chinook salmon goal was set at 25,000 fish. However, if the U.S. conducted a commercial fishery the goal would be increased to 28,000 fish.

[c] Interim management escapement goal (IMEG) using the mainstem Yukon River sonar operated near Eagle, previous years were measured by mark–recapture abundance estimates.

[d] Interim Management Escapement Goal (IMEG) established for 2008–2013, by default (no new analysis) recommended in subsequent years. Three year increments have been used to coincide with escapement goal reviews prior to Board of Fisheries meetings.

[e] The IMEG goal of 42,500 to 55,000 was chosen at the Spring 2010 Yukon River Panel meeting to include a precautionary approach to put more large older fish on the spawning grounds. The Panel agreed with 42,500 for the lower end of the range based on an average of the 2 proposed lower goals of 40,000 and 45,000 discussed.

[f] The IMEGs for fall chum salmon from 2010 and Chinook salmon from 2011 were recommended to continue in 2017.

Appendix I17.– Chinook salmon estimated U.S.-Canada border passage, total Canadian harvest, and spawning escapement in Canadian, 1982–2016.

Year	Historic mark-recapture border passage estimate a	Eagle sonar estimate	U.S. harvest above Eagle sonar b	Canadian mainstem border passage estimate		Canadian mainstem harvest	Spawning escapement estimate c
1982	36,598			60,346	d	16,808	43,538
1983	47,741			63,227	d	18,752	44,475
1984	43,911			66,300	d	16,295	50,005
1985	29,881			59,586	d	19,151	40,435
1986	36,479			61,489	d	20,064	41,425
1987	30,823			58,870	d	17,563	41,307
1988	44,445			61,026	d	21,327	39,699
1989	42,620			77,718	d	17,419	60,299
1990	56,679			78,192	d	18,980	59,212
1991	41,187			63,172	d	20,444	42,728
1992	43,185			56,958	d	17,803	39,155
1993	45,027			52,713	d	16,469	36,244
1994	46,680			77,219	d	20,770	56,449
1995	52,353			70,761	d	20,088	50,673
1996	47,955			93,606	d	19,546	74,060
1997	53,400			69,538	d	15,717	53,821
1998	22,588			41,335	d	5,838	35,497
1999	23,716			49,538	d	12,354	37,184
2000	16,173			30,699	d	4,829	25,870
2001	52,207			62,333	d	9,774	52,559
2002	49,214			51,428	e	9,070	42,358
2003	56,929			90,037	e	9,446	80,591
2004	48,111			59,415	e	10,946	48,469
2005	42,245	81,528	2,566	78,962	f	10,977	67,985
2006	36,748	73,691	2,303	71,388	f	8,758	62,630
2007	22,120	41,697	1,999	39,698	f	4,794	34,904
2008	14,666	38,097	815	37,282	f	3,399	33,883

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Year	Historic mark-recapture border passage estimate a	Eagle sonar estimate	U.S. harvest above Eagle sonar	Canadian mainstem border passage estimate	Canadian mainstem harvest	Spawning escapement estimate b
2009	-	69,957	382	69,575 [f]	4,297	65,278
2010	-	35,074	604	34,470 [f]	2,456	32,014
2011	-	51,271	370	50,901 [f]	4,594	46,307
2012	-	34,747	91	34,656 [f]	2,000	32,656
2013	-	30,725	152	30,573 [f]	1,904	28,669
2014	-	63,482	51	63,431 [f]	100	63,331
2015	-	84,015	341	83,674 [f]	1,000	82,674
2016	-	72,329	762	71,567 [f]	2,769	68,798
Averages						
1982–2015	40,136			60,298	11,874	48,423
2006–2015	NA			51,565	3,330	48,235
2011–2015	NA			52,647	1,920	50,727
Minimum-15	14,666			30,573	100	25,870
Maximum-15	56,929			93,606	21,327	82,674

Note: Minimums and maximum indicate the lowest and highest values for each year presented through 2015.

[a] From 1982 to 2008, a mark–recapture program was used to determine border passage; fish were sampled and tagged near the border using fish wheels and sampled for marks/tags in upstream fisheries. The Eagle sonar project replaced the mark-recapture program in 2005.

[b] U.S. harvests between the sonar site and border prior to 2008 is unknown because subsistence harvest in the Eagle area extended above and below the sonar site, but were most likely in the hundreds for Chinook salmon. Starting in 2008, subsistence harvests between the sonar site and the U.S./Canada border were recorded specifically for purpose of estimating border passage.

[c] Canadian spawning escapement estimated as border passage minus Canadian harvest.

[d] Chinook salmon passage for Yukon mainstem at U.S./Canada border from 1982-2001 was reconstructed using a linear relationship with 3-area index (aerial surveys of Little Salmon, Big Salmon, and Nisutlin rivers in 2002-2007) plus Canadian harvests.

[e] Border passage estimated in 2002-2004 using escapement estimate from a radio tagging proportion study, plus Canadian harvest.

[f] Since 2005, border passage estimated as fish counted at Eagle sonar minus the U.S. harvest upriver from the sonar project.

Appendix I18.–Fall chum salmon passage, expansion, border passage, and escapement estimates based on the mainstem Yukon River projects near the U.S. and Canada border, 1980–2016.

Date	Sonar Estimate	Expanded Estimate [a]	Eagle Area Subsistence Harvest	U.S./Canada Mainstem Border Passage Estimate [b]	Canadian Mainstem Harvest	Mainstem Escapement Estimate [c]
1980				39,130	16,218	22,912
1981				66,347	19,281	47,066 [d]
1982				47,049	15,091	31,958
1983				118,365	27,490	90,875
1984				81,900	25,267	56,633 [d]
1985				99,775	37,765	62,010
1986				101,826	13,886	87,940
1987				125,121	44,345	80,776
1988				69,280	32,494	36,786
1989				55,861	20,111	35,750
1990				82,947	31,212	51,735
1991				112,303	33,842	78,461
1992				67,962	18,880	49,082
1993				42,165	12,422	29,743
1994				133,712	35,354	98,358
1995				198,203	40,111	158,092
1996				143,758	21,329	122,429
1997				94,725	9,306	85,419
1998				48,047	1,795	46,252
1999				72,188 [e]	13,636	58,552
2000				57,978 [e]	4,246	53,732
2001				38,769 [e]	5,278	33,491
2002				104,853 [e]	6,232	98,621
2003				153,656 [e]	10,523	143,133
2004				163,625 [e]	9,545	154,080
2005				451,477	13,979	437,498
2006	236,386	245,290	17,775	227,515 [f,g]	6,617	220,898
2007	235,871	265,008	18,691	246,317 [f,g]	9,330	236,987
2008	171,347	185,409	11,381	174,028 [f,g]	6,130	167,898

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Date	Sonar Estimate	Expanded Estimate [a]	Eagle Area Subsistence Harvest	U.S./Canada Mainstem Border Passage Estimate [b]		Canadian Mainstem Harvest	Mainstem Escapement Estimate [c]
2009	95,462	101,734	6,995	94,739	f	1,113	93,626
2010	125,547	132,930	11,432	121,498	f	3,709	117,789
2011	212,162	224,355	12,477	211,878	f	6,312	205,566
2012	147,710	153,248	11,681	141,567	f	3,905	137,662
2013	200,754	216,791	12,642	204,149	f	3,887	200,262
2014	167,715	172,887	13,041	159,846	f	3,050	156,796
2015 [h]	112,136	125,095	12,540	112,555	f	3,050	109,505
2016 [h]	144,035	161,027	13,015	148,012	f	2,745	145,267
Goal [i]							>80,000
IMEG [j]							70,000–104,000
Averages							
1980–2015				124,031		15,743	108,288
2006–2015	170,509	182,275	12,866	169,409		4,710	164,699
2011–2015	168,095	178,475	12,476	165,999		4,041	161,958
Minimum-15	95,462	101,734	6,995	38,769		1,113	22,912
Maximum-15	236,386	265,008	18,691	451,477		44,345	437,498

Note: Estimates for subsistence caught salmon between the sonar site and border (Eagle area) prior to 2008 include an unknown portion caught below the sonar site. This number is most likely in the thousands for chum salmon. Starting in 2008, the estimates for subsistence caught salmon only include salmon harvested between the sonar site and the U.S./Canada border. Minimums and maximum indicate the lowest and highest values for each year presented through 2015.

[a] Sonar estimates include an expansion for fish that may have passed after operations ceased through October 18.

[b] Border Passage Estimate is based on a mark-recapture estimate unless otherwise indicated.

[c] Excludes Fishing Branch River escapement (estimated border passage minus Canadian mainstem harvest).

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

[e] From 1999 to 2004 border passage estimates were revised using a Stratified Population Analysis System (Arnason et. al 1995).

[f] 2006 to present border passage estimate is based on sonar minus harvest from Eagle residents upstream of deployment.

[g] Mark–recapture border passage estimates include 217,810, 235,956, and 132,048 from 2006 to 2008 respectively, during transition to sonar.

[h] Data are preliminary.

[i] Escapement Objective (EO) based on US/Canada Treaty Obligations, some years stabilization or rebuilding goals are applied.

[j] Interim Management Escapement Goal (IMEG) established for 2010-2012 based on brood table of Canadian-origin mainstem stocks (1982 to 2003).

Appendix I19.–U.S. Fish and Wildlife Service restoration projects in the Yukon River drainage from 2002 to 2007.

1.	2002	Chena River Streambank Restoration	The site is a residential parcel with 70ft of waterfront on the Chena River. Wave action from water craft was rapidly eroding the bank and threatening loss of riparian habitat. Bioengineering methods include stabilizing the bank with large plant cuttings, live willow fascines and bare root seedlings.	Natural Resources Conservation Service (NRCS) and Private Landowner
2.	2002	Chena River Fish Passage Project	This city-owned parcel included a culverted road crossing at Doughchee Road near North Pole south of Fairbanks, Alaska. The culvert at the crossing was crushed and moved water at such a steep angle that fish couldn't move upstream. Beaver Springs Creek passes through the culvert and merges with Chena Slough just downstream of the Doughchee crossing. The project involved removal of two, dysfunctional culverts and placement of a 40ft steel bridge that meets engineering specifications.	City of North Pole
3.	2002	Salcha River Streambank Restoration	Vegetated riprap & rootwads was installed along 202ft of bank. Extreme flooding in the spring of 2002 removed much of the riprap previously installed the previous year.	Private Landowner
4.	2002	Chena River Streambank Restoration	The residential parcel includes 195ft of waterfront within the River Bend Estates Subdivision in the North Star Borough near Fairbanks, Alaska. Wave action from water craft is rapidly eroding the bank of the Chena River at the site which is threatening the loss of riparian habitat. The construction on the waterfront at this site consisted of placing a continuous log berm (several large diameter trees drilled and pinned with branches left intact) at the toe of the bank, 195ft of vegetated riprap (live staking of willows between the riprap) behind the log berm, and several large birch and juniper trees planted at the top of the bank.	Private Landowner
5.	2002	Salcha River Streambank Restoration	This project involves the construction of 300ft of rootwad revetment with vegetated rip rap along the edge of the Cooperator's property on the north bank of the Salcha River.	Private Landowner

6.	2003	Chena River Streambank Restoration	The project involved construction of approximately 100ft of bio-engineered streambank restoration along the edge of the Cooperator's property on the southwest bank of the Chena River. The construction on the waterfront at this site consisted of placing rock riprap, constructing layers of fabric-wrapped soil with willows between the layers, placing live fascines on the slope, and planting live trees and grasses.	Private Landowner
7.	2003	Salcha River Streambank Restoration	This project involved the construction of 120ft of root wad revetment with vegetated rip rap along the edge of the Cooperator's property on the north bank of the Salcha River. The Salcha River was rapidly-eroding an outer bank of a bend at the site.	Private Landowner
8.	2003	Salcha River Streambank Restoration	This project involved the construction of 110ft of root wad revetment with vegetated rip rap along the edge of the Cooperator's property on the north bank of the Salcha River.	Private Landowner
9.	2003	Chena River Streambank Restoration	The project involves construction of approximately 200ft of bio-engineered streambank restoration along the edge of the Cooperator's property on the northwest bank of the Chena River. All disturbed areas of the bank were stabilized by fertilizing and seeding to control erosion.	Private Landowner
10.	2003	Salcha River Streambank Restoration	Parcel is located on the Salcha River approximately 32mi upriver from the Richardson Highway. The Salcha River is rapidly eroding an outer bank of a bend at the site which is threatening several recreational cabins and could reduce the value of the parcels. Just upstream at another property, the Service partnered with NRCS from September 1999 to July 2000 to help stabilize that property with gabion baskets and willow plantings to stabilize the bank. The purpose of the project is to address the erosion problem with proper planning that will protect the fish and wildlife resources as well as the cooperator's investment at the site.	NRCS and Private Landowner

11.	2003	Salcha River Streambank Restoration	The purpose of the project is to address the erosion problem with proper planning that will protect the fish and wildlife resources as well as the cooperator's investment at the site. Parcel is located on the Salcha River approximately 32mi upriver from the Richardson Highway near Salcha, Alaska. The Salcha River is rapidly eroding an outer bank of a bend at the site, which is threatening several recreational cabins and could reduce the value of the parcels. No efforts have been made previously to stabilize this site.	ADF&G and Private Landowner
12.	2003	Tanana River Streambank Restoration	The Old Valdez Trail where it crosses 23-Mile Slough is owned and maintained by the local road service area. In order to access property on the other side of the slough, a low-water crossing is in place. As the population in the area grows, an increased number of vehicles will be using the crossing. Fish habitat is impacted each time a vehicle crosses the slough, especially during rearing, migration and spawning periods. At one time, a wooden bridge connected the Old Valdez Trail across 23-Mile Slough. The purpose of this project is to reconstruct a bridge across 23-Mile Slough at the Old Valdez Trail. A 45ft long, single-lane steel box-girder bridge has been donated to this project.	ADF&G and Private Landowner
13.	2004	Chena River Fish Passage Project	Perched, obstructed culverts restrict passage of fish at the Spruce Branch Road crossing near North Pole, Alaska. This road is owned and maintained by the Spruce Branch Subdivision. One 24in culvert partially blocks the flow of water and restricts the passage of fish. For any future habitat restoration to be successful, this culvert should be replaced with a bridge over Chena Slough.	FSWCD and Fairbanks North Star Borough (FNSB)
14.	2004	Chena River Fish Passage Project	This project is a demonstration project to spearhead culvert replacement on the entire length of the slough. The Chena River Watershed Study (U.S. Army Corps of Engineers 1997) recommends that culverts be replaced with bridges. This project is part of a larger program to restore fish and wildlife habitat along the entire urban segment of the slough.	FSWCD
15.	2005	Chena River Streambank Restoration	The project includes construction of 2-50ft log vanes that protect an 80ft root-wad bank full bench and approximately 300ft of bank from erosion along the edge of the Cooperator's property on the northwest bank of the Chena River.	Private Landowner

16.	2005	Chena River Streambank Restoration	The project involves construction of approximately 307ft of bio-engineered streambank restoration along the edge of the Cooperator's property on the northeast bank of the Chena River. The construction on the waterfront at this site consisted of the placement of approximately 307ft of rock riprap with two 15ft keyways, constructing 2 layers of fabric-wrapped soil with willows between the 2 layers, and planting grasses.	Private Landowner
17.	2004	Chena River Streambank Restoration	The project involved construction of approximately 130ft of bio-engineered streambank restoration along the edge of the Cooperator's property on the northeast bank of the Chena River.	Private Landowner
18.	2004	Chena River Streambank Restoration	The project involved construction of approximately 136ft of bio-engineered streambank restoration along the edge of the Cooperator’s property on the northeast bank of the Chena River.	Private Landowner
19.	2004	Tanana River Fish Passage Project	The residential/agricultural parcel involved is near the Old Valdez Trail and Eielson Farm Loop Road near Eielson Air Force Base, Alaska. In order to access the parcel, the property owner had constructed a driveway with a 36" perched culvert to cross 23-Mile Slough. The driveway interfered with fish passage. The purpose of this project was to remove the existing driveway and construct a bridge across 23-Mile Slough to access the parcel.	Private Landowner
20.	2005	Tanana River Fish Passage Project	The residential parcel near Salcha, Alaska. In order to access the parcel, the property owner had constructed a gravel road with a small culvert to cross Piledriver Slough. The road and culvert interferes with fish passage. The purpose of this project was to remove the existing culvert and construct a bridge across Piledriver Slough.	Private Landowner
21.	2005	Tanana River Fish Passage Project	The residential parcel near Salcha, Alaska. The property owner had constructed a gravel road with a small culvert to cross Piledriver Slough. The road and culvert interfered with fish passage. The purpose of the project was to remove the existing culverted road crossing and construct a bridge. A 40ft one-lane bridge was	Private Landowner

			constructed. Work required for bridge installation included engineering a bridge design, preparing the bridge approach road surface, constructing bridge abutments/pilings, and placing the bridge.	
22.	2005	Chena River Streambank Restoration	The residential parcel includes 200ft of waterfront in the Nissen Ranch Subdivision near Fairbanks, Alaska. The property is on a high bank on an outside bend of the Chena River. Erosion is extreme and threatening the loss of riparian habitat. With this project the bank was stabilized with bio-engineered methods. With this assistance, impact to fish using this anadromous fish stream was prevented.	Private Landowner
23.	2005	Chena River Streambank Restoration	The parcel includes 300ft of waterfront near Chena Hot Springs Road, Alaska. The rapidly-eroding bank of the Chena River at the site was threatening the loss of riparian habitat as well as remaining structures. A small cabin at the site washed away during the flood of 2002. No efforts had been made previously to stabilize the site. The project involved in-stream construction of J-hooks or Cross Vane Weirs to protect streambank from erosion along the edge of the Cooperator's property on the west bank of the Chena River.	Private Landowner
24.	2005	Chena River Streambank Restoration	The residential parcel includes 300ft of waterfront near Phillips Field Road in the North Star Borough near Fairbanks, Alaska. Wave action from water craft is rapidly eroding the bank and threatening the loss of riparian habitat. With this project the bank was stabilized with bio-engineered methods. This project helped to educate landowners along the Chena River about bio-engineered streambank restoration methods.	Private Landowner
25.	2006	Chena River Streambank Restoration	This parcel includes 730ft of waterfront. Wave action from water craft is rapidly eroding the bank of the river at the site which is threatening the loss of riparian habitat and could reduce the value of the parcel. No efforts had been made previously to stabilize the site.	Private Landowner

26.	2006	Chena River Streambank Restoration	The residential parcel includes 320ft of waterfront in the Anchor Subdivision. The property is on the lower section of the Chena River just upstream of the Tanana River. High water from the Tanana River backs up into the lower Chena River, causing the Chena River to act like a lake. Erosion caused by boat wakes is threatening the loss of riparian habitat. With this project the bank was stabilized with bio-engineered methods.	Private Landowner
27.	2006	Chena River Streambank Restoration	The parcel includes 240ft of waterfront near Phillips Field Road. Wave action from water craft is rapidly eroding the bank of the river at the site which is threatening the loss of riparian habitat and could reduce the value of the parcel. No efforts had been made previously to stabilize the site.	Private Landowner
28.	2006	Tanana River Fish Passage Project	The residential parcel is near Salcha, Alaska. In order to access their land, the property owner had constructed a bridge that had fallen into Piledriver Slough and blocked fish passage. The purpose of this project was to remove the old bridge and construct a new bridge across Piledriver Slough. A 30ft, one-lane bridge was constructed.	Private Landowner
29.	2006	Chena River Fish Passage Project	The Plack Road crossing at Chena Slough was a dysfunctional culvert that blocked fish passage. The project implemented 2, 10ft culverts and replaced the small 18in and 36inculverts to improve fish passage.	Alaska Department of Transportation (ADOT), FSWCD and NRCS
30.	2006	Chena River Streambank Restoration	The parcel includes 300ft of waterfront near Chena Hot Springs Road, Alaska. River morphology is changing in this area. The rapidly-eroding bank of the Chena River at the site is threatening the loss of riparian habitat as well as a cabin structure. No efforts had been made previously to stabilize the site. The project consists of a combination of root wads and log vane structures for bank protection, and root wads on a bank full bench approximately 80-ft long, with a log vane to protect the upstream transition. In addition, a root wad/log vane structure downstream of the bank full bench provides bank protection for the transition downstream of the project site. The downstream log vane/root wad structure was keyed into a high-flow slough channel outlet, with the structure set at the outlet elevation (below Ordinary High Water).	Private Landowner

31.	2006	Chena River Streambank Restoration	The residential parcel includes 175ft of waterfront in the Chena Acres Subdivision. Erosion was threatening the loss of riparian habitat. With this project the bank was stabilized with bio-engineered methods. A new bio-engineering technique was used for the first time on Chena River: Longitudinal Stone Toe with willows on the bank side of the toe.	Private Landowner
32.	2006	Salcha River Streambank Restoration	This parcel is located adjacent to the south bank of the Salcha River on Bessie Barnabus Road near Salcha, Alaska. The Salcha River was rapidly eroding an outer bank of a bend at the site. This project involved the construction of 150ft of root wad revetment layered with geo-fabric burritos and willow cuttings along the edge of the Cooperator's property on the south bank of the Salcha River.	Private Landowner
33.	2006	Chena River Streambank Restoration	The residential parcel includes 250ft of waterfront in the River Bend Estates. The property is located on the outside of a bend with cut banks and high erosion. Large wakes caused by boat traffic also affected erosion rates of the cut bank. Erosion is extreme and threatened the loss of riparian habitat. The construction on the waterfront was Longitudinal Peaked Stone Toe Protection at the toe of the bank slope with willow pole planting behind the toe and planting willows on the upper and lower bank.	Private Landowner
34.	2006	Chena River Fish Passage Project	The Chena Slough is an anadromous stream from its confluence with the Chena River upstream to Nordale Road (approximately 5 mi). Chinook salmon were believed common in Chena Slough. Quality and quantity of favorable fish spawning and rearing habitat may have declined because of several factors, including blocked passage due to culverts and beaver dams, filling in of gravel riffles/pools with sediment, and eutrophication. The Nordale Road crossing at Chena Slough was a dysfunctional culvert that blocked fish passage. A large 13ft culvert replaced the small culvert and improved fish passage.	ADOT, FSWCD and NRCS
35.	2007	Chatanika River Tributary Fish Passage Project	This patented mining claim is located off Goldstream Road in the Fairbanks North Star Borough near Fox, Alaska. Goldstream Creek has been diverted for gold mining operations several times over the past 50 years. In order to restore over-wintering fish habitat, an existing 50ft deep pond will be connected to Goldstream Creek, a	Private Landowner

			tributary of the Chatanika River. This project will help to educate other miners about habitat restoration.	
36.	2008	Chena River Streambank Restoration	The parcel includes 330ft of Chena River waterfront. Wave action from water craft is rapidly eroding the bank of the river threatening loss of riparian habitat and could reduce the value of the parcel. Many years ago a rip rap project was used to stabilize the site, but that project was failing because the slope is very steep. This project introduced planted vegetation to reduce erosion.	Private Landowner
37.	2007	Chena River Streambank Restoration	The residential parcel includes Chena Slough waterfront in the Jolley Acres Subdivision near North Pole, Alaska. The property is located near the Airway Bridge. Numerous beaver dams have been (and continue to be) built under the existing bridge. The beaver dams have caused erosion to the parcel. If erosion was not stopped, the existing bridge abutment would be undercut and might cause the bridge to cave into the Slough. Erosion is extreme and threatening the loss of private property as well as a bridge. The bank was stabilized using bio-engineered methods.	FSWCD and Private Landowner
38.	2007	Chena River Streambank Restoration	The residential parcel includes waterfront within the Steamboat Landing Subdivision near Fairbanks, Alaska. Because the property is located on the outside bend of Chena River erosion is threatening the loss of riparian habitat and could reduce the value of the parcel. In 2007 the landowner tried to stabilize the bank with small concrete slab pieces. With this project the concrete pieces on the upper slope were removed, and the bank was stabilized with bio-engineered methods.	Private Landowner
39.	2007	Chena River Streambank Restoration	The Service partnered with a private landowner on the Chena River to restore and protect degraded streambank habitat near Chena Hot Springs Road, Alaska. The project consisted of a combination of root wads and log vane structures for bank restoration and protection along approximately 80ft of riparian.	Private Landowner

40.	2008	Chena River Streambank Restoration	The parcel includes 550ft of waterfront near Chena Hot Springs Road. The rapidly-eroding bank of the Chena River at the site was threatening the loss of riparian habitat as well as the cabin structure. The purpose of the project was to address the erosion problem. The project involved in-stream construction of J-hooks or Rock Vanes to protect approximately 500ft streambank from erosion along the edge of the Cooperator's property on the northwest bank of the Chena River.	Private Landowner
41.	2007	Chena River Fish Passage Project	Alaska Department of Transportation and Public Facilities rehabilitated the Parks Highway Milepost 351-356. In the process of surveying the project, they located Happy Creek that flowed under the existing road in a small culvert. The 24in culvert blocked fish passage. With technical assistance from USFWS, ADOT removed the 24in culvert and replaced it with an 84in culvert that passes fish.	ADOT
42.	2007	Tanana River Streambank Restoration	Big Delta State Historical Park is situated on the outside bank of a wide bend on the south side of the Tanana River, a short distance upstream from the confluence of the Tanana and Delta Rivers. Riverbank erosion threatens the historic site and buildings at the Park. In 2003 NRCS recommended that 4 weirs (60' long by 25' wide) be constructed in the Tanana River over prime chum salmon habitat. After several years of working with multiple partners, the project was completed using a combination of 1 vane, a bank full bench, rootwad system and willow plantings, the erosion has been arrested and prime fish habitat remains intact.	ADNR and NRCS
43.	2007	Chena River Streambank Restoration	The residential parcel includes waterfront in the Nissen Ranch Subdivision, North Star Borough near Fairbanks, Alaska. The property is on a high bank on an outside bend of the Chena River. Erosion is extreme and threatening the loss of riparian habitat. With this project the bank will be stabilized with bio-engineered methods.	Private Landowner

44.	2007	Chena River Fish Passage Project	The Chena Slough is an anadromous stream from its confluence with the Chena River upstream to Nordale Road (approximately 5 mi). Chinook salmon were believed to once be common in Chena Slough. Quality and quantity of favorable fish spawning and rearing habitat has declined because of several factors, including blocked passage due to a culvert that blocks fish passage at Dawson Road crossing of Chena Slough. The project replaced a 9ft improperly-positioned culvert at Dawson Road crossing with a 14ft culvert that opened 2mi of fish habitat.	ADOT, Alaska Dept. of Natural Resources (ADNR) and FSWCD
45.	2008	Chena River Streambank Restoration	The parcel includes approximately 80ft of waterfront near Chena Hot Springs Road, Alaska. The rapidly-eroding bank of the Chena River at the site is threatening the loss of riparian habitat as well as the cabin structure. No efforts had been made previously to stabilize the site. The purpose of the project is to address the erosion problem. The project consisted of a combination of root wads and log vane structures for bank protection.	Private Landowner
46.	2008	Tanana River Fish Passage Project	The residential parcel is near Salcha, Alaska. In order to access their land, the property owners intended to construct a culvert bridge or an in-stream crossing of Piledriver Slough. Both would interfere with fish passage. The purpose of this project was to avoid the in-stream crossing and construct a bridge across Piledriver Slough to access the parcel. A one-lane bridge was constructed.	Private Landowner
47.	2009	Chena River Fish Passage	This project worked with partners to identify culverts with fish passage problems on Chena Hot Springs Road (CHSR). With cooperation from Alaska DOT, several of the identified culverts were reopened to fish passage, and the remaining culverts were added to ADOT's maintenance schedule for removal of obstructions.	ADF&G, ADOT, FSWCD and US Army
48.	2010	Chena River Streambank Restoration	This project involves 400ft of cabled spruce trees. This project is necessary to provide fish habitat and stability to the riverbank.	ADF&G, FSWCD and Private Landowner

49.	2010	Chena River Streambank Restoration	The residential parcel includes 158ft of waterfront within the Hamilton Acres Subdivision. Wave action from water craft was rapidly eroding the bank threatening the loss of riparian habitat. Previous efforts to stabilize the site became unstable due to flooding and ice flow damages. The property owner volunteered more land to dedicate for stream bank restabilization through revegetation with donated native riparian plants.	FSWCD and Private Landowner
50.	2010	Chena River Streambank Restoration	The Chena River is rapidly eroding an outer bank of the bend at the site. This project involves the construction of 200ft of root wad revetment with vegetated rip rap along the edge of the cooperator's property.	FSWCD and Private Landowner
51.	2010	Chena River Streambank Restoration	The Chena Flats are adjacent to the Tanana River, a major tributary of the Yukon River. The purpose of this project was to reduce impacts from unplanned trails to wetland properties owned by the Fairbanks North Star Borough and Interior Alaska Land Trust. Juvenile Chinook salmon use Cripple Creek, which flows through the property.	FNSB and Interior Alaska Land Trust
52.	2010	Chena River Streambank Restoration	The project restored 9ac of wetland habitat adjacent to Clear Creek approximately 3mi southeast of Ft. Wainwright located between the Old Richardson Highway and Bradway Road. This area of land was used for vehicle salvage storage and gravel extraction in the 1950s. The west end of the gravel pit and a smaller pond were used for trash dumps in the 1960s and 1970s. Natural wetland vegetation will be transplanted along the riparian perimeter.	FSWCD and Private Landowner
53.	2010	Emmonak Slough Fish Passage	This project opened 10mi of historic rearing habitat for Chinook, coho, chum, sockeye, pink salmon, and whitefish. Emmonak Slough originally served as a side channel of the Yukon River, connecting the river to the Bering Sea.	ADOT and Private Landowner
54.	2011	Chena River Streambank Restoration	Residential parcel of 175ft of waterfront within Steamboat Landing Subdivision in the North Star Borough near Fairbanks, Alaska. Because the property is located on the outside bend of the Chena River, erosion is threatening the loss of riparian habitat. In July 2007	Private Landowner

			the landowner tried to stabilize the bank with small concrete slab pieces. With this project the concrete pieces on the upper slope were removed, and the bank was stabilized with bio-engineered methods.	
55.	2010	Nenana River Streambanks Restoration	Approximately 5ac of Anderson Riverside Park was restored. The purpose of the project was to address erosion with the manual removal of White Sweet Clover, the tilling of the compacted soils with a rototiller, placing topsoil where needed, transplanting non-invasive plant and native tree species and seeding remaining areas with native grass mixtures to encourage rapid vegetation re-growth. Revegetating the area reduces erosion and vehicular disturbance in waters occupied by juvenile salmon.	FSWCD and City of Anderson
56.	2012	Chena River Streambank Restoration	To improve water quality in the Chena River Watershed for Chinook salmon, the Service partnered with the City of Fairbanks, the Cold Climate housing Research Center (CCHRC), GW Scientific, and Fairbanks Soil & Water Conservation District, to develop a Green Infrastructure Resource Guide for homeowners in the Fairbanks area.	City of Fairbanks, Cold Climate Housing Research Center, GW Scientific and FSWCD
57.	2011	Yukon River Streambank Restoration	This project was a cooperative effort between the City of Eagle, the Eagle Community School and Alaska Gateway School District, local 4H, private land owners, State Soil and Water Conservation District and the Service. The goal was to restore habitat for birds and wildlife around the school and upland area of approximately 3ac along the south side of the Yukon River. Native vegetation was re-established throughout the site; bird houses were built by students; and trails and interpretive signs were established.	City of Eagle, Eagle Community School District, State Soil and Water Conservation District and Private Landowner

58.	2011	Chena River Streambank Restoration	The residential parcel includes 158ft of waterfront within the Hamilton Acres Subdivision. Wave action from water craft is rapidly eroding the bank threatening the loss of riparian habitat. Previous efforts to stabilize the site became unstable due to flooding and ice flow damages. The property owner volunteered more land for stream bank restabilization through re-vegetation with donated native riparian plants. The property owner prepared the site for the 2010 Fairbanks Youth Habitat Restoration Corps. This work included digging and transplanting native Alaskan plants, trees, and shrubs from donor sites to re-vegetate the project site.	FSWCD and Private Landowner
59.	2011	Chena River Streambank Restoration	This project restored 3ac of prime wetland habitat near 20mi Chena Hot Springs Road. This area of land was restored where wetland had been impacted. This was accomplished by creating shallow littoral zones along the embankments of a pond's perimeter and creating a nesting/loafing area for waterfowl. This site is adjacent to known Chinook juvenile rearing habitat.	FSWCD and Private Landowner
60.	2010	Chena River Streambank Restoration	This project involves the installation of 450ft of rootwads with live native vegetative mat installed on top of the rootwad bank rehabilitation. This project is necessary to provide and sustain fish habitat and vegetation that provides fish habitat, stability to the riverbank and maintains riparian function.	ADF&G, FSWCD and Private Landowner
61.	2011	Chena River Streambank Restoration	This project involves the installation of 195ft of cabled spruce trees, 130ft of rootwads with live native vegetative mat and trenched willows installed on top of the rootwad bank rehabilitation. This project is necessary to provide and sustain fish habitat and vegetation that provides fish habitat, stability to the riverbank and maintains riparian function.	ADF&G, FSWCD and Private Landowner
62.	2011	Tanana River Watershed Streambank Restoration	This project consists of the installation of 50ft of cabled spruce trees, 40ft of brush layering, 68ft of double layered trenched willows, 108ft by 6ft area of native vegetated mat on top of the brush layering and landward and between the trenched willows and supplementing a 108ft by 6ft area along the bank with live rooted native vegetation. The rehabilitation work and cabling of spruce trees was completed as part of the 2011 Fairbanks Workshop.	ADF&G and Private Landowner

63.	2011	Chena River Streambank Restoration	The parcel includes waterfront near Milepost 52 on Chena Hot Springs Road. The rapidly-eroding bank threatened riparian habitat. No efforts had been made previously to stabilize the site. The project consisted of a combination of root wads and log vane structures for bank protection.	Private Landowner
64.	2012	Chena River Streambank Restoration	This project is necessary to provide vegetation that provides fish habitat, stability to the riverbank and maintains riparian function. It involved the installation of a 4ft by 8ft elevated, light-penetrating gangway to a 16ft by 5ft floating dock. This project is necessary to protect fish habitat and vegetation that provides fish habitat, stability to the riverbank and maintains riparian function. In addition this project consists of the installation of 36ft of brush layering, 40ft of double-layered trenched willows and a 76ft by 4ft area of native vegetated mat. The rehabilitation work was completed as part of the 2012 Fairbanks Restoration Workshop.	ADF&G and Private Landowner
65.	2012	Chena River Streambank Restoration	This project involves the installation of 160ft of cabled spruce trees. This project is necessary to provide fish habitat and stability to the riverbank.	Private Landowner
66.	2012	Chena River Streambank Restoration	This project involved removal the existing metal drums, rock, asphalt, metal piping and wooden debris and disposing of the debris at an appropriate upland location. To stabilize and rehabilitate the riverbank, 70ft of cabled spruce trees was installed.	ADF&G and Private Landowner
67.	2012	Chena River Streambank Restoration	This project stabilized and rehabilitated the riverbank by installing 240ft of cabled spruce trees, approximately 80ft of brush layering topped with an 80ft by 4ft area of native vegetated mat, and the installation of a 24ft by 6ft elevated, light penetrating aluminum walkway on the top of the bank with a 3ft by 25-step stairway to the river.	ADF&G and Private Landowner
68.	2012	Chena River Fish Passage Project	The objective of this project was to avoid the use of in-stream crossing on Monument Creek. A 30ft, one-lane bridge was constructed to provide access to the landowners parcel. Work required for bridge installation included engineering a bridge design, preparing the bridge	Private Landowner

			approach road surface, constructing bridge abutments/pilings, and placing the bridge.	
69.	2012	Chena River Streambank Restoration	This project involves the removal the existing metal drums, rock, asphalt, metal piping and wooden debris and disposing of the debris at an appropriate upland location. To stabilize and rehabilitate the riverbank, 243ft of cabled spruce trees and approximately 75ft of brush layering were installed.	ADF&G and Private Landowner
70.	2013	Tanana River Streambank Restoration	This project involved the installation of cabled spruce trees. The trees were held in place by duck-billed earth anchors driven into the river bank. The cabled spruce trees were drawn tightly against the bank at and below Ordinary High Water. This project is necessary to provide fish habitat and stability to the riverbank.	ADF&G, FSWCD and Private Landowner
71.	2013	Chena River Streambank Restoration	This project involved the installation of 195ft of cabled spruce trees, 130ft of rootwads with live native vegetative mat and trenched willows installed on top of the rootwad bank rehabilitation.	ADF&G, FSWCD and Private Landowner
72.	2013	Tanana River Streambank Restoration	This project involved the installation of rootwad bank stabilization with live native vegetative mat and up to four rows of trenched willow installed on top of the rootwads. An estimated 190ft by 12ft area of native grasses, woody-stem vegetative mat and other native rooted plants was planted from behind the header log up to the top of the re-sloped riverbank, between and above each layer of trenched willow.	ADF&G, FSWCD and Private Landowner
73.	2013	Chena River Streambank Restoration	This project involved the installation of rootwad bank stabilization with live native vegetative mat and up to four rows of trenched willow installed on top of the rootwads. An estimated 200ft by 12ft area of native grasses, woody-stem vegetative mat and other native rooted plants was planted from behind the header log up to the top of the re-sloped riverbank, between and above each layer of trenched willow.	FSWCD and Private Landowner

74.	2013	Chena River Streambank Restoration	Block erosion at this site was threatening a public building. This project involved the installation of rootwad bank stabilization with live native vegetative mat and up to four rows of trenched willow installed on top of the rootwads spanning 0.3mi along the Chena River. Native grasses, woody-stem vegetative mat and other native rooted plants were planted from behind the header log up to the top of the re-sloped riverbank, between and above each layer of trenched willow.	ADF&G, FNSB, FSWCD, Festival Fairbanks, US Army Wounded Warriors Program and Tanana Valley Watershed Assoc. (TVWA)
75.	2013	Chena River Streambank Restoration	Using a restoration workshop, this project was necessary to provide and sustain fish habitat and riparian vegetation that provides fish habitat and stability to the riparian and maintains riparian function.	ADF&G, ADEC, City of Fairbanks, FNSB School District, FSWCD, US Army Wounded Warrior Program, and Private Landowner
76.	2013	Chena River Streambank Restoration	This project was necessary to provide fish habitat and stability to the riverbank. The project involved the installation of cabled spruce trees. The trees were held in place by duck-billed earth anchors driven into the river bank.	ADF&G, FSWCD and Private Landowner
77.	2013	Chena River Streambank Restoration	This project involved the installation of cabled spruce trees. The spruce trees were cabled along the river bank with the butt end of the tree facing upstream and held in place by duck-billed earth anchors driven into the river bank. This project is necessary to provide fish habitat and stability to the riverbank.	ADF&G, FSWCD and Tanana Chiefs Conference
78.	2013	Chena River Streambank Restoration	The Landowner was experiencing erosion of approximately 150ft of riverbank. This project involved the installation of cabled spruce trees. Also the landowner installed six interpretive panels at a location that serves tens of thousands of non-resident and resident visitors per year. Increasing the general knowledge local residents will help local landowners understand better ways to develop their properties while limiting impacts to salmon habitat and help sustain riparian vegetation and function.	ADF&G, FSWCD and Private Landowner

79.	2014	Tanana River Streambank Restoration	Approximately 230ft of stream bank was restored via installation of rootwads with live native vegetative mat and trenched willows installed on top of the rootwad bank rehabilitation.	ADF&G and Private Landowner
80.	2014	Chena River Streambank Restoration	This accomplishment involved the installation of cabled spruce trees to restore 140ft of Chena River streambank. This bioengineering technique helps to stabilize the stream bank while providing habitat for juvenile salmonids.	ADF&G and Private Landowner
81.	2014	Chena River Streambank Restoration	This project was the installation of cabled spruce trees to improve fish habitat and promote bank stability.	ADF&G and Private Landowner
82.	2014	Chena River Streambank Restoration	This project involved a landowner cooperative agreement to install 100ft of rootwads with live native vegetative mat and trenched willows installed on top of the rootwad bank rehabilitation.	Tanana Chiefs Conference
83.	2014	Chena River Streambank Restoration	This project involved installation of rootwads with live native vegetative mat and trenched willows installed on top of the rootwad bank rehabilitation. Approximately, 180ft of stream bank was restored.	Private Landowner
84.	2014	Chena River Streambank Restoration	The landowner worked with the Service to restore an eroded river bank. This project used root wads to stabilize rapidly-eroding sections of the river where development has occurred.	Private Landowner
85.	2014	Chena River Streambank Restoration	Using spruce tree revetment, the landowner worked with the Service to restore an eroded river bank to benefit fish and riparian wildlife on her property.	Private Landowner
86.	2015	Chena River Streambank Restoration	This project involved the installation of rootwad bank stabilization with live native vegetative mat and up to two rows of trenched willow installed on top of the rootwads. An estimated 190ft by 12ft area of native grasses, woody-stem vegetative mat and other native rooted plants was planted from behind the header log up to the top of the re-sloped riverbank, between and above each layer of trenched willow.	ADF&G, ADEC, City of Fairbanks, FNSB, Festival Fairbanks, TVWA and Private Landowner

87.	2015	Chena River Streambank Restoration	This project involved the installation rootwads on the Chena with live native vegetative mat and trenched willows installed on top of the rootwad bank rehabilitation. Approximately 134ft of stream bank was restored.	Private Landowner
88.	2015	Chena River Streambank Restoration	This project involved the rehabilitation of 119ft of riverbank using a willow trenching technique. The revegetation technique was used to secure the toe of the slope, trap sediment and create fish rearing habitat. The willow formed a living brushy arrangement at the water's edge. A concern the partner had was that the willow would grow too high and obscure the view from park. The previous practice of cutting down the willow completely by the partner (creating a bare bank) was avoided. Working with the Service they learned to train the willow by pulling down high willow out over the surface of the water to construct an overhanging arrangement of tall willow.	ADF&G, City of Fairbanks, Festival Fairbanks, FNSB and TVWA
89.	2015	Chena River Streambank Restoration	This project involved the rehabilitation of riverbank with 150ft of willow using trenching technique and 340ft of cabled spruce trees.	ADF&G, FSWCD and Private Landowner
90.	2015	Chena River Streambank Restoration	This project involved installation rootwads on the Little Chena with live native vegetative mat and trenched willows installed on top of the rootwad bank rehabilitation and spruce trees along the foot of the bank. Approximately 246ft of stream bank was restored.	ADF&G, FSWCD and Private Landowner
91.	2015	Chena River Streambank Restoration	This project involved the installation of rootwads with live native vegetative mat and trenched willows installed on top of the rootwad bank rehabilitation. Approximately 155ft of stream bank was restored.	ADF&G and Private Landowner

92.	2015	Chena River Streambank Restoration	The project introduced and assisted students in constructing a storm water runoff and wetland restoration project focused on water quality and habitat improvements. Three waterbodies within the Chena River watershed are ranked as high priority for Alaska Clean Water Actions. Returning proper hydrology will not only eliminate water pollution but also eliminate erosion along the riverbank. A bioswale was installed to remove silt and pollution from surface water runoff draining using a shallow depression with a berm on the downslope side to direct overflow from the parking area. Native water tolerant plants were planted and then mulched within the depression. This bioswale provided filtration for 2 storm drains that emptied directly from a large roof and parking area into the river. The landowner agreed to discontinue lawn maintenance (mowing) around the adjacent area of the bioswale allowing additional native vegetation to propagate.	FNSB, FSWCD and Private Landowner
93.	2015	Andreafsky River Streambank Restoration	Students attending the Andreafsky River Weir science camp helped restore a 90ft section of eroding stream bank in front of the main camp as part of their science camp curriculum. Students counted and aged salmon as part of in-season salmon management. They also learned about the importance of the river and riparian habitats to spawning and rearing salmon. Learning techniques to restore an eroding section of bank was also a valuable lesson and information they shared with their communities.	Nerklikmute Native Corporation
94.	2015	Chena River Streambank Restoration	This project involved working with the landowner on building a riparian buffer (25ft) by planting native willow and allowing native vegetation to grow in over an existing lawn totaling 103ft. The purpose of this project is to address the future erosion problems with proper planning that will protect the fish and wildlife resources as well as the landowner's property.	FSWCD and Private Landowner
95.	2015	Chena River Streambank Restoration	Students from outlying villages, attending the University of Alaska Fairbanks summer habitat course titled One Tree assisted in restoring a section of river/slough bank that had some minor erosion and riprap rock along a section of stream bank of the Chena River meeting a side channel slough. Students worked alongside biologists and partners from the Tanana Valley Watershed Association as part of their	University of Alaska Fairbanks, TVWA and Private Landowner

			summer 3-wk course to create a trail that would direct foot traffic off the bank and avoid riparian vegetation damage. Students also removed rock and replanted willow along the river bank. They also participated in activities to learn about the importance of the river and riparian habitats to spawning and rearing salmon.	
96.	2015	Chena River Streambank Restoration	This project involved working with the landowner to agree on a setback (10ft) off the riverbank maintaining the revegetation of the landowner's riparian. The total length of project was 246 ft. The purpose of this project is to address future erosion problems with proper planning that will protect the fish and wildlife resources as well as the landowner's property.	Private Landowner
97.	2015	Chena River Streambank Restoration	This project involved working with the landowner on planting willow within an agreed setback (20ft) off the river and maintaining the native vegetation along the stream bank. The purpose of this project is to address the future erosion problems with proper planning that will protect the fish and wildlife resources as well as the landowner's property.	Private Landowner
98.	2015	Chena River Streambank Restoration	This project involved the rehabilitation of 922ft of riverbank with cabled spruce trees drawn tightly against the bank at and below ordinary high water, capturing the trunks of the trees. This project is necessary to provide fish habitat and vegetation that provides fish habitat, stability to the riverbank and maintains riparian function.	FSWCD and Private Landowner
99.	2015	Chena River Fish Passage Project	Cripple Creek once drained an extensive watershed north of Chena Ridge, likely providing important fish and wildlife habitat including Chinook salmon. During past hydraulic mining in the valley, runoff to the Chena River was flushed down a diversion drain approximately 6-mi long within the Cripple Creek basin; the flow now bypasses the lower reach of Cripple Creek resulting in loss of habitat. The lower section of the Creek is now fed via groundwater yet has existing channel habitat remains. As part of a larger project to repair and replace aging ditch culverts by ADOT, the IALT and Service will removed a small, damaged culvert along a transmission right-of-way within the natural stream channel. This project was the start of an	Interior Alaska Land Trust (IALT)

			overall restoration project on connecting the natural flow to Cripple Creek, which is a priority of the Service and its partners.	
100.	2016	John River Streambank Restoration	Village Corporation land along Contact Creek, a tributary to the John River, is a producer of Chinook salmon. The landowner is working with the Service to remove riprap along a stretch of stream bank habitat to benefit fish and riparian wildlife on their property. The Landowner wanted to remove a large expanse of riprap and still control erosion on the streambank along a channel of the Contact Creek that runs through Anuktuvak Pass and has no riparian vegetation and used riprap construction to shore up the failing bank.	Arctic Slope Regional Corporation, Petro Star, Village of Anuktuvak and FSWCD
101.	2016	Chena River Streambank Restoration	The project was constructed on an Alaska Department of Natural Resources State Recreation Area (DNR) campground along the Chena River within the Fairbanks North Star Borough. The DNR worked with ADG&G and the Service to restore 400ft of eroded river bank to benefit fish and riparian wildlife on the property.	ADNR, ADF&G, FSWCD and FNSB
102.	2016	Chena River Streambank Restoration	This project involved working with the landowner to conduct a workshop for demonstration/educational purposes in addition to erosion control using bioengineering techniques from the Alaska Streambank Revegetation and Protection Guide. The landowner voluntarily developed a 10 to 15ft buffer along their property by eliminating land use activities that would cause negative impacts to the native riparian vegetation, including mowing, bank trampling, and other bank hardening actions. The total length of project was 75ft of streambank restored.	ADF&G, FSWCD and Private Landowner
103.	2016	Chena River Streambank Restoration	The project was located on a residential parcel with 136ft of streambank along a side channel of the Chena River within the Fairbanks City limits. Previous efforts to stabilize the site involved dumping dead brush in the eroded areas of streambank. This project involved the use of restoration revegetation techniques and land use education to eliminate activities that cause negative impacts; land use	FSWCD and Private Landowner

			education and natural vegetation recovery is a simple and cost effective way to restore riparian areas. The site conditions were favorable for natural recovery; active revegetation occurred in a 10ft buffer along 136ft of streambank.	
104.	2016	Tanana River Streambank Restoration	The Landowner is experiencing erosion on the riverbank along the Tanana River. This project involved the rehabilitation of 500ft of riverbank using cabled spruce trees. This project is necessary to provide fish habitat and vegetation that provides fish habitat, stability to the riverbank, and maintains riparian function.	ADF&G, FSWCD and Private Landowner
105.	2016	Chena River Streambank Restoration	This project involved active revegetation and land-use education to eliminate activities that negatively impact streambanks. Revegetation occurred on a 10ft buffer along 447ft of the property. The site included an area of the streambank with bare sections and sink holes among older spruce and birch trees that was threatening the landowner's property. Workshop participants included the landowner and 12 other landowners. They discussed the importance of the Chena River salmon runs and how streambank restoration and stabilization at the property benefited juvenile salmon.	FSWCD and Private Landowner
106.	2016	Chena River Streambank Restoration	This project was on Thirty-mile Slough. In order to provide fish habitat and protect the stream bank, two layers of brush layering with native vegetated mat on top and rooted willow plantings were installed.	FSWCD and Private Landowner
107.	2016	Chena River Streambank Restoration	This project provides fish habitat and protects the streambank via a vegetative mat consisting of native vegetation and rooted willow plantings were installed along the streambank. Previous land use had cleared vegetation to the water's edge of the property. No riparian vegetation was growing along the streambank.	FSWCD and Private Landowner
108.	2016	Chena River Streambank Restoration	The purpose of this project is to address streambank erosion problems and remove the debris (consisting of asphalt and concrete) and plant the riparian zone with native vegetation to provide fish and wildlife habitat. This project consisted of three parts: root wad, spruce tree revetment, and revegetation. An estimated 150ft by 10ft area of native	ADF&G, FSWCD and Private Landowner

			grasses, woody-stem vegetative mat and other native-rooted plants were planted.	
109.	2016	Chena River Fish Passage	This project maintained fish passage by repairing a degraded bridge on Spruce Branch, an upper tributary of Chena Slough. The existing bridge, installed to replace a barrier culvert, has deteriorated over time. Repair of the bridge assured access to habitats in the tributary, and that public safety is not jeopardized.	ADF&G, ADOT, and FSWCD
110.	2017	Chena River: Juvenile Chinook Salmon, Temperature, and Large Wood Habitat	The project will map the distribution of large woody debris (LWD) in the Chena River basin and estimate use of LWD by rearing juvenile Chinook salmon, an Alaska Region priority species. The project assesses LWD and evaluates the potential for restoring habitats in the lower river. This project will link one factor that may be influencing production rates and guide future habitat restoration efforts.	ADF&G, IALT, TVWA, USGS-Alaska Cooperative Fishery Research Unit
111.	2017	Chena River Streambank Restoration	This project involved the installation of rootwads on a side channel of the Tanana River with live native vegetative mat and trenched willows installed on top of the rootwad bank rehabilitation. Approximately 501ft of stream bank was restored.	ADF&G and Private Landowner
112.	2017	Tanana River Streambank Restoration	The project site is located along a critical fall chum salmon spawning area on the Tanana River. The project's end results provided fish habitat and protects the streambank by utilizing cabled spruce trees.	FSWCD and Private Landowner
113.	2017	Chena River Streambank Restoration	This project used a Root-wad Bulkhead with Brush Layering to arrest river bank erosion and restore riparian health.	FSWCD and Private Landowner
114.	2017	Chena River Streambank Restoration	The project's end results provide fish habitat and protect the stream bank utilizing cabled spruce trees. This project was necessary to provide and sustain fish habitat and vegetation that provides fish habitat, stability to the riverbank and maintains riparian function.	FSWCD and Private Landowner

115.	2017	Chena River Streambank Restoration	The purpose of this project was to address streambank erosion problems and remove debris (consisting of riprap) and plant the riparian zone with native vegetation to provide fish and wildlife habitat along approximately 100ft Root-wad bulk heads for bank stabilization with live native vegetative mat and up to two rows of trenched willow were installed on top of the root wads.	FSWCD and Private Landowner
116.	2017	Chena River Streambank Restoration	This project resulted in new fish habitat and protected the streambank by utilizing cabled spruce trees. Spruce trees were cabled along the river bank held in place by duck-billed earth anchors driven into the riverbank.	Private Landowner
117.	2017	Tanana River Streambank Restoration	This project will restore riparian health on an eroding streambank at Rika's Roadhouse.	ADNR, ADF&G, FSWCD
118.	2018	Tanana River Streambank Restoration	This project just downstream of the Chena River will restore riparian health on an eroding streambank on private property.	Private Landowner
119.	2018	Chena River Streambank Restoration	This project will restore riparian health on an eroding streambank on private property.	Private Landowner
120.	2018	Chena River Streambank Restoration	This project will restore riparian health on an eroding streambank on private property.	Private Landowner
121.	2018	Chena River Streambank Restoration	This project will restore riparian health on an eroding streambank on private property.	Private Landowner
122.	2018	Chena River Streambank Restoration	This project will restore riparian health on an eroding streambank on private property.	Private Landowner
123.	2018	Chena River Streambank Restoration	This project will restore riparian health on an eroding streambank on private property.	Private Landowner

124.	2018	Chena River Streambank Restoration	This project will restore riparian health on an eroding streambank on private property.	Private Landowner
125.	2018	Chena River Streambank Restoration	This project will restore riparian health on an eroding streambank on private property.	Private Landowner
126.	2018	Chena River Streambank Restoration	This project will restore riparian health on an eroding streambank on private property.	FNSB and TVWA
127.	2018	Chena River Streambank Restoration	This project will restore riparian health on an eroding streambank on private property.	Private Landowner

Appendix I20.–Yukon Area salmon processors and buyers, and associated data for those referenced in the text, 2017.

Commercial operation (Processing location/buying station)	Product	District
Kwik'pak Fisheries LLC 2909 Arctic Blvd Anchorage, AK 99503 (Emmonak/Mountain Village)	Fresh Salmon Frozen Salmon Salmon Roe	1 and 2
Fish People Corporation 2540 NE MLK Jr Blvd Portland, OR 97212 (St. Mary's)	Fresh Salmon	2
Yukon River Gold LLC. 107 Fairside Dr. Lynden, WA 98264 (Kaltag)	Fresh Salmon Frozen Salmon Salmon Roe	4
Interior Alaska Fish Processors 2400 Davis Rd. Fairbanks, AK 99701 (Fairbanks, Yukon Bridge, Nenana)	Fresh/Frozen Salmon Salmon Roe Salted/Brined Salmon Smoked Salmon	5 and 6
David Dausel P.O. Box 80291 Fairbanks, AK 99708 (Fairbanks)	Fresh Salmon	6
John Krieg 3641 Dubia Rd North Pole, AK 99705 (Fairbanks)	Fresh Salmon	6
Gregory Taylor 1477 Chena Point Ave. Fairbanks, AK 99709 (Fairbanks)	Fresh Salmon	6
Edmund Lord P.O. Box 183 Nenana, AK 99760 (Nenana)	Fresh Salmon	6
Robert Pierce Sr. P.O. Box 614 Nenana, AK 99760 (Nenana)	Fresh Salmon	6