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Reprinted from the Alaska Fishery Research Bulletin
Vol. 12 No. 1, Summer 2006
The Alaska Fisheries Research Bulletin can be found on the World Wide Web at URL:
http://www.adfg.state.ak.us/pubs/afrb/afrbhome.php

Alaska Fishery Research Bulletin 12(1):1–146. 2006.

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ABSTRACT: Alaska's commercial salmon fisheries have harvested an average of 172 million salmon annually since 1990, ranging from 123 million to 221 million fish per year. This stands in stark contrast to the average annual harvest of 41 million fish during the 1950s—the final decade under federal management of the state's commercial salmon fisheries. When Alaska assumed management authority of its salmon fisheries in 1960, one year after statehood, many of the state's salmon runs were depressed and its salmon fisheries were in desperate shape. In this paper we describe how these once depleted salmon fisheries have been rebuilt over the last 45 years into one of the strongest and most sustainable fishery resources in the world. We review state policies and regulatory structure, describe how the resource is managed, and provide outputs from the management program including harvest levels and values, the number of fishermen involved, and the current status of Alaska's salmon stocks. Detailed information is provided for each of 11 commercial fishing areas in the state. We also provide information on funding levels and sources that the Alaska Department of Fish and Game has used to support its salmon management and assessment programs. Challenges faced by the state in maintaining and improving resource management and by the state and industry in improving fishery profitability are discussed.

INTRODUCTION

For centuries, indigenous people have used the salmon resources of Alaska for subsistence purposes. These salmon resources include Chinook *Oncorhynchus tshawytscha*, sockeye *O. nerka*, coho *O. kisutch*, pink *O. gorbuscha*, and chum *O. keta*.

During the latter part of the 18th century, Alaska was increasingly explored by various nations. The charter of the Russian-American Company in 1799 was the first attempt to control natural resources for economic reasons. However, the salmon resource during the Russian years was not used commercially, but instead was used as a subsistence resource as it had been for centuries. Alaska became a customs district under the U.S. Treasury after purchase from Russia in 1867. In 1868, the first salmon saltery was established; a year later the first cannery was established. Some fisheries research was conducted by the U.S. Fisheries Commission but there was no attempt to manage fisheries; one treasury agent and an assistant enforced the law and monitored salmon fishing along 34,000 miles of the Alaskan coastline (Pennoyer 1988). In the late 1800s and early 1900s, the Alaska commercial salmon fishery quickly grew as technology improved and new markets were developed. By 1898, 59 canneries were operating in Alaska and by 1920, 160 canneries were operating (Cooley 1963). The annual average Alaskan commercial harvest from 1900 to 1910 was about 30 million salmon but doubled in the next decade to about 65 million salmon.

Under the American system of federalism, states have the power to regulate fisheries within their jurisdiction. However, for U.S. territories, the power to regulate fisheries sometimes remained with the federal government and was held in trust.

In 1884, Congress passed the first Organic Act for Alaska which provided limited self-government un-

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Acknowledgements: We thank James Hasbrouck and Kathrin Sundet of the Alaska Department of Fish and Game, Division of Sport Fish; James Hasbrouck provided extensive information on Cook Inlet salmon escapements and Kathrin Sundet provided estimates of the sport harvest of salmon included in this report. Many staff members of the Alaska Department of Fish and Game, Division of Commercial Fisheries presented information included in this report; we would like to thank Fredrick Bue, Bonnie Borba, Linda Brannian, Geron Bruce, Douglas Eggers, Dani Evenson, Steve Hayes, Steve Honnold, John Linderman Jim Menard, Bob Murphy, Eric Reiter, Gene Sandone, Ted Spencer, and Mark Willette. We would like to thank Evelyn Russell for the section maps. A variety of staff members from the Alaska Department of Fish and Game provided helpful comments on drafts of this report; we thank Sue Aspelund, Charles Burkey, Dani Evenson, Scott Kelly, Jim Menard, and Jeff Regnart.

der a federally appointed governor, but the act did not transfer jurisdiction for fisheries management to the territorial government. The U.S. Fisheries Commission implemented general studies on Alaskan fishery resources but resisted attempts to be given management authority. Early U.S. Fisheries Commission investigators predicted the collapse of Alaskan salmon fisheries if left unregulated and showed particular concern over the use of barricades for harvest.

In 1889, Congress adopted the Alaska Salmon Fisheries Act and thus prohibited the erection of dams, barriers, or other obstructions in Alaskan rivers for the purpose of impeding salmon migrations. Funding for enforcement of the act was first available in 1892 and staffing was one fishery agent (Cooley 1963).

In 1896, Congress amended the Alaska Salmon Fisheries Act. Commercial fishing above tidewater in streams less than 500 feet wide was banned. Fishing below mean high tide remained unregulated. Weekly closed fishing periods were established except in Bristol Bay, Cook Inlet, and Prince William Sound. The amended act also required canneries to report harvests and to establish hatchery programs.

In 1903, Congress established the Department of Commerce and Labor and within it, a Bureau of Fisheries, which, along with other duties, became responsible for Alaskan fisheries. Bureau staff continued some investigations of Alaskan salmon but did little in the way of management and enforcement. The Alaska Salmon Fisheries Act of 1906 implemented a license tax on the salmon harvest along with a rebate to those companies operating hatcheries. Due to concerns that overfishing was depleting salmon runs in Alaska, there were 42 bills introduced in Congress between 1906 and 1924 proposing a variety of restrictive regulations on the commercial salmon fishery. All were defeated or seriously weakened by the lobbying efforts of the salmon canning industry (Regnart 1993).

The second Organic Act was passed in 1912. This act provided for a territorial legislature with limited self-government. However, the act contained a provision prohibiting the territorial legislature from passing any laws that would "alter, amend, modify or repeal any federal laws relating to the fisheries of Alaska." Alaska remained the sole exception to the convention that new territories were given some degree of autonomy in the management of fisheries. Fishery management responsibility remained with the federal government until January of 1960, one year after statehood.

Congress adopted the White Act in 1924. This act denied the Bureau of Fisheries the power to control the amount of fishing gear, stating "no exclusive or individual right to fisheries shall be granted." While preventing the federal government from effectively limiting participants in the Alaskan commercial salmon fishery, the White Act gave broad authority to the Secretary of Commerce to regulate fisheries in all territorial waters including the authority to limit catch, size and type of fishing gear, and seasons. The White Act specified 36-hour weekend closures of the salmon fishery including the closure of fish traps. The act stated Congressional intent that not less than 50% of the salmon were to be allowed to escape the fishery in streams with wiers installed, representing one of the first attempts to regulate Alaska's salmon fishery for sustained yield. The White Act did not allow federal agencies to manage salmon fisheries by limiting the number of participants. Instead salmon fishery management policies were adopted that decreased efficiency—such as limits on fishing time and gear type restrictions—which resulted in overcapitalization. Interest groups then sought to try shift the burden of conservation to other competing interest groups. Federal agencies were not consistent in enforcing fishing efficiency across Alaska. They encouraged technological advances in boats and gear in some areas of Alaska; at the same time they adopted regulations to reduce efficiency in others. For example, in Bristol Bay, commercial salmon fishing was restricted to sail boats, yet highly efficient fish traps were allowed for commercial salmon fishing in several other areas of Alaska.

Following World War I, prices paid for Alaskan salmon decreased and harvests increased. The annual average Alaskan commercial harvest from 1920 to 1929 was about 70 million salmon. Lacking Congressional action to limit fishing effort and the amount of gear being deployed in Alaskan salmon fisheries, a presidential order was issued in 1933 called the Southwest Alaska Fisheries Reservation. This order limited the case pack (harvest), the amount of gear that a fisherman could use, and the number of cannery operations. The new licensing system effectively limited a fisherman to working for a specific company on an assigned boat (Pennoyer 1979).

Between 1930 and 1939, the Alaskan commercial harvest averaged about 90 million salmon; the industry was prosperous and salmon prices increased. Industry lobbied hard in Washington D.C. to assure that new regulations restricting harvests proposed by the Bureau of Fisheries were abandoned or liberalized. Federal funding for fisheries research and enforcement dwindled.

In 1939, salmon runs had declined, the harvest decreased to about 75 million salmon, and attacks on the federal management program forced the Commissioner of the Bureau of Fisheries to resign. The Bureau was transferred to the Department of the Interior and merged

with the Bureau of Biological Survey to form the U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service, through its Bureau of Commercial Fisheries, was responsible for management of Alaska's salmon fisheries through 1959.

The need for food production during World War II caused liberalization of commercial salmon fishery regulations. Prior closed areas were opened and prior weekly closed periods were abolished. Between 1940 and 1949, annual Alaskan commercial harvests averaged about 75 million salmon. Industry resisted proposals to restrict fishing after the war, arguing to do so would deprive returning veterans of employment (Cooley 1963). In an effort to rebuild overfished salmon runs, a 1951 proposal to prohibit fishing in several Kodiak Island fisheries was overturned by industry lobbyists who argued that allowing greater escapements would be wasteful (Roppel 1986). As the salmon runs declined throughout the 1950s, President Eisenhower declared parts of Alaska disaster areas, authorizing federal relief funds and the Department of Agriculture to provide food supplies. Between 1950 and 1959, annual Alaskan commercial harvests decreased to an average of about 40 million salmon. By the late 1950s there were 4 times as many fishermen as in the early 1900s yet the total harvest had decreased to about 25 million salmon in 1959.

The territorial legislature created the Alaska Department of Fisheries and the Alaska Fisheries Board in 1949, along with a territorial fish tax. The department had no specific authority, but did provide a mechanism for scientific research and review of federal regulations. The lack of self-rule in salmon management and the influence of the major lower 48 canning companies on federal salmon management were primary forces in Alaska for statehood. In the 1950s, the 6 largest canning companies owned 40% of the canneries and processed 50% of the salmon harvest (Regnart 1993). They maintained permanent legal staff in Washington D.C. to lobby federal fishery managers and law makers and they exercised direct influence in the Alaskan salmon fishery through ownership in fish traps. Of the 434 fish traps licensed in 1948, only 38 (9%) belonged to Alaskan residents while 245 (56%) were owned and operated by the 8 largest canning companies (Regnart 1993). Fish traps, due to their monopolistic control by canneries, created controversy throughout Alaska. Federal officials refused to ban fish traps even though traps had been outlawed in all other salmon fisheries in British Columbia and on the west coast of the U.S. Fish traps became a rallying issue for statehood when the federal government refused to ban this type of fishing gear. According to Cooley (1963), "Alaska residents viewed themselves in a one-sided battle against 2 mammoth forces—the absentee capitalists and absentee government—neither of which seemed to have the welfare of the Alaska in mind."

Alaska achieved statehood in 1959. In January of 1960, in his message to the Joint Assembly of the First Alaska State Legislature, Governor William A. Egan had this to say: "On January 1 of this year, Alaska's Department of Fish and Game was handed the depleted remnants of what was once a rich and prolific fishery. From a peak of three-quarters of a billion pounds in 1936, production dropped in 1959 to its lowest in 60 years. On these ruins of a once great resource, the department must rebuild. Our gain is that we can profit by studying the destructive practices, mistakes and omissions of the past. The revival of the commercial fisheries is an absolute imperative. The livelihood of thousands of fishermen and the very existence of many communities scattered along thousands of miles of continental and island coastline depends upon improvement of the fisheries. To this end we will give our best efforts."

In June of 1960, in a speech on the floor of the U.S. Senate, Senator Ernest Gruening stated: "Had it not been for the Federal Government's neglecting and permitting the abuse of the salmon fisheries resource of Alaska, they would today constitute a great and rich heritage for this and future generations."

In 1963, Cooley stated: "The State of Alaska faces a tremendous task as it attempts to rehabilitate the salmon resources to something of its former grandeur. The lack of adequate biological knowledge and the need for much more study and research has already been stressed. The state must be willing and able to invest heavily in a large-scale program of research and management with little likelihood of a significant return on the investment for many years to come. While the willingness may be there, the ability to finance it remains a crucial question, for the state must meet many new financial obligations that are concurrent with statehood."

The intent of this paper is to present information concerning commercial salmon fisheries of Alaska (Figure 1); how this resource is managed and outputs from the management program including harvest levels, value of those harvests, and number of fishermen involved. Also provided will be summary information concerning the funding that the Alaska Department of Fish and Game (ADF&G) has used over the last 45 years to rebuild these once depleted salmon fisheries into one of the strongest and most sustainable fishery resources in the world.

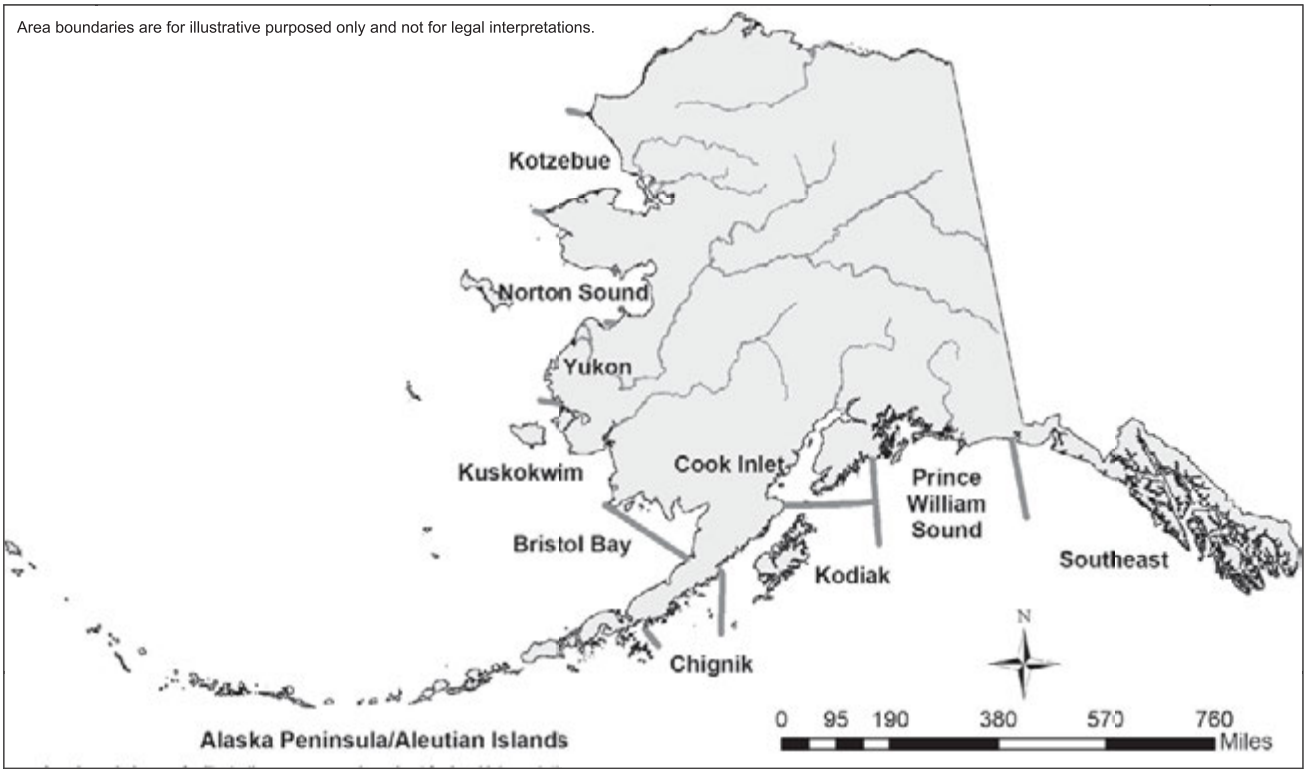

Figure 1. Map of Alaska showing the locations and approximate boundaries of 11 Alaska salmon fisheries.

State of Alaska Salmon Management Authority

Authority for the management of the subsistence and commercial salmon fisheries of Alaska was primarily vested with ADF&G, Division of Commercial Fisheries at statehood. The Alaska constitution provided policy guidance. At statehood, the Alaska legislature created the Department of Fish and Game and the Division of Commercial Fisheries and gave them a mandated fishery management mission. The Alaska legislature has passed laws since statehood providing further authority and guidance. The Alaska Board of Fish and Game and later the Alaska Board of Fisheries has promulgated a diverse set of regulations and plans for management of Alaska's subsistence and commercial salmon fisheries that provide guidance for day-to-day management by area biologists of the Division of Commercial Fisheries. Since statehood, some major changes in authority for management of the Alaska salmon fishery have occurred.

Article VIII of the Alaska Constitution is dedicated to natural resources. Sections pertinent to the management of salmon include:

"Section 1. It is the policy of the State to encourage the settlement of its land and the development of its resources by making them available for maximum benefit of its people.

"Section 2. 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 its people.

"Section 3. Wherever occurring in the natural state, fish, wildlife, and waters are reserved to the people for common use.

"Section 4. Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses.

"Section 15. No exclusive right or special privilege of fishery shall be created or authorized in the natural waters of the State." Section 15 of the Alaska Constitution was included due to the special privileges granted to the salmon canning industry by the federal fishery management program prior to statehood, particularly the ownership and use of fish traps. Fish traps were quickly prohibited by regulation, but language in Section 15 prevented the Board of Fisheries and Game from implementing regulations to limit total fishing effort. In 1972, the Constitution was amended to facilitate a limited entry program for the Alaska commercial salmon fishery. Section 15 now reads "No exclusive right or special privilege of fishery 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."

In 1973, the Alaska legislature passed a bill creating the first comprehensive limited entry program in the United States. The limited entry program implemented for commercial salmon fisheries in Alaska stabilized the number of fishermen and therefore the amount of gear used in each of the State's salmon fisheries. It improved management effectiveness and the ability of the fishery managers to regulate the fishery so that harvestable surpluses could be taken while still meeting escapement objectives in an orderly and predictable fishery. Limited entry also succeeded in maintaining a high proportion of Alaska resident participation in the state's salmon fisheries.

The Alaska legislature created ADF&G with the commissioner as the principle executive and charged the commissioner to "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." At statehood, Alaska made 2 very significant departures from the prior federal fishery management regime. At statehood, Alaskans keenly understood the value of a decentralized salmon management program after dealing for decades with the centralized federal salmon management regime.

First, in an important organizational change, ADF&G offices were opened in numerous towns and villages across Alaska and staffed with area management biologists. Second, these area management biologists were provided with fishery management authority to address the rapidly changing inseason fishery management needs of the salmon fisheries in Alaska. Area biologists in the Division of Commercial Fisheries were charged with managing subsistence and commercial salmon fisheries while area biologists in Sport Fish Division were charged with managing sport fisheries for salmon. Since statehood, emergency order authority has been vested in area management biologists giving the department's field staff authority to make regulatory announcements that carry the force of law and can be implemented immediately. AS 16.05.060, Emergency Orders, states: "(a) This chapter does not limit the power of the commissioner or an authorized designee, when circumstances require, to summarily open or close seasons or areas or to change weekly closed periods on fish or game by means of emergency orders" and "(c) An emergency order has the force and effect of law after announcement by the commissioner or an authorized designee…". Sustained yield management of commercial salmon fisheries requires precise timing of fishery openings and closures and adjustments in gear, often with short notice, to allow the harvest of surplus fish and simultaneously assuring adequate escapement of spawning fish. Prior to statehood, federal managers had been given limited authority to make field announcements, however, less than 25 such announcements were made per year across the State of Alaska by federal managers in the 1950s. In contrast, under State of Alaska management, in 2004, 745 emergency orders were issued by Division of Commercial Fisheries staff to manage salmon fisheries.

While a key ingredient to the effective salmon management program implemented in Alaska at statehood was the placement of local area management biologists with emergency order authority in area offices throughout the state, also at statehood, 4 regional offices were formed along with a headquarters office. These portions of the Division of Commercial Fisheries program were put in place to provide supervision and support for the states commercial fishery management program. Key staff in regional and headquarters offices were, and continue to be, vested with emergency order authority. The fact that the basic structure and organization of the Division of Commercial Fisheries was implemented 45 years ago and has largely stayed in place is a testament to the wisdom of the initial leadership of ADF&G and the long-term effectiveness of the organization structure implemented at statehood.

Regulations for prosecution of the commercial salmon fisheries in Alaska were promulgated by the Alaska Board of Fish and Game from statehood until 1975 when that Board was split and the Alaska Board of Fisheries was formed. The Board of Fisheries is defined is defined in AS 16.05.251 as "for purposes of the conservation and development of the fishery resources of the State, there is created the Board of Fisheries composed of 7 members appointed by the governor, subject to confirmation by a majority of the members of the legislature in joint session. The governor shall appoint each member on the basis of interest in public affairs, good judgment, knowledge, and ability in the field of action of the board, and with a view to providing diversity of interest and points of view in the membership. The appointed members shall be residents of the State and shall be appointed without regard to political affiliation or geographic location of residence." In part those authorities include: establishing fishing seasons, setting fishing quotas, setting bag limits, establishing harvest levels along with sex and

size limitations on these harvests, establishing means and methods employed in the pursuit, capture and transport of fish, and regulating commercial, sport, subsistence, and personal use fisheries. The Board of Fisheries has sole authority to allocate fishery resources among commercial, sport, personal use, and subsistence users. Regulations enacted by the Board of Fisheries for management of the Alaska salmon commercial fishery are extensive, taking up a substantial portion of the 1,147 page booklet entitled "Alaska Fish and Game Laws and Regulations Annotated, 2004–2005 Edition, Including updates to the Alaska Administrative Code through Register 171." These diverse and detailed fishery regulations provide much of the basis for management of the Alaska commercial salmon fishery. These regulations provide guidance but are supplemented by hundreds of emergency orders developed and announced by ADF&G area management biologists who are directly responsible for management of specific salmon fisheries across the State of Alaska.

In 2000, the Policy for the Management of Sustainable Salmon Fisheries was adopted into state regulation (5 AAC 39.222). Referred to as Alaska's Sustainable Salmon Fisheries Policy, the regulation states that "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." The goal of the policy is to "ensure conservation of salmon and salmon's required marine and aquatic habitats, protection of customary and traditional uses and other uses, and the sustained economic health of Alaska's fishing communities." The landmark policy updates and strengthens longstanding principles of Alaska's salmon management program. Most importantly, it directs ADF&G and the Alaska Board of Fisheries to follow a systematic process for evaluating the health of salmon stocks throughout the state by requiring ADF&G to provide the Board, in concert with its regulatory cycle, with reports on the status of salmon stocks and fisheries under consideration for regulatory changes. The policy also defines a new process for identifying stocks of concern (stocks which have not met escapement goals or yield expectations), and requires ADF&G and the Alaska Board of Fisheries to develop action plans to rebuild these stocks through the use of management measures, improved research, and restoring and protecting habitat. Three levels of concern are identified; (1) a yield concern is the least severe and results from an inability to maintain expected harvest levels over a 4- to 5-year period, (2) a management concern relates to the inability to maintain escapements within escapement goal ranges over a 4- to 5-year period despite the use of management measures, and (3) a conservation concern is the most severe and relates to the inability over a 4- to 5-year period to maintain escapements above a minimum threshold below which the stock's ability to sustain itself is jeopardized.

To comply with the new policy, ADF&G has expended considerable effort since 2000 to update salmon stock status information and review and update the scientific basis of salmon escapement goals—producing an extensive series of published reports in the process. There are currently over 270 escapement goals established for salmon stocks or stock aggregates throughout the state of Alaska. The goals are classified either as "biological escapement goals," which are scientifically-based and represent the escapement estimated to provide the greatest potential for maximum sustained yield, or as "sustainable escapement goals," which represent an escapement level that is known to provide for sustained yield over a 5- to 10-year period.

In contrast to the dismal state of many salmon runs in other areas of the west coast of North America, salmon stocks in Alaska are in excellent shape. No stocks have been identified as threatened or endangered under the Endangered Species Act. Relative to the criteria of Alaska's Sustainable Salmon Fisheries Policy, as of spring 2006 only 3 salmon stocks in Alaska are classified as stocks of management concern; Kvichak River sockeye salmon in the Bristol Bay area, Yukon River summer chum salmon and Nome subdistrict chum salmon in the Norton Sound area. An additional 5 stocks, all located in northern Alaska in the Yukon, Kuskokwim and Norton Sound areas, are identified as stocks of yield concern which are meeting escapement objectives but producing low levels of harvest. The Board of Fisheries and ADF&G have developed action plans to address rebuilding of each of these stocks.

The Alaska legislature delegated authority to the ADF&G commissioner to deputize employees as peace officers and to enforce fish and game laws and regulations. In territorial days, the protection of fish and game resources over vast expanses of water and land by a few fishery agents was ineffective. The Division of Fish and Wildlife Protection commissioned full-time enforcement officers at statehood and was initially assigned as a division within ADF&G. In 1971, the Division of Fish and Wildlife Protection was moved from ADF&G to the Department of Public

Safety and in 2003 was reorganized into a bureau. A massive improvement in salmon fishery law enforcement occurred at statehood and has continued as a result of the combined efforts of protection officers from Fish and Wildlife Protection and other deputized employees of the Department of Fish and Game.

A recent development that effects state authority to manage salmon fisheries in Alaska and that has led to a renewal of federal salmon fishery management authority is associated with subsistence fishing. When the U.S. Congress passed the Alaska National Interest Lands Conservation Act (ANILCA) in 1980, the act contained a provision that defined subsistence as "the customary and traditional uses by rural Alaska residents of wild renewable resources for direct personal or family consumption; and for customary trade." Congress thereby defined subsistence entitlement by geography or demographics. The Alaska legislature and the Alaska Board of Fisheries attempted to adopt State laws and regulations so that State management would come into compliance with ANILCA. As part of this process, a new use designation was created—personal use—to accommodate Alaska citizens who would no longer qualify to subsistence fish for salmon under rural definition. In 1988, he Alaska Supreme Court prohibited Alaska from using rural residency as the basis for subsistence eligibility because such a restriction violated the common use principle of the Alaska Constitution. After years of additional State and Federal legal actions, in 1995 the U.S. Ninth Circuit Court ruled that the subsistence priority in ANILCA applies to waters in which the U.S. has reserved water rights. Federal management authority for salmon fisheries was reinitiated in 1998 with a Federal Board issuing regulations for salmon subsistence fisheries under a rural priority approach. While state and federal regulators and managers have attempted to implement a co-management approach, the direct federal authority to manage and regulate salmon fisheries in State of Alaska waters represents a distinct change from about 40 years of State of Alaska management, an issue of paramount importance during Alaska's drive for Statehood.

High Seas Salmon Fishing

In the late 1930s, the Japanese had begun fishing salmon in international waters near Bristol Bay. After World War II, negotiations between the U.S., Canada, and Japan resulted in the International North Pacific Fisheries Convention (INPFC) and the establishment of a tripartite commission to deal with research and management of salmon harvested on the high seas. The international fisheries expanded after 1960 and remained unmanaged except through treaty negotiations. A series of bilateral negotiations with Korea, Japan and Russia led to some control and regulation of foreign take, and from 1974 to 1977 the Japanese voluntarily restricted their high seas fishing fleet—perhaps in anticipation of the outcome of the ongoing Law of the Sea Conferences and the threat of extended jurisdiction (Pennoyer 1979). The Law of the Sea negotiations faltered and a number of Alaskan salmon stocks continued to decline. International interceptions of North American salmon stocks became a public issue and management conflicts increased. In 1976, Congress adopted the Magnuson-Stevens Fisheries Management and Conservation Act (MSFCMA). This legislation extended U.S. control of its fishery resources from 3 miles offshore to 200 miles offshore. The high seas harvest of Alaskan salmon stocks was substantially reduced immediately after passage of the MSFCMA. It is likely that high seas harvest of some western Alaska stocks of salmon were reduced by as much as 80% (Pennoyer 1979). Control of the exclusive economic zone in Alaska, the area from 3 to 200 miles offshore, is vested in the North Pacific Fishery Management Council (NPFMC), an 11-member council appointed by the Secretary of Commerce. Fishery management plans adopted by the council are codified by the Secretary of Commerce and implemented by the National Marine Fisheries Service (NMFS). The NPFMC developed a management plan for salmon caught in waters from 3 to 200 miles offshore of Southeast Alaska and the NMFS delegated authority to manage salmon fisheries in this area to the State of Alaska.

Pressure by the State of Alaska contributed to a continued international effort to control high seas fishing for salmon after the MSFCMA was enacted. Directed fishing of salmon by foreign fishing fleets within 200 miles of Alaska was banned. However, directed high seas fishing for salmon continued in waters outside of 200 miles offshore of Alaska. The INPFC was the mechanism used to attempt the control of high seas fishing of Alaskan-origin salmon through 1991. In 1992, the north Pacific nations (Canada, Japan, Russia, and the United States) with anadromous fish resources formed the North Pacific Anadromous Fish Commission (NPAFC) and closed the international waters of the North Pacific Ocean to directed fishing for salmon. The NPAFC has continued the role of research and enforcement previously conducted through the INPFC, but also included Russian participation and more recently Korean participation. Some Alaska-origin salmon continue to be caught in ocean fisheries that occur in the Russian exclusive economic zone. However, the

magnitude of interception of Alaska-origin salmon by Asian foreign fleets has markedly decreased as a result of the MSFCMA, INPFC, and NPAFC with resultant benefits accruing to inshore Alaskan fishermen.

Pacific Salmon Treaty

Coastal and freshwater salmon fisheries, such as those in Alaska, sometimes harvest salmon that spawn in other jurisdictions. Significant interceptions of Alaskan, southern U.S., and Canadian spawned salmon occur in coastal fisheries of Southeast Alaska, Canada, and Washington. Alaskan fisheries also intercept significant numbers of salmon that originate in Canadian waters of the Yukon River. A long series of negotiations between the U.S. and Canada concluded in the signing of the Pacific Salmon Treaty (PST) in 1985. The PST was renegotiated in 1999 with an increased effort to implement abundance based management regimes. The resultant U.S.–Canada agreement(s) through the Treaty process reflects a political balance of the fishing and conservation interests of Alaska, Washington, Oregon, Idaho, 24 southern U.S. treaty Indian tribes, and Canada. Various annexes in the PST provide policy guidance to the salmon management regimes in place in Southeast Alaska, specific limits are applied to Chinook salmon harvests in Southeast Alaska, limits are applied to sockeye salmon harvests in specific Alaskan fisheries near the U.S.–Canada border in the southern portion of the region, and limits are applied to harvests of salmon originating from Canadian waters of the 3 transboundary rivers (Taku, Stikine, and Alsek). The PST, through annexes, provides fishery management authority, direction, and policy guidance to ADF&G staff responsible for management of the salmon fisheries in Southeast Alaska. The PST also put into place a cooperative management program in the Yukon River that is intended to ensure adequate passage of Canadian origin Yukon River salmon through Alaskan fisheries for both conservation and continuation of Canadian fisheries that use these stocks. The PST through the Yukon Article thus provides fishery management authority, direction, and policy guidance to ADF&G staff responsible for fishery management of Yukon salmon fisheries.

Alaska Salmon Hatcheries

The first hatcheries in Alaska were developed in the early 1890s. Despite a long history of attempts at hatchery development and operation prior to statehood (Roppel 1982), little evidence exists to suggest these efforts were successful in significantly increasing salmon returns to Alaska. At statehood, 3 small hatcheries were operating in Alaska primarily as research facilities. The modern Alaska hatchery program was initiated in the early 1970s, in response to a period of depressed commercial salmon fisheries in Alaska. In 1971, the Alaska Legislature created the Fisheries Rehabilitation, Enhancement and Development Division (FRED) of ADF&G to develop a coordinated salmon enhancement program. A major expansion in salmon aquaculture research and production began in the 1970s. The new program was intended to supplement, not supplant, wild stock production (McGee 2004), unlike hatchery programs operating in other areas of the Pacific Northwest where many hatcheries were developed as mitigation measures for degradation of salmon production due to loss of habitat or overfishing (Heard 2003). Formal policies and regulations were developed and enacted to minimize the potential for adverse effects of the enhancement program on wild stocks. These included a rigorous hatchery permitting process requiring location of hatcheries away from significant wild stocks and use of local brood sources, development of a genetics policy and pathology guidelines, and hatchery fish marking requirements (McGee 2004).

By the early 1980s, ADF&G was involved with construction and or operation of about 20 additional salmon aquaculture facilities located from southern Southeast Alaska to as far north as the Noatak River near Kotzebue. As State support for salmon enhancement developed, the Alaska legislature created a framework for private salmon enhancement through creation of private nonprofit corporations. North Slope oil revenues to Alaska declined in the 1980s and natural salmon production increased. As a result, Alaska explored the option of private sector operation of State salmon enhancement programs. In 1993, the Governor issued an executive order merging the FRED Division with the Division of Commercial Fisheries. By the mid-1990s, most state-run salmon aquaculture facilities were taken over by the private sector. State aquaculture facilities that primarily produced fish caught in sport fisheries were transferred to the Division of Sport Fish and by the later 1990s, the Division of Commercial Fisheries neither funded nor operated salmon hatcheries. The Division of Commercial Fisheries, however, has continued to provide much of the technical support to the salmon aquaculture facilities operated in Alaska (Figure 2). This support, such as such as disease screening and production evaluation, was formerly provided by FRED Division.

In commercial salmon fisheries in Southeast Alaska and Prince William Sound, a major responsibility of the area biologists is the management of enhanced salmon returns. Area biologists attempt to provide for

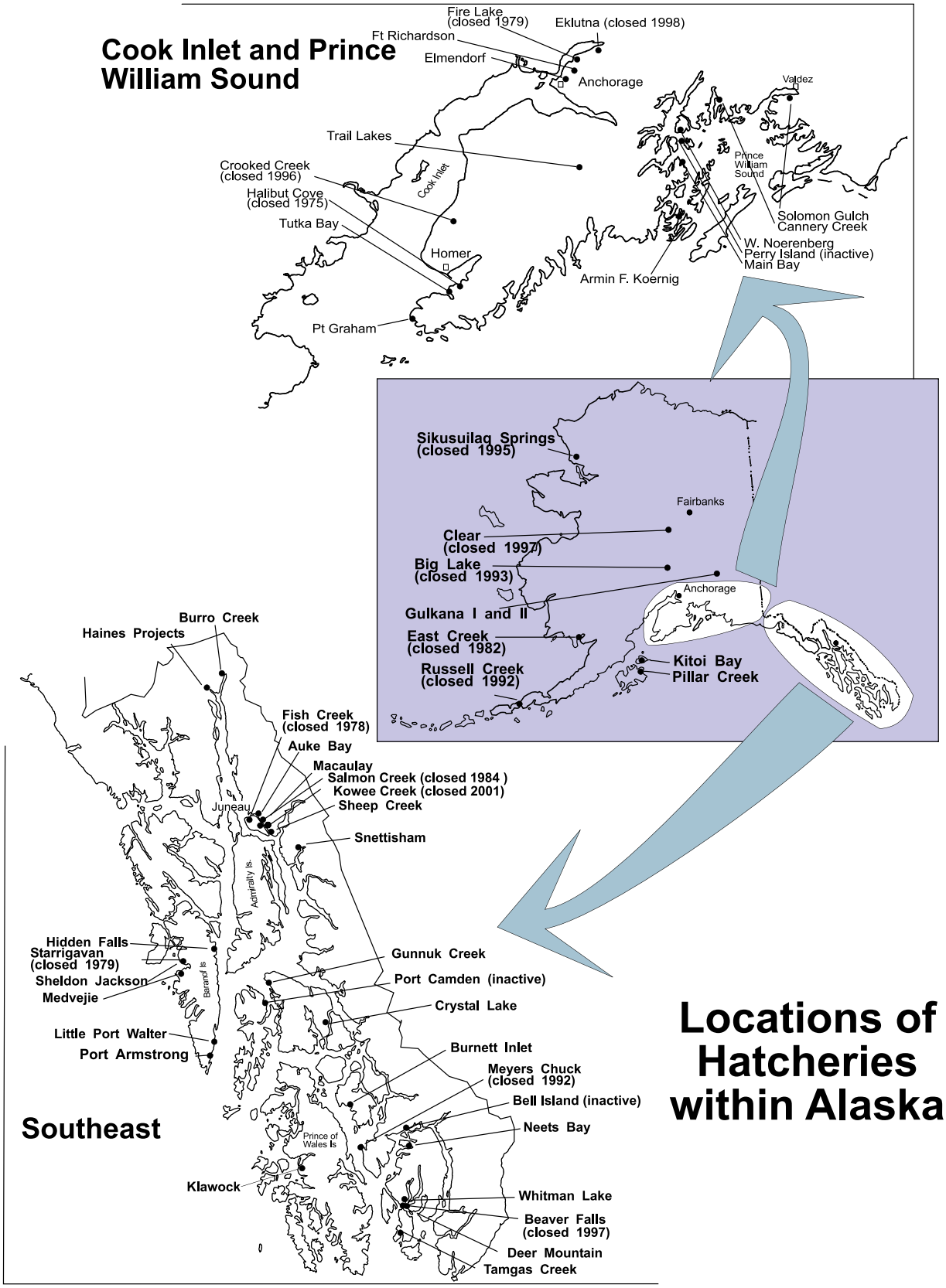

Figure 2. Locations of salmon hatcheries in Alaska.

the full harvest of surplus hatchery fish while providing adequate protection to wild stocks of salmon. In 2004, over 1.7 billion salmon eggs were collected by Alaskan salmon operators, over 1.6 billion fish were released, and over 20 million salmon originating from Alaskan hatcheries were harvested in common property commercial salmon fisheries as a result of the Alaska salmon hatchery program. The 2004 Alaska salmon enhancement program consisted of 29 private nonprofit salmon hatcheries, 2 federal operated salmon hatcheries, 2 state operated hatcheries, and several streamside incubation and restoration projects (White 2005).

While hatcheries play an important role in Alaska's salmon production, the practice of finfish farming, defined as raising fish to maturity in captivity for commercial purposes, is outlawed in Alaska. Salmon farming began in Washington State in the 1970s. By the 1980s, salmon farms in Washington and British Columbia were importing Atlantic salmon from eastern Canada and Europe. By 1990, the State of Alaska concluded that the dangers posed by salmon farming to its healthy wild salmon stocks, environment, and commercial salmon fishing industry were too great, and the legislature passed a law banning the practice. Hundreds of escaped Atlantic salmon from Washington and British Columbia salmon farms have been recovered in Alaska waters since 1991, and Alaskans remain very concerned about the possible deleterious impacts this exotic species could have on Alaska salmon (ADF&G 2002).

ADF&G Budget History and Fiscal Support for the Salmon Program

The State of Alaska assumed management authority over its salmon fisheries on January 1, 1960. The FY 60 ADF&G operational budget totaled a little over $2 million and the FY 61 budget was almost $4 million. The FY 60 budget included about $406,000 in federal grants (17%) and the FY 61 budget included about $560,000 in federal grants (14%). The Division of Commercial Fisheries budget totaled $495,879 in FY 60 but increased to $885,072 in FY 61 (Table 1). The Division of Commercial Fisheries funding source in FY 60 and FY 61 was entirely State of Alaska general funds, which have, ever since, provided the backbone of the funding for managing salmon fisheries. Given that the salmon fishery was the major commercial fishery at statehood, the majority of the FY 60 and FY 61 allocation was undoubtedly spent on very basic salmon management—the funding of area biologists, area office support costs, and operational costs associated with conducting escapement and fishery surveys.

Table 1. Budget allocations to ADF&G in FY 60 and FY 61.

ADF&G Program	FY 60 Expenditures	FY 61 Expenditures
Board of Fish and Game	$9,685	$16,337
Administration	$110,308	$170,223
Commercial Fisheries	$495,879	$885,072
Biological Research	$253,313	$319,989
Sport Fish	$270,304	$328,992
Game	$371,799	$538,120
INPFC	$1,780	$5,074
Engineering	$129,558	$157,543
Bounty Payments	$125,000	$125,000
Protection	$397,800	$1,224,424
Total ADF&G Expenditures	$2,165,426	$3,770,724

At statehood, the Division of Biological Research was an important component of ADF&G and a substantial portion of its funding was based upon federal grants. Much of the work accomplished by the Division of Biological Research was associated with assessing salmon stock strength. In FY 65, just a few years into statehood, the Division of Biological Research was combined with the Division of Commercial Fisheries, thus the Division of Commercial Fisheries thereafter had both a management component and a research component. With the research component came federal grant support for salmon stock assessment which totaled $289,600 in the FY 65 budget.

An accurate and exact history of the amounts of funding used by ADF&G to manage salmon fisheries since statehood is not available because budget allocations were at the division level and the Division of Commercial Fisheries has always had responsibility for management of shellfish, herring, and other fishery resources in addition to salmon. However, trends in funding for salmon management and research can be elucidated through a summary of budget allocations at the division and department level.

The State of Alaska increased general fund support to ADF&G in a continuous fashion from statehood until the mid-1980s, going from a general fund allocation level of under $2 million in FY 60 to a level of over $52 million in FY 85 (Figure 3). General fund support to ADF&G decreased from the mid-1980s through the current time with the FY 05 general fund allocation to ADF&G being $26,167,000. While general fund support to ADF&G decreased since the mid-1980s, total funding continued to increase, primarily due to increases in federal funding. Total ADF&G funding since statehood increased from a level of about $2 million in FY 60 to a level in excess of $140 million in FY 05.

The consumer price index as provided by the U.S. Bureau of Labor and Statistics (web site: http:

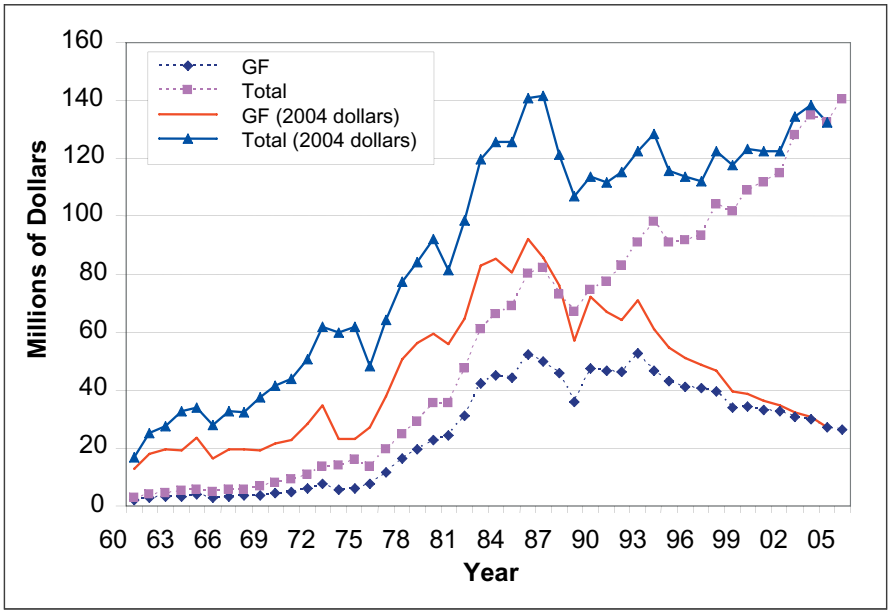

Figure 3. ADF&G budget trends (general fund and total), fiscal year 1960–2005.

//www.bls.gov/) was used to approximate historic budget allocations into 2004 dollar equivalents. This adjustment provides the ability to compare buying power since FY 60 and indicates that the ADF&G general fund budget peaked from the mid-1980s through the early 1990s and has since decreased to about the buying power of the late 1970s. Currently, the ADF&G total budget in terms of buying power is equivalent to about the level it was in the mid-1980s.

The State of Alaska increased general fund support to the Division of Commercial Fisheries in a fairly continuous fashion from statehood until the early 1990s, going from a general fund allocation level of less than half a million dollars in FY 60 to a level of over $23 million in FY 92 (Figure 4). General fund support to the Division of Commercial Fisheries decreased slightly in FY 93 and FY 94, but increased substantially in FY 95 once the FRED Division merger occurred.[1] The merger resulted in a fisheries development component being created within the Division of Commercial Fisheries with an FY 95 budget allocation of $8,158,200 of which $6,039,400 were general funds. Since FY 95, when the allocation of general funds to the Division of Commercial Fisheries totaled $30,376,400 (80% fishery management and 20% fishery development), the general fund allocation has steadily decreased with an allocation of $22,281,500 in FY 05. General funds have been the major source of revenue for salmon management and stock assessment activities in the Division of Commercial Fisheries since statehood. General fund allocations, once adjusted for inflation show that the buying power increased from statehood until the early 1980s, then varied around $30 million (in 2004 dollars) until FY 95, when it increased with the FRED Division merger and the additional responsibilities assumed by the Division. Since FY 95, buying power of the general fund budget has decreased, with current funding equivalent to late 1970s levels of buying power (Figure 4).

Federal funding was first used within the Division of Commercial Fisheries in FY 65 when the Division of Biological Research was merged with the Division of Commercial Fisheries. In some areas of Alaska, the current Division of Commercial Fisheries management program for salmon is heavily dependent upon federal funding. Federal support for the Division of Commercial Fisheries operations has steadily increased since FY 65. Hence, total funding has steadily increased from FY 60 when the total operational budget allocation was under $500,000 (100% general funds) to FY 05 when the budget allocation totaled $48,980,200 (45% general fund). As the Division of Commercial Fisheries has relied more and more on federal support for its overall budget, the same trend has occurred for the salmon management and assessment program. The

[1] General fund support for the FRED Division program started in FY 72 with a budget of $831,100, increased to a peak in FY 85 of $14,878,800 and then decreased to nothing by FY 95. Total funding for FRED Division operations peaked in FY 93 at $24,891,100 while in that same fiscal year the Division of Commercial Fisheries total budget allocation was $28,888,000.

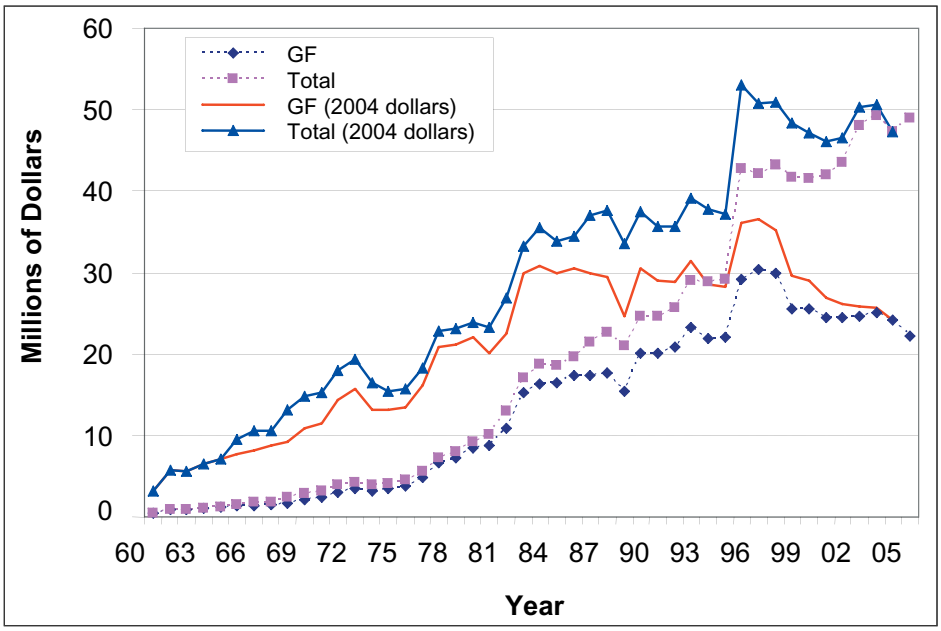

Figure 4. Division of Commercial Fisheries budget trends (general fund and total), fiscal year 1960–2005.

buying power of the total allocation to the Division of Commercial Fisheries in the last few years is higher than it was in the 1980s and early 1990s, however, much of that buying power is associated with specific federal grants and the Division has much less flexibility in use of its fiscal resources than was the case in the first 30 years of state management. The portion of the total budget that the Division of Commercial Fisheries spends on salmon management and stock assessment has decreased over the last 20 years as other commercial fisheries have developed and increased in value. Further, as will be discussed later in this paper, the loss in the Division's overall fiscal flexibility due to recent increased reliance on federal grants and the incremental loss of general fund buying power has resulted in some commercial salmon fisheries having substantially more fiscal support than other salmon fisheries with greater fiscal needs.

As state-generated fiscal support for commercial salmon fishery management and stock assessment waned in the early 1990s, the Division of Sport Fish has shouldered an increased portion of the salmon stock assessment program implemented in Alaska. The Division of Sport Fish budget allocation increased from a level of $270,304 in FY 60 to an allocation level of $39,179,400 in FY 05. Much of the Division of Sport Fish program involves management of salmon sport fisheries and like Division of Commercial Fisheries area biologists, Division of Sport Fish area biologists are heavily dependent upon salmon stock assessment information. Management of salmon fisheries has become more complex and data intensive as area biologists of both divisions strive to provide as much fishing opportunity as possible while still securing salmon escapements. As a result, over the last 15 years, more and more salmon stock assessment efforts—such as the operational cost of the Situk River weir near Yakutat—that were funded by the Division of Commercial Fisheries have been picked up and funded by Division of Sport Fish. As state fiscal support for commercial salmon management has waned over the last 10 years, the Division of Sport Fish has become a leader in much of the technical planning and review functions associated with the management of salmon fisheries in Alaska.

While it is nearly impossible to summarize total salmon management and stock assessment expenditures since statehood by the Division of Commercial Fisheries in a precise and accurate fashion, information can be provided concerning allocations made at the fishery-specific level. Salmon fishery information provided later in this paper will be presented for 11 areas of Alaska. Fiscal Year 05 allocations of state funds for these 11 salmon fisheries totaled $11,406,000 (Table 2). While Table 2 provides a summary of the direct state allocations supporting the Alaska commercial salmon fishery, it is an incomplete accounting of the total cost of the state salmon management program because other activities that are directed at salmon management in Alaska and supported with general funds are not included. Funds such as those used to support the ADF&G coded-wire tag and otolith lab,

Table 2. Number of area offices in Alaska with Division of Commercial Fisheries area management biologists present, number of area biologists with emergency order authority, and State of Alaska FY 05 operational budget allocations for salmon management and stock assessment. Federal and other grants are not included in these budget allocations.

Area	No. of Area Offices	No. of Area Management Biologists	FY 05 Allocation Basic Salmon Management[a]	FY 05 Allocation Salmon Stock Assessment[b]	FY 05 Allocation Salmon Test Fishing[c]	FY 05 Total Allocation
Southeast–Yakutat	8	14	$1,553,100	$695,700	$108,600	$2,357,400
Prince William Sound	1	2	$363,500	$588,300	–	$951,800
Cook Inlet	2	3	$548,500	$686,300	$97,000	$1,331,800
Kodiak	1	2	$412,800	$287,100	$33,600	$733,500
Chignik	1	2	$274,700	$37,600	$60,600	$372,900
Peninsula–Aleutians	3	4	$749,600	$144,700	$67,300	$961,600
Bristol Bay	3	4	$622,800	$863,500	$405,100	$1,891,400
Kuskokwim	1	3	$486,600	$482,700	$2,800	$972,100
Yukon	3	4	$663,100	$371,000	$4,000	$1,038,100
Norton Sound	2	2	$368,200	$363,400	–	$731,600
Kotzebue	0	0	$41,300	$22,500	–	$63,800
Totals	23	40	$6,084,200	$4,542,800	$779,000	$11,406,000

[a] Includes the cost of area biologists, office support costs, and funds used for surveys of fisheries and indices of escapements; these are general funds and are the activities that represent the very basic salmon management program adopted by Alaska at statehood.

[b] Includes general funds used for weirs, towers, sonar, and other methods for enumerating total escapements, catch sampling efforts, and all other salmon stock assessment activities supported with general funds.

[c] Funding from the sales of salmon caught during ADF&G test fishing activities and subsequently used for salmon related stock assessment activities.

the ADF&G genetics lab, the ADF&G pathology lab, the fish ticket system used in Alaska to document salmon harvests, and funds used for planning, review, and supervision of the salmon program but funded at the regional and headquarters level, are not included in Table 2. General fund allocations to the 3 labs alone totaled $1,893,500 in FY 05 and all 3 lab's activities are almost entirely associated with support of the Alaska salmon management and stock assessment program. When taking into account the direct salmon management and stock assessment allocations included in Table 2 with these other activities, it is apparent that the majority of the general funds allocated to the Division of Commercial Fisheries are used to support the salmon program. A reasonable estimate in FY 05 is about 75% of the general funds allocated to the Division of Commercial Fisheries was used to support the state's salmon management and stock assessment program.

Because general funds are the major source of support for commercial fishery salmon management and stock assessment, and because buying power has decreased since the period of stability from the early 1980s to mid-1990s (Figure 4), an informative comparison involves general fund allocations by fishery in the early 1980s to current general fund allocations. General fund support allocated and used for management and stock assessment for the 11 salmon fisheries increased by about $3.6 million between FY 82 and FY 05 (Table 3). The consumer price index as discussed earlier was used to approximate the FY 82 general fund allocations into 2004 dollar equivalents. Once adjusted for inflation, the buying power of the general funds used for these 11 salmon fisheries is estimated to have decreased by about $4 million. However, the effect of these fiscal changes was variable on an area-by-area basis (Figure 5). For instance, buying power associated with general fund allocations for management and stock assessment of the Kuskokwim salmon fishery are about the same between FY 82 and FY 05. Buying power associated with the Kodiak and Peninsula–Aleutians salmon fisheries substantially increased, and buying power associated with the other 8 salmon fisheries decreased. In the case of the Kotzebue salmon fishery, the reduction in funding and buying power of 89% was massive; while the Kotzebue salmon fishery is a small fishery with low exvessel value, this loss of budget support has resulted in a very weakened stock assessment and fishery management program in the area. Loss of general fund buying power for the Southeast–Yakutat salmon fishery was also massive—a loss of about 50% in a major salmon fishery with high exvessel value and the largest number of limited entry permits in Alaska. Other salmon fisheries with large reductions in funding support include the Bristol Bay and Yukon salmon fisheries. Federal funding has been used to partially fill these large funding gaps in the Southeast–Yakutat and Yukon fisheries. However, for

Table 3. Comparison of Division of Commercial Fisheries general fund budget allocations for salmon management and stock assessment in FY 82 and FY 05.

Area	FY 82 General Fund Allocation	FY 82 Adjusted for Inflation and Expressed as Current Dollars	FY 05 General Fund Allocation	FY 82 to FY 05 Actual Dollar Change	FY 82 to FY 05 Buying Power Dollar Change
Southeast–Yakutat	$2,135,000	$4,436,760	$2,248,800	+$113,800	–$2,187,960
Prince William Sound	$532,600	$1,106,800	$951,800	+$419,200	–$155,000
Cook Inlet	$771,800	$1,603,884	$1,234,800	+$463,000	–$369,084
Kodiak	$261,800	$544,049	$699,900	+$438,100	+$155,851
Chignik	$164,700	$342,264	$312,300	+$147,600	–$29,964
Peninsula–Aleutians	$234,500	$487,316	$894,300	+$659,800	+$406,984
Bristol Bay	$1,047,400	$2,176,610	$1,486,300	+$438,900	–$690,310
Kuskokwim	$468,800	$974,217	$969,300	+$500,500	–$4,917
Yukon	$760,500	$1,580,401	$1,034,100	+$273,600	–$546,301
Norton Sound	$402,500	$836,438	$731,600	+$329,100	–$104,838
Kotzebue	$277,900	$577,506	$63,800	–$214,100	–$513,706
Totals	$7,057,500	$14,666,246	$10,627,000	+$3,569,500	–$4,039,246

the salmon fishery in Bristol Bay, which has the second highest number of permits in Alaska, there has been very little infusion of federal funding support; instead, substantial reductions in stock assessment activities have occurred.

Alaska Commercial Salmon Fishery Users

Fishermen can only participate in the commercial salmon fisheries in Alaska by holding a limited entry permit or by working as a crew member for a limited entry permit holder. As of August 31, 2005, there were a total of 11,301 valid commercial salmon limited entry permits (Table 4).

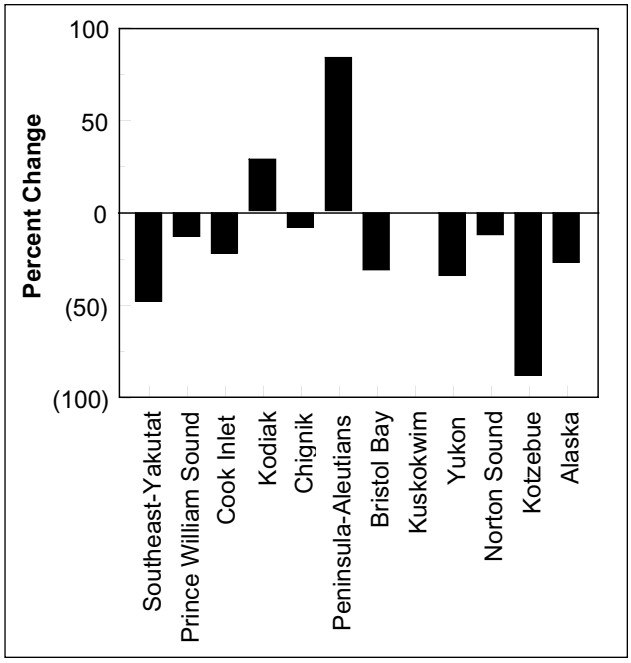

Figure 5. Percent change in the buying power of Division of Commercial Fisheries general fund allocations from FY 82 to FY 05 by salmon fishery.

Each limited entry permit is valid for a specific gear type and area in Alaska. Gillnet permits issued for western Alaska (Kuskokwim, Yukon, Norton Sound, and Kotzebue) do not specify set gillnetting or drift gillnetting, but regulations by the Board of Fisheries restrict fishing in Kotzebue to set gillnet fishing only. Drift gillnet permits are the most common gear, representing about 32% of all valid permits to fish for salmon in Alaska. There are more valid permits issued for the Southeast–Yakutat area salmon fishery (3,133 permits, 28% of total) than for any of the other salmon fisheries in Alaska. The Bristol Bay salmon fishery includes 2,866 valid permits (25% of total), the second highest number of permits issued for salmon fisheries in Alaska. Limited entry permits are bought and sold on the open market and their value is based upon gear type and area (Table 5). Based on average market value in 2004, as determined from permit sales, the most valuable limited entry permit types in Alaska were purse seine permits in the Chignik area with an estimated value of about $182,000. The least valuable permits, based upon permit transactions in 2004, were gillnet permits for the Kotzebue salmon fishery which were worth about $2,000. Across Alaska, the most valuable permit type was drift gillnet permits, with a weighted average value of about $32,700 and the least valued type of permit was hand troll permits with an average value of about $4,100. Based upon the number of valid permits issued and average value per permit, the estimated value of the 11,301 commercial salmon limited entry permits in 2004 was about $228 million.

Table 4. Number of Alaska commercial salmon limited entry permits by area and gear type. Information provided by the Alaska Commercial Fishery Limited Entry Commission, August 31, 2005.

Area	Drift Gill Net	Set Gill Net	Gill Net	Purse Seine	Hand Troll	Power Troll	Beach Seine	Fish Wheel	Totals
Southeast–Yakutat	478	168		415	1,112	960	–	–	3,133
Prince William Sound	538	30		266	–	–	–	–	834
Cook Inlet	571	737		82	–	–	–	–	1,390
Kodiak	–	188		374	–	–	31	–	593
Chignik	–	–		99	–	–	–	–	99
Peninsula–Aleutians	162	115		119	–	–	–	–	396
Bristol Bay	1,878	988		–	–	–	–	–	2,866
Kuskokwim	–		770	–	–	–	–	–	770
Yukon	–		758	–	–	–	–	135	893
Norton Sound	–		154	–	–	–	–	–	154
Kotzebue	–		173	–	–	–	–	–	173
Totals	3,627	2,226	1,855	1,355	1,112	960	31	135	11,301

Table 5. Estimated average value of Alaska commercial salmon limited entry permits based on permit transactions in 2004. Information provided by the Alaska Commercial Fishery Limited Entry Commission, August 31, 2005.

Area	Drift Gill Net	Set Gill Net	Gill Net	Purse Seine	Hand Troll	Power Troll	Beach Seine	Fish Wheel
Southeast–Yakutat	$21,800	$10,800		$32,100	$4,100	$16,400		
Prince William Sound	$40,400	$62,800		$14,000				
Cook Inlet	$20,300	$7,600		$9,600				
Kodiak		$44,400		$10,200			$13,500	
Chignik				$182,000				
Peninsula–Aleutians	$28,000	$38,100		$17,300				
Bristol Bay	$37,400	$14,700						
Kuskokwim			$5,900					
Yukon[a]			$7,350					$6,400
Norton Sound			$4,400					
Kotzebue			$2,000					
Weighted Average	$32,700	$16,400	$6,000	$30,800	$4,100	$16,400	$13,500	$6,400

[a] Average of lower and upper Yukon areas.

Not all permits are fished each year. As prices paid to commercial fishermen declined in the 1990s due to the availability of farmed salmon, the number of permits fished in Alaska commercial salmon fisheries declined. As the prices started to increase recently, the number of permits fished has increased (Figure 6). In 2004, 7,179 of the valid limited entry permits in Alaska were fished (64%).

Each of the limited permits for commercial salmon fishing in Alaska represents the equivalent of a small independent business. When the permit is fished it represents a business with employees; in most cases, a crew is used for commercial salmon fishing and thus jobs are created, wages are paid, and the fishing activity adds to the economic foundation within Alaska.

Alaska Commercial Salmon Fishery Harvests

Commercial harvests of salmon in Alaska are monitored through the fish ticket system, which are sales receipts issued to commercial fishermen upon selling their catch to processors. As a result, harvest data is available by fishing district and opening date. The last year of federal management of the commercial salmon fishery in Alaska was 1959; in that year the harvest totaled only 25.1 million salmon. The average commercial harvest in the 1950s was 41.4 million salmon, the lowest decadal average since the early 1900s (Figure 7, Panel F). State managers in the 1960s made judgment calls concerning appropriate escapement levels needed and took management actions to achieve the spawning goals. The salmon stock assessment program improved in the 1970s, goal setting improved, and salmon managers used emergency order authority to achieve the spawning goals. Commercial harvests of salmon averaged about 50 million salmon during the 20-year period from 1960 to 1979. By the 1970s, budget support for salmon management had increased substantially, an Alaska salmon plan was developed, and payoff from investments in salmon escapements,

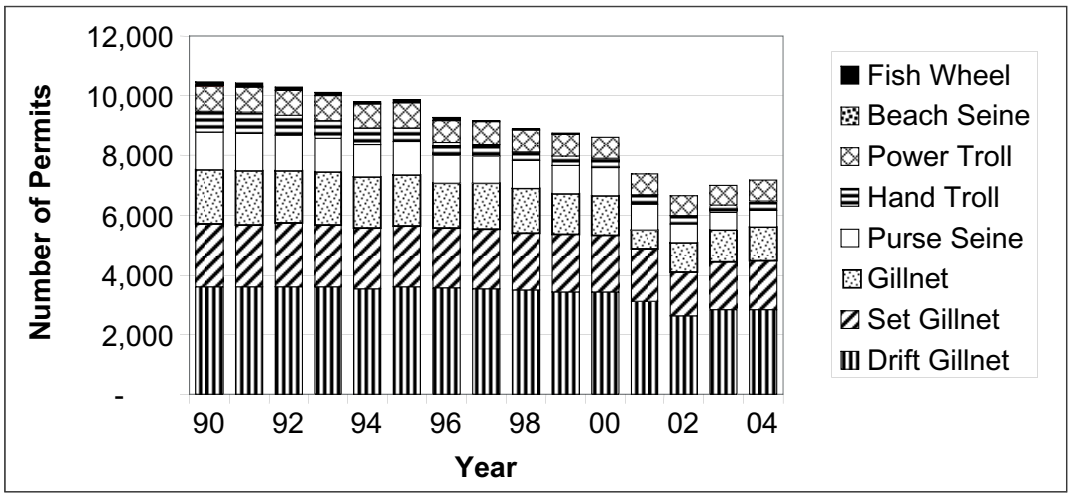

Figure 6. Number of Alaska commercial salmon limited entry permits fished annually during the years 1990–2004.

salmon stock assessment programs, and inseason salmon management started to accrue to the Alaska commercial salmon fisheries. The average commercial harvest level in the 1980s increased to 122 million salmon, a 2-fold increase over the prior period. Budget support for the commercial salmon management program peaked in the 1980s and payoff from better management, improved stock assessment tools, and prior investments in the Alaska salmon hatchery program combined to result in another significant increase in sustained harvest levels. The average commercial harvest in the 1990s was about 175 million salmon. So far, the average commercial harvest in the 2000s has been similar to the 1990s average of about 167 million salmon.

Trends by species in the commercial salmon harvests have been variable. Chinook harvests by the commercial fishery in Alaska have not varied much over the past 90 years (Figure 7, Panel A), with the last ten decadal averages ranging from about 600,000 to 800,000 fish. On the other hand, significant use of Chinook salmon in Alaska occurs in sport and subsistence fisheries and those harvests have increased substantially. In several areas of Alaska, Chinook harvests in the commercial fishery are restricted to provide for other users. Alaskan Chinook salmon populations are currently at high levels of abundance.

Recent sockeye salmon harvests by the Alaska commercial fishery have been higher than occurred historically; harvests since 1980 have averaged about 41 million sockeye; the highest decadal average prior to that was in the 1910s (Figure 7, Panel B). Most major stocks of sockeye salmon in Alaska are managed for scientifically-based escapement goals; sustained harvests are high and productive annual escapement strength is maintained on an annual basis. The pre-statehood coho commercial harvests peaked in the 1940s with a decadal average of about 3.1 million fish. The average commercial harvest since 1980 for coho salmon has been about 5.1 million fish—about 65% higher than in the 1940s (Figure 7, Panel C).

Coho salmon in many parts of Alaska are important to sport fisheries, which have grown substantially in the last few decades. In several areas of Alaska, coho salmon are underused.

Commercial fishery harvest trends for pink salmon are similar to coho salmon, a historic peak in the 1940s of about 49 million, with harvests since 1980 being about 92.6 million fish—about 53% higher than in the 1940s (Figure 7, Panel D). While hatchery programs have been responsible for some of the increase in pink salmon production, a major factor has been regulation of harvest and achievement of escapements. In some parts of Alaska, pink salmon are underused due to low market value.

Chum salmon commercial harvests in Alaska were relatively stable from 1910 to 1980, averaging about 6.9 million fish. As a result of the Alaska hatchery program, harvests were 11.3 million in the 1980s, 15.3 million in the 1990s and 16.5 million in the 2000s. Like pink salmon, chum salmon are underused in some parts of Alaska due to low prices. Further improvements in the salmon stock assessment program could lead to increased production and harvests of all 5 species of salmon if such improvements could be maintained over a long period of time.

The Southeast–Yakutat area harvests of salmon from 1980 to 2004 represented about 35% of the total Alaska harvest, the largest percentage of the 11 areas (Figure 8). The Prince William Sound area represented about 20% of the Alaska harvest of salmon and Bristol Bay about 17% of the harvest. The 4 areas

within the Arctic–Yukon–Kuskokwim Region (Kuskokwim, Yukon, Norton Sound, and Kotzebue) in total represented about 1.5% of the statewide commercial harvest. Harvest trend information within each of the 11 commercial salmon fishing areas of Alaska will be provided later in this paper.

In the early 1970s, Governor Hammond instructed ADF&G to develop an Alaska salmon plan. The plan

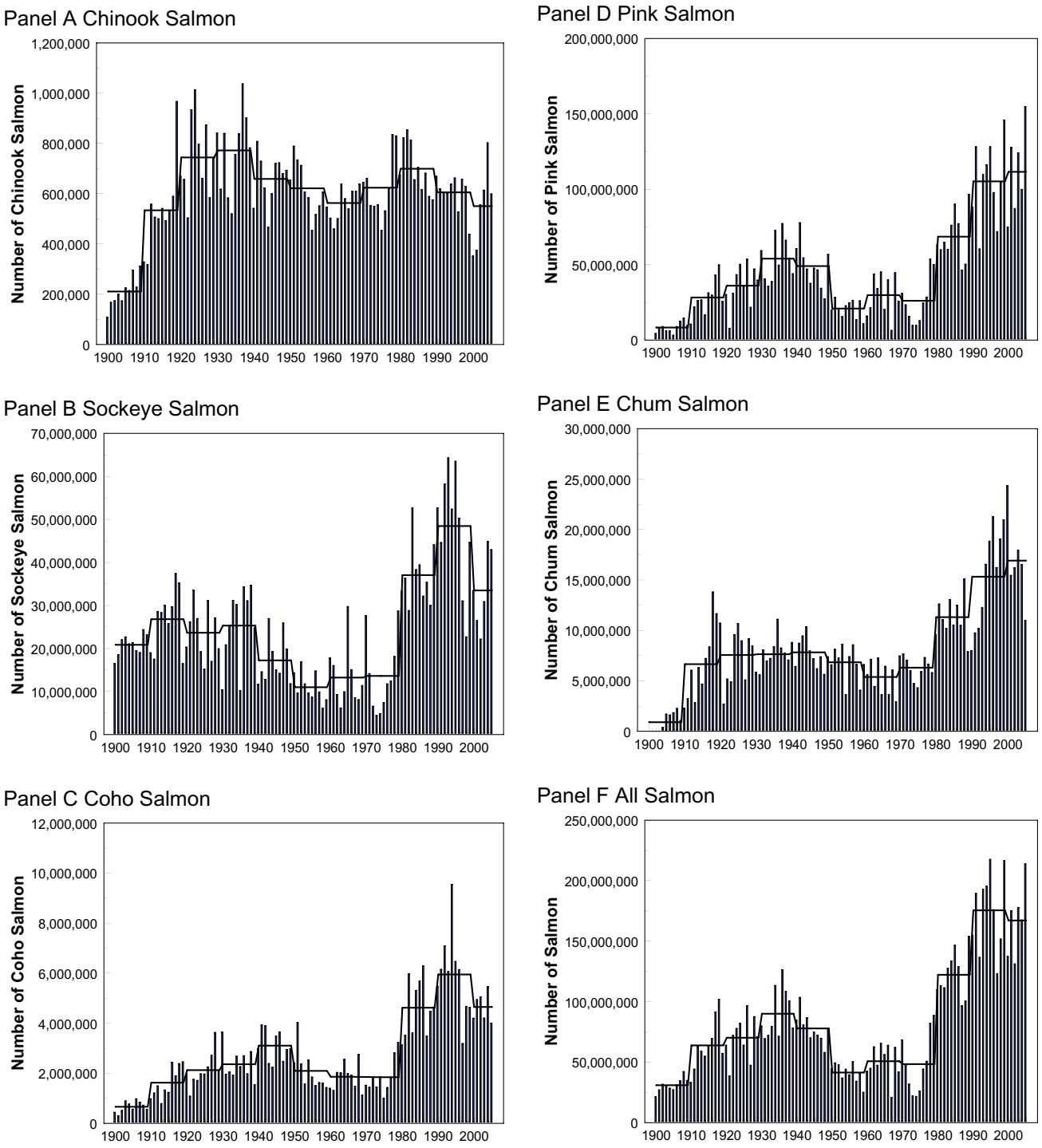

Figure 7. Commercial salmon harvests in Alaska from 1900–2005; bars provide annual catches and lines provide decade averages.

was completed in 1976 (Table 6) and was used to assist the State of Alaska in developing and implementing the Alaska hatchery program. It was also used as a focus for improved stock assessment and management of salmon. With support from the Governor's office and the Legislature, the operational budget for the Division of Commercial Fisheries increased substantially from the early 1970s through the mid-1980s.

The Alaska salmon plan suggested the salmon resources of Alaska could support a commercial fishery with average annual harvests in excess of 100 million salmon—given reasonable survival conditions, improved management technology, and improved budget support (Table 6). At the time the plan was written, the highest decadal commercial harvest level was in the 1930s when the average harvest was about 90 million salmon. At the time, many salmon stocks had been overfished, the runs depleted, and in need of rehabilitation. Plan developers in the early 1970s were optimistic that with improved management tools and better inseason management, these historic harvest levels could be surpassed. While most people familiar today with the Alaska salmon fishery would consider annual commercial salmon harvests of less than 100 million as a disaster, from the inception of the salmon fishery in the late 1800s through the 1970s, such harvest levels were considered a godsend. Prior to the plan being written, annual commercial harvest levels in excess of 100 million salmon had only happened in 6 years (1918, 1934, 1936 to 1938, and 1941; only 6% of the years prior to 1980). Since 1980, the Alaska commercial salmon fishery has only once (4% of the years)

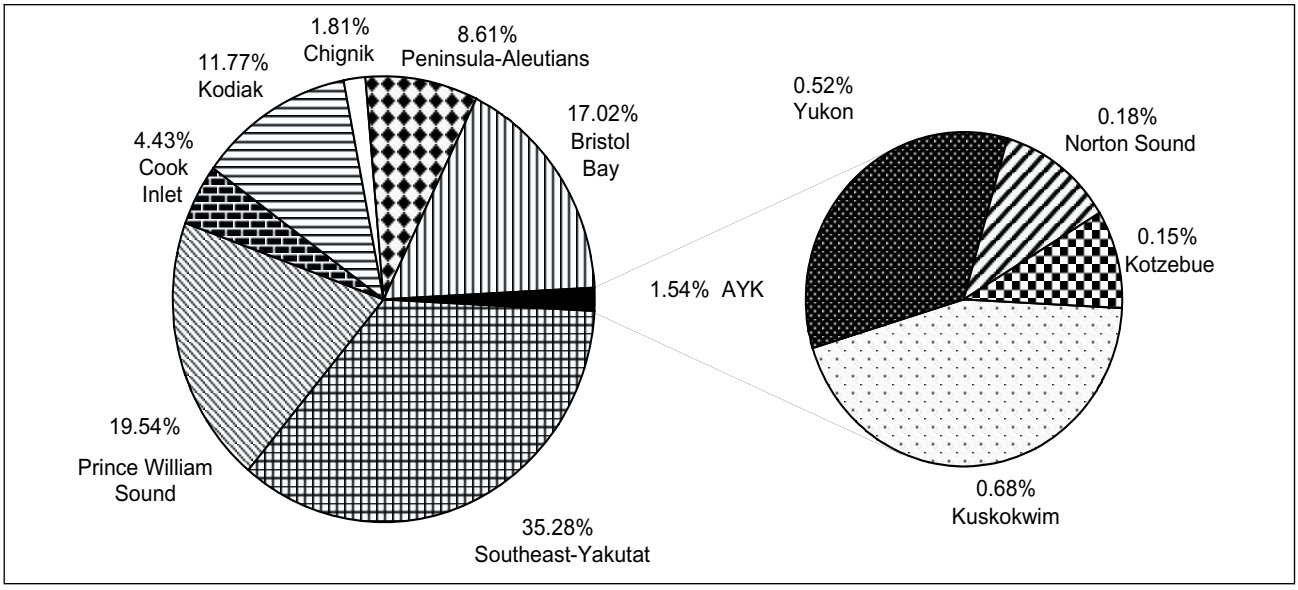

Figure 8. The percent of the total commercial salmon harvested from 1980–2004 in 11 areas of Alaska.

Table 6. Commercial salmon harvest objectives as described in the Alaska salmon plan developed in the mid 1970s and as used in the Division of Commercial Fisheries budget documents in the early to mid 1980s. These wild salmon harvest objectives were based on stock status determinations, assumed long-term average survival conditions, increasing funding levels and improved technological abilities for salmon management.

Area	Chinook	Sockeye	Coho	Pink	Chum	Total
Southeast–Yakutat	315,000	840,000	1,500,000	19,300,000	3,000,000	24,955,000
Prince William Sound	20,000	855,000	317,000	5,305,000	401,000	6,898,000
Cook Inlet	100,000	15,250,000	265,000	5,000,000	1,050,000	21,665,000
Kodiak	2,000	2,500,000	100,000	10,000,000	825,000	13,427,000
Chignik	1,500	1,500,000	40,000	950,000	250,000	2,741,500
Peninsula–Aleutians	12,000	1,410,000	175,000	4,960,000	1,205,000	7,762,000
Bristol Bay	100,000	15,000,000	250,000	2,500,000	750,000	18,600,000
Kuskokwim	90,000	30,000	240,000	100,000	475,000	935,000
Yukon	120,000	–	20,000	–	2,000,000	2,140,000
Norton Sound	6,000	–	10,000	500,000	250,000	766,000
Kotzebue	–	–	–	–	250,000	250,000
Totals	766,500	37,385,000	2,917,000	48,615,000	10,456,000	100,139,500

harvested less than 100 million salmon—in 1987, the harvest was 96.6 million fish. The Alaska commercial salmon harvest history ably demonstrates that the plan developers were right—given long-term average survival conditions, coupled with better support to the salmon managers of Alaska through improved technological abilities and funding, the overall Alaska salmon resource could support sustained production in excess of 100 million salmon per year. In fact, the Alaska salmon management program is one of the most successful natural resource management programs in the world. While overall commercial salmon harvests have exceeded expectations listed in the Alaska salmon plan, salmon harvests for some species in some areas have not met the plan objectives (Table 7). Notable exceptions include Chinook salmon harvests in some areas of Alaska, and pink and chum harvests in much of western Alaska. The Board of Fisheries decisions concerning allocation of Chinook among commercial, sport, and subsistence fisheries, along with the U.S.-Canada Treaty limits on harvest of Chinook, reduced commercial harvests of Chinook in Alaska. Lack of market interest in pink and chum salmon, coupled with remoteness, played a part in the failure to achieve plan objectives in western Alaska.

Currently in North America, the scientific rhetoric most often heard associated with salmon stock status and management bemoans the condition of salmon. Topics of concern are: (1) the U.S. Endangered Species Act listing of many salmon stocks in Washington, Oregon, Idaho, and California, (2) conditions of salmon stocks in Canada, (3) downturns in stock strength of some salmon stocks in western Alaska that resulted in disaster declarations, and (4) unending arguments within some scientific circles that claim escapement goal setting associated with salmon stocks in Alaska is inadequate. A careful and thoughtful examination of the success of the Alaskan salmon management program with its demonstrated long-term sustainability of the stocks might be prudent by management entities and fishery scientists. Possibly the least understood part of the Alaska salmon management program is the reliance on inseason stock assessment and swift management response. There are no other salmon management programs in North America where—depending upon inseason stock strength—field level managers have both the responsibility and the full authority to act quickly to provide additional fishing opportunity or to take such opportunity away From 2000 to 2004, an average of 713 emergency orders were issued inseason by Division of Commercial Fishery managers just to manage Alaskan commercial salmon fisheries (Table 8); additional emergency orders were issued inseason that regulated sport, personal use, and subsistence fisheries. A thorough understanding of the Alaska salmon management program needs to take this important aspect and fact of the Alaska management program into account.

Other Alaska Salmon Harvests

While the intent of this paper is to provide information concerning the Alaskan commercial salmon fishery, an understanding of the commercial fishery would be incomplete without providing information on harvests by other user groups. Since statehood, as the population in Alaska has grown, the recreational use of the Alaskan salmon resource has also increased. The subsistence harvest of salmon has historically been, and continues to be, an integral part of the lifestyle of Alaskans in many villages and towns across rural Alaska.

Since the late 1970s, the Division of Sport Fish has implemented an annual postal survey of sport fishermen in an effort to document sport fishing effort and harvests. This data source was used to develop estimates of the sport fishery harvest levels

Table 7. Percent deviations of average 1980–2004 Alaska commercial salmon harvests from the stated harvest objectives listed in the Alaska salmon plan developed in the mid-1970s.

Area	Chinook	Sockeye	Coho	Pink	Chum	Total
Southeast–Yakutat	–10%	112%	80%	115%	136%	113%
Prince William Sound	113%	99%	64%	377%	373%	327%
Cook Inlet	–80%	–73%	53%	–67%	–51%	–69%
Kodiak	632%	21%	186%	36%	5%	32%
Chignik	216%	3%	283%	–11%	–28%	–1%
Peninsula–Aleutians	86%	203%	124%	36%	29%	67%
Bristol Bay	–8%	60%	–32%	–84%	36%	38%
Kuskokwim	–43%	302%	101%	–87%	–23%	10%
Yukon	–22%		61%		–67%	–63%
Norton Sound	2%		348%	–71%	–68%	–64%
Kotzebue					–11%	–11%
Totals	–18%	8%	78%	85%	37%	51%

Table 8. Number of emergency orders issued by area management biologists while directly managing Alaska commercial salmon fisheries from 2000–2004.

Salmon Fishery	2000	2001	2002	2003	2004	Average
Southeast–Yakutat	156	132	136	117	121	132
Prince William Sound	88	114	101	140	123	113
Cook Inlet	45	44	47	54	80	54
Kodiak	39	30	41	44	34	38
Chignik	36	34	42	46	30	38
Peninsula–Aleutians	172	132	173	152	111	148
Bristol Bay	126	117	118	122	134	123
Kuskokwim	28	42	41	31	24	33
Yukon	5	0	22	25	29	16
Norton Sound	20	18	9	9	4	12
Kotzebue	8	16	1	1	1	5
Sum/Average	723	679	731	741	691	713

for salmon in the 11 areas of Alaska discussed in this paper. Sport harvests of salmon across Alaska have steadily increased over the last 25 years. Average sport harvest levels in Alaska since 2000 are about 176,000 Chinook salmon, 414,000 sockeye salmon, 771,000 coho salmon, 161,000 pink salmon, and 34,000 chum salmon (Table 9). Currently, average harvest levels in the 2000s show increases over harvest levels in the 1980s of about 90% for Chinook and sockeye salmon, about 3.5-fold for coho salmon, about 10% for pink salmon, and about 50% for chum salmon.

The average salmon harvest by sport fishermen in Alaska from 2000 to 2004 was about 1.6 million fish; the commercial salmon harvest during the same time frame was about 158 million fish, a commercial to sport ratio of about 100:1. The commercial to sport ratio by salmon species from 2000 to 2004 was about 3:1 for Chinook salmon, about 75:1 for sockeye salmon, about 6:1 for coho salmon, about 640:1 for pink salmon, and about 530:1 for chum salmon.

Monitoring subsistence harvests of salmon in Alaska is not as comprehensive as monitoring commercial fisheries and sport fisheries. Some subsistence harvests are monitored through permits issued and returned to ADF&G while other subsistence harvests are estimated based upon fishermen, household, or community surveys. Comparable subsistence harvest data is available from 1994 to 2003. In some cases, but not all, harvests of salmon taken under personal use regulations are included in the available harvest estimates for Alaska subsistence fisheries.

The average annual harvest of salmon in subsistence fisheries during the 10-year period of 1994 to 2003 was about 1.1 million salmon (Table 10). Sockeye salmon represented about 40% of the average annual subsistence harvest, followed by chum salmon (30%), Chinook salmon (15%), coho salmon (10%), and pink salmon (5%). The Yukon area had the largest subsistence harvest of salmon in Alaska from 1994 to 2003, with an annual average of about 251,000 salmon representing about 22% of the Alaska total (Figure 9). Other areas in Alaska with large subsistence harvests of salmon were the Kuskokwim with an average of about 217,000 salmon (19%), Prince William Sound with an average of about 196,000 salmon (17%), and Bristol Bay with and average of about 135,000 salmon (12%). Average annual subsistence harvests of salmon from 1994 to 2003 in the Cook Inlet, Kodiak, Chignik, and Peninsula–Aleutian areas were each less than 50,000 salmon during the 10-year period from 1994 to 2003 (Figure 9).

Commercial fishery area biologists manage salmon subsistence fisheries in state-managed waters of Alaska. In most areas, few emergency orders are issued annually restricting or revising subsistence fishing regulations because the harvest in these fisheries is small

Table 9. Average annual harvest of salmon in the Alaska sport fishery.

Species	1980–1989	1990–1999	2000–2004
Chinook	91,795	164,959	175,896
Sockeye	216,480	306,628	413,537
Coho	218,519	447,897	771,395
Pink	145,378	149,966	160,882
Chum	23,413	24,754	34,457
Total	695,585	1,094,204	1,556,167

Table 10. Average annual subsistence harvests of salmon in Alaska, 1994–2003. Primary data source: ADF&G 2005.

Species	Lowest Annual Harvest	Highest Annual Harvest	Average Annual Harvest
Chinook	134,000	188,000	167,000
Sockeye	386,000	525,000	448,000
Coho	92,000	139,000	108,000
Pink	33,000	95,000	63,00
Chum	230,000	500,000	337,000
Total	956,000	1,285,000	1,123,000

relative to salmon abundance and commercial harvest levels. However, in some areas of Alaska, significant inseason management of the salmon subsistence fisheries occurs. Table 11 provides a summary of the number of emergency orders issued by Division of Commercial Fisheries managers in Alaska from 2000 to 2004 that were specific to subsistence salmon fisheries. As can be seen, extensive inseason management occurred in the Yukon and Norton Sound areas.

Economic Value of the Alaska Commercial Salmon Fishery

Commercial salmon fisheries are vital to the economy of Alaska. A report on the impacts of the seafood industry on Alaska's economy in 2001 (Northern Economics Inc. 2003) demonstrated that: (1) about 53,900 persons earned all or some of their income in 2001 from the seafood harvesting or processing sectors, (2) the seafood industry in Alaska provided more jobs than oil, gas, mining, agriculture, and forestry combined plus their associated primary processing industries, (3) the salmon fishery accounted for 40% of the direct seafood industry jobs, (4) the seafood industry generated an estimated $932 million in direct payments to labor in 2001, and (5) the seafood industry paid more taxes to the State of Alaska general fund than any other industry in Alaska except oil and gas. Some areas within Alaska are economically more dependent upon commercial fisheries than others. Hartman (2002) reported that: (1) the commercial fishing industry in Southeast Alaska in 1994 contributed about $224 million in personal income, (2) the commercial fishery in Southeast Alaska provided about 7,500 jobs, and (3) the seafood industry in Southeast was the largest private sector employer accounting for about 45% of the region's private sector employment. Some areas of Alaska, like Cook Inlet, are less economically dependent upon commercial salmon fishing than Southeast Alaska, while others such as the Kodiak and Bristol Bay areas, are even more dependent upon commercial salmon fishing.

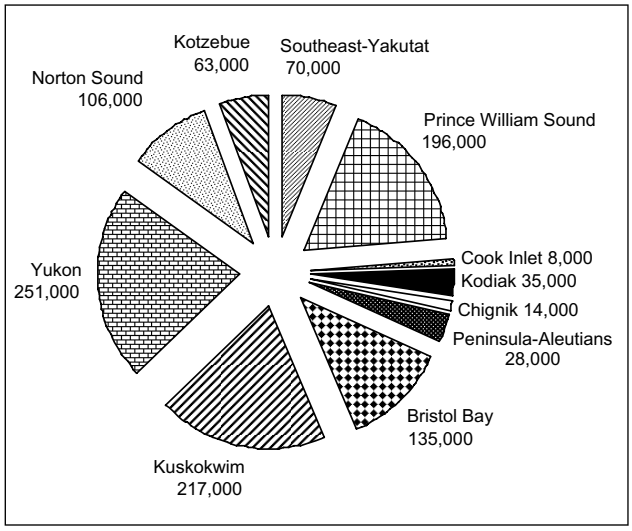

Figure 9. Average subsistence harvests of salmon from 1994–2003 in 11 areas of Alaska.

Table 11. Number of emergency orders issued by Commercial Fishery Division area biologists from 2000–2004 that were specific to management of subsistence fisheries for salmon. These emergency orders are in addition to those presented in Table 8; many of the emergency orders included in Table 8 changed legal fishing requirements simultaneously for both commercial and subsistence users.

Salmon Fishery	2000–2004 Sum
Southeast–Yakutat	19
Prince William Sound	1
Kodiak	8
Chignik	2
Peninsula–Aleutians	1
Kuskokwim	21
Yukon	141
Norton Sound	77
All	270

This report will not provide a detailed description of the economic importance of the commercial salmon fishery to Alaska. Instead, information concerning exvessel values and first wholesale values of the Alaska commercial salmon fishery will be provided along with information concerning importance of the various species of salmon and the areas where these harvests occur. Value data was compiled from the ADF&G fish ticket (ZEPHYR) and commercial operators annual reports (COAR) data bases.

The annual exvessel value of the Alaska salmon fishery from 1985 to 2004 ranged from a low of about $165 million in 2002 to a high of about $780 million in 1988. Annual exvessel value of the Alaskan commercial salmon fishery generally decreased from the late 1980s until 2002, while modest increases occurred in 2003 and 2004 (Figure 10). The consumer price index as described earlier was used to approximate exvessel values for the years between 1984 and 2003 into 2004 dollar equivalents. Once inflation was taken into account, the downturn in exvessel value of the Alaskan commercial salmon fishery is even more pronounced. The reason for the downward trend is reduced prices paid to salmon fishermen in Alaska as a result of the increased availability of farm-raised salmonids. Harvests of salmon in Alaska across this 20-year period were consistently high (Figure 7). Fishery

statistics have demonstrated that management of the commercial fishery has been biologically successful and that with timely inseason stock assessment and emergency order regulatory adjustments, the salmon runs in Alaska can sustain harvests in excess of 100 million fish per year over 95% of the time.

Annual first wholesale value from 1985 to 2004 for the Alaska salmon fishery once adjusted to 2004 dollar equivalents ranged from a low of about $540 million in 2002 to a high of about 1.8 billion in 1988. Trends in the 20 year period are similar to exvessel trends whether inflation is accounted for or not. The reduced trend in first wholesale value of the Alaska commercial salmon fishery reflects the changing worldwide market conditions that have occurred over the last 20 years.

From a species perspective, exvessel sales of sockeye salmon represented about 63% of the total salmon sales from 1985 to 2004. Pink salmon were next most important (15%), followed by chum salmon (9%), coho salmon (8%), and Chinook salmon (5%). Annual exvessel value of sockeye salmon from 1985 to 2004 ranged from a low of about $82 million in 2002 to a high of about $457 million in 1992, a 5.5-fold level of variation. Similar values for other species were as follows: pink salmon range was $30 million (2002) to $144 million (1989) a 4.8-fold level of variation, chum salmon range was $23 million (2003) to $105 million (1988) a 4.5-fold level of variation, coho salmon range was $14 million (2002) to $67 million (1994) a 4.7-fold level of variation, and Chinook salmon range was $11 million (2001) to $25 million (2004) a 2.2-fold level of variation. Annual trends in exvessel value by species adjusted to 2004 dollar equivalents are provided in Figure 11.

Exvessel value of the Alaskan salmon fishery from 1985 to 2004, split into the 11 areas of Alaska, show that the Bristol Bay salmon fishery has the highest exvessel value, accounting for 31.6% of the total Alaskan commercial salmon fishery exvessel value over that 20-year period (Figure 12). The next most valuable fishery was the Southeast–Yakutat salmon fishery with 23.46% of the total. Listed in decreasing order of proportional value is the Prince William Sound salmon fishery (11.55%), the Cook Inlet commercial fishery (10.16%), the Peninsula–Aleutians commercial fishery (8.85%), the Kodiak commercial fishery (8.46%), the Chignik commercial fishery (3.33%), the Yukon commercial fishery (1.35%), the Kuskokwim commercial fishery (1.01%), the Norton Sound commercial fishery (0.13%), and the Kotzebue commercial fishery (0.12%).

On a species basis, first wholesale value of sockeye salmon represented about 54% of the total salmon sales from 1985 to 2004. Pink salmon were next most important (25%), followed by chum salmon (11%),

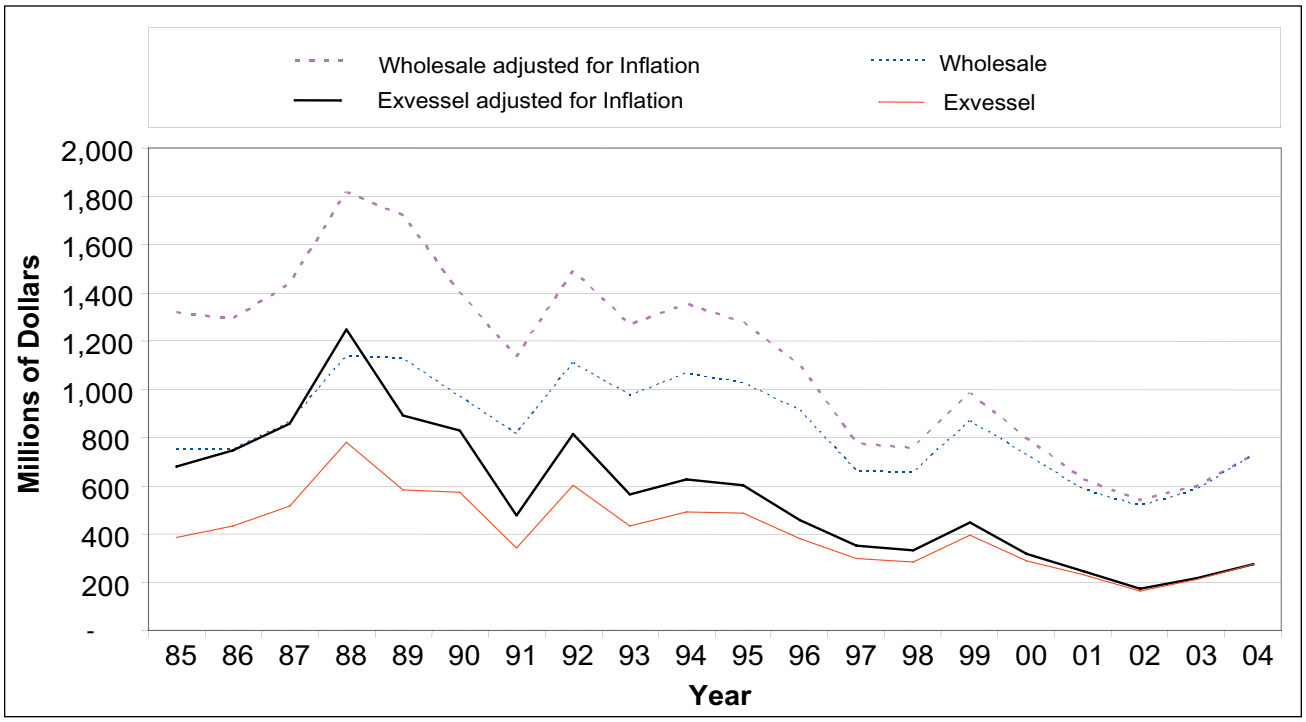

Figure 10. Exvessel and first wholesale values of the Alaskan commercial salmon fishery, 1985–2004, presented as annual values unadjusted for inflation and as annual values adjusted for inflation into 2004 dollars.

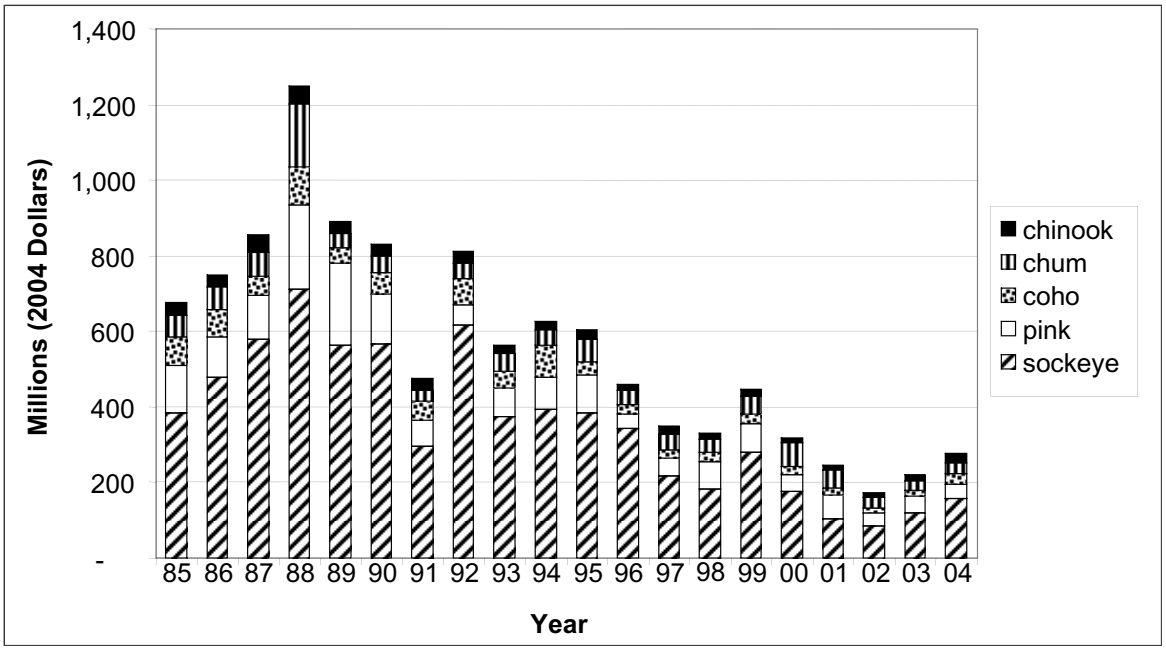

Figure 11. Exvessel value of the Alaskan commercial salmon fishery by species, 1985–2004, adjusted for inflation into 2004 dollars.

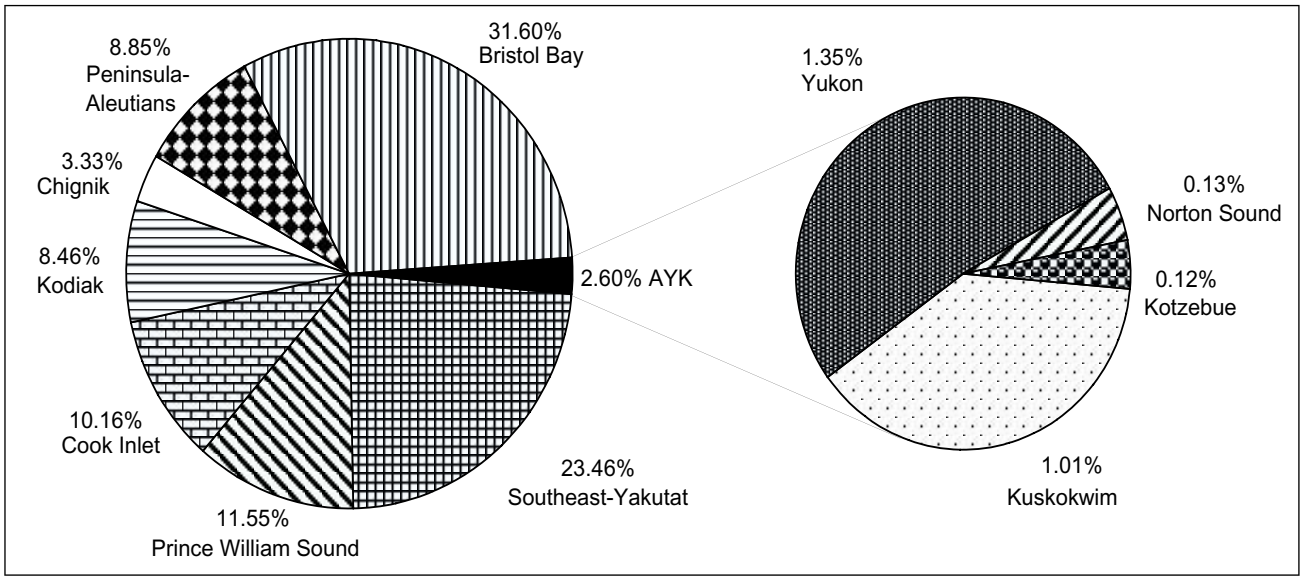

Figure 12. Proportions of the total exvessel value from the 11 Alaskan salmon commercial fisheries during 1984–2004.

coho salmon (7%), and Chinook salmon (3%). Annual trends by species are provided in Figure 13. First wholesale value of the Alaska salmon fishery split out by area cannot be provided for some of the 11 areas because of confidentiality of data; in some areas less than 4 processors purchased salmon some of the years.

As described earlier in this report, the State of Alaska allocates operational funding to the Division of Commercial Fisheries on an annual basis for management of Alaska's commercial fisheries. Within the Division of Commercial Fisheries, funding is allocated each year to the area level for salmon management and stock assessment. The relative investment in salmon management among salmon fisheries in Alaska can be obtained by dividing fiscal allocations by long-term average value of the fisheries being managed (Table 12). This comparison does not include funding within the Division of Commercial Fisheries for non-area

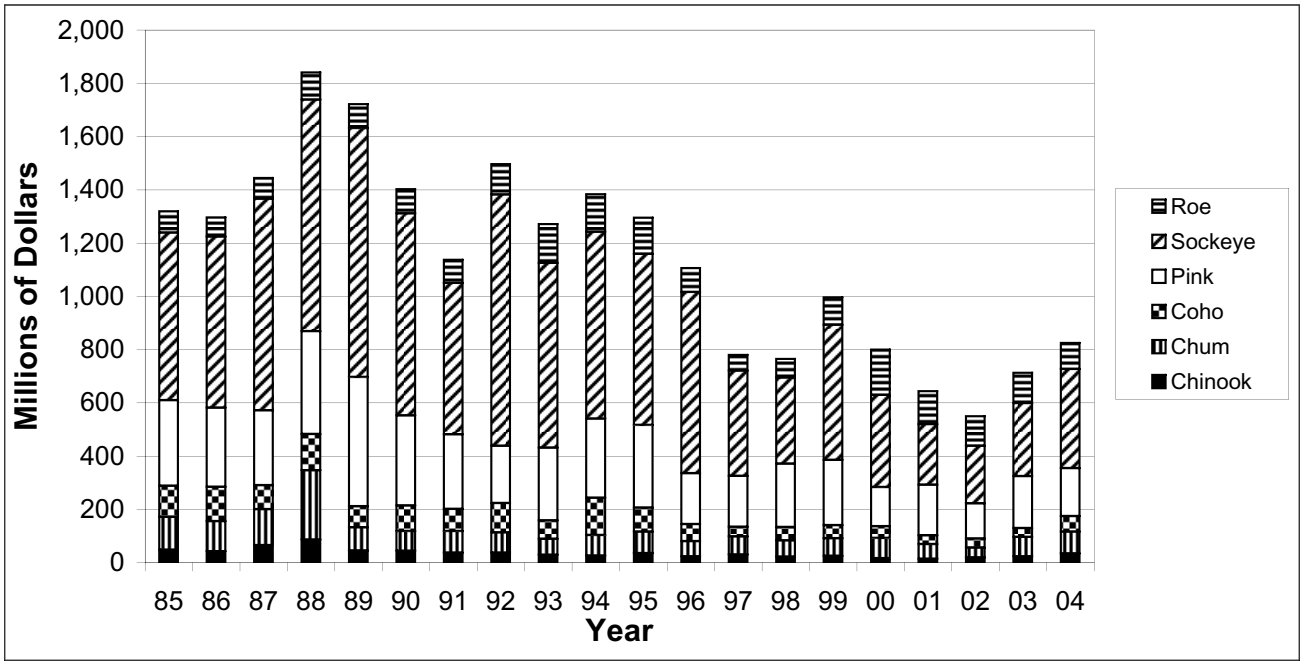

Figure 13. First wholesale value of the Alaskan commercial salmon fishery by species, 1985–2004, adjusted for inflation into 2004 dollars.

level activities, or funding by the State of Alaska (but allocated to entities other than the Division of Commercial Fisheries) to support these salmon fisheries. However, the comparison does provide a perspective of relative investment within the commercial salmon management program. The comparison indicates that on a statewide basis, the funding used for direct management and stock assessment of salmon in FY 05 was equivalent to about 2% of the recent 20-year average in inflation-adjusted exvessel value. Relative investment in the large major salmon fisheries of Alaska (Southeast–Yakutat, Prince William Sound, Kodiak, Peninsula–Aleutians, and Bristol Bay) tended to be less than 2%. Relative investment in the Bristol Bay salmon fishery was least at 1.1%. Relative investment in Arctic–Yukon–Kuskokwim salmon fisheries was highest, ranging from 8.7% for the Kotzebue fishery to 98.9% for the Norton Sound salmon fishery.

The remainder of this paper will provide more detailed information concerning these 11 Alaskan commercial salmon fisheries, including historic catches, exvessel values, trends in escapement, and explanations of the management program in place.

Table 12. Average inflation-adjusted exvessel value of the Alaska commercial salmon fishery by area, State of Alaska funds allocated for management and stock assessment of salmon by area in FY 05, and the relative investment by Alaska in the direct management of these commercial salmon fisheries by area.

Alaska Salmon Commercial Fishing Area	1985–2004 Average Exvessel Value Expressed in 2004 Dollars	FY 05 Allocation of Alaska State Funds	State of Alaska Investment in Direct Area Management and Stock Assessment
Southeast–Yakutat	$127,783,180	$2,357,400	1.8%
Prince William Sound	$62,880,186	$951,800	1.5%
Cook Inlet	$59,419,360	$1,331,800	2.2%
Kodiak	$46,934,292	$733,500	1.6%
Chignik	$18,742,534	$372,900	2.0%
Peninsula–Aleutians	$50,065,642	$961,600	1.9%
Bristol Bay	$176,729,030	$1,891,400	1.1%
Kuskokwim	$5,816,024	$972,100	16.7%
Yukon	$7,750,080	$1,038,100	13.4%
Norton Sound	$739,749	$731,600	98.9%
Kotzebue	$733,479	$63,800	8.7%
Totals	$557,593,557	$11,406,000	2.0%

SOUTHEAST–YAKUTAT COMMERCIAL SALMON FISHERY

Area Description and Gear Types

Commercial fisheries in the southeast panhandle portion of the state, the Southeast Alaska–Yakutat (SEAK) area, harvest a diverse assemblage of species and stocks and include a wider variety of gear types than in any other region of the state (Figure 14). Purse seine and drift gillnet gear are used in the Southeast Alaska area, which extends from Dixon Entrance to Cape Fairweather. Set gillnet gear is used in the Yakutat area, located between Cape Fairweather and Cape Suckling. Commercial trolling is allowed in both areas, but nowhere else in the state. While the salmon net fisheries are limited to state waters, the troll fishery operates in both state waters and federal waters of the Exclusive Economic Zone east of the longitude of Cape Suckling. Purse seine, drift gillnet, troll gear and floating fish traps are allowed in the Annette Island Fishery Preserve, a 3,000-foot wide zone offshore of Annette Island established by Presidential proclamation in 1916, where natives have exclusive fishing rights. The state does not actively manage Annette Island Fishery Preserve fisheries.

Since statehood, the numbers of salmon landed in the purse seine fishery have comprised 80% of the commercial salmon harvest in SEAK, followed by 7% in the drift gillnet fishery, 5% in the troll fishery, 1% in the set gillnet fishery, 2% at Annette Island, and the remainder coming from miscellaneous harvests including hatchery cost–recovery, test fisheries and confiscated fish (Figure 15).

While the purse seine fishery accounts for the vast majority of the salmon harvested in the SEAK salmon fishery, it primarily targets pink and chum salmon, the species with the lowest exvessel value per pound. The area's other commercial fisheries target higher value species. The drift gillnet fishery targets sockeye, coho, and chum salmon, and to a lesser extent Chinook salmon, while set gillnetters in the Yakutat area primarily harvest sockeye and coho salmon. Chinook and coho salmon are the predominant species harvested in the troll fishery. Although exvessel prices paid to fishermen are dependent on a wide variety of factors, sockeye salmon and troll-caught Chinook and coho salmon fetch a premium price relative to other gear types and species harvested in the SEAK commercial salmon fishery (Table 13).

History of the Commercial Salmon Fishery

Commercial utilization of salmon in SEAK began in the late 1870s. Sockeye salmon was the first species exploited, but pink salmon have dominated the region's harvest since the early 1900s. Prestatehood average harvests peaked in the 1910s for sockeye and chum, in the 1930s for Chinook and pink salmon and in the 1940s for coho salmon (Figure 16, Panels A–E). As a result of lax federal management and chronic overfishing, harvest levels of all species were at very low levels by statehood. Following a period of stock rebuilding under state management and a period of reduced marine survivals in the late 1960s and early 1970s, harvests of all species have rebounded. During the 1990s, Chinook and sockeye salmon reached poststatehood peaks, and coho, pink and chum salmon reached all-time peaks.

Since statehood, annual commercial harvests of salmon in SEAK have averaged about 36.3 million fish, the highest of the 11 areas examined in this paper. With the exception of sockeye salmon, average annual catches for each species are also the highest of any of the 11 areas. Total annual commercial harvests have ranged from a low of about 5.7 million fish in 1975 to a high of almost 98 million fish in 1999 (Figure 16, Panel F). Average annual catches by species since statehood include 28 million pink (77%), 4.7 million chum (13%), 2 million coho (5.5%), 1.3 million sockeye (3.7%) and about 300,000 Chinook salmon (0.8%). The diverse commercial fisheries of the SEAK area are clearly among the most important in the entire state of Alaska. Annual reports on the area's fisheries are produced by ADF&G staff and offer detailed fishery data and insightful summaries of the fishery as well as management and assessment programs. See Bachman et al (2005).

Other Salmon Harvests

Salmon are also harvested for subsistence and personal use in SEAK. Estimated harvests are determined from returns of harvest permits issued to users by ADF&G. The subsistence harvest averaged about 70,000 salmon from 1994 to 2003 (Table 14). Catches have been stable over this period (Figure 17). Sockeye salmon comprise slightly over 80% of the harvest. Studies indicate actual subsistence harvests are probably somewhat larger than those compiled from the return of harvest permits (Geiger et al 2005).

Salmon harvests in the SEAK sport fishery have rapidly increased over the last 25 years (Table 15). Chinook and coho salmon are the primary species tar-

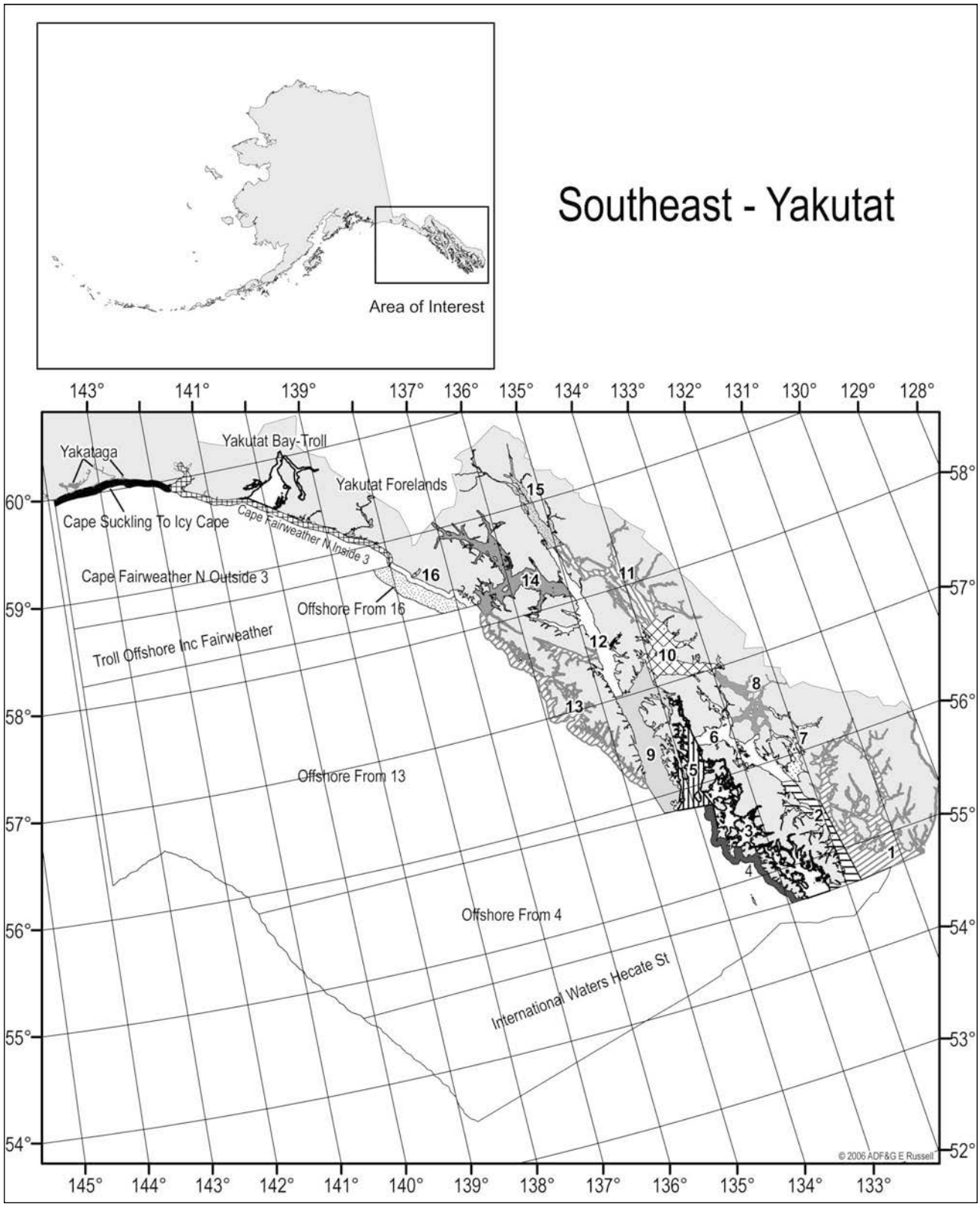

Figure 14. Southeast–Yakutat area commercial salmon fishery.

geted by sport anglers. Like subsistence and personal use fisheries, harvests in the sport fishery are generally minor in comparison to the commercial harvest, with the notable exception of Chinook salmon. Allocation of sport and commercial harvests of Chinook salmon in the SEAK fisheries is specified in state regulations established by the Alaska Board of Fisheries; since 1996, 20% of the combined sport and commercial troll fishery Chinook salmon allocation has been to sport fisheries. The ratio of the total commercial to sport fishery harvests during the last 25 years is about 200:1; ratios vary considerably by species from about 680:1 for pink salmon to 6:1 for Chinook salmon.

Commercial Salmon Fishery Users

As of August 31, 2005, there were 3,133 active limited entry permits for SEAK commercial salmon fisheries, including 478 drift gillnet, 168 set gillnet, 415 purse seine, 1,112 hand troll and 960 power troll permits. From 1990 to 2004, there has been a downward trend in the number of permits of each gear type that are annually fished (Figure 18). The total number of permits fished in SEAK in 2004 (1,684) was one-third less than the number fished in 1990 (2,525). The biggest reductions have come in the hand troll and purse seine gear types.

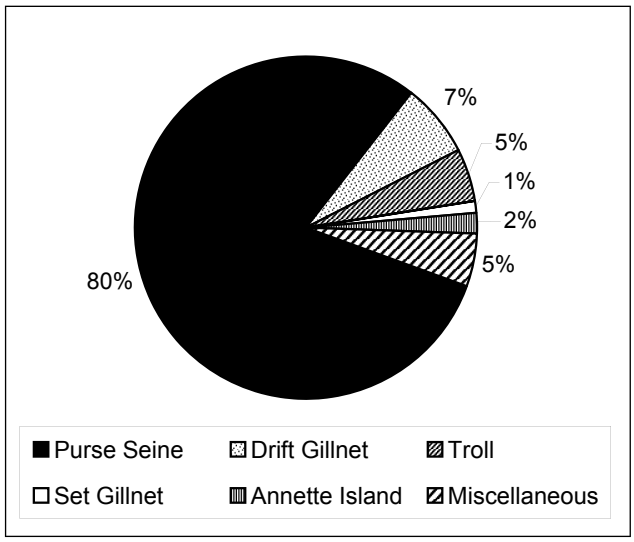

Figure 15. Average percent of the commercial salmon harvest by gear type in the SEAK area, 1960–2004.

Table 13. Average exvessel price per pound by species and harvest gear in SEAK area commercial fisheries, 2000–2004.

	Species				
Fishery	Chinook	Sockeye	Coho	Pink	Chum
Purse Seine	$0.50	$0.87	$0.32	$0.12	$0.25
Drift Gillnet	$0.86	$0.90	$0.48	$0.10	$0.32
Set Gillnet	$0.84	$0.63	$0.30	$0.10	$0.16
Troll	$1.99	$1.15	$0.93	$0.10	$0.24

Exvessel Value

From 1985 to 2004, the average annual exvessel value of the commercial salmon fishery in SEAK was about $96 million, ranging from a low of about $52 million in 2002 to a high of about $143 million in 1989. Adjusted for inflation and expressed in 2004 dollars, the average annual exvessel value was about $128 million. Inflation-adjusted exvessel value ranged from a low of $54 million in 2002 when about 57 million salmon were harvested to a high of $217 million in 1989 when about 66 million salmon were harvested (Figure 19). As elsewhere in Alaska, value has trended downward during this 20-year period, although a modest upward trend is apparent for 2003 and 2004. From 1985 to 2004, pink salmon accounted for 31.6% of the inflation adjusted total exvessel value, followed by coho salmon (21.5%), chum salmon (21.4%), sockeye salmon (16.2%) and Chinook salmon (9.4%).

Management

There are over 5,500 salmon producing streams and tributaries in the SEAK area, and as a result most of the region's fisheries operate on mixed stocks and species. Due to the presence of salmon bound for transboundary rivers—rivers that flow into Southeast Alaska waters from headwaters in Canada, as well as streams in Canada and the Pacific Northwest—management of many SEAK commercial fisheries is influenced by PST agreements.

Management and regulatory frameworks for commercial SEAK salmon fisheries are highly complex. Fisheries are managed to obtain escapement objectives, promote the harvest of good quality salmon, attain Alaska Board of Fisheries allocations among gear groups and abide by PST agreements. Stock-specific management based on run strength of individual systems is practiced in the region's more terminal fisheries. The region's more mixed-stock fishing areas are managed through inseason monitoring of fishery performance and assessment of escapements and stock composition data; harvest rates are controlled through distribution of effort and regulation of time and area openings.

Hatcheries contribution to the commercial and sport fisheries in Southeast Alaska is significant. A total

of 18 hatcheries are currently operating in Southeast Alaska. Most are operated by private groups, but 2 research facilities are run by the federal government and one state-owned facility is operated by a PNP hatchery association through a professional services contract with ADF&G Division of Sport Fish (Figure 2). No hatcheries are located in the Yakutat area. Hatcheries located in the Pacific Northwest and British Columbia

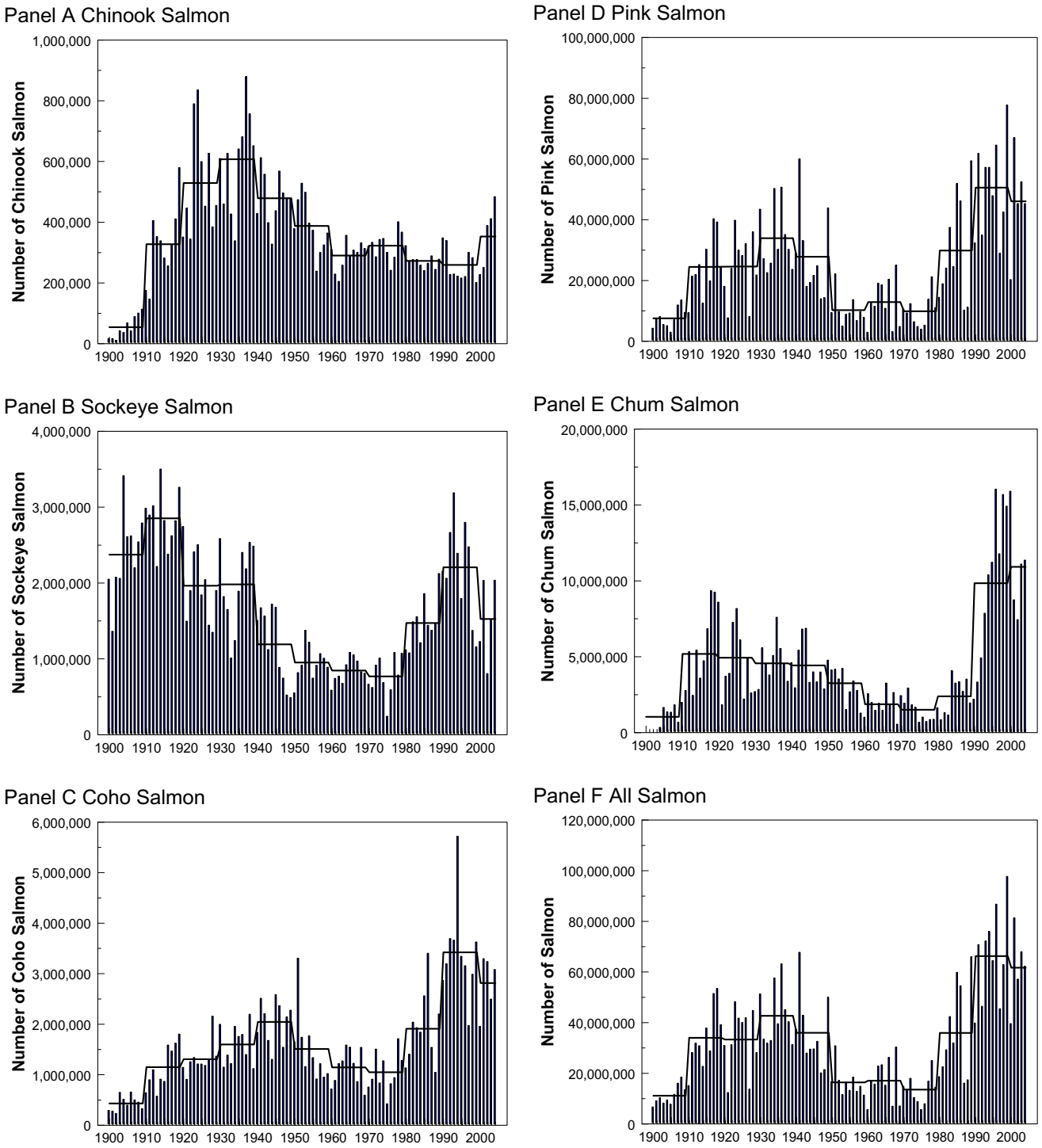

Figure 16. Commercial salmon harvests in SEAK from 1900–2004; bars provide annual catches and lines provide decade averages.

also contribute to some of the region's fisheries, particularly the Chinook salmon troll fishery.

From 1995 to 2004, Alaska hatcheries contributed an average of 14% of the total annual commercial common property salmon harvest in Southeast Alaska. By species, the average annual hatchery contributions were 71% for chum salmon, 22% for coho salmon, 21% for Chinook salmon, 13% for sockeye salmon, and 2% for pink salmon (White 2005 and Joint Northern/Southern Southeast Regional Planning Team 2004). Hatchery contributions to fisheries are estimated in several ways. Intensive coded-wire tag catch monitoring programs provide reliable inseason estimates of contributions of hatchery Chinook and coho salmon. Thermal otolith mark–recovery programs are used to estimate contributions of hatchery sockeye salmon and chum salmon in specific fisheries, particularly where fishery performance information is used for inseason management.

Table 14. Average annual harvests of salmon in SEAK area subsistence and personal use fisheries (rounded to the nearest 1,000 fish). Beginning in 1996, estimated harvests have been expanded to account for unreturned harvest permits (ADF&G 2005).

Species	1994–2003 Average	Annual Minimum	Annual Maximum
Chinook	1,000	1,000	2,000
Sockeye	58,000	45,000	69,000
Coho	3,000	2,000	4,000
Pink	4,000	3,000	4,000
Chum	5,000	2,000	6,000
Total	70,000	57,000	82,000

Implementing the area's commercial salmon fishery management program is the responsibility of a region-wide troll fishery manager and 6 area management biologists and their assistants, located in Ketchikan/Craig, Petersburg/Wrangell, Sitka, Juneau, Haines and Yakutat. A management supervisor responsible for maintaining a coordinated regional management approach is needed because fish and fishermen move between the different management areas. Management is conducted by emergency order and publicized through issuance of news releases. Content of emergency orders is generally restricted to a single gear type, except those dealing with Terminal Harvest Area and Special Harvest Area fisheries that target hatchery fish, but most contain detailed time and area adjustments for multiple fishing areas. From 2000 to 2004 an average of 136 emergency orders were annually issued by Division of Commercial Fisheries staff to manage commercial, subsistence, and personal use fisheries in the SEAK area (Table 16). These same biologists are responsible for managing state subsistence and personal use salmon fisheries and numerous other non-salmon commercial fisheries, so the workload and responsibility of the positions is substantial.

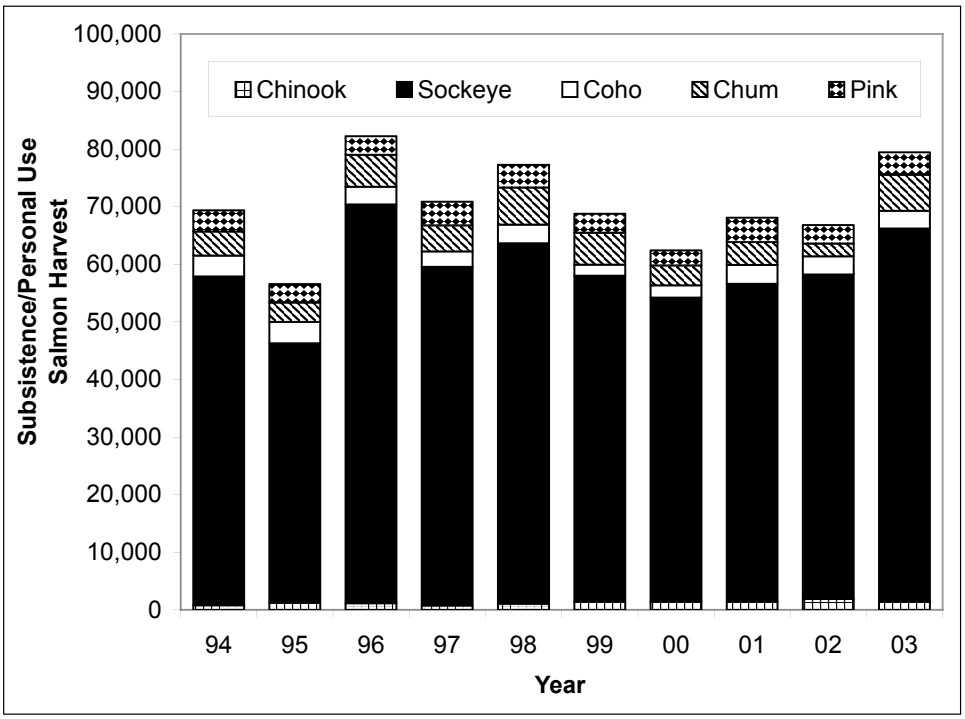

Figure 17. Subsistence and personal use harvests in the SEAK area from 1994–2003.

Annual preseason management plans are produced by ADF&G for the region's troll, purse seine, drift gillnet and set gillnet fisheries. The management plans include the department's expectations for salmon returns and summarize important management issues, regulatory requirements, and harvest strategies for the upcoming season. Staff from ADF&G also participates in annual department and industry task force forums prior to each fishing season to discuss management of the purse seine and drift gillnet fisheries. They also conduct an extensive series of preseason meetings on troll fisheries management in towns throughout the SEAK area.

The purse seine fishery operates by regulation in all or portions of 13 fishing districts in Southeast Alaska. Pink salmon is the primary species targeted by the fishery, and most management actions are based on inseason assessment of pink salmon abundance. Adult tagging studies have demonstrated differences in migratory routes for pink salmon returning to northern and southern Southeast Alaska, and stocks from the different subregions are grouped accordingly for management and assessment purposes. The northern subregion is further divided into inside and outside areas. Targeted fishing for summer chum salmon occurs primarily early in the season in hatchery terminal harvest areas such as Hidden Falls, and as the season progresses, near several rivers with wild fall chum salmon runs. The vast majority of the purse seine harvests of sockeye, coho and Chinook salmon are taken incidentally during the pink salmon fishery.

Preseason pink salmon forecasts are developed by ADF&G each year, primarily to provide industry with an expectation for the upcoming year's fishery. The purse seine fishery is managed based on inseason assessment of run strength obtained from catch and catch per unit effort data, test fishing, and frequent aerial surveys of salmon abundance along migratory corridors and in terminal bays and spawning streams. Pink salmon sex ratios in the harvest are determined and compared with historical data to evaluate run timing. The magnitude of incidental purse seine harvests of sockeye salmon in several areas is controlled by regulation or PST agreement. The purse seine fishery

Table 15. Average annual harvest of salmon in the SEAK sport fishery, rounded to the nearest 1,000 fish).

Species	1980–1989	1990–1999	2000–2004
Chinook	24,000	55,000	71,000
Sockeye	6,000	16,000	22,000
Coho	53,000	158,000	289,000
Pink	49,000	63,000	78,000
Chum	5,000	12,000	20,000
Total	138,000	305,000	480,000

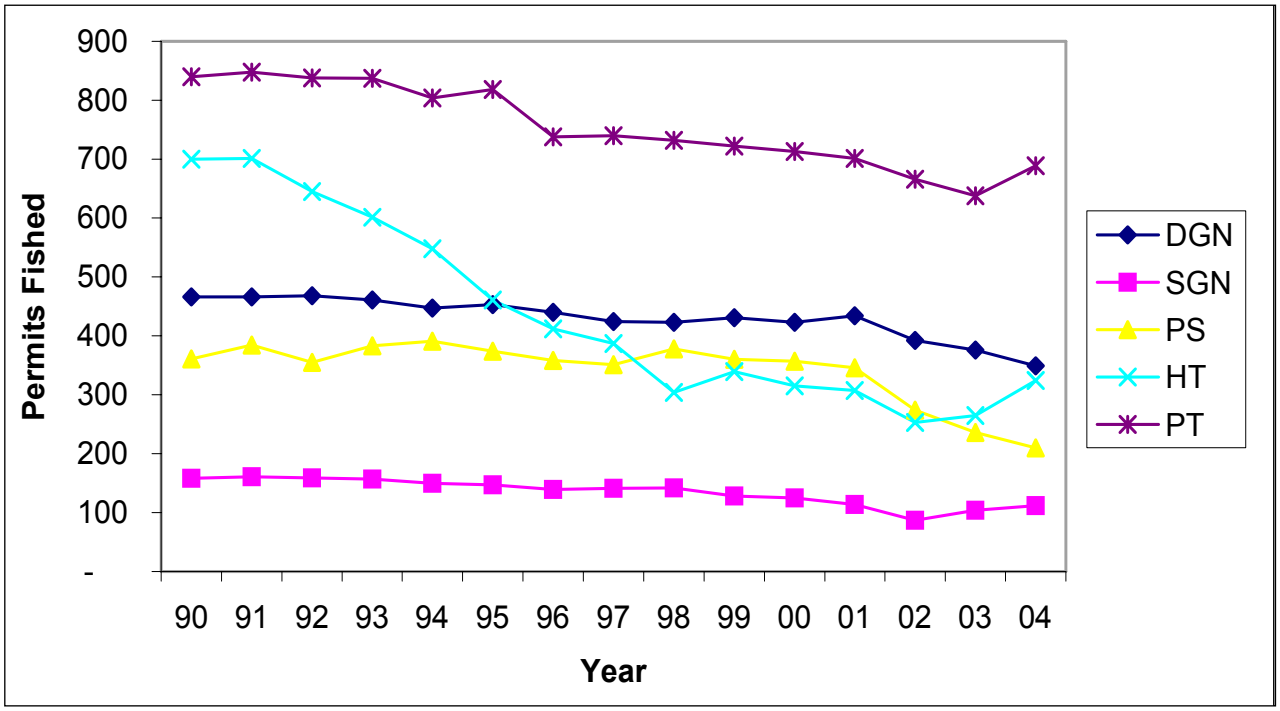

Figure 18. Commercial salmon limited entry permits fished in the SEAK area, by gear type and year, 1990–2004. (DGN=drift gillnet, SGN=set gillnet, PS=purse seine, HT=hand troll, and PT=power troll.)

in District 104, on the outside coast of southern Southeast Alaska, is managed through late July (statistical week 31) to abide by PST provisions that limit the fishery's harvest of sockeye salmon bound for the Nass and Skeena rivers in northern British Columbia. Since 1999 this has limited the District 104 fishery to 2.45% of the annual allowable harvest of Nass and Skeena River sockeye salmon. Annual allowable harvest and total allowable catch are terms defined in the PST that represent the harvestable surplus in excess of the escapement goal.The purse seine harvest of sockeye salmon along the Hawk Inlet shore of Admiralty Island in upper Chatham Strait is limited by state regulation for allocative reasons during the month of July.

In response to requests from industry, in 2002 ADF&G changed its management approach for the purse seine fishery from the traditional 2-day-on, 2-day-off fishing schedule that had been in place during the peak of the fishing season in the late 1980s, to a more flexible fishing schedule involving longer fishing periods. In years of large returns, open fishing periods are now commonly from 4 to 6 days during the peak of the season, with specific fishing areas opening and closing within that time frame. The change has allowed industry to spread out deliveries of fish to processing plants, reducing the time from fish capture to delivery and processing. This improves the quality of the product, but has resulted in increased fishery monitoring costs for ADF&G.

There are 5 traditional drift gillnet fishing areas in Southeast Alaska, stretching from District 1 (Tree Point and Portland Canal) in the south near the inter-

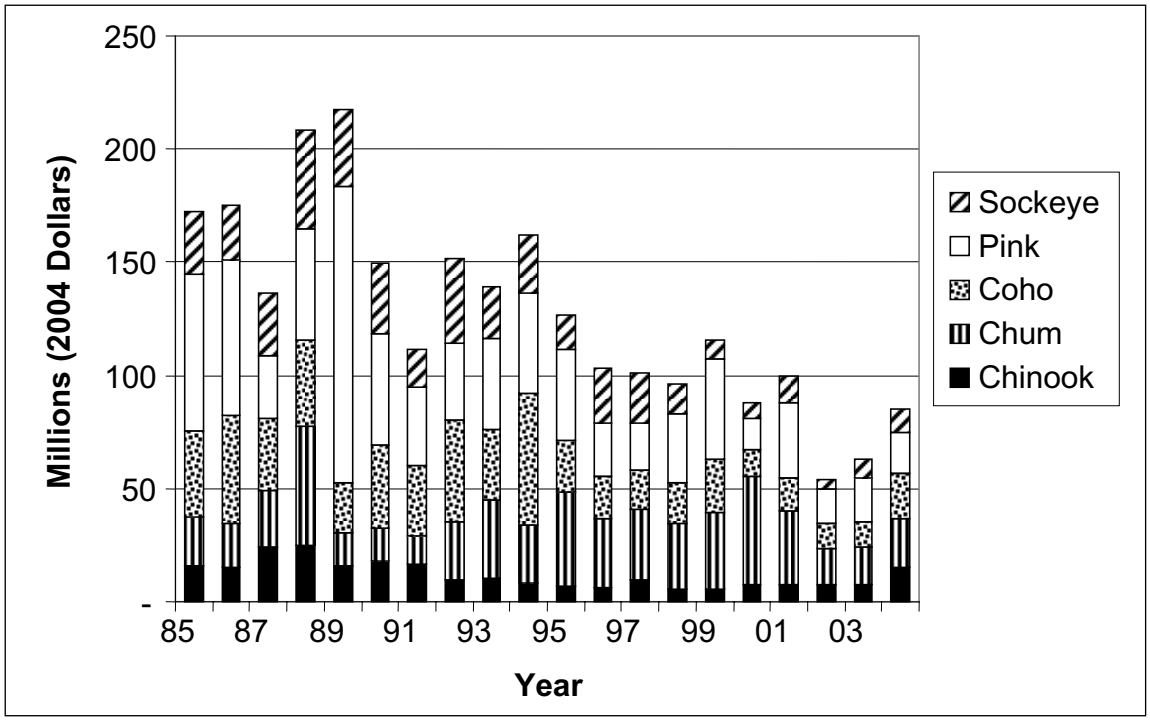

Figure 19. Exvessel value of the Southeast Alaska/Yakutat area commercial salmon fisheries, 1985–2004, adjusted for inflation into 2004 dollars.

Table 16. Number of emergency orders issued by Division of Commercial Fisheries staff in 2000–2004 for inseason management of commercial and subsistence/personal use fisheries in the SEAK area.

Fishery	2000	2001	2002	2003	2004	Total
Commercial Purse Seine	29	24	26	23	25	127
Commercial Drift Gillnet	16	21	20	18	20	95
Commercial Troll	51	35	33	29	20	168
Commercial Set Gillnet (Yakutat)	38	24	36	29	34	161
Commercial THA and SHA[a]	22	28	21	18	22	111
Subsistence/Personal Use	3	2	7	4	3	19
Regional Total	159	134	143	121	124	681

[a] Terminal Harvest Areas and Special Harvest Areas.

national border with Canada, to District 6 (Prince of Wales) and District 8 (Stikine River) in central portions of the region, and to District 11 (Taku–Snettisham) and District 15 (Lynn Canal) in the north (Figure 14). Drift gillnetting is also allowed in several terminal areas to target returns of enhanced fish near hatcheries or remote release sites. The drift gillnet fisheries target sockeye, pink and summer-run chum salmon during the summer season from mid-June through mid-August, and coho and fall- run chum salmon thereafter through late September or early October.

Drift gillnet fishing areas are opened concurrently on a weekly basis. Fishing time varies among districts depending on the strength of runs migrating through each district. Fishing time and area within each district is regulated as necessary to adjust overall harvest rates or harvests of specific stocks. In 2005, following a long-term cooperative international Chinook salmon rebuilding program under the auspices of the PST, agreement was reached with Canada over joint management and harvest sharing of transboundary Taku and Stikine River Chinook salmon runs. After being closed for almost 30 years, drift gillnet and troll fisheries targeting Chinook salmon were reinstituted in 2005 in Alaska near the mouths of the 2 rivers and Canadian commercial fisheries were allowed within Canadian portions of the rivers. In 2005, close to 50,000 Chinook salmon were taken in Alaska in these fisheries, worth an estimated exvessel value of approximately $2 million. The resumption of these Alaskan fisheries is due in large part to major improvements made in stock assessment programs, and the long-term sacrifices of Alaskan fishermen to rebuild the runs.

With the exception of the Lynn Canal fishery, all the region's drift gillnet fisheries are affected by provisions of the PST. The PST agreement signed in 1999 specifies that, through 2008, the District 1 fishery can harvest an average of 13.8% of the annual allowable harvest of the Nass River sockeye salmon run, the District 6 and 8 gillnet fisheries can harvest 50% of the total allowable catch of Stikine River sockeye salmon, and that the District 11 gillnet fishery can harvest 82% of the total allowable catch of wild Taku River sockeye salmon and 50% of the total allowable catch of sockeye salmon produced from joint U.S.-Canada Taku River sockeye salmon enhancement projects.

In order to implement such complex harvest sharing agreements, ADF&G has developed intensive sockeye salmon stock identification programs. A variety of biological attributes including scale pattern features, age composition, and parasite prevalence are examined to estimate contributions of specific sockeye salmon stocks to harvests in the region's drift gillnet and southern Southeast Alaska purse seine fisheries. By combining estimates of harvest with information from escapement enumeration programs, estimates of total run and PST harvest sharing performance are determined. The contribution of sockeye salmon from Alaska hatcheries is determined by sampling the harvests for thermal otolith marks; all sockeye salmon released from the region's hatcheries are otolith marked. The department is studying the potential application of genetic stock identification methods to improve the resolution and inseason processing capabilities of the region's sockeye salmon stock identification program.

The drift gillnet fisheries are managed through inseason assessment of run strength, although preseason forecasts of Taku and Stikine River Chinook and Stikine River sockeye salmon are used to guide the season's initial openings in specific districts. Fishery managers closely monitor fishery performance (catch and catch per unit effort), stock composition data, escapement information, test fisheries, statistical run forecasting models, and information from other fisheries to assess run strength inseason. Contribution of hatchery stocks to harvests is taken into account, particularly in areas where fishery performance is used as a primary management tool.

In contrast to the region's other commercial fisheries, which generally occur over large areas and target mixed stocks, the set gillnet fisheries in the Yakutat area are, with few exceptions, confined to intertidal areas and ocean waters immediately adjacent to the mouths of rivers. Although close to 25 different fisheries are typically opened each year, most of the set gillnet harvest is typically taken in a few major areas, including the Situk–Ahrnklin, Alsek and Tsiu rivers and Yakutat Bay. The terminal nature of the fisheries has enabled the department to assemble stock–recruit information and develop escapement goals for many of the major stocks taken in the set gillnet fisheries.

Management of the set gillnet fisheries is accomplished primarily through inseason escapement monitoring, including survey counts for many systems and a weir on the Situk River, which supports the area's largest commercial, sport and subsistence fisheries. Monitoring of catch and catch per unit effort data is also important, particularly for several glacial rivers in which escapement surveys are of limited value.

The region's commercial troll fishery primarily harvests Chinook and coho salmon and, with few exceptions, other species are harvested incidentally. The troll fleet is comprised of hand and power troll gear types. Power troll vessels are generally larger than hand troll vessels and gurdies used to deploy and

retrieve troll lines are power-operated, whereas hand troll gear includes hand-operated gurdies or sport fishing poles. Power trollers have taken an average of 89% of the Chinook salmon and 86% of the coho salmon harvested in the troll fishery from 1975 to 2004.

The Chinook salmon troll fishery is separated into winter and summer seasons. During the October 1 to April 30 winter season, trolling is limited to the inside waters of the region. The summer season lasts from May 1 to September 30, and is further separated into spring and summer fisheries. The spring fisheries, which occur primarily in inside waters near hatchery release sites or along migration routes of returning hatchery fish, are intended to increase the harvest of Alaska hatchery Chinook salmon. The majority of the annual troll harvest of Chinook salmon is taken during the summer fishery, which opens in early July.

The SEAK Chinook salmon troll fisheries have been managed since 1980 to not exceed an annual catch quota (Gaudet et al 2004). Annual all-gear Chinook salmon harvest quotas have been in effect since the PST was signed in 1985. The 1999 PST agreement implemented a bilateral abundance-based management approach for west coast Chinook salmon fisheries. Rather than being managed for a fixed annual catch ceiling, SEAK fisheries catch quotas are now determined annually by the Pacific Salmon Commission's Chinook Technical Committee, and are based on preseason and inseason forecasts of the aggregate abundance of all Chinook salmon stocks present in Southeast Alaska. Quotas do not include Alaska hatchery fish, except for a base level of 5,000 fish that represents pretreaty harvests of Alaska hatchery Chinook salmon. Regulations adopted by the Alaska Board of Fisheries further specify harvest sharing of the all-gear quota among commercial and sport users.

The commercial troll fishery for coho salmon is managed to comply with conservation and allocation objectives established by the Alaska Board of Fisheries. Currently, regulations specify a troll closure for conservation reasons in late July if the total projected commercial harvest is less than 1.1 million wild fish, and an August closure if the number of coho reaching inside areas is inadequate to either provide for spawning needs or achieve allocation objectives among competing commercial drift gillnet and recreational fisheries. There are no PST harvest quotas for SEAK coho salmon fisheries, although the 1999 PST agreement stipulates that the troll fishery in waters near the U.S.–Canada border will close if harvest rates by Alaska trollers in that area fall below specified levels.

Inseason management of the commercial Chinook salmon troll fishery is accomplished through monitoring harvest and fishing effort and assessing contribution of Alaska hatchery stocks generated from coded-wire tag data. Due to the fast pace of the summer fishery, ADF&G generates inseason harvest estimates using a fisheries performance data program to estimate catch per unit effort from confidential interviews of trollers and estimates of effort from aerial surveys of the fishing grounds. Inseason monitoring of the coho salmon troll harvest is accomplished through the troll fisheries performance data program, compilation of fish tickets, coded-wire tag data that provides information on run strength of long-term wild indicator stocks and hatchery stocks, and escapement monitoring programs.

A complex set of stock assessment programs has been developed to support management and long-term monitoring of salmon stock status in the SEAK area. Funding sources for the developing assessment programs have evolved over time, and many programs have become much more reliant on federal grant appropriations over the last 20 years. Information gathered from these programs forms the basis for SEAK salmon escapement goals. Currently, ADF&G has 11 escapement goals for Chinook salmon, 14 for coho salmon, 13 for sockeye salmon and 3 for pink salmon. Der Hovanisian and Geiger (2005) provide detailed information on the region's salmon escapement goals and stock status. In this paper we provide a brief review of the assessment programs, escapement goals and abundance trends for some of the region's major stocks.

The origins of the region's Chinook salmon stock assessment program date back to the 1970s. Long-term escapement monitoring projects were initiated for 11 of the region's 34 known Chinook salmon producing rivers, including all of the major producers (production greater than 10,000 fish), 7 medium producers (production of 1,500 to 10,000 fish), and one minor producer (production of less than 1,500 fish) (McPherson et al 2005). Over time, the program was modified from simply obtaining peak survey counts of spawners to estimating total escapement. Expansion factors were developed relating survey counts to total escapement. Presently, weirs, mark–recapture programs, and helicopter surveys are used to monitor escapements. Biological data is collected to estimate escapement by age and sex. Obtaining stock-specific estimates of harvest is an active area of current research. Wild-stock coded wire tagging programs have been conducted for varying periods on 7 of the rivers, and harvest rates for nearby wild or hatchery stocks have been used as proxies to estimate harvests for other systems. For the last several years, genetic

stock identification techniques have been applied to the region's Chinook salmon harvests in an attempt to improve estimates of stock composition.

Chinook salmon

Chinook salmon escapements in the SEAK area have increased substantially from levels seen prior to the start of the stock rebuilding program mid-1970s. Biological escapement goals have been developed for all 11 Chinook salmon index systems (McPherson et al 2005). Escapements for all systems, with the exception of the Blossom River, have been within or above goal ranges for at least 5 of the last 6 years. Peak survey counts of escapement for the Blossom River were within the goal range of 250 to 500 fish during 2004 and 2005, but averaged 14% (35 fish) below the lower end of the range from 2000 to 2003. Figure 20 shows escapements over the last 30 years to the region's 3 largest producers of Chinook salmon, the transboundary Stikine, Taku and Alsek rivers.

The Division of Sport Fish has, over time, assumed more responsibility for funding and operation of the region's Chinook salmon stock assessment program. Although many of the programs remain jointly operated by both divisions, the Canadian Department of Fisheries and Oceans is also involved in the stock assessment programs of transboundary rivers. The region's Chinook salmon stock assessment program is almost entirely supported through a wide variety of federal funding sources—a less than ideal situation given the uncertain nature of future federal budgets.

Sockeye salmon

In the SEAK area, ADF&G operates a wide variety of sockeye salmon stock assessment projects centering efforts on the region's largest producers. These are the rivers that drive commercial fisheries management decisions. The stock assessment projects include long-term escapement monitoring on (1) the transboundary Alsek, Taku and Stikine rivers, which are operated with assistance from the Canadian Department of Fisheries and Oceans, (2) large mainland lake systems including Situk, Chilkat, Chilkoot, and McDonald lakes, and (3) smaller mainland systems such as Hugh Smith Lake. Estimates of harvest and total run size are available for about a dozen of the SEAK sockeye salmon stocks, including many of the region's larger producers. The department's escapement monitoring efforts are augmented by other governmental agencies and several tribal and aquaculture associations. They operate or assist with operation of smaller enumeration projects at other sockeye salmon systems scattered throughout the region. The U.S. Fish and Wildlife Service's Office of Subsistence Management has provided ADF&G with about $2.6 million since 2000 through its Fisheries Resource Monitoring Program to partner with other agencies and tribal groups in conducting short-term assessment projects on 17 sockeye lake systems that support important subsistence fisheries in Southeast Alaska.

Sockeye salmon escapement goals are currently established for 3 Yakutat area stocks, 4 transboundary river stocks, and 6 stocks that spawn in Southeast Alaska (Geiger et al 2005). The majority of these stocks have met or exceeded escapement goals in most or all years over the last 20 years. Further discussion in this

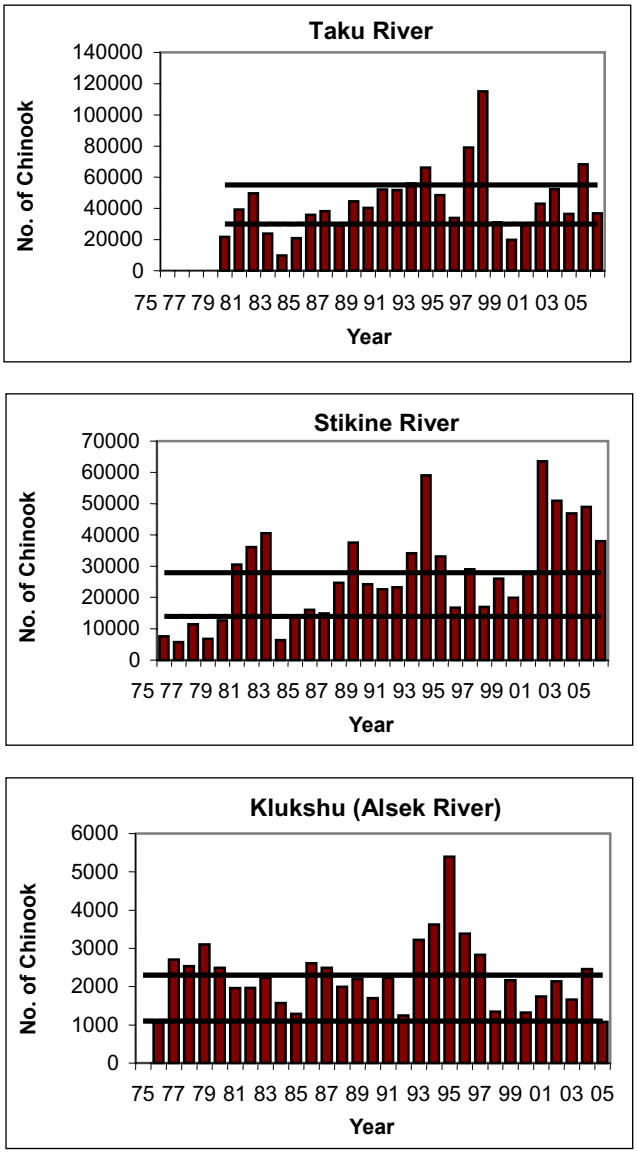

Figure 20. Estimated escapements of Chinook salmon in the Taku, Stikine and Klukshu (index tributary for Alsek River) rivers from 1975–2005 and the respective biological escapement goal ranges.

section will concentrate on a subset of the sockeye stocks distributed across the region, including several that have recently recovered from 5 to10 year periods of low production.

The Situk River system supports the largest commercial set gillnet, subsistence, and sport fisheries for sockeye salmon in the Yakutat area. The stock was managed by ADF&G to achieve an escapement goal of 45,000 to 55,000 fish during the early 1990s before adopting a biological escapement goal of 30,000 to 70,000 fish in 1995. Escapement is monitored with a weir, and escapements have exceeded the lower end of the escapement goal range each year since 1976 (Figure 21).

Chilkoot Lake is one of 2 large sockeye salmon producing lakes in the Lynn Canal area. The sockeye salmon stock of Chilkoot Lake experienced a severe downturn in production in the 1990s. In response, ADF&G took management action to limit commercial harvest of the stock and obtained federal funding to study the lake's freshwater productivity. Studies identified the lake's freshwater rearing environment probably contributed to the stock's decline, and indicated increased glacial turbidity and a drastic reduction in zooplankton abundance as possible mechanisms. Returns to the system have rebounded in recent years and the escapement goal has been met in each of the last 5 years (Figure 22). The Chilkoot Lake weir is the only sockeye salmon enumeration project in the entire SEAK area that remained in the state's FY 06 general fund budget. Studies of the lake's freshwater productivity were discontinued in 2005 due to a lack of funding.

The transboundary Taku River is one of the region's largest producers of sockeye salmon. The sockeye salmon returns are jointly managed by ADF&G and the Canadian Department of Fisheries and Oceans through the Transboundary Technical Committee to the Pacific Salmon Commission and according to PST agreements. Escapement has been monitored since 1984 with a joint U.S.–Canada mark–recapture program. Escapements have met or exceeded the escapement goal range every year (Figure 23).

Tahltan Lake, located in northwestern British Columbia, is the largest producer of sockeye salmon in the transboundary Stikine River drainage and a significant contributor to fisheries in Southeast Alaska. As is the case for the Taku River, management of Stikine River sockeye salmon is shared with Canada and subject to PST agreements. The Tahltan stock has shown cyclical trends in abundance since 1959, when a weir was first operated on the system. Recently, from 1997 to 2002, the stock experienced a series of low returns when the escapement goal was not achieved (Figure 24). Both agencies developed a coordinated management approach to reduce harvests in the countries'

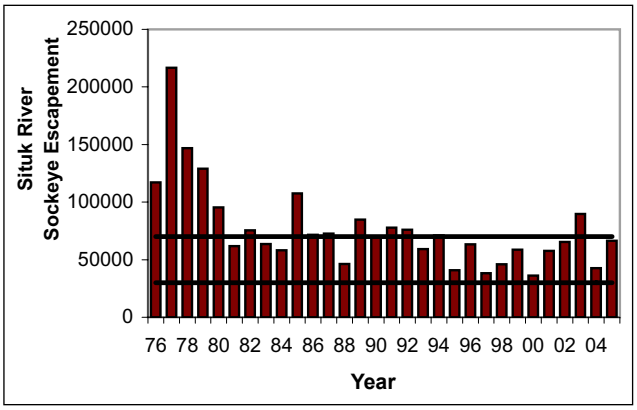

Figure 21. Situk River weir counts of sockeye salmon from 1976–2005 and the sustainable escapement goal of 30,000–70,000 fish.

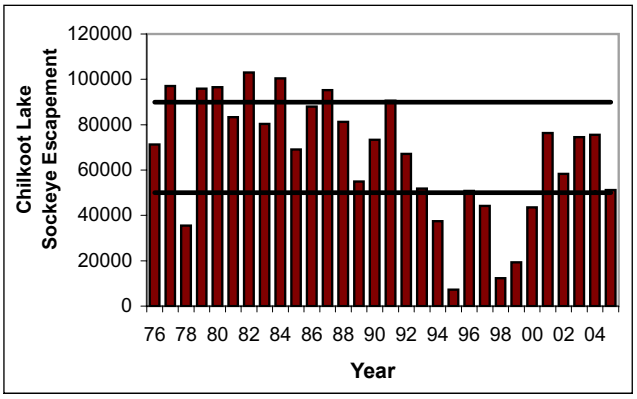

Figure 22. Chilkoot Lake weir counts of sockeye salmon from 1976–2005 and the sustainable escapement goal of 50,000–90,000 fish.

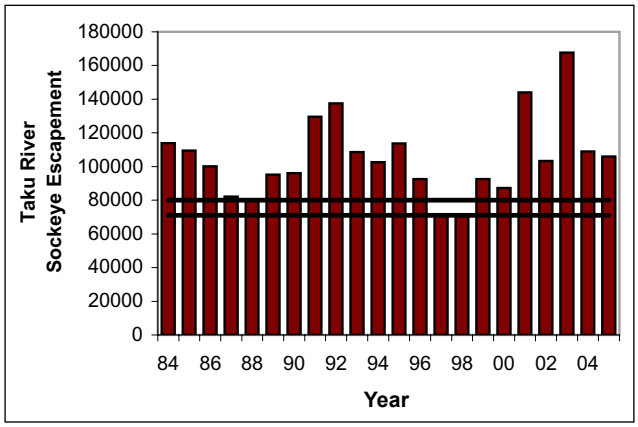

Figure 23. Mark–recapture estimates of Taku River sockeye salmon escapement from 1984–2005 and the sustainable escapement goal of 71,000–80,000 fish.

respective fisheries. Adult returns increased dramatically from 2003 to 2005 and estimates of the numbers of outmigrating smolts forecast healthy returns for the system over the next several years.

The Hugh Smith Lake sockeye salmon stock was recognized as a stock of concern in 2003 after a series of poor returns during which the escapement goal was not achieved. After analyzing stock productivity information, ADF&G developed a revised escapement goal of 8,000 to 18,000 fish, replacing the existing non-scientifically-based goal of 15,000 to 35,000 fish, and in concert with the Board of Fisheries developed an action plan for the stock. The action plan specified management actions to reduce harvests in nearby commercial drift gillnet and purse seine fisheries and ordered a review of the fry stocking rehabilitation and stock assessment programs. New funding to support increased assessment efforts on the stock was obtained through the Southeast Sustainable Salmon Fund (part of the Pacific Coast Salmon Recovery Fund). These studies have shown that management measures outlined in the action plan are appropriately timed and located to effect harvests of the stock. Studies have also shown that although fry stocking efforts increased adult returns they have, to date, been ineffective in boosting the system's long-term production (Geiger et al 2005), and ADF&G recently decided to suspend lake stocking efforts for one life cycle to allow further study of the program. Escapements to Hugh Smith Lake exceeded the escapement goal range each year from 2003 to 2005 (Figure 25), and the Board of Fisheries removed Hugh Smith Lake sockeye salmon as a stock of concern in 2006 because the stock no longer meets the criteria for the designation.

Coho salmon

Coho salmon are found in roughly 2,500 primary anadromous streams throughout the SEAK area. From a practical standpoint, it is feasible to closely monitor production of only a small fraction of these streams to serve as health indicators of the region's coho salmon stocks. Indicator stocks are distributed geographically across the region, and assessments are categorized as full indicator or escapement indicator stock programs. Full indicator stock programs include juvenile coded wire tagging and adult harvest and escapement monitoring. From this, detailed population dynamic parameters can be estimated, including smolt production, adult escapement, harvest contributions and distribution, exploitation rates, marine survival and total adult production. There are currently 7 long-term indicator stock programs in the region, the majority of which were established in the early 1980s. Escapement indicator stocks include those that meet survey timing and consistency standards so that ADF&G can conduct foot or helicopter surveys of spawner abundance. Currently, the list of long-term escapement indicator stocks includes 14 streams near Ketchikan, 6 near Sitka, 5 near Juneau and 4 near Yakutat.

Coho salmon escapement goals have been established for 13 individual stock or aggregated stock groups distributed across a broad range of production magnitude—from a few thousand to several hundred thousand (Shaul et al 2005). Escapement goals have been met most years for all these stocks. Figure 26 shows information on catch, escapement, and total run size for the 4 longest-term full indicator stocks in the region.

By expanding the coho indicator stock program to cover a larger number of systems, ADF&G hopes and provide more thorough geographic coverage throughout the Southeast Alaska–Yakutat area. Fund-

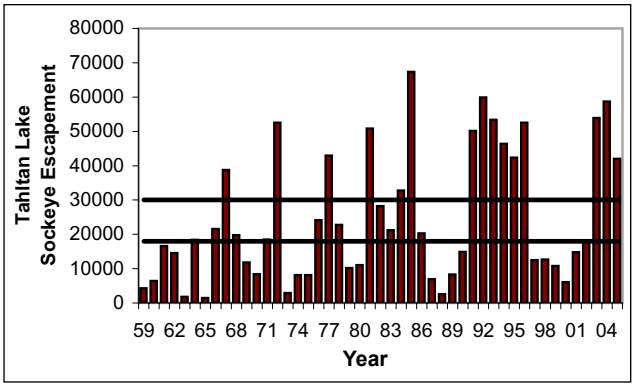

Figure 24. Tahltan Lake weir counts of sockeye salmon from 1959–2005 and the biological escapement goal of 18,000–30,000 fish.

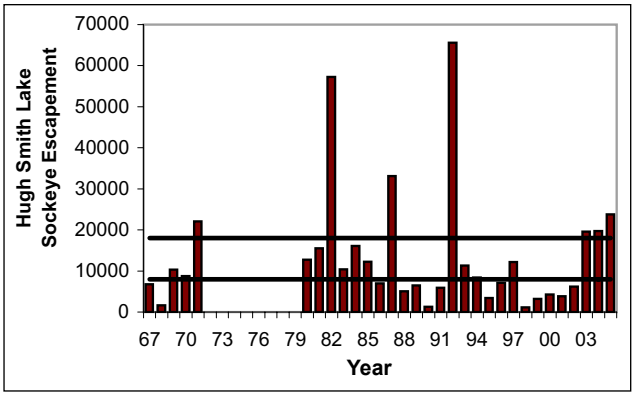

Figure 25. Hugh Smith Lake weir counts of sockeye salmon from 1967–2005 and the biological escapement goal of 8,000–18,000 fish (the weir was not operated from 1971–1979).

ing availability, however, is hindering these efforts. Indeed, the erosion of state general fund budgets has required ADF&G to move funding for several of the full indicator stock programs to short-term federal funding sources, threatening the long-term viability of the coho salmon assessment program.

Pink salmon

Monitoring pink salmon escapement in Southeast Alaska requires ADF&G to survey roughly 700 of the region's more than 2,500 pink salmon spawning streams. Peak aerial survey counts are calibrated to adjust for bias in counting rates among observers, but there is not currently a scientifically accepted way of converting index counts to total escapement. Escapement goals were established in the 1970s for aggregated streams in northern and southern portions of the region, and have been modified several times since. In 1998, the escapement goal for the northern area was split into goals for stocks in inside and outside waters. Finally, in 2003, biological escapement goals were established for the Southern Southeast, Northern Southeast Inside and Northern Southeast Outside subregions. The commercial fisheries are actively managed by ADF&G to distribute escapement among 45 pink salmon stock groups. Each group represents a geographic grouping of streams that support pink salmon runs with similar migratory routes and run timing. Escapement targets for each stock group are determined using historical escapement data to apportion subregion escapement goals. Pink salmon production in the Yakutat area is minor and is monitored primarily with a weir on the area's largest producer, the Situk River.

Southeast Alaska has enjoyed prodigious abundance of pink salmon over the last 20 years. Not only have average harvests been the highest in history during this period, escapement measures have been at their highest levels on record as well (Figure 27). Escapements in the Southern Southeast and Northern Southeast Inside subregions have met or exceeded escapement goals in all but one year since 1985, and the Northern Southeast Outside subregion has met or

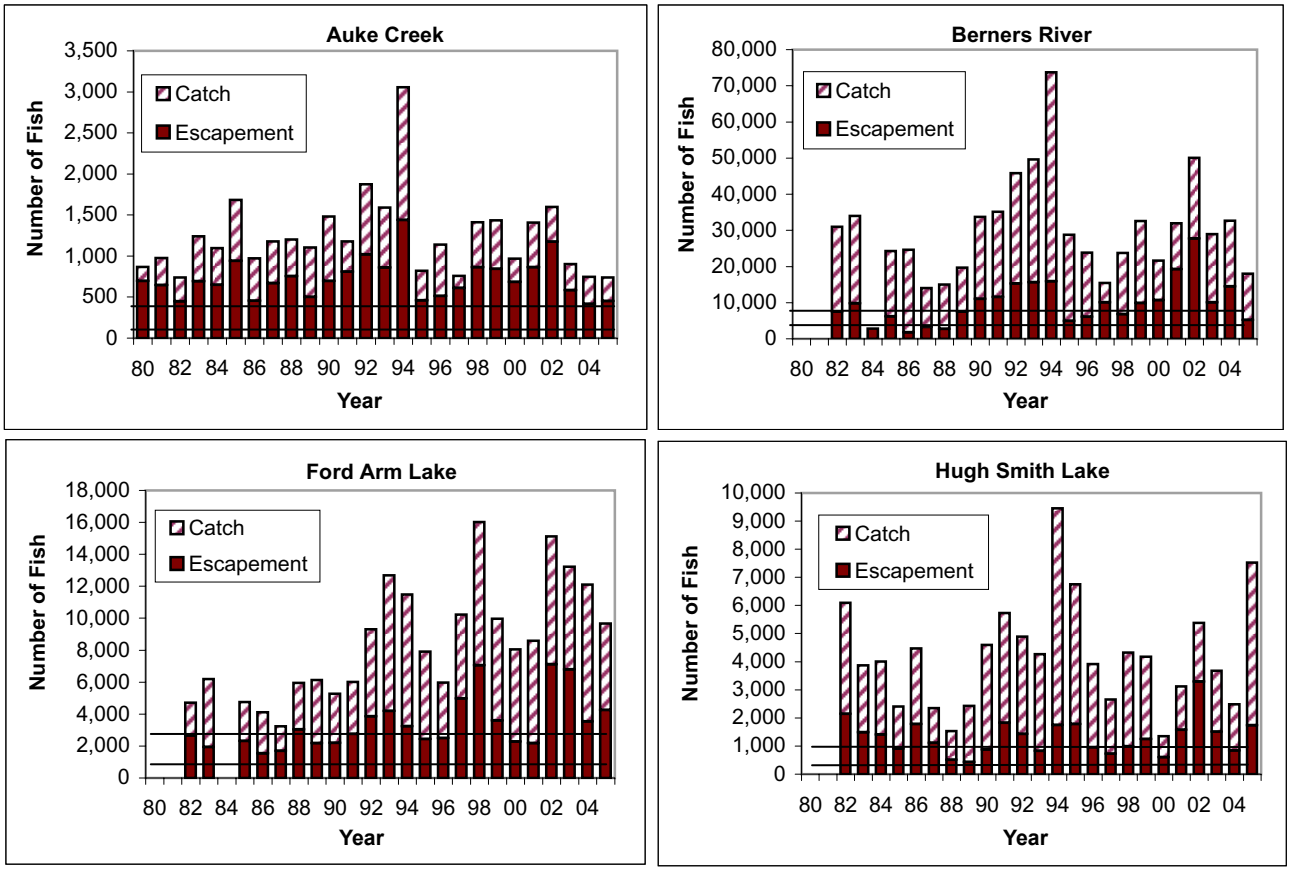

Figure 26. Catch, escapement, total run size and the current escapement goal range for Auke Creek, Berners River, Ford Arm Lake and Hugh Smith Lake wild coho salmon indicator stocks from 1980–2005. No data is available for Ford Arm Lake in 1984, and only escapement data is available for Berners River in 1984.

exceeded escapement goals every year since 1994. During this period, market limitations have constrained maximum harvests somewhat below what stock abundance would have allowed.

The ADF&G stock assessment program for chum salmon in the SEAK area is less developed than for other salmon species. Escapements are assessed through aerial and foot surveys but several factors limit the usefulness of the survey data. Most survey counts are obtained opportunistically during surveys to monitor pink salmon escapement in conjunction with management of the purse seine fishery. The vast numbers of pink salmon in many streams prevents observers from obtaining accurate counts of the less abundant chum salmon. Also, there is currently no way to adjust survey counts for bias among observers. The region's total harvest of wild chum salmon is estimated; detailed stock-specific harvest information is available for very few stocks.

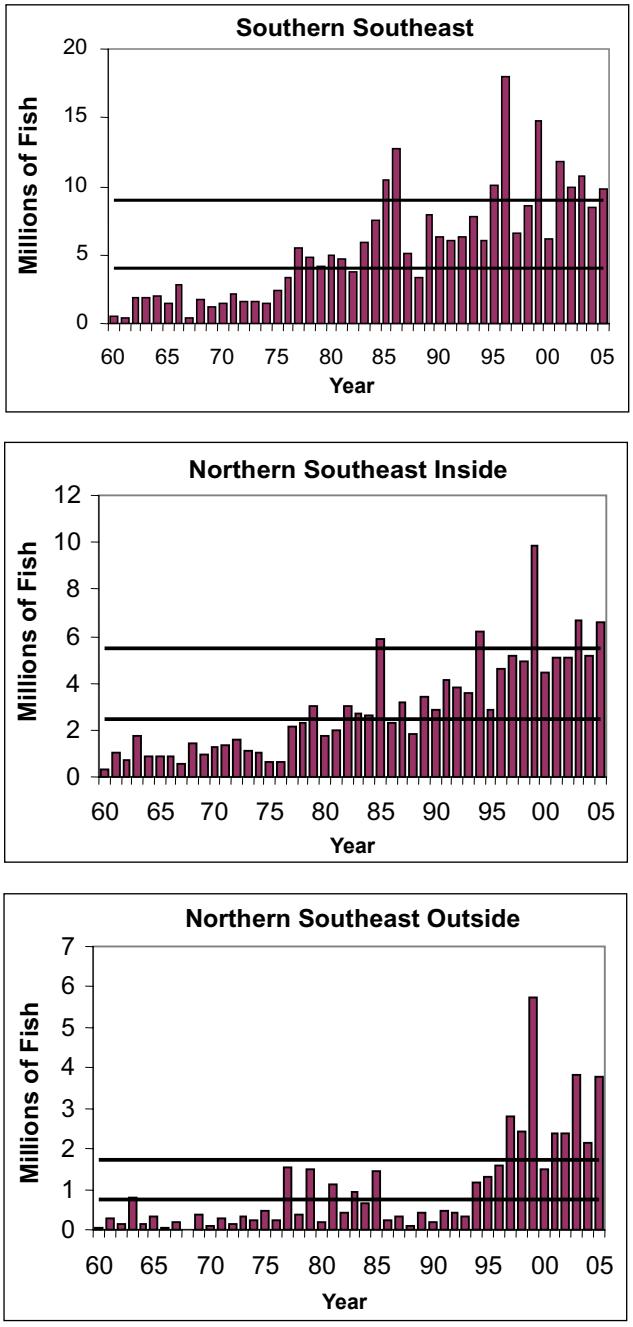

Figure 27. Annual pink salmon escapement index for the Southern Southeast, Northern Southeast Inside and Northern Southeast Outside subregions from 1960–2005 and the respective biological escapement goal ranges.

Available data indicates increasing trends in overall escapement and harvest of wild chum salmon stocks in the SEAK area. Heinl (2005) identified 82 streams in Southeast Alaska with sufficient long-term survey data to assess trends in chum salmon escapement. After converting stream count data to rank index values, Heinl showed an annual increasing trend of 2.3% (Figure 28) in the combined 82-stream index during the years from 1984 to 2004. Considered individually, escapement trends in 60 (73%) of the streams were stable or increasing and 22 (27%) were declining. Estimated harvests of wild chum salmon in the region's fisheries over this time period also show an increasing trend of 3.7% (Figure 28).

Budget History and Fiscal Support

While broad gauges of the overall abundance of wild chum salmon in the SEAK area show positive trends and indicate stocks are generally being managed in a sustainable manner, the lack of quality escapement and stock-specific harvest information has prevented ADF&G from establishing biologically-based escapement goals for chum salmon in Southeast Alaska. The department obtained federal funds through the Southeast Sustainable Salmon Fund to estimate chum salmon escapement from 2002 to 2005 in the Chilkat River, believed to be the region's largest chum salmon producer. This information will be used to develop a reliable index of annual abundance for that stock. Further improvements to the existing assessment program for chum salmon will require significant funding increments.

It is clear that salmon stocks in the SEAK area are being managed in a sustainable manner and that overall stock status is currently very healthy. The long-term prognosis for funding many of the Division of Commercial Fisheries core assessment and management programs in the region is less certain, however. State general fund support for the region's salmon programs has essentially remained static since 1982, but effective

buying power over this period has declined by over 50% (Table 3).

The State of Alaska is fortunate to have received substantial federal budgetary support in recent years for the salmon program in the SEAK area, although much of this money has been directly associated with increased responsibilities of implementing PST fishing agreements. Two long-term federal grants have provided substantial funding for the SEAK area salmon program. An annual Pacific Salmon Commission grant has provided funding since the mid-1980s to implement Treaty fishery regimes. With the exception of a couple of 1-year supplemented appropriations, funding from this grant has declined slightly over time, particularly when inflation is taken into account; annual appropriations have averaged approximately $3 million since 1997. A federal–state matching grant through the Anadromous Fisheries Act has provided an average of about $300,000 annually in federal funds for salmon management and assessment over a similar time period.

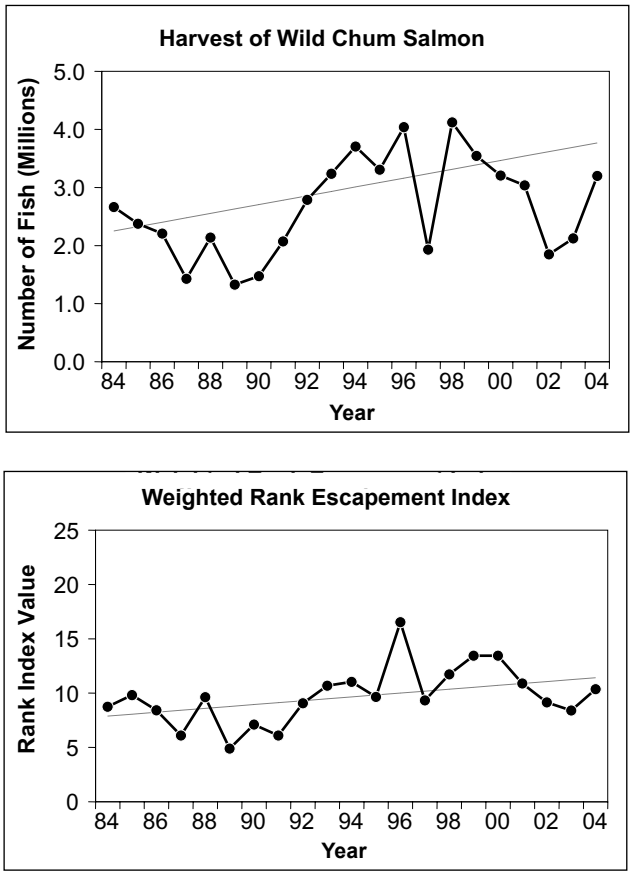

Figure 28 (from Heinl 2005). Annual estimated 82-stream escapement index and commercial harvest of wild chum salmon in Southeast Alaska from 1984–2004 (escapement index is represented in rank terms rather than numbers of fish; the dashed lines represent regression lines, as described in Heinl 2005).

Several new sources of funding have come into play in recent years. Since 1998, ADF&G has received about $350,000 annually in federal funds for Chinook salmon stock assessment in the region in conjunction with signing of a Letter of Agreement on Chinook salmon management with several Pacific Northwest states. A total of approximately $7.5 million in funding through the Southeast Sustainable Salmon Fund has been provided since 2000 to the Division of Commercial Fisheries to support their research and assessment projects in the SEAK area and to aid in implementing the new abundance-based PST agreements. The first substantial distributions from the Northern Fund were made in 2004 and 2005. The Northern Fund is an endowment fund established by the 1999 PST agreement and funded through appropriations from the U.S. Congress. It is used to improve the scientific basis of management, small-scale enhancement, and habitat restoration in central and northern British Columbia, Southeast Alaska and the transboundary Stikine, Taku and Alsek rivers. In 2004 and 2005, the primary distributions to ADF&G from this fund were to support development of sockeye and Chinook salmon genetic stock identification capabilities in Southeast Alaska and to improve the infrastructure for the ADF&G statewide genetics lab.

While federal funds have allowed ADF&G to maintain and improve some of its salmon assessment and management programs in the SEAK area, long-term funding for the federal grants is uncertain. Furthermore, due to erosion of state general fund support, substantial amounts of some federal grants, including over half of the base Pacific Salmon Commission grant, are currently used to pay salaries for ADF&G permanent full-time and seasonal management and research staff. To counter this trend, approximately $400,000 is included in the Governor's FY 07 state budget request to move salary costs for 11 of the region's management biologists off federal funding and onto state general fund dollars. Adequate and stable fiscal support for ADF&G is essential to continue its outstanding resource monitoring program in the SEAK area, particularly during a time when increasing demands are being made by a commercial fishing industry under intense pressure to restructure and improve profitability.

PRINCE WILLIAM SOUND COMMERCIAL SALMON FISHERY

Area Description and Gear Types

The Prince William Sound salmon management area is located northwest of Yakutat along the north central Gulf of Alaska, and includes coastal waters and drainages between Cape Suckling and Cape Fairfield. The area is divided into 11 commercial fishing districts corresponding to geography and the distribution of salmon runs (Figure 29). Regulations specify where gear types can be fished. Fishermen using drift gillnets target salmon returns to the Copper and Bering rivers in the easternmost districts in the management area near the mouths of the 2 rivers. In the adjacent waters of Prince William Sound, the fishery is driven by production originating from many small streams and—over the last 30 years—hatcheries. Purse seine gear is allowed in 8 of the 9 fishing districts in Prince William Sound, while drift gillnet gear is allowed in 3 districts and set gillnet gear is allowed only in the Eshamy District.

Private nonprofit corporations operate 6 hatcheries that contribute to salmon production in the area, 5 of which are located along the shores of Prince William Sound and one in the upper Copper River drainage. Salmon production from Prince William Sound hatcheries is dominated by pink salmon, but there is also substantial production of chum, sockeye and coho salmon. Hatchery production in the Copper River drainage is limited to sockeye salmon. The beginning of the Prince William Sound hatchery program dates back to the early 1970s. Large-scale returns of hatchery fish began in the 1980s and have continued to the present.

History of the Commercial Salmon Fishery

Commercial utilization of salmon in the Prince William Sound area began in the late 1880s. The commercial salmon fishery developed first along the Copper River delta. Prior to 1916, only a single cannery operated in the region, near the mouth of the Copper River at the town of Eyak (PWSRPT 1983). Annual salmon harvests from 1900 to 1915 ranged from about 0.4 million to 1.5 million fish, and were comprised primarily of sockeye salmon. Then, as additional canneries were constructed and became operational, fisheries expanded into new portions of the Prince William Sound area and began to target other species. Since 1916, the number of pink salmon harvested annually in Prince William Sound commercial fisheries has typically far exceeded that of sockeye salmon. Average decadal harvests of all salmon in the Prince William Sound area during the 1930s through the 1950s ranged from about 6.5 million to 9.7 million fish. Prestatehood average harvests peaked in the 1920s for Chinook salmon, in the 1930s for sockeye salmon, and in the 1940s for coho, pink and chum salmon (Figure 30, Panels A–E).

Responding to declining catches in the fishery, the federal government greatly restricted and even closed Prince William Sound fishery (except for the Copper River and Bering River Districts) for several years during the 1950s. Pink and chum salmon catches increased during the early years of state management. After a brief upsurge in pink and chum salmon catches during early years of management by the State of Alaska in the early 1960s. The Good Friday earthquake of 1964 struck and caused major changes to many Prince William Sound streams and a period of instability and lower catches ensued during the remainder of the decade (PWSRPT 1983). Harsh winters in the early 1970s provided a further setback for Prince William Sound salmon production, and ADF&G closed or severely limited the purse seine fishery from 1972 through 1974 due to poor returns. Improved survival conditions and the beginning of hatchery returns led to increased catches of pink and chum salmon in the late 1970s. Hatchery returns have greatly increased harvests of these species since that time. Poststatehood harvest peaks in the Prince William Sound area occurred in the 1990s for Chinook salmon and the 2000s for sockeye, coho, pink and chum salmon.

Commercial harvests of all salmon in the Prince William Sound management area since statehood have averaged about 18.7 million fish annually, ranging from a low of 1.2 million salmon in 1972 to a high of 59.1 million salmon in 2003 (Figure 30, Panel F). Average catch by species during this period has been about 15.8 million pink (84.4%), 1.3 million sockeye (6.8%), 1.2 million chum (6.6%), 400,000 coho (2.1%) and 30,000 Chinook salmon (0.2%).

Since 1985, the numbers of salmon landed in the purse seine fishery have comprised 85% of the total commercial common property harvest in the Prince William Sound area, followed by 14% in the drift gillnet and 1% in the set gillnet fishery (Figure 31). While the purse seine fishery accounts for the large majority of the salmon harvest, it primarily targets pink salmon, the species with the lowest exvessel value per pound. The drift and set gillnet fisheries target other, higher valued species.

Other Salmon Harvests

Harvests of salmon by noncommercial users in the Prince William Sound area are minor in comparison

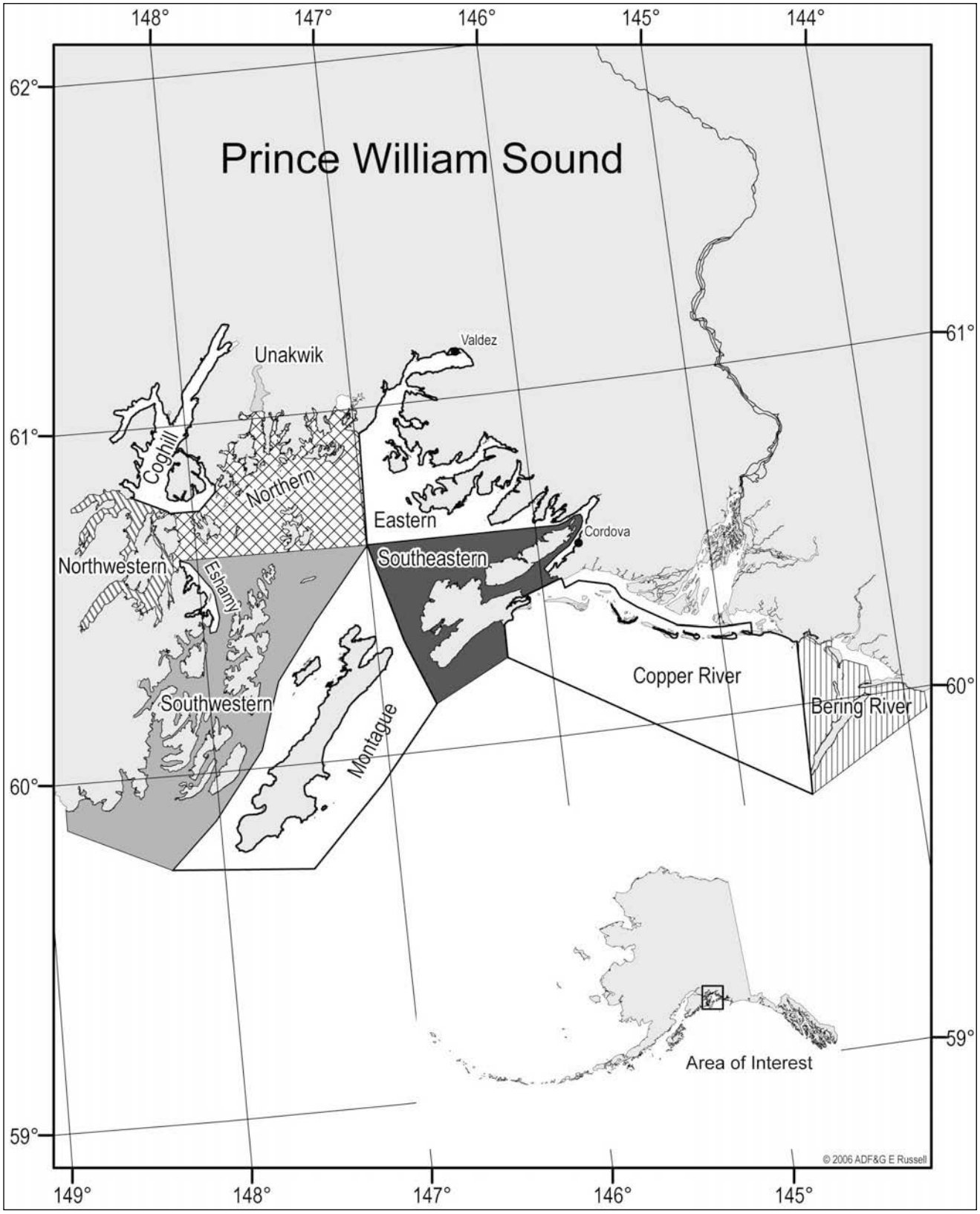

Figure 29. Prince William Sound area commercial salmon fishery.

to commercial harvests, but are increasing over time. Subsistence and personal use salmon fisheries in the Prince William Sound area are among the largest in Alaska (Figure 9). The average annual subsistence and personal use harvest from 1988 to 2003 was about 129,000 salmon (Table 17), of which 99% was taken within the Copper River drainage or at the mouth of the river. Harvests have increased during this time period (Figure 32). Sockeye salmon represent over 90% of the harvest.

Sport harvests of salmon in the Prince William Sound management area have increased rapidly over

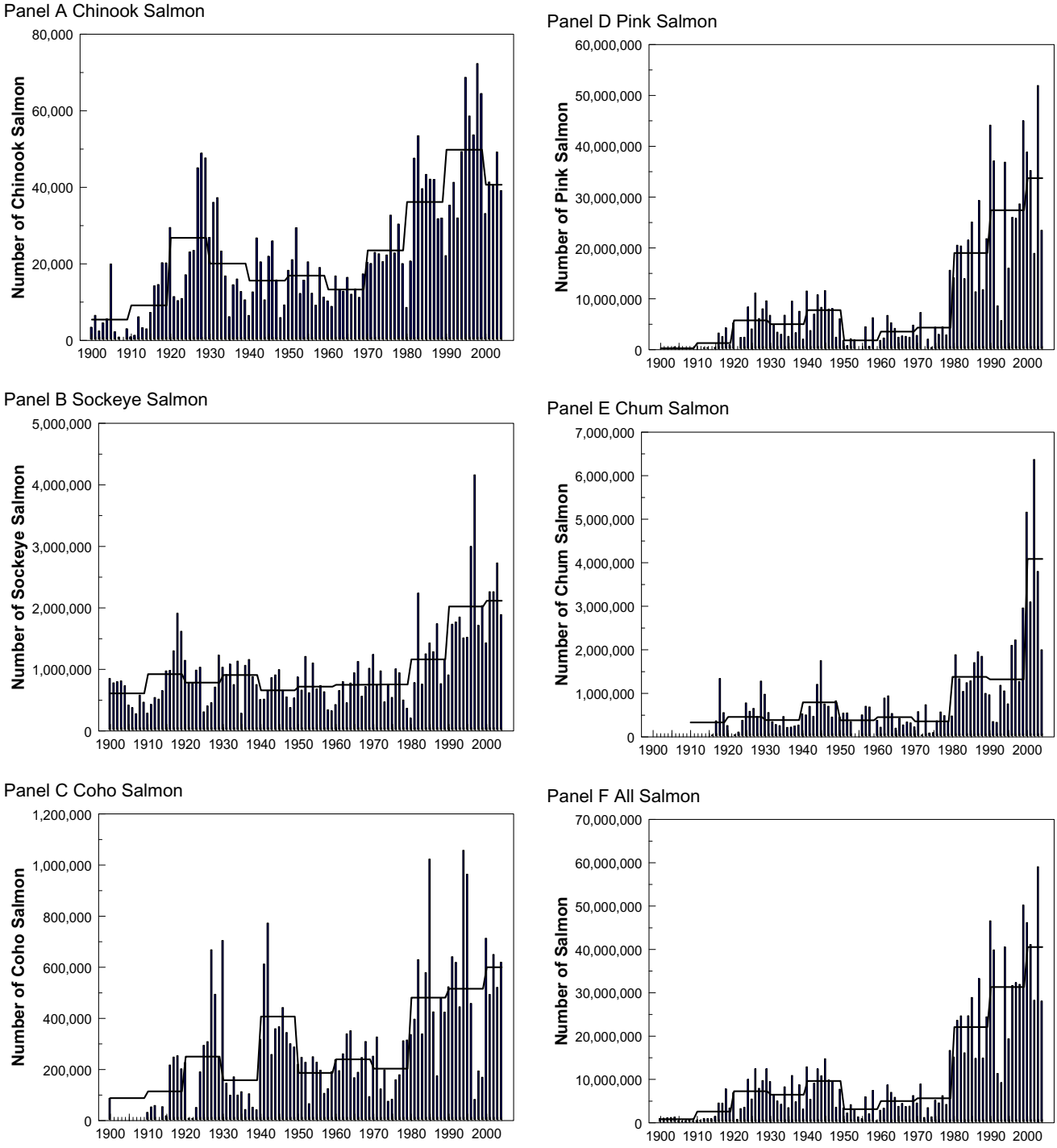

Figure 30. Commercial salmon harvests in Prince William Sound from 1900–2004; bars provide annual catches and lines provide decade averages.

the last 25 years (Table 18), particularly for coho, sockeye and Chinook salmon. Sport fishing harvests remain minor compared to commercial harvests. Coho salmon have represented the majority of the sport harvest of salmon over the last 15 years. The ratio of the average annual commercial harvest to sport harvest of salmon in the Prince William Sound area during the last 25 years is about 200:1, but ranges widely by species from about 5:1 for Chinook and 6:1 for coho, to about 680:1 for pink salmon.

Commercial Salmon Fishery Users

As of August 31 2005, there were 834 active commercial salmon limited entry permits for Prince William Sound commercial salmon fisheries, including 538 drift gillnet, 266 purse seine, and 30 set gillnet permits. From 1990 to 2004, the number of drift and set gillnet permits actively fished has remained stable but the number of purse seine permits fished has dramatically declined (Figure 33). The reduction in the number of purse seine users fishing in Prince William Sound reflects the drop in prices for pink salmon; the average price per pound for seine-caught pink salmon was $0.32 in 1990 but only $0.10 in 2004. Pink salmon provides an average of about 80% of the exvessel value of the seine fishery. In contrast, the drift and set gillnet fleets derive the majority of the exvessel value of their catch from sockeye salmon. While sockeye salmon prices have also declined over this period, the relative decline is less than for pink salmon; the average price per pound for sockeye salmon taken in the drift gillnet fishery in 1990 was $2.24, compared to $1.53 in 2004. This is due in part to development of successful marketing strategies for Copper River salmon.

Exvessel Value

The exvessel value of the Prince William Sound salmon fishery, including sales of hatchery cost recovery fish, has averaged about $47 million annually from 1985 to 2004. Adjusted for inflation and expressed in

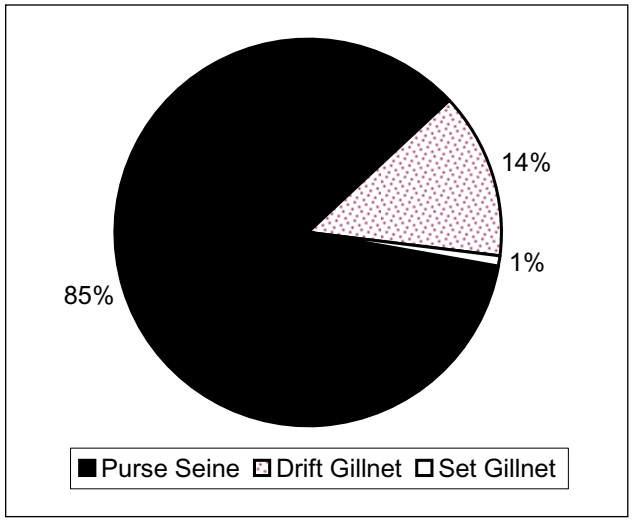

Figure 31. Average percent of the commercial common property salmon harvest by gear type in the Prince William Sound management area, 1985–2004.

Table 17. Average annual harvests of salmon in Prince William Sound area subsistence and personal use fisheries (rounded to the nearest 1,000 fish).

Species	1988–2003 Average	Annual Minimum	Annual Maximum
Chinook	5,000	3,000	10,000
Sockeye	122,000	86,000	234,000
Coho	2,000	1,000	7,000
Pink	<1,000	<1,000	1,000
Chum	<1,000	<1,000	1,000
Total	129,000	92,000	245,000

Table 18. Average annual harvests of salmon in the Prince William Sound sport fishery (rounded to the nearest 1,000 fish).

Species	1980–1989	1990–1999	2000–2004
Chinook	3,000	11,000	10,000
Sockeye	8,000	15,000	19,000
Coho	31,000	91,000	195,000
Pink	31,000	44,000	37,000
Chum	4,000	2,000	3,000
Total	77,000	164,000	264,000

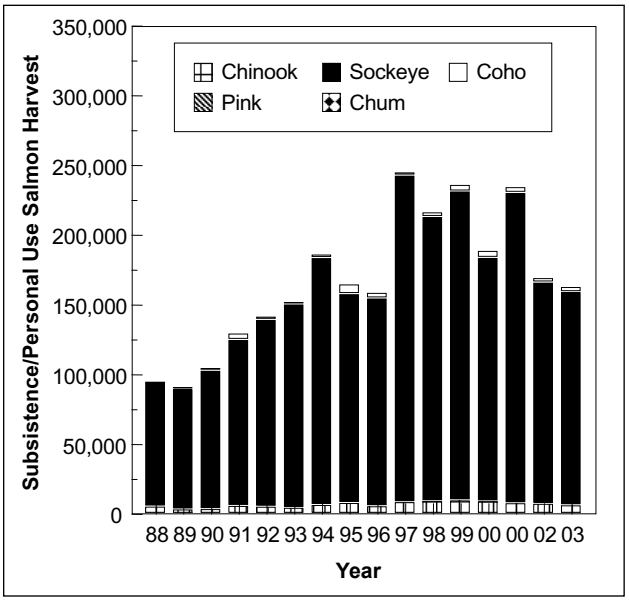

Figure 32. Harvests of salmon in subsistence and personal use fisheries of Prince William Sound, 1988–2003.

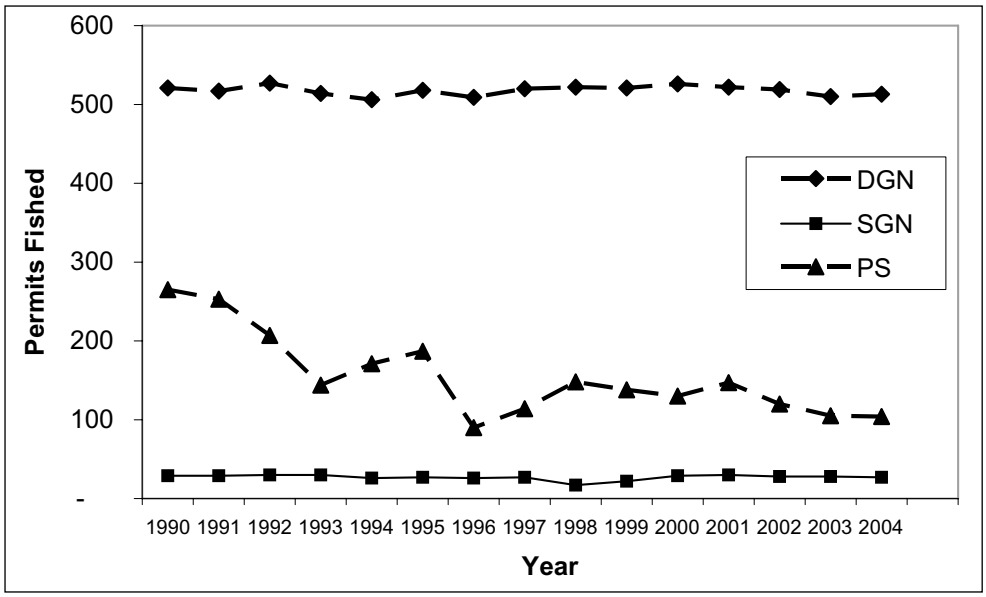

Figure 33. Number of commercial salmon limited entry permits fished in the Prince William Sound area, by gear type and year, 1990–2004. (DGN = drift gillnet, SGN = set gill net, PS = purse seine).

2004 dollars, the average annual exvessel value during this period was about $63 million, ranging from a low of about $33 million in 1993 to a high of about $127 million in 1988 (Figure 34). Exvessel value of the fishery declined sharply in 1991 from the high levels of the mid- to late 1980s and has remained fairly stable since then. Reduction in the price per pound paid for pink salmon has been the major reason for the decline. From 1985 to 2004, pink salmon accounted for 41% of the inflation adjusted total exvessel value, sockeye salmon for 34%, chum salmon for 12%, coho salmon for 8% and Chinook salmon for 5%. Since 1991, however, sockeye salmon have contributed a greater share of the value of the salmon harvest in the Prince William Sound area than have pink salmon.

Management

The Prince William Sound commercial salmon fisheries are managed by ADF&G to achieve escapement goals while allowing for the orderly harvest of surplus wild and hatchery stocks. Management plans established in regulation provide guidance for the department to manage fisheries for sustained yield of wild stocks. Regulatory plans also establish criteria for the exvessel value allocation of the harvest among commercial

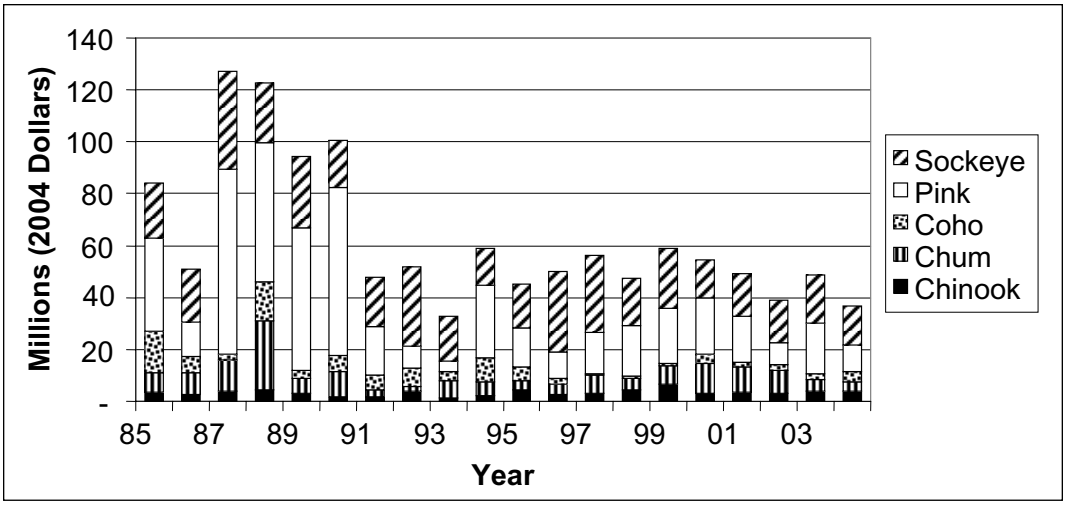

Figure 34. Exvessel value of the Prince William Sound commercial salmon fishery, 1985–2004, adjusted for inflation into 2004 dollars.

gear groups, and designate changes in gear group access to specific fishing areas to correct discrepancies in allocations. The Prince William Sound Task Force, an advisory body composed of commercial processors, gear groups, and aquaculture associations, serves as a forum for industry to exchange ideas and provide management recommendations to ADF&G.

The unique aspect of present-day salmon management in Prince William Sound is that, unlike any other area in Alaska, enhanced fish far outnumber wild fish in the harvest. The prevalence of hatchery fish has complicated management and assessment programs for Prince William Sound salmon. Hatchery management plans established in regulation specify terminal areas near each of the 5 large Prince William Sound hatcheries where ADF&G, in consultation with PNP hatchery operators, manages fisheries to achieve cost recovery and brood stock objectives. Annual hatchery management plans developed by PNP operators and ADF&G specify cost recovery, brood stock goals and harvest management strategies for each hatchery.

Preseason forecasts are developed to aid industry in planning for upcoming fishing seasons and to guide early season management. Annual preseason forecasts of run size are prepared by ADF&G staff for wild Prince William Sound pink and chum salmon, sockeye runs to Eshamy and Coghill lakes, and the Copper River (Eggers 2006). Forecasts of hatchery returns are developed by the aquaculture associations. As information on run strength accrues from catch and escapement monitoring programs, management decisions become increasingly more reliant on inseason assessments of run strength.

Prince William Sound commercial salmon fisheries are managed out of the Cordova ADF&G office. Two management biologists are in charge of day-to-day management of the fisheries, and have issued an average of 113 emergency orders annually from 2000 to 2004 (Table 19) in the process of managing the area's commercial, subsistence, and personal use fisheries. Detailed summaries of salmon fisheries management and assessment programs are produced annually for the Prince William Sound, Copper River and Bering River. See Ashe et al (2005).

The drift gillnet fleet is the largest of the Prince William Sound gear groups. The fleet targets salmon returns to the Copper and Bering River Districts, and the Eshamy, Coghill and Unakwik Districts of Prince William Sound. Almost all Prince William Sound fishermen drift gillnet in the Copper River District during portions of the fishing season, although substantial numbers move to other districts as opportunities arise to target other returns. Drift gillnet fishery openings in the various districts are, to the extent possible, scheduled concurrently in order to spread effort among fishing areas. Drift gillnet fisheries in the Copper and Bering River Districts are located in marine waters adjacent to the mouths of these large rivers, and target stocks bound for the respective drainages. With the exception of hatchery sockeye salmon that augment the Copper River return, management in the 2 districts is unaffected by hatchery stocks. The Copper River drainage is the largest in the Prince William Sound area and is the fifth largest river system in Alaska (Hollowell and Taube 2005). It is the single largest producer of wild salmon in the Prince William Sound area, supporting substantial runs of Chinook, sockeye and coho salmon. The Bering River drainage is much smaller and primarily produces sockeye and coho salmon.

The Copper River fishery is managed according to guidelines contained in 2 regulatory management plans. The Copper River District Management Plan specifies an inriver sockeye salmon escapement goal that includes components for spawning, subsistence, personal use, and sport harvests, as well as brood stock and surplus for Gulkana hatchery returns. The Copper River King Salmon Management Plan specifies a Chinook salmon escapement goal and a suite of tools for managers to manage Chinook salmon returns. The Copper River fishery typically opens in mid-May due to the early migratory timing of Chinook and sockeye salmon bound for spawning locations in the upper drainage. The openings occur earlier in the year than any other salmon net fisheries in Alaska, with the exception of recently reopened Chinook salmon fisheries on Taku and Stikine River in Southeast Alaska. Salmon marketing programs have taken advantage of

Table 19. Number of emergency orders issued by Division of Commercial Fisheries staff from 2000–2004 for inseason management of commercial and subsistence/personal use salmon fisheries in the Prince William Sound area.

	Year					
Fishery	2000	2001	2002	2003	2004	Average
Commercial Purse Seine	38	47	31	51	35	40
Commercial Gillnet	50	67	70	88	88	73
Other	1	–	–	1	–	<1
Regional Total	89	114	101	140	123	113

the early availability and outstanding quality of Copper River Chinook and sockeye salmon, and lucrative markets have developed for the fish. By mid-June, management emphasis is on upriver wild and hatchery sockeye salmon stocks as well as sockeye salmon that spawn in the lower Copper River delta seaward of the Chugach Mountains. Management focus switches to coho salmon beginning in early August. Inseason management of the Copper River District relies on enumeration of Copper River escapement past a sonar site located about 50 km upstream from the river mouth at Miles Lake, aerial escapement surveys of lower delta systems, and comparison of harvests with weekly forecasts developed from historical run timing information. Contributions of hatchery fish to the Copper River sockeye harvest and escapement are determined from an otolith mark–recovery program. The Bering River district typically opens in mid-June, and managers schedule fishery openings concurrently with the Copper River district. Inseason management of the Bering District relies on aerial surveys of escapement and monitoring of catches.

Drift and set gillnetting is allowed in the Eshamy District, where the fishery primarily targets sockeye salmon returning to Eshamy Lake and the Main Bay Hatchery. A weir operated at Eshamy Lake provides inseason escapement information. Drift gillnet and purse seine fishermen share returns to the Coghill District and much smaller Unakwik Districts. In the Coghill District, the gillnet fishery targets sockeye returns to Coghill Lake and enhanced chum salmon returns to the Wally Noerenberg Hatchery. A weir at Coghill Lake provides inseason escapement information for sockeye salmon returns to that system.

The purse seine fishery is managed to achieve wild pink and chum salmon escapements and to allow for the orderly harvest of surplus wild and hatchery stocks. Pink and chum salmon escapements are monitored through weekly aerial surveys of 208 index streams distributed throughout Prince William Sound. The Southwestern District, the chief entrance corridor for salmon migrating back to Prince William Sound, is closed to purse seining prior to July 18 by regulation to allow early run salmon to reach inner waters of the Sound. Test fishing is conducted in the Southwestern District in July and August to provide information on pink salmon stock composition and sex ratios. All salmon released from Prince William Sound hatcheries can be distinguished by presence of otolith marks. This information is used, together with monitoring of escapements and catch rates, to manage purse seine fishing in the general districts. Management to achieve cost recovery goals for the area's PNP hatcheries is accomplished by opening and closing subdistricts near the hatcheries. When wild stocks are weak, these terminal areas can be opened to selectively target hatchery returns.

Escapement goals currently in effect for Prince William Sound salmon stocks are: one for Chinook, 5 for sockeye, 2 for coho, 2 for pink and 5 for chum salmon stocks or stock aggregates (M. J. Evenson, ADF&G Fairbanks, personal communication). All goals are sustainable escapement goals, with the exception of the biological escapement goal in place for Eshamy Lake sockeye salmon. A brief description of the goals and associated data sets follows.

Chinook salmon

The Copper River is the only appreciable producer of Chinook salmon in the Prince William Sound area. A sustainable escapement goal of 24,000 or more Chinook salmon was established for the system in 2002 (Bue et al 2002), based on an age-structured analysis used to generate historical estimates of escapement (Savereide 2001). Historically, ADF&G monitored Copper River Chinook salmon escapements through aerial surveys of 9 clearwater spawning tributaries. Radio telemetry studies conducted by ADF&G between 1999 and 2004 revealed that the aerial survey program provided neither a consistent nor reliable measure of total escapement of Copper River Chinook salmon (Savereide 2005). Mark–recapture methods are now used to estimate the total drainage-wide escapement of Copper River Chinook salmon. The Native Village of Eyak, in cooperation with LGL Alaska Research Associates Inc. has operated the program annually since 2000 (Smith et al 2005). Figure 35 shows the estimated Copper River Chinook salmon escapements

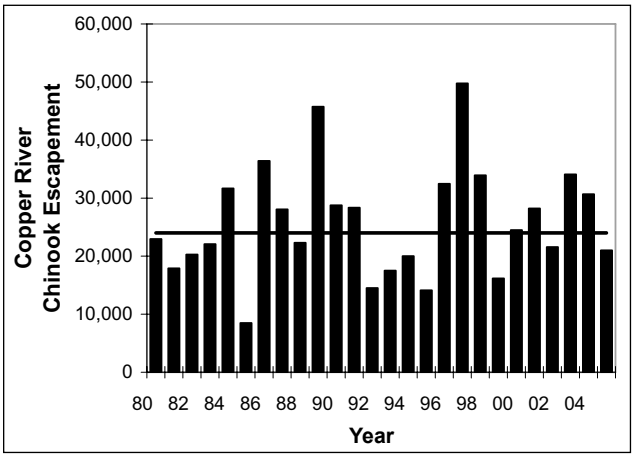

Figure 35. Estimated Copper River Chinook salmon escapements from 1980–2005 and the sustainable escapement goal of 24,000 fish.

since 1980 relative to the current escapement goal, which has been met or exceeded in about half of the years since 1980.

Sockeye salmon

The Copper River is the main producer of sockeye salmon in the Prince William Sound area. Sustainable escapement goals are established for stocks spawning in the upper Copper River basin and further downriver in the Copper River delta area. The inriver return of upper Copper River sockeye salmon has been monitored using sonar since 1978. Escapement is estimated by subtracting upstream sport, subsistence, and personal use harvests from sonar counts. The contributions of upriver and delta stocks to the Copper River commercial harvest have not been consistently estimated, so total return data is not available. The current escapement goal for the stock is 300,000 to 500,000 fish. Escapements have exceeded the lower end of the goal range in 23 of 28 years, including 15 of the last 16 years (Figure 36).

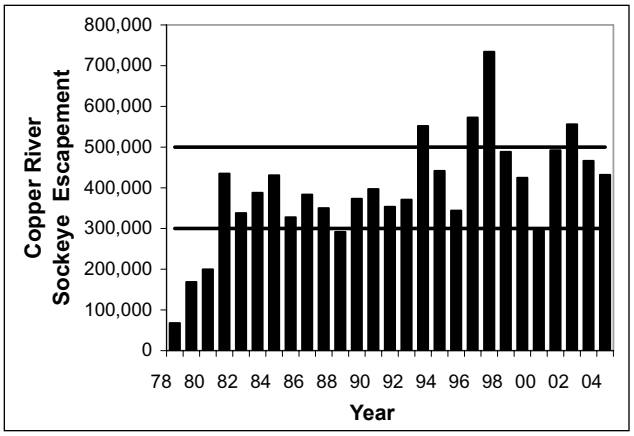

Figure 36. Estimated sockeye salmon escapement to the upper Copper River from 1978–2005 and the sustainable escapement goal range of 300,000–500,000 fish. Data from 2005 not shown because inriver harvest data is not yet available.

Escapements of Copper River delta stocks are monitored by aerial survey, and the sustainable escapement goal of 55,000 to 130,000 fish represents the sum of peak aerial counts from 17 index streams. Escapements have been above the lower end of the current goal range in 29 of 35 years since 1971, including every year since 1990 (Figure 37).

Bering River sockeye salmon are monitored by aerial survey, and the current sustainable escapement goal of 20,000 to 35,000 fish represents the sum of peak aerial survey counts from 7 index systems. Since 1983, Bering River escapements have exceeded the lower end of the current escapement goal range in 18 of 23 years (Figure 38).

Weirs are used to count sockeye salmon escapement into Coghill and Eshamy Lakes. Production from Coghill Lake has been affected by fry plants and lake enrichment programs, which complicates analysis of stock productivity. A period of low returns in the early 1990s may have been caused by high densities of sockeye salmon fry overgrazing zooplankton populations (Edmundsen et al 1992). Since 1962, weir counts of the Coghill Lake escapement have been highly variable, ranging from a high of 187,000 fish to a low of 7,000 fish, but have exceeded the lower end of the current sustainable escapement goal range of 20,000 to 40,000 fish in 37 of 44 years (Figure 39).

A biological escapement goal of 20,000 to 40,000 sockeye salmon is in place for Eshamy Lake. Following a period of very poor runs in the 1970s, when escapements were below 20,000 fish in all but one year, Eshamy Lake escapements have exceeded the lower

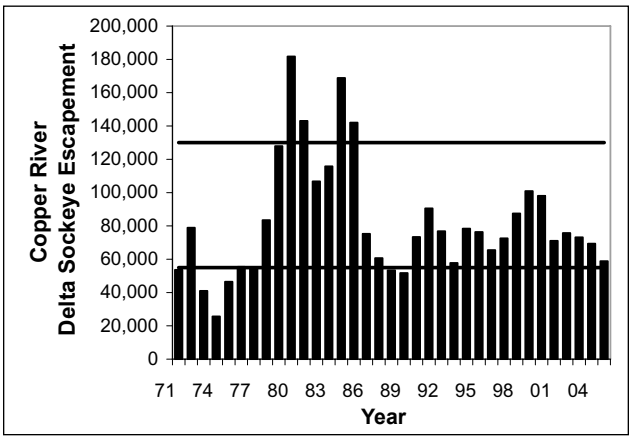

Figure 37. Peak aerial survey counts of Copper River Delta sockeye salmon from 1971–2005 and the sustainable escapement goal range of 55,000–130,000 fish.

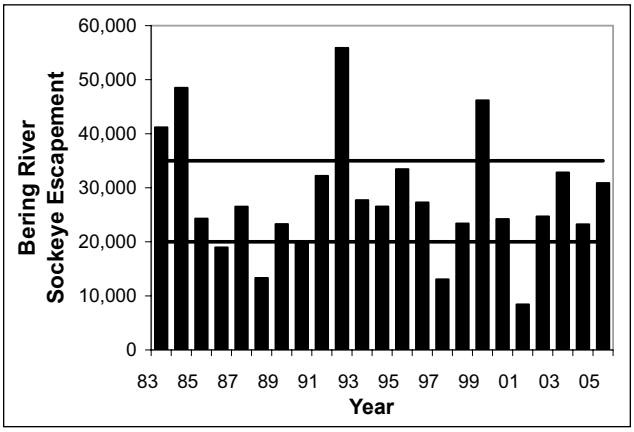

Figure 38. Peak aerial survey counts of Bering River sockeye salmon from 1983–2005 and the sustainable escapement goal range of 20,000–35,000 fish.

end of the current escapement goal range in 18 of the 24 years since 1980, when the weir became operational (Figure 40).

Coho salmon

There are 2 sustainable escapement goals for coho salmon in the Prince William Sound area, one for fish spawning in the Copper River delta and the other for Bering River delta streams. Escapements are measured as peak aerial survey counts, including 18 streams in the Copper River delta and 7 streams in the Bering River delta. Since 1981, escapements of both stocks have exceeded the lower end of their respective escapement goal ranges in all but 4 years (Figure 41 and 42).

Pink salmon

A sustainable escapement goal of 1.25 million to 2.75 million fish is established for Prince William Sound pink salmon. Escapement surveys are conducted on a weekly basis for 208 index streams, and indices of spawning escapement are estimated using area-under-the-curve methodology and a 17.5-day stream life (Bue et al 1998). As seen in Figure 43, escapements during the mid-1960s through the mid-1970s were below the current goal, followed by a period of high escapements from the late 1970s through the mid-1980s. Escapements since 1985 have been above the lower end of the escapement goal range in 15 of 21 years. In addition to the sustainable escapement goal for pink salmon that spawn in Prince William Sound streams, ADF&G has established management objectives to ensure distribution of spawning pink salmon among streams in the area.

Chum salmon

Threshold sustainable escapement goals have been established for chum salmon in 5 districts of Prince William Sound. Escapement indices dating back to

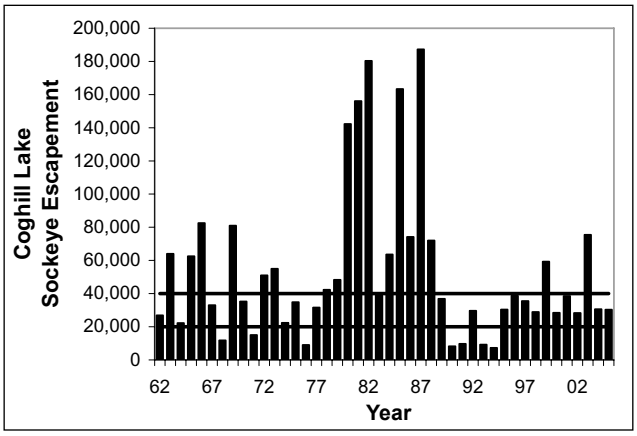

Figure 39. Coghill Lake weir counts of sockeye salmon from 1962–2005 and the sustainable escapement goal range of 20,000–40,000 fish.

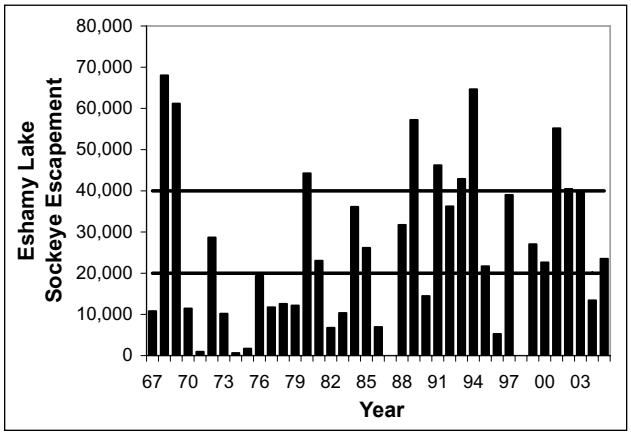

Figure 40. Eshamy Lake weir counts of sockeye salmon from 1967–2005 and the biological escapement goal range of 20,000–40,000 fish. The weir was not operated in 1987 and 1998.

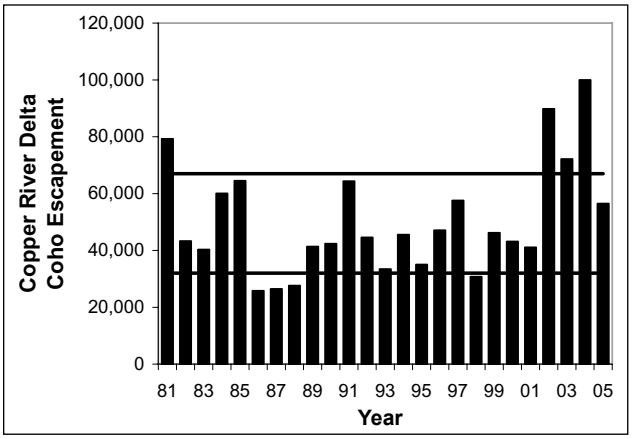

Figure 41. Peak aerial survey counts of Copper River Delta coho salmon from 1981–2005 and the sustainable escapement goal range of 32,000–67,000 fish.

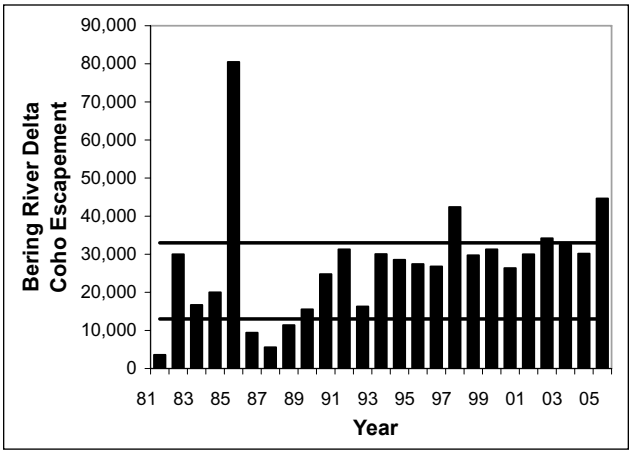

Figure 42. Peak aerial survey counts of Bering River Delta coho salmon from 1981–2005 and the sustainable escapement goal range of 13,000–33,000 fish.

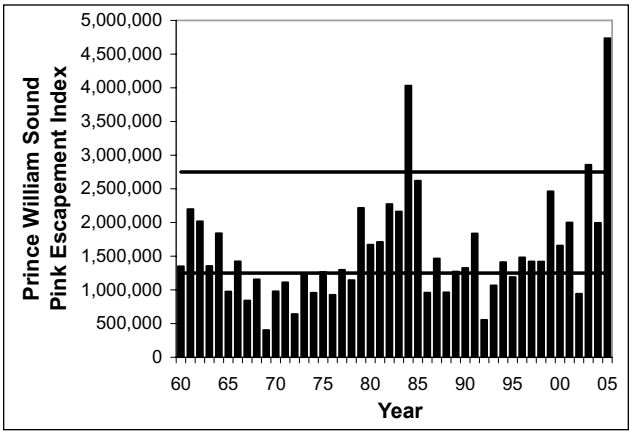

Figure 43. Index of escapement for Prince William Sound pink salmon and the sustainable escapement goal of 1.25 million to 2.75 million fish.

1965 have been developed using similar methods as detailed above for pink salmon. From 1996 to 2005, escapements to the Eastern and Southeastern Districts were above threshold levels in all years. During the same 10-year period, escapements of chum salmon in the Northern and Northwestern Districts met or exceeded their respective escapement thresholds in 9 of the 10 years while chum salmon escapements in the Coghill District met or exceeded the threshold in 7 of the 10 years (Figure 44).

Budget History and Fiscal Support

State general fund support for the ADF&G Prince William Sound salmon management and stock assessment programs has increased by approximately 79% since 1982, but the effective buying power of these funds has actually decreased substantially as a result of inflation (Table 3). During the last 15 years, several other agencies and funding sources have supported salmon stock assessment projects in the Prince William Sound area, including the Exxon Valdez Oil Spill Trustee Council and the U.S. Fish and Wildlife Service, Office of Subsistence Management. These funded studies have helped improve escapement monitoring programs in Prince William Sound and the Copper River drainage and have helped develop programs to estimate hatchery and wild stock contributions to commercial fisheries.

Although commercial salmon harvests in the Prince William Sound area have been at record levels in recent years and ADF&G's stock assessment capabilities have improved, the job of fishery managers has grown more complex. High proportions of the harvest are now composed of hatchery fish, particularly pink and chum salmon, and managing for sustained production of wild stocks requires more inseason information and attention. From a longer-term perspective, it is important to continue to improve assessment programs to enable inspection of trends in hatchery and wild stock production. There is controversy about the possible impacts of Prince William Sound enhanced production on the region's wild salmon stocks. Hilborn and Eggers (2000) assert that the productivity (return per spawner) of wild pink salmon in Prince William Sound has declined in the face of large scale hatchery releases, though the magnitude of the hatchery effect has been challenged (Wertheimer et al 2001, Hilborn and Eggers 2001). Wertheimer et al (2004) provide evidence that wild stocks of pink salmon in Prince William Sound remain highly productive and that enhanced production of pink salmon in Prince William Sound resulted in a net gain of up to 25 million fish per year between the 1990 and 2000 return years, at the expense of the possible displacement of up to 4.6 million wild pink salmon. There is a need to continue analyses and additional research into interaction of hatchery and wild fish in Prince William Sound. As Wertheimer et al point out in their 2004 paper "We need to continue both retrospective analyses and empirical research examining the interaction of hatchery and wild fish in Prince William Sound, to better understand and quantify the impacts of hatcheries, and to refine hatchery strategies and regulation to minimize impacts when and where necessary." Adequate funding will be needed to conduct such studies and analyses in the future.

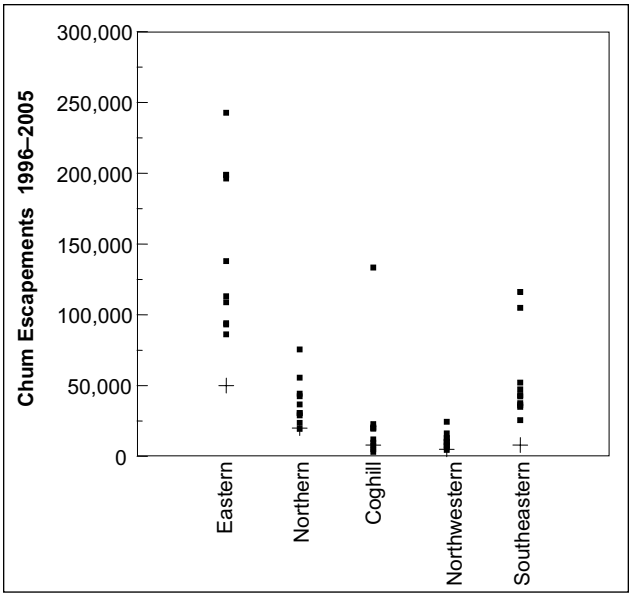

Figure 44. Escapements of chum salmon in 5 districts of Prince William Sound from 1996–2005 with sustainable escapement goals (annual escapements shown as solid squares, threshold sustainable escapement goals shown as + signs).

COOK INLET COMMERCIAL SALMON FISHERY

Area Description and Gear Types

Salmon were first caught commercially in Cook Inlet in 1882. From the inception of the fishery until statehood, various gear types including fish traps, gillnets, and seines were used to commercially harvest salmon in Cook Inlet. Since statehood, Lower Cook Inlet commercial salmon fisheries have been managed by the ADF&G Homer office; these fisheries occur in the Southern, Outer, Eastern and Kamishak Bay fishing districts. Salmon fisheries in Upper Cook Inlet are managed out of the ADF&G Soldotna office; these fisheries occur in the Central and Northern fishing districts. Figure 45 illustrates the commercial salmon fishing areas in Cook Inlet. Currently, only set gillnet gear is allowed in the Northern District. Set gillnet, drift gillnet, and purse seine gear is allowed in the Central District, however seine gear is restricted to the Chinitna Bay Subdistrict where it is only used sporadically. Set gillnets in Lower Cook Inlet are restricted to the Kachemak Bay area of the Southern District. Purse seine gear is used in all 4 of the Lower Cook Inlet commercial fishing districts (Southern, Outer, Eastern, and Kamishak Bay).

History of the Commercial Salmon Fishery

Commercial harvests of Chinook salmon in Cook Inlet generally increased until reaching a decadal average of about 92,000 fish in the 1940s. Average harvests of Chinook salmon were about 13,000 fish in the 1960s, 12,000 fish in the 1970s, 25,000 fish in the 1980s, 17,000 fish in the 1990s, and 19,000 fish since 2000 (Figure 46, Panel A). The significant reduction in commercial fishery Chinook salmon harvests since statehood was due to (1) perceived overharvest of the species in Cook Inlet during the 1960s and (2) direct allocation of harvestable surplus to the sport fishery by actions taken at various Alaska Board of Fisheries meetings since then. Sockeye salmon harvests in Cook Inlet did not exceed 3 million fish in any year until 1982 (Figure 46, Panel B). The peak decadal average annual harvest prior to the 1980s occurred in the 1940s when about 1.6 million sockeye salmon were harvested commercially. Commercial harvests of sockeye salmon were about 4.5 million fish in the 1980s, 4.1 million fish in the 1990s, and 3.6 million fish since 2000. Prior to statehood, the peak average annual commercial harvest of coho salmon in Cook Inlet was about 400,000 fish with the catch decreasing to a lower level in the 1950s, 1960s and 1970s (Figure 46, Panel C). During the 1980s the commercial harvest averaged about 540,000 fish, in the 1990s the harvest averaged about 360,000 fish and since 2000 the harvest has averaged about 215,000 fish. As is the case for Chinook salmon over the past 25 years, the Alaska Board of Fisheries has made allocative decisions limiting commercial harvests of coho salmon in Cook Inlet and has allocated substantial surplus production of the species to the sport fishery. In the early years of the Cook Inlet commercial fishery, even-year pink salmon were very dominant with odd-year pink salmon seldom being caught. The 2 runs have been growing closer in abundance over the last 30 years in comparison to patterns in the early part of the 1900s (Figure 46, Panel D). The largest commercial harvest of pink salmon in Cook Inlet occurred in 1952 when almost 5 million were caught and sold. Decadal average harvests of pink salmon since the 1940s have fluctuated between about 1.3 million and 1.8 million fish per year. Harvests of chum salmon in the Cook Inlet commercial fishery increased until they peaked in the 1980s at about 906,000 fish (Figure 46, Panel E). Annual commercial harvests of chum salmon in the 1990s averaged about 258,000 fish and since 2000 have averaged about 219,000 fish. Total commercial salmon harvests in Cook Inlet peaked in the 1980s at about 7.7 million fish. Annual harvests since then averaged about 6.3 million fish in the 1990s, and about 5.8 million fish since 2000 (Figure 46, Panel F).

Over the 10-year period from 1994 to 2003, about 35% of all salmon commercially harvested in Cook Inlet were taken in Lower Cook Inlet and 65% were taken in Upper Cook Inlet. For the 3 higher-value commercial fishery species—Chinook, sockeye, and coho salmon (Table 20)—only 10% or less of the harvest occurred in Lower Cook Inlet. Proportions of the total Cook Inlet salmon harvest that have been caught in Lower Cook Inlet fishing districts by species were Chinook salmon (8%), sockeye salmon (10%), coho salmon (4%), pink salmon (87)%, and 13% for chum salmon (Figure 47).

Most salmon harvested in the Lower Cook Inlet commercial fishery are caught in the Southern District (80%). The Outer District has been next most important, accounting for about 10% of the harvest, while about 7% is caught in the Kamishak District and about 3% in the Eastern District (Figure 48). In Upper Cook Inlet, about 95% of the salmon harvest takes place in the Central District (Figure 49).

Other Salmon Harvests

Subsistence harvests of salmon in Cook Inlet averaged about 8,200 fish from 1994 to 2003 while ranging from about 3,000 to 16,800 fish (Table 21). Recent harvests have increased somewhat from those observed in the

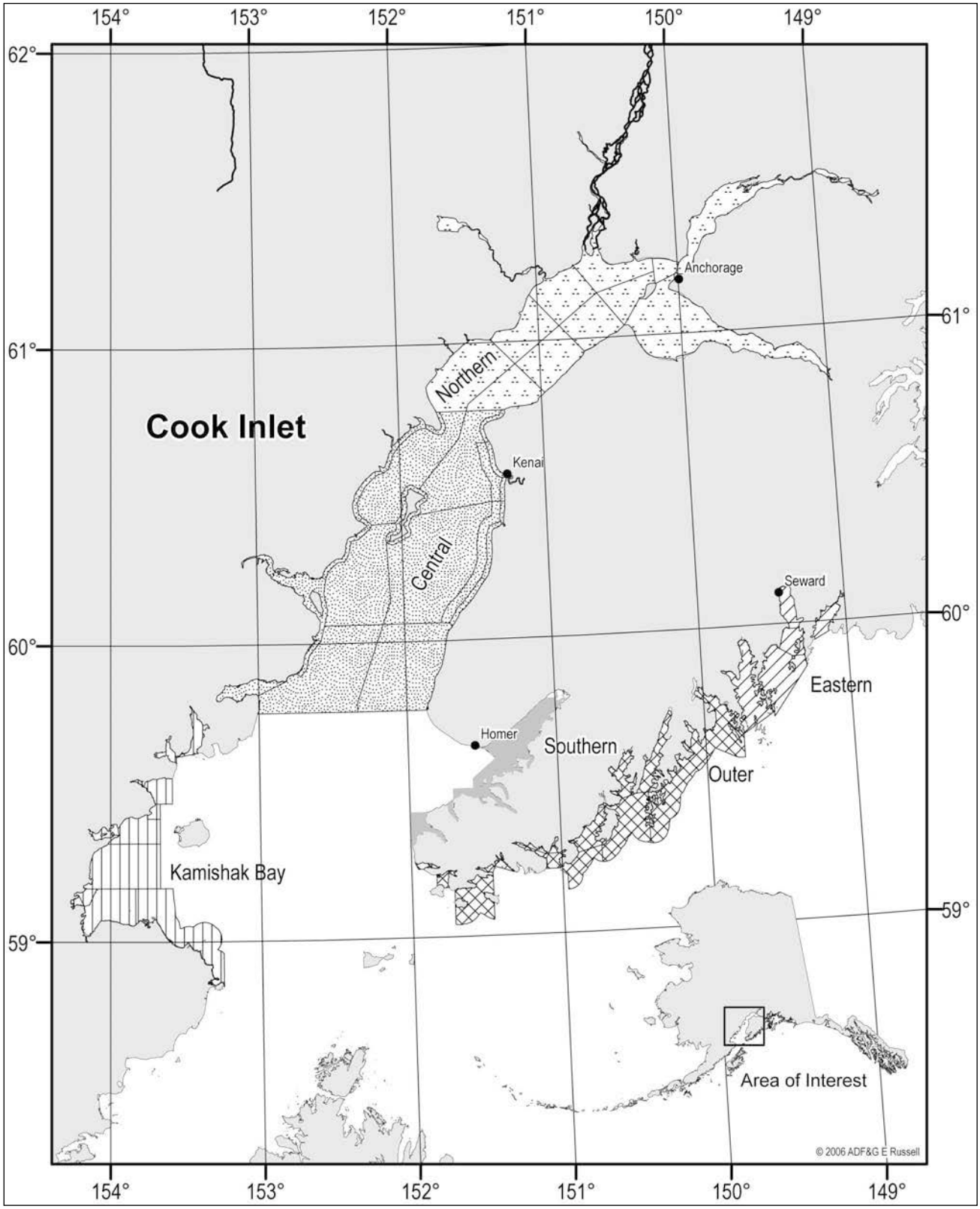

Figure 45. Cook Inlet area commercial salmon fishery.

1980s, particularly for sockeye salmon (Figure 50). Sockeye salmon have comprised about 35% of the harvest over the time period of 1980 to 2003, followed by Chinook salmon (23%), pink salmon (22%), coho salmon (16%), and chum salmon (4%). Subsistence harvests of salmon in Cook Inlet are minor compared to commercial harvest levels. The ratios of commercial harvests to subsistence harvests from 1994 to 2003 were 10:1 for Chinook salmon, 870:1 for sockeye salmon, 220:1 for coho salmon, 1,260:1 for pink salmon, 435:1 for chum salmon, and 660:1 for all salmon.

Salmon harvests in the Cook Inlet sport fishery have increased over the last 25 years (Table 22). Chinook, sockeye, and coho salmon are the primary

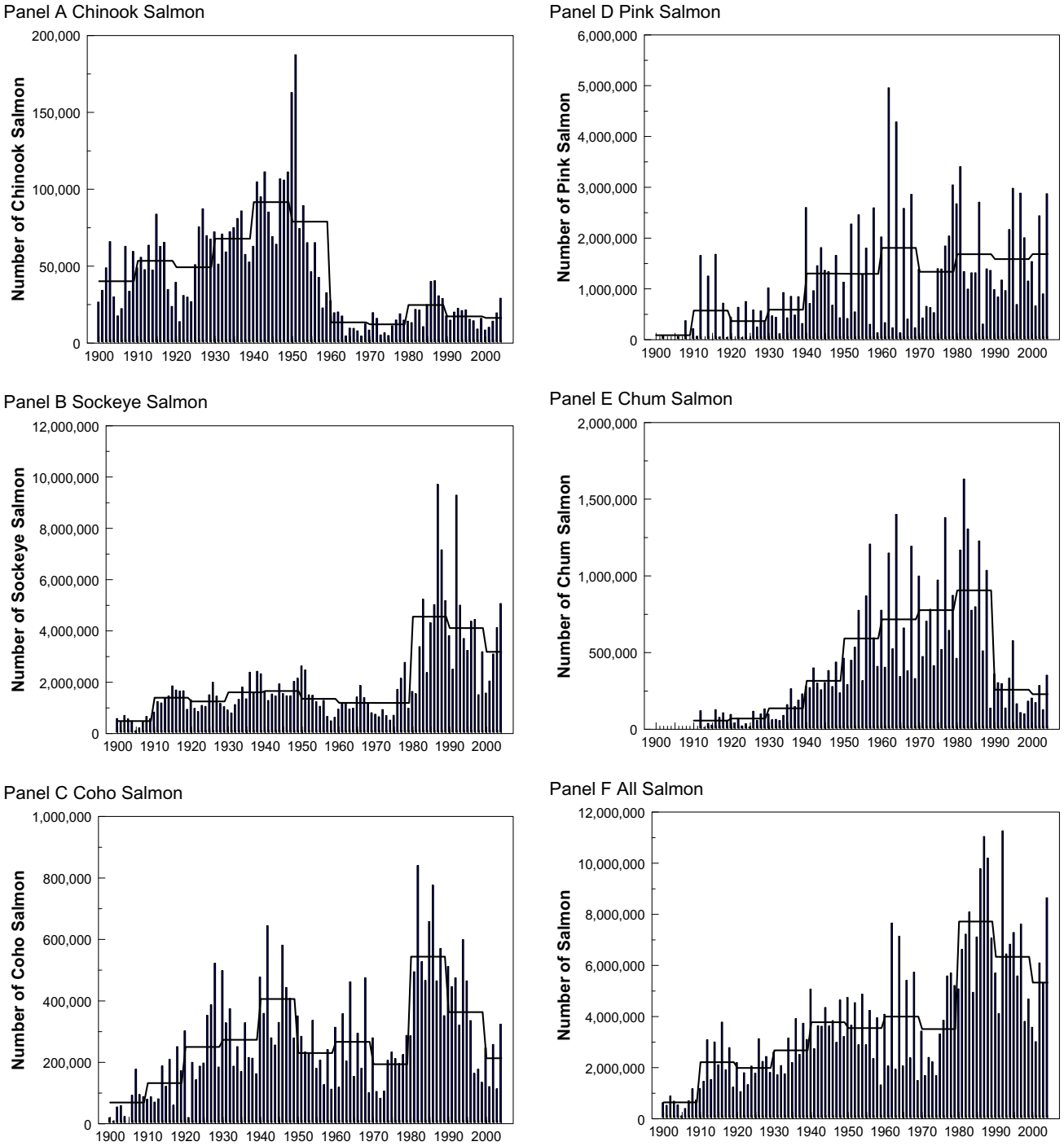

Figure 46. Commercial salmon harvests in Cook Inlet from 1900–2004; bars provide annual catches and lines provide decade averages.

species targeted by sport anglers. Like subsistence fisheries, harvests in the sport fishery are generally small in comparison to the commercial harvest, with the notable exceptions of Chinook and coho salmon.

Table 20. Average price paid per pound for salmon caught in Cook Inlet commercial fisheries during 2004.

	Chinook	Sockeye	Coho	Pink	Chum
Lower Cook Inlet	$1.56	$0.77	$0.47	$0.04	$0.20
Upper Cook Inlet	$1.00	$0.65	$0.20	$0.05	$0.12

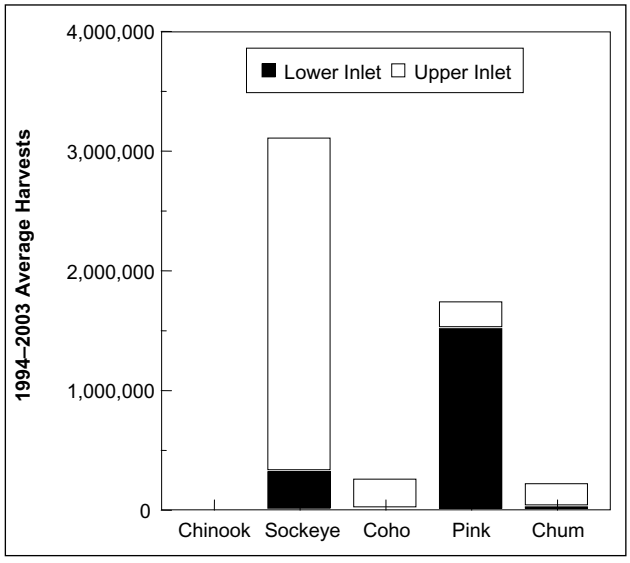

Figure 47. Recent 10-year (1994–2003) average commercial salmon harvests by species in Lower and Upper Cook Inlet.

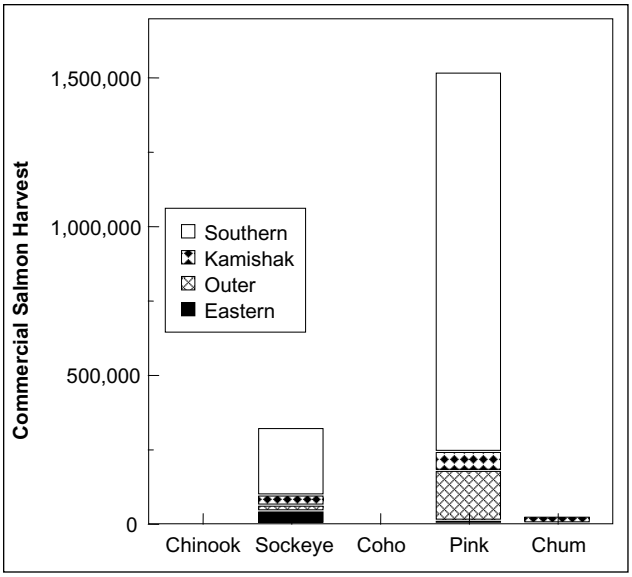

Figure 48. Recent 10-year (1994–2003) average commercial salmon harvests by species in the 4 fishing districts of Lower Cook Inlet.

The Alaska Board of Fisheries has made allocative decisions and adopted management plans that have limited access by commercial fishermen to Chinook and coho salmon in Cook Inlet. The ratio of the total commercial to total sport fishery salmon harvests since 2000 is about 8:1; ratios vary considerably by species. Since 2000, the ratio of commercial harvests to sport harvests are 0.25:1 for Chinook salmon, 10:1 for sockeye salmon, 1:1 for coho salmon, 60:1 for pink salmon, and 35:1 for chum salmon.

Commercial Salmon Fishery Users

As of August 31, 2005, there were 1,390 limited entry permits valid for salmon fishing in Cook Inlet; 82 (6%) were purse seine permits, 571 (41%) were drift gillnet permits, and the remaining 737 (53%) were set gillnet permits (Table 4). Purse seine gear has accounted for about 34% of the commercial harvest of salmon in Cook Inlet while set gillnet accounts for 31% and

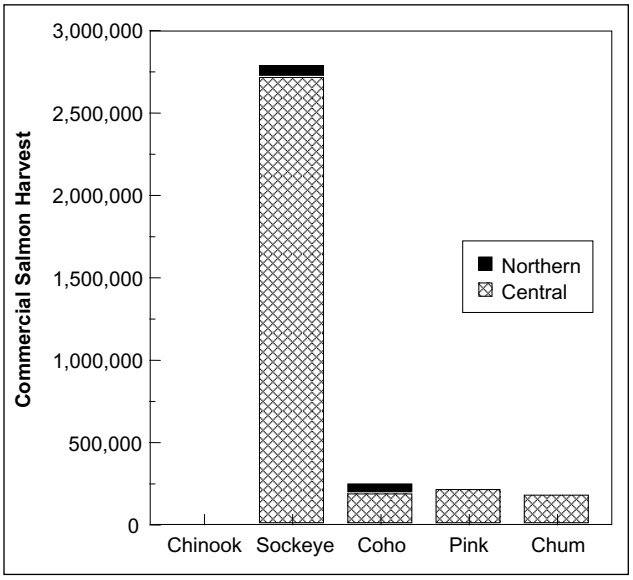

Figure 49. Recent 10-year (1994–2003) average commercial salmon harvests by species in the 2 fishing districts of Upper Cook Inlet.

Table 21. Average annual harvests of salmon in Cook Inlet subsistence fisheries from 1994–2003 (rounded to the nearest 100 fish).

Species	1994–2003 Average	Annual Minimum	Annual Maximum
Chinook	1,500	900	1,900
Sockeye	3,600	900	11,500
Coho	1,200	400	2,000
Pink	1,400	500	2,100
Chum	500	200	1,200
Total	8,200	3,000	16,800

drift gillnet gear accounts for 35% (Figure 51). For Chinook salmon in Cook Inlet commercial fisheries, about 95% are harvested by set gillnet gear, 3% by drift gillnet gear and 1% by purse seine gear. About 47% of sockeye salmon in Cook Inlet are harvested by drift gillnet gear, about 44% by set gillnet gear and about 9% by purse seine gear. About 50% of coho salmon in Cook Inlet are harvested by drift gillnet gear, about 47% by set gillnet gear and about 3% by purse seine gear. About 86% of pink salmon in Cook Inlet are harvested by purse seine gear, about 8% by set gillnet gear and about 6% by drift gillnet gear. For chum salmon, about 78% are harvested by drift gillnet gear while set gillnets and purse seines are used to each capture about 11% of the total chum salmon catch.

Exvessel Value

The average annual exvessel value of the commercial salmon fishery in Cook Inlet from 1985 to 2004 was about $41 million, ranging from a low of about $9 million in 2001 to a high of about $136 million in 1988. Adjusted for inflation and expressed in 2004 dollars, the average annual exvessel value was about $59 million. Inflation-adjusted exvessel value ranged from a low of $10 million in 2001 when about 3 million salmon were harvested to a high of $218 million in 1988 when about 10 million salmon were harvested (Figure 52). As elsewhere in Alaska, value has trended downward during the last 15 years, although a minor upward trend is apparent since 2001. From 1985 to 2004, sockeye salmon accounted for 90% of the inflation adjusted total exvessel value, followed by coho salmon (4%), chum salmon (3%), pink salmon (2%) and Chinook salmon (1%).

A substantial portion of the reduction in the exvessel value of the commercial salmon fishery over the past 15 years is due to a large reduction in the price paid per pound to fishermen when they sell their catch. For instance, in 1988 when exvessel value for sockeye salmon peaked in the Cook Inlet commercial fishery, fishermen were paid about $2.50 per pound, whereas in 2001 when the lowest exvessel value occurred, fishermen were only paid $0.62 in Lower Cook Inlet and $0.65 in Upper Cook Inlet (Figure 53).

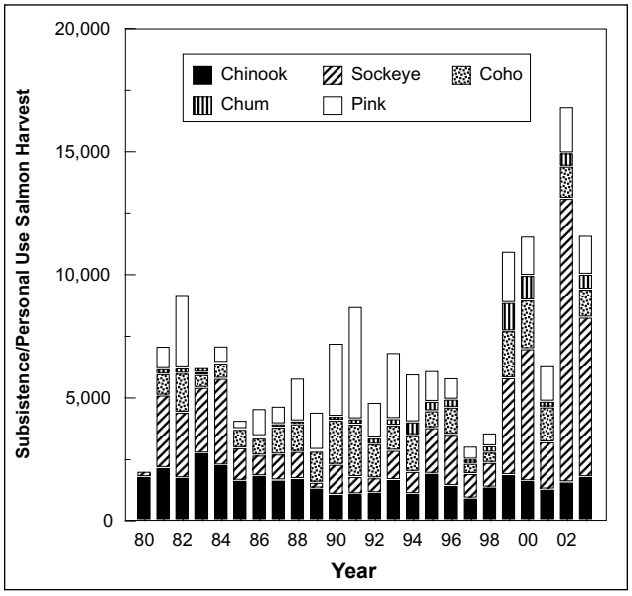

Figure 50. Harvests of salmon in subsistence fisheries of Cook Inlet, 1980–2003.

Table 22. Average annual harvests of salmon in the Cook Inlet sport fishery.

Species	1980–1989	1990–1999	2000–2004
Chinook	51,600	78,669	72,244
Sockeye	186,119	246,404	345,680
Coho	104,252	160,487	224,106
Pink	36,599	23,505	29,948
Chum	8,406	4,914	6,273
Total	386,976	513,979	678,251

Management

The salmon fisheries of Cook Inlet are managed by ADF&G with the goal of achieving and maintaining sustained production. Much of the management effort in Upper Cook Inlet is directed at gillnet fisheries that target sockeye salmon in the Central District, whereas in Lower Cook Inlet, much of the management effort

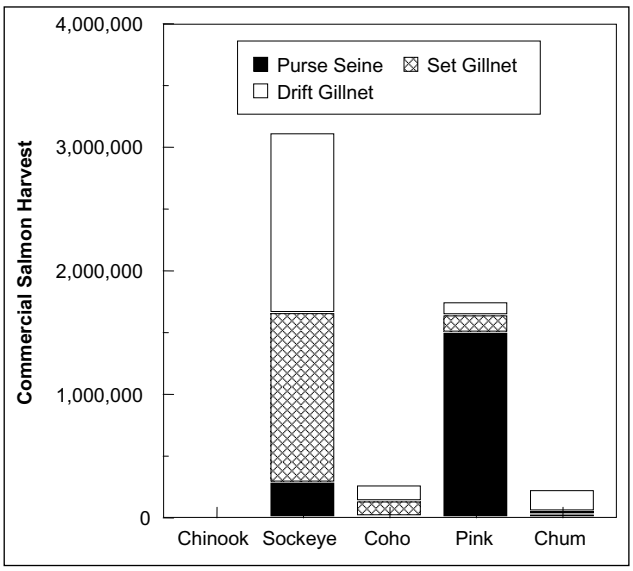

Figure 51. Recent 10-year (1994–2003) average commercial salmon harvests by gear type in Cook Inlet.

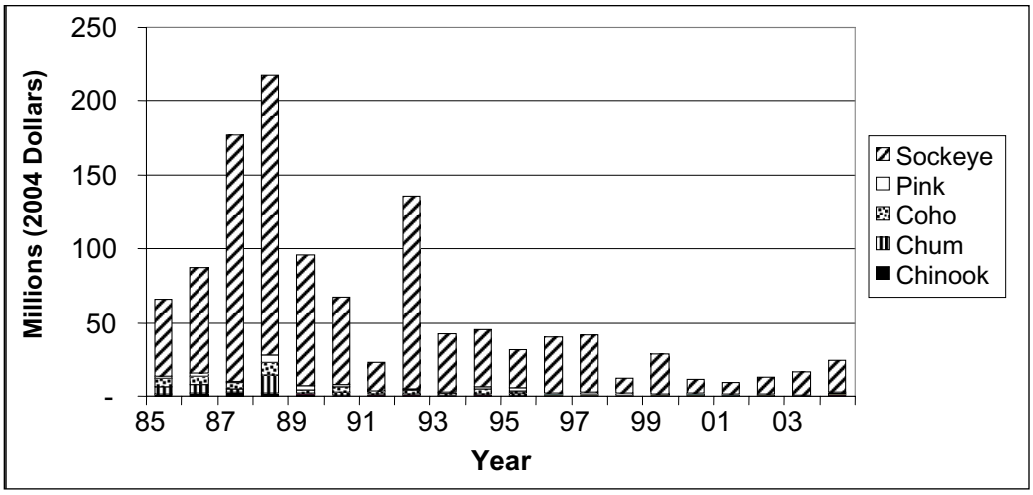

Figure 52. Exvessel value of the Cook Inlet commercial salmon fishery, 1985–2004, adjusted for inflation into 2004 dollars.

involves purse seine fishing in the Southern District. The Board of Fisheries has developed a number of management plans for Cook Inlet salmon fisheries. Salmon managers at ADF&G in Homer and Soldotna use their emergency order authority to carry out these regulatory management plans that serve to both allocate salmon to competing users and to conserve the salmon resource.

An active salmon fishery enhancement program has existed in Cook Inlet for the past several decades. The emphasis of that program has shifted somewhat from production of pink salmon to various enhancement techniques for sockeye salmon. Enhanced production can contribute as much as half of the catch of sockeye salmon in Lower Cook Inlet. While the enhancement program is very important in Upper Cook Inlet, the proportion of the catch from enhancement is less than 10%. Fishery managers in both Homer and Soldotna work with aquaculture associations and others to ensure commercial fishermen access to enhanced salmon runs. Annual management reports written by ADF&G staff since the early 1960s provide extensive and detailed fishery data and insight into the Cook Inlet management program and fishery. See Hammarstrom and Dickson (2005) for Lower Cook Inlet and Shields and Fox (2005) for Upper Cook Inlet.

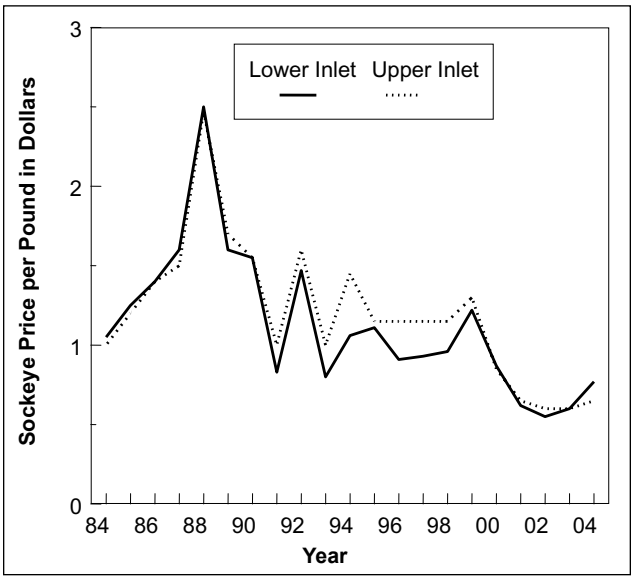

Figure 53. Average price paid per pound for sockeye salmon in Lower and Upper Cook Inlet commercial fisheries, 1984–2004.

Management of Cook Inlet commercial salmon fisheries is difficult and complex because annual run sizes and timing is often uncertain when decisions must be made, mixed stocks are harvested while some of the harvested stocks are still a considerable distance from their home streams, and the Board of Fisheries adopted management plans that address allocative issues and concerns between commercial and other users of the salmon resource. Inseason management of Cook Inlet commercial salmon fisheries is based upon salmon run abundance and timing indicators. Catch data, catch per effort data, test fish data, catch composition data, and escapement information from a variety of sources is used to assess stock strength on an inseason basis. Escapements of major stocks of sockeye salmon returning to Upper Cook Inlet are monitored continuously with the aid of sonar or weirs; for other stocks, surveys are made to index escapement abundance. Inseason run timing models are used to predict subsequent escapement levels using historic run passage information. These various data and predictions are used in concert with management plans adopted by the Board of Fisheries to adjust fishing areas and times with the goal of achieving escapement targets and allocative criteria

set by the Board of Fisheries. From 2000 to 2004, ADF&G Division of Commercial Fisheries managers issued an average of 54 emergency orders per year to regulate Cook Inlet salmon harvests, with a range of 44 in 2001 to 80 in 2004. Descriptions of each emergency order and the reasons for their issuance are provided in annual management reports. For an example, see Shields and Fox (2005) for the 2004 Upper Cook Inlet season.

Escapement goals currently in effect for management of salmon fisheries in the Cook Inlet area are fully described in Otis and Hasbrouck (2004) for Lower Cook Inlet and in Hasbrouck and Edmundson (2006) for Upper Cook Inlet. There are 40 sustainable escapement goals in effect in Lower Cook Inlet and 5 biological escapement goals and 26 sustainable escapement goals in effect in Upper Cook Inlet. Several of the escapement data sets available for Cook Inlet salmon are described in the following paragraphs.

Chinook salmon

There are 3 biological escapement goals and 18 sustainable escapement goals in effect for Chinook salmon spawning in Upper Cook Inlet and 3 sustainable escapement goals in effect for Chinook salmon in Lower Cook Inlet. Chinook salmon returning to the Kenai River are assessed by sonar in the lower river and 2 runs are recognized—an early run and a late run. The biological escapement goal for early-run Chinook salmon in the Kenai River is from 7,200 to 14,400 fish and in 17 of the past 19 years (89%) the observed escapement has met or exceeded the lower end of the goal range (Figure 54). The late run has a biological escapement goal range of 17,800 to 35,700 fish and all 19 recent escapements have exceeded the lower end of the range (Figure 55). The escapements for both runs in 2002 were lower than in most other years, the early run was short of the goal and the late run just barely surpassed the lower end of the goal range. The third biological escapement goal for Chinook salmon in Cook Inlet is 13,000 to 28,000 fish for the Deshka River stock of Chinook salmon (Figure 56). Since 1974, the escapement of Chinook salmon in the Deshka River exceeded the lower end of the goal range in 28 of the 31 years (90%); exceptions were in 1975, 1994, and 1995. There are an additional 18 spawning populations of Chinook salmon in Upper Cook Inlet with sustainable escapement goals. Of those 18, the 12 largest populations with the most complete recent 10-year escapement observations are included in Figure 57. With 10 years of observed escapement for the 12 spawning populations, 120 cells are possible; of these possible 120 cells, escapement counts were not obtained in 4 cells, resulting in a set of 116 cells with observations. During the time period from 1995 to 2004, 109 of the observed escapements (93%) exceeded the lower end of the sustainable escapement

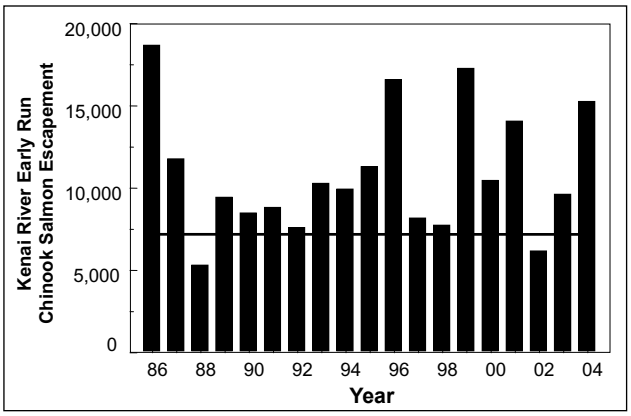

Figure 54. Early-run Chinook salmon escapements from 1986–2004 in the Kenai River, Upper Cook Inlet and the lower end of the biological escapement goal range of 7,200–14,400.

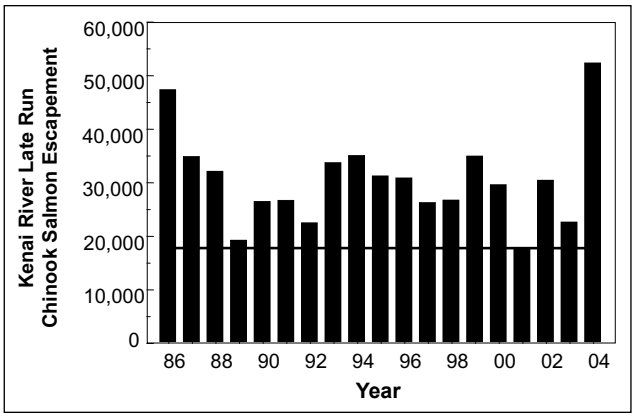

Figure 55. Late-run Chinook salmon escapements from 1986–2004 in the Kenai River, Upper Cook Inlet and the lower end of the biological escapement goal range of 17,800–35,700.

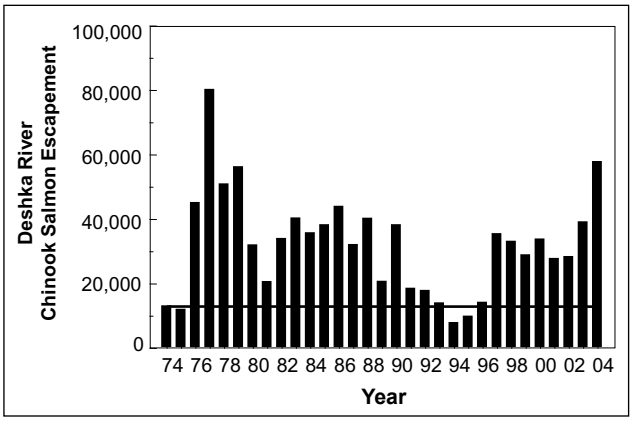

Figure 56. Chinook salmon escapements from 1974–2004 in the Deshka River, Upper Cook Inlet and the lower end of the biological escapement goal range of 13,000–28,000.

goal ranges (Figure 57). During the most recent 5-year period from 2000 to 2004, in 56 of the possible 58 cases (97%), the observed escapement exceeded the lower end of the sustainable escapement goal range.

Sockeye salmon

There are 2 biological escapement goals and 4 sustainable escapement goals in effect for sockeye salmon spawning in Upper Cook Inlet and 8 sustainable escapement goals in effect in Lower Cook Inlet. The largest stock of sockeye salmon in Cook Inlet spawns in the Kenai River system, and since 1968, escapements have been monitored by counting upstream fish with the aid of sonar equipment and subsequently subtracting fish caught upstream or entering a couple of tributaries where weirs are in place. The current sustainable escapement goal is 500,000 to 800,000 fish; since 1987 the annual escapements have exceeded the lower end of the goal range in 15 of the 19 years (79%); escapements less than the goal range occurred in 1990, 1991, 2000, and 2001 (Figure 58). The Russian River is located in the Kenai River drainage and it supports 2 runs, an early run and a late run. The early-run escapements have been counted with the aid of a weir since 1965 and have consistently exceeded the lower end of the sustainable escapement goal range of 14,000 to 37,000 fish since 1976 (Figure 59). The late-run escapements have been counted with the aid of a weir since 1963 and have consistently exceeded the lower end of the sustainable escapement goal range of 30,000 to 110,000 fish since 1994 (Figure 60).

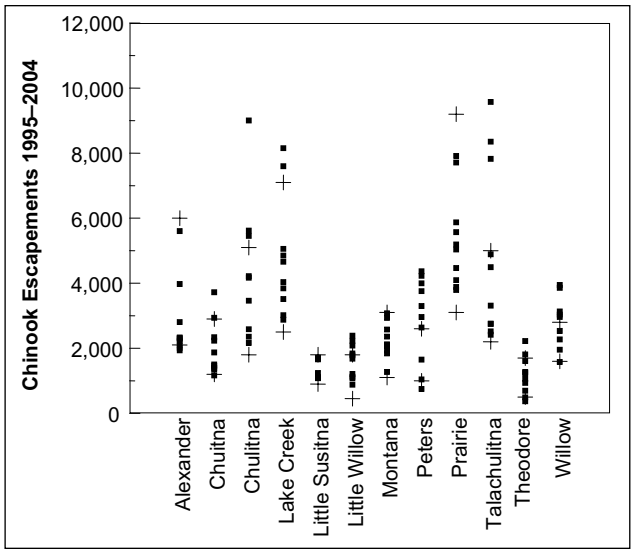

Figure 57. Chinook salmon escapements from 1995–2004 for 12 of the 18 Upper Cook Inlet stocks with sustainable escapement goals (annual escapements shown as solid squares, lower and upper ends of sustainable escapement goal range shown as + signs).

The Kasilof River has a biological escapement goal of 150,000 to 250,000 sockeye salmon; escapements in this river are counted with the aid of sonar

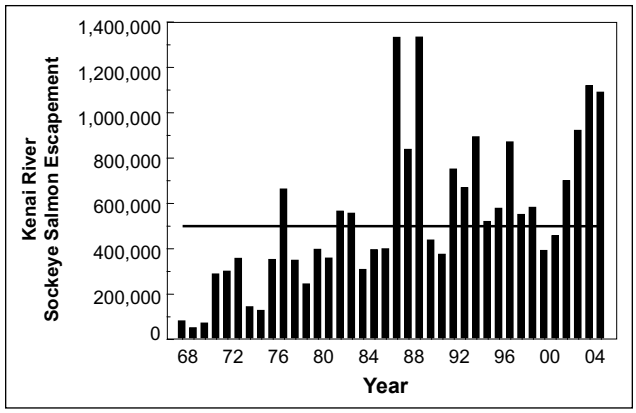

Figure 58. Sockeye salmon escapements from 1968–2005 in the Kenai River, Upper Cook Inlet and the lower end of the sustainable escapement goal range of 500,000–800,000.

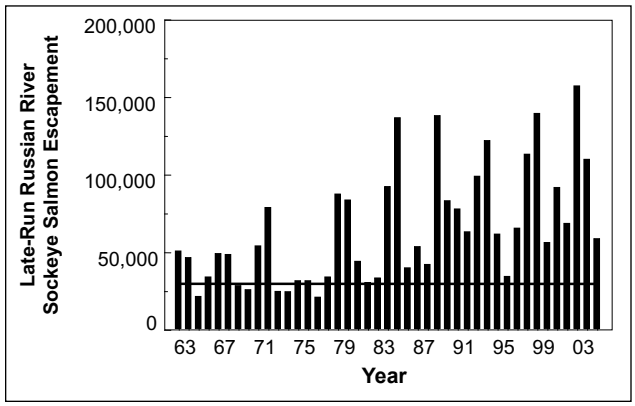

Figure 59. Early-run sockeye salmon escapements from 1965–2005 in the Russian River, Upper Cook Inlet and the lower end of the sustainable escapement goal range of 14,000–37,000.

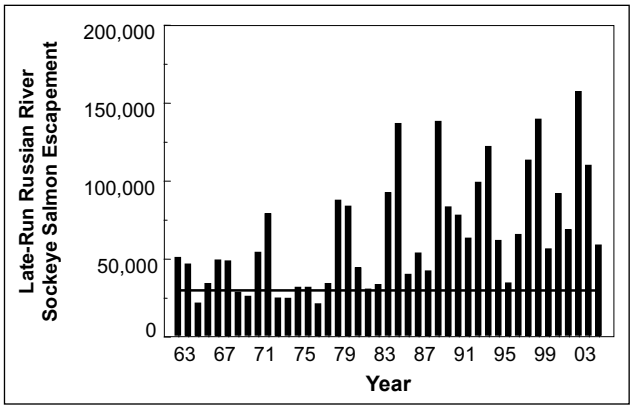

Figure 60. Late-run sockeye salmon escapements from 1963–2005 in the Russian River, Upper Cook Inlet and the lower end of the sustainable escapement goal range of 30,000–110,000.

gear. Since 1994, sockeye salmon escapements in the Kasilof River have consistently exceeded the lower end of the goal range (Figure 61). The biological escapement goal range for sockeye salmon in the Crescent River is 30,000 to 70,000 fish, escapements are counted with the aid of sonar gear and have consistently exceeded the lower goal range since 1997 (Figure 62). Sockeye salmon spawn in the Susitna River and ADF&G has counted salmon with the aid of sonar gear in the Yentna River, a tributary to the Susitna, since 1981. The sustainable escapement goal for the Yentna River is 90,000 to 160,000 fish (Figure 63) and this goal has been met or exceeded in 18 of the last 24 years (75%). However, in the last 5 years, the sustainable escapement goal for the Yentna River has only been met once (20%).

Figure 64 shows escapements from 1995 to 2004 and sustainable escapement goal ranges for 8 spawning populations of sockeye salmon in Lower Cook Inlet. With 8 stocks and 10 years of annual escapements, there are 80 cells included and of those, the observed escapement exceeded the sustainable escapement goal range in 71 of the cases (89%). Desire Lake failed to achieve its sustainable escapement goal range in 4 of the 10 years (1998, 2000, 2001, and 2003); Aialik Lake failed to achieve its goal in 1995 and 1996, Chenik Lake failed to achieve its goal in 1995 and 2001, and Mikfik Lake failed to achieve its goal in 2001 (Figure 64).

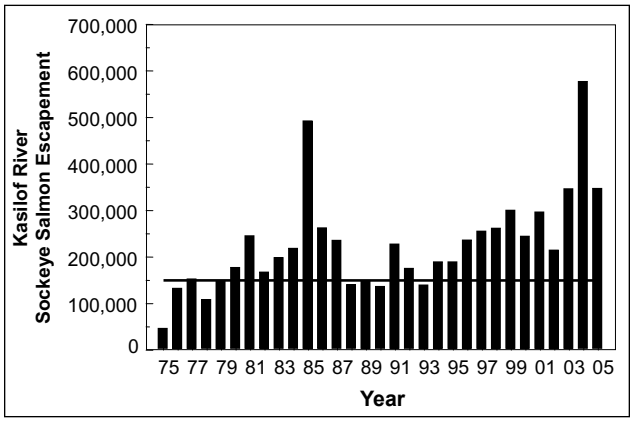

Figure 61. Sockeye salmon escapements from 1975–2005 in the Kasilof River, Upper Cook Inlet and the lower end of the biological escapement goal range of 150,000–250,000.

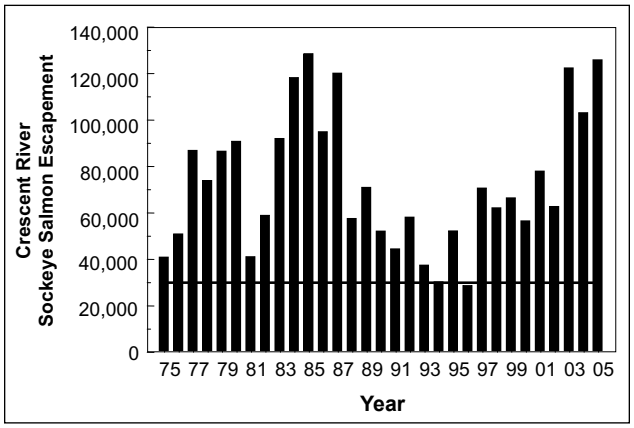

Figure 62. Sockeye salmon escapements from 1975–2005 in the Crescent River, Upper Cook Inlet and the lower end of the biological escapement goal range of 30,000–70,000.

Coho salmon

There are 3 sustainable escapement goals in place for coho salmon spawning in Upper Cook Inlet. The

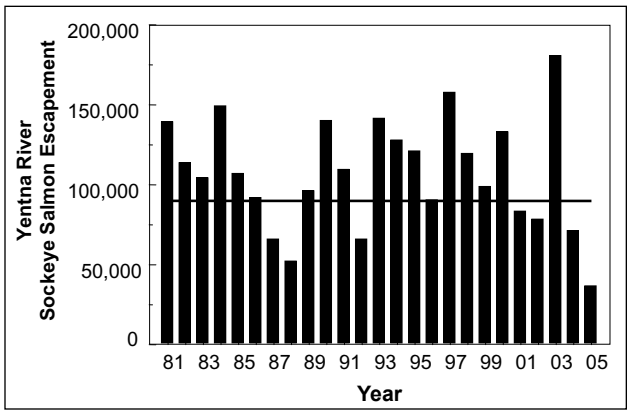

Figure 63. Sockeye salmon escapements from 1981–2005 in the Yentna River, Upper Cook Inlet and the lower end of the sustainable escapement goal range of 90,000–160,000.

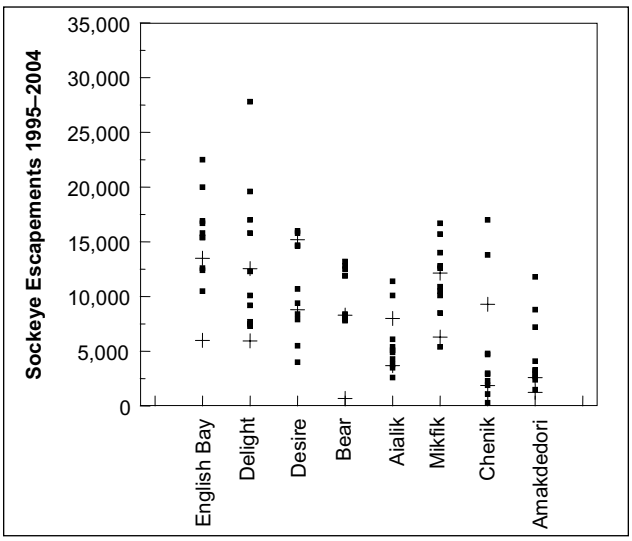

Figure 64. Sockeye salmon escapements from 1995–2004 for the 8 Lower Cook Inlet stocks with sustainable escapement goals (annual escapements shown as solid squares, lower and upper ends of sustainable escapement goal range shown as + signs).

sustainable escapement goal for coho salmon in Jim Creek is 450 to 700 fish (Figure 65) and this goal has been met or exceeded in 17 of the last 20 years (85%). Efforts have been made to count coho salmon in the Little Susitna River since 1988 and the sustainable escapement goal for the stock is 10,100 to 17,700 fish (Figure 66). The Little Susitna River escapement goal for coho salmon has been met or exceeded in 15 of the last 17 years (88%), however, the escapement in 1999 was substantially less than desired.

Pink salmon

There are 20 sustainable escapement goals in effect for pink salmon that spawn in streams of Lower Cook Inlet. Like pink salmon stocks elsewhere, spawning strength in individual streams shows tremendous variability from year to year. Observed annual counts of pink salmon escapement in 3 of the largest spawning populations in Lower Cook Inlet are shown in Figure 67, 68, and 69. In general, since statehood, abundance of pink salmon in Lower Cook Inlet has increased. Pink salmon escapement strength in the last 3 life cycles (since 1999) for even-year fish spawning in the Bruin River exceeded the sustainable escapement goal of 18,650 to 155,750 fish, while the odd-year line failed to achieve the goal in 1999 and 2001 but then exceeded the goal in 2003 (Figure 67). In the Rocky River, the sustainable escapement goal is 9,350 to 54,250 fish and both the even-year line and the odd-year line exceeded the goal in each of the last 3 life cycles of pink salmon (Figure 68). In Sunday Creek, the sustainable escapement goal is 4,850 to 28,850 pink salmon and both lines exceeded the goal in each of the last 3 life cycles (Figure 69). Ten of the other 17 sustainable escapement goals for spawning populations of pink salmon in Lower Cook Inlet are shown in Figure 70 along with observed escapement counts from 1995 to 2004. The 10 spawning popula-

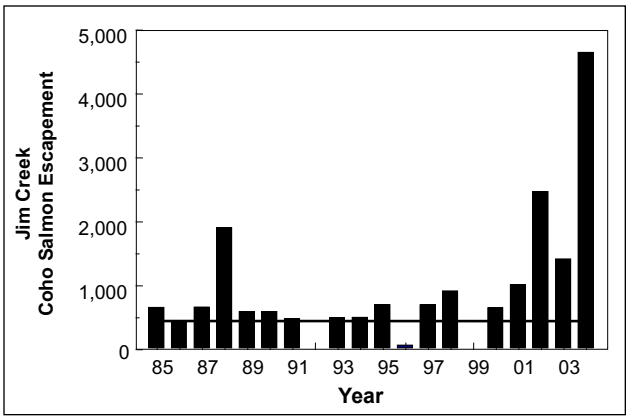

Figure 65. Coho salmon escapements from 1985–2004 in Jim Creek, Upper Cook Inlet and the lower end of the sustainable escapement goal range of 450–700.

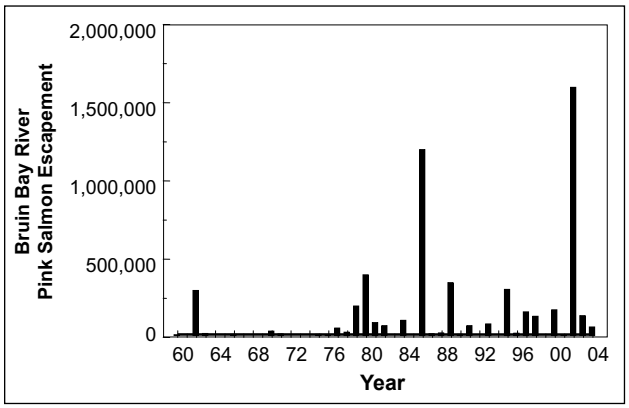

Figure 67. Pink salmon escapement counts from 1960–2004 in the Bruin River, Lower Cook Inlet and the lower end of the sustainable escapement goal of 18,650–155,750; counts not obtained in 1961, 1964, 1965, and 1968.

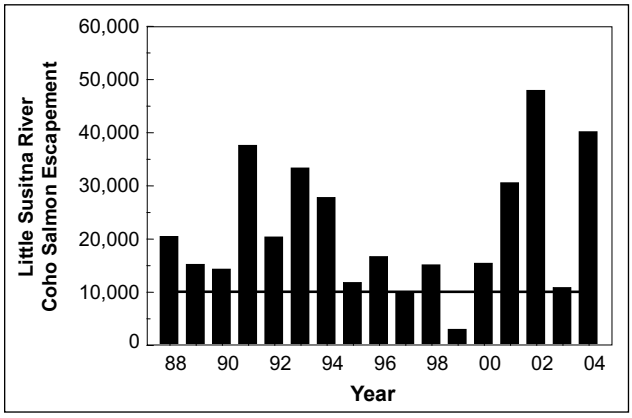

Figure 66. Coho salmon escapements from 1988–2004 in the Little Susitna River, Upper Cook Inlet and the lower end of the sustainable escapement goal range of 10,100–17,700.

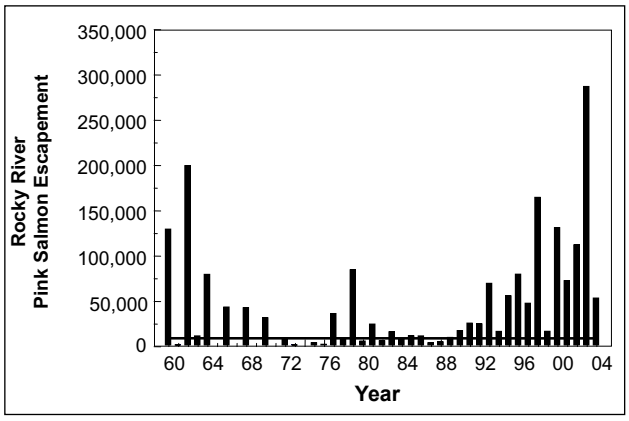

Figure 68. Pink salmon escapement counts from 1960–2004 in the Rocky River, Lower Cook Inlet and the lower end of the sustainable escapement goal of 9,350–54,250.

tions shown are the most numerous of the 17 stocks and have the most complete escapement observations. Of the 100 possible stock-year cells, the observed escapement exceeded the sustainable escapement goal in 87 cases (87%). Since 2000, for these 10 spawning populations of pink salmon, the rate of observed escapements exceeding the sustainable escapement goal was 96%. Like the Bruin River, Rocky River, and Sunday Creek pink salmon escapement counts, the observed escapements for these other 10 pink salmon populations often grossly exceeded the escapement goal (Figure 70).

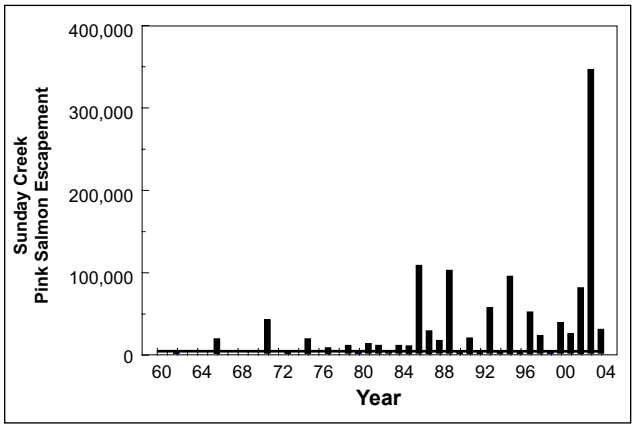

Figure 69. Pink salmon escapement counts from 1960–2004 in Sunday Creek, Lower Cook Inlet and the lower end of the sustainable escapement goal of 4,850–28,850; counts not obtained in 1961, 1964, 1965, 1967, and 1968.

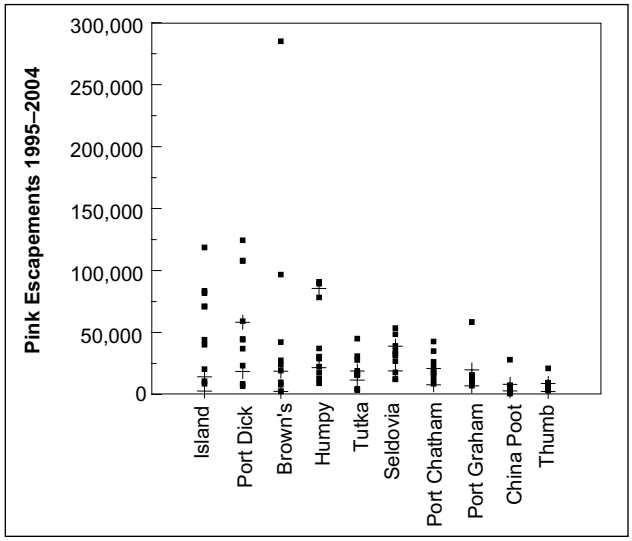

Figure 70. Pink salmon escapements from 1995–2004 for ten of the Lower Cook Inlet stocks with sustainable escapement goals (annual escapements shown as solid squares, lower and upper ends of sustainable escapement goal range shown as + signs).

Chum salmon

There are 12 sustainable escapement goals in effect for chum salmon spawning in Lower Cook Inlet and one sustainable escapement goal in effect for chum salmon spawning in Upper Cook Inlet. The largest stock of chum salmon in Lower Cook Inlet spawns in the McNeil River; the sustainable escapement goal is 13,750 to 25,750 fish. The McNeil River goal for chum salmon has been met in 15 of the past 21 years (Figure 71). Nine of the 11 other Lower Cook Inlet chum salmon stocks that have consistent escapement observations over the past 10 years are shown in Figure 72. Over the 10-year period of time, observed escapements have exceeded sustainable escapement goals for these 9 spawning populations of chum salmon in 87% of the cases (Figure 72). Since 2000, escapement goals for these 9 stocks of chum salmon have been met in 93% of the cases. In Upper Cook Inlet, the chum salmon that spawn in Clearwater Creek have a sustainable escapement goal of 3,800 to 8,400 fish. From 1989 to 2003, the goal was met in 11 of the 15 years (73%). Escapement was not counted in 2004 (Figure 73).

Budget History and Fiscal Support

Many of the salmon stock assessment activities carried out in Cook Inlet are implemented and funded by the ADF&G Division of Sport Fish, including most for Chinook and coho salmon as well as several for sockeye salmon. Other organizations also implement stock assessment activities, such as the Cook Inlet Aquaculture Association, which funds and operates weir-based salmon enumeration programs and other activities in Cook Inlet.

The salmon stock assessment program implemented by the Division of Commercial Fisheries in

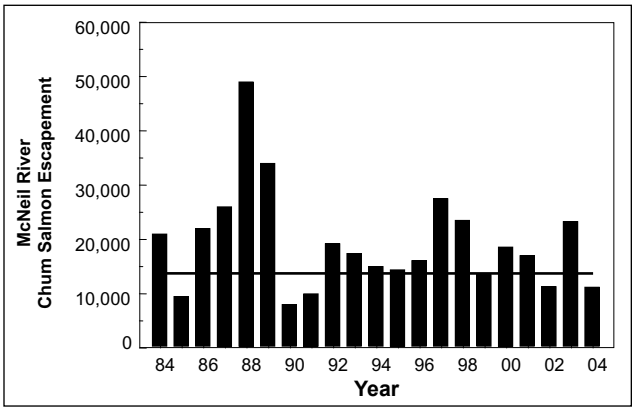

Figure 71. Chum salmon escapement counts from 1984–2004 in the McNeil River, Lower Cook Inlet and the lower end of the sustainable escapement goal of 13,750–25,750.

Lower Cook Inlet consists of about $60,000 for aerial and ground-based escapement surveys, about $15,000 to support a weir based salmon enumeration effort at Delight Lake, and about $40,000 for catch composition sampling. These modest funding amounts and the data they provide are used by the Homer-based staff to manage salmon fisheries in a sustainable manner in Lower Cook Inlet. Any significant improvement in the Lower Cook Inlet salmon stock assessment program will require additional fiscal resources over the modest amounts used for management in this area over the past 40 years.

Substantial program development has taken place in Upper Cook Inlet to assess sockeye salmon and much of the effort is funded and operated by the ADF&G Division of Commercial Fisheries. Sonar gear has been developed, purchased, and used over the past 30 years to count salmon passing upstream in the mainstems of the Kenai, Kasilof, and Crescent rivers as well as the Yentna River, a tributary to the Susitna River. These systems are all glacial and salmon cannot be observed visually. Development and application of sonar-based enumeration represented breakthrough technology in the 1970s. The annual implementation of these stock assessments has greatly assisted the fishery management program in Upper Cook Inlet. Operating costs for these 4 sonar-based escapement assessment efforts total about $200,000 per year. Salmon are counted and sampled for age–sex–size composition as they pass upstream at these 4 locations. While the sonar-based estimates of sockeye salmon passage have benefited fishery management in Cook Inlet, the estimates of passage have not been verified with other methodology since their inception in the 1970s.

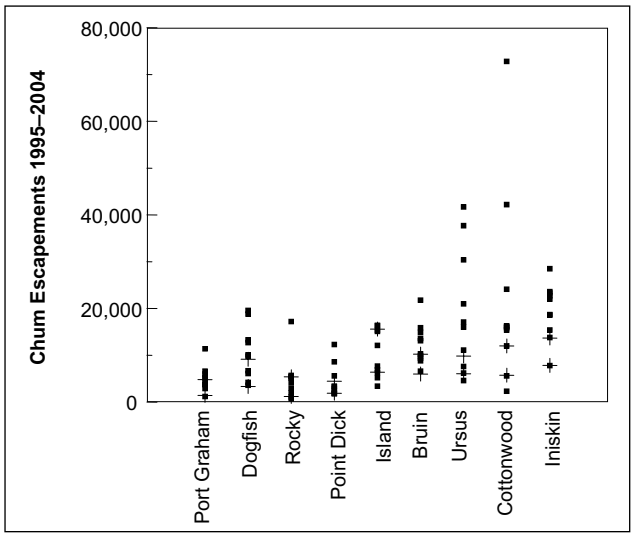

Figure 72. Chum salmon escapements from 1995–2004 for 9 of the Lower Cook Inlet stocks with sustainable escapement goals (annual escapements shown as solid squares, lower and upper ends of sustainable escapement goal range shown as + signs).

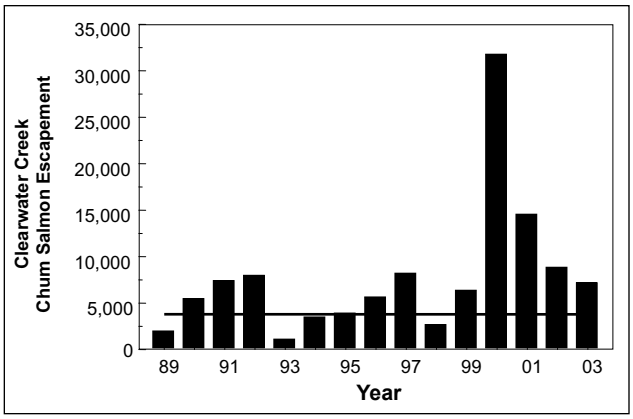

Figure 73. Chum salmon escapement counts from 1989–2003 in Clearwater Creek, Upper Cook Inlet and the lower end of the sustainable escapement goal of 3,800–8,400.

Commercial harvests of sockeye salmon in Upper Cook Inlet are monitored with the fish ticket system. These catches are sampled to estimate age composition of the harvest; costs for catch sampling are about $90,000 per year. In some areas of Cook Inlet, age composition has typically been used to estimate stock composition of the harvest under the assumption of equal exploitation by age class for major sockeye salmon stocks. This information is coupled with assumptions of single stock harvests in other areas. The estimates of stock- and age-specific catch and escapement data have been the basis for development of brood tables, which are used for both preseason forecasting capability and for estimation of stock productivity and identification of biological escapement goals. These efforts have provided the basis for about a 25-year set of paired estimates of escapements and subsequent recruitments for major stocks of sockeye salmon returning to Upper Cook Inlet. These same data can be used to estimate annual harvest rates exerted on these stocks of sockeye salmon. Examination of such estimated harvest rates on Kenai, Kasilof, Crescent, and Susitna-origin sockeye salmon from 1980 to 2005 indicates that very high sustained harvest rates have been exerted on the Kenai stock of sockeye salmon while conversely, moderate harvest rates have been exerted on the Crescent River stock (Figure 74).

While accuracy and precision of estimated annual catches, as well as annual age compositions of both escapements and catches, is considered to be excellent on a postseason basis, the allocation methodology used to apportion sockeye salmon catches to component stocks in Cook Inlet is little more than a crude approxi-

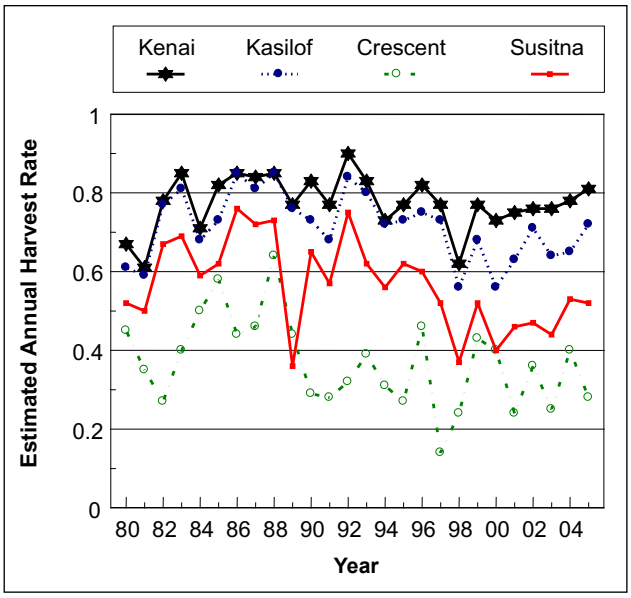

Figure 74. Estimated annual harvest rates for 4 stocks of Upper Cook Inlet sockeye salmon from 1980–2005.

mation of the actual catch by stock. Annual estimates of escapement are of unknown accuracy and precision and, as stated above, these sonar-based estimates have not been verified during the 30 years that they have been used for stock assessment in Upper Cook Inlet. Further, the escapement of the Susitna River stock of sockeye salmon is deemed double the sonar-based estimate derived from the Yentna River; concurrent sonar estimates made in the 2 rivers from 1981 to 1985 indicated the Yentna contributed, on average, 49% of the Susitna drainage escapement of sockeye salmon. The series of largely untested assumptions used to allocate stock composition is problematic. In some parts of Upper Cook Inlet, the assumption is made that sockeye harvests are comprised of a single stock. In other areas, it is assumed that all stocks are exploited at the same level on an age class basis. These assumptions need to be verified with scientifically based stock composition estimation techniques. In the 1980s and 1990s, sporadic efforts were made to implement better fishery science for catch allocations, but budget cuts, logistics, and technical concerns with the methodology resulted in a situation where methods used over the last several years are based on the approach described herein. This is a technical area of the stock assessment program that begged for improvement. Recent advances in DNA-based genetic stock identification methods provide the potential to develop accurate and precise scientifically-based stock composition estimates. In FY 06, with a new increment of general funds, the Division of Commercial Fisheries has embarked on a $250,000-per-year effort to implement genetic stock identification of sockeye salmon in Cook Inlet and hence improve the scientific basis of catch allocations. A test fish program implemented annually in Cook Inlet to gauge abundance of sockeye salmon entering Upper Cook Inlet (ongoing operational cost of about $70,000)—if coupled with inseason genetic-based stock composition—has the potential to provide abundance by stock, and thereby provide better inseason information for fishery management than currently exists.

Another major concern right now is stock assessment and status of Susitna River-origin sockeye salmon. Only the fish migrating in the Yentna are annually assessed and the Yentna River sockeye salmon sustainable escapement goal has only been met in one of the last 5 years (Figure 63). As a result, in 2006, ADF&G is planning to initiate a large-scale stock assessment effort in the Susitna River in an effort to better understand productivity and to document when and where Susitna River-origin sockeye salmon are caught in fisheries. This information will be used to develop an improved regulatory management regime. In FY 06, the Division of Commercial Fisheries obtained a new increment of $200,000 in operational funds for Susitna sockeye escapement assessment and has requested additional new funding in FY 07.

The Division of Commercial Fisheries faces several challenges in Cook Inlet. The Cook Inlet commercial salmon fishery is an important fishery in Alaska, yet the Division has had difficulty maintaining adequate fiscal resources needed to implement the intense inseason management and stock assessment effort required to manage sockeye salmon stocks in Upper Cook Inlet. Operational budget increments obtained in FY 06 for genetic-based stock identification and improved stock assessment in the Susitna River have helped the situation; however, additional resources are needed. The commercial fishing industry in Cook Inlet faces other challenges. Low prices paid for sockeye salmon since the early 1990s, even when coupled with strong annual harvests, have resulted in business failures for both fishermen (low exvessel prices) and processors (low first wholesale prices). Can the industry and fishery be restructured, can the fishery management regime be modified, and can the product be harvested and processed such that value increases with the end result being improved economic viability of the Cook Inlet commercial salmon fishery?

KODIAK COMMERCIAL SALMON FISHERY

Area Description and Gear Types

The Kodiak area includes the waters of the western Gulf of Alaska surrounding the Kodiak Archipelago and the portion of the Alaska Peninsula that drains into Shelikof Straight between Cape Douglas (boundary with Cook Inlet) and Kilokak Rocks (boundary with Chignik). The area includes 7 fishing districts (Afognak District, Northeast Kodiak District, Eastside Kodiak District, Alitak Bay District, Southwest Kodiak District, Northwest Kodiak District, and Mainland District) each comprised of numerous sections (Figure 75). Gear types currently used in Kodiak area commercial salmon fisheries include purse seines, set gillnets and beach seines. Salmon spawning activity has been documented in about 800 streams within the Kodiak area. An estimated 440 streams support significant salmon production. Of those streams, 4 support Chinook salmon spawning populations, 39 support sockeye salmon spawning populations, 174 support coho salmon spawning populations, all support pink salmon spawning populations, and about 150 support chum salmon spawning populations. Salmon tagging studies have demonstrated the presence of nonlocal stocks of salmon in the commercial salmon harvests of the Kodiak area. Nonlocal stocks of salmon present in Kodiak area commercial salmon fisheries include sockeye salmon migrating to streams in Cook Inlet, Chignik, and the southern portion of the Alaska Peninsula and Chinook salmon from Oregon through Cook Inlet.

History of the Commercial Salmon Fishery

The harvest of salmon in the Kodiak area for subsistence use has been ongoing for thousands of years. Commercial use began in the early 1800s by the Russians; however, the fisheries were small and consisted of salted salmon ventures. Salmon streams were blocked and salmon were captured as they schooled behind the barriers. Commercial salmon fishing in the Kodiak area by U.S. citizens began in 1882 when a cannery was built on Karluk spit and 58,800 sockeye salmon were beach seined and processed (Rich and Ball 1931). The Karluk commercial fishery harvest in 1901 was about 4 million sockeye salmon. Thereafter, the Karluk sockeye salmon stock declined in productivity along with the commercial fishery. Since the 1930s, many researchers have discussed the Karluk sockeye salmon stock and theorized about the reasons for the decline.

During the 1880s and 1890s, many additional salmon canneries were built throughout the Kodiak management area and the commercial salmon fishery quickly grew. Within a few years the commercial salmon fishery had spread throughout the Kodiak salmon management area. The first fish trap was built in 1896. Harvest gears used in the Kodiak area as the U.S. salmon fishery developed included beach seines, fish traps, purse seines, and gillnets. Between 1900 and 1909, the annual average commercial harvest in the Kodiak area was about 3,000 Chinook salmon, 3.2 million sockeye salmon, 60,000 coho salmon, and 90,000 pink salmon. Growth of the commercial salmon fishery as measured by increasing harvests continued in the Kodiak management area until the 1930s.

From inception of the fishery until 1987, commercial harvests of Chinook salmon in the Kodiak area ranged from 100 to 5,000 fish per year with decadal average annual harvests ranging from 1,100 to 3,300 fish. In 1988, almost 22,400 Chinook salmon were commercially harvested, about 4-fold the earlier peak catch. In 1989, only about 100 Chinook salmon were harvested. Since 1990, annual commercial harvests of Chinook salmon have ranged from 12,300 to 41,000 fish and have averaged about 21,000 fish (Figure 76, Panel A). Sockeye salmon harvests in Kodiak steadily decreased from 3.2 million fish in the 1900s to about 390,000 fish in the 1950s (Figure 76, Panel B). Since statehood, sockeye salmon harvests have increased substantially, averaging 1.7 million fish in the 1980s, 4.3 million fish in the 1990s and 3.1 million fish since 2000. Commercial harvests of coho salmon in the Kodiak area reached a prestatehood average of about 130,000 fish in the 1920s and 1930s. Coho salmon harvests increased substantially over the last 25 years with average catch levels about 194,000 fish in the 1980s, 312,000 fish in the 1990s, and 414,000 fish since 2000 (Figure 76, Panel C). Commercial harvests of pink salmon from the Kodiak area have generally increased over the last 100 years (Figure 76, Panel D). Average annual catch levels for Kodiak pink salmon have been about 9.7 million fish in the 1980s, 15.9 million fish in the 1990s, and 18.9 million fish since 2000. Chum salmon harvests in the Kodiak area, like pink salmon harvests have generally increased over the last 100 years (Figure 76, Panel E), with average harvest levels of about 911,000 fish in the 1980s, 743,000 fish in the 1990s, and 942,000 fish since 2000. Commercial harvests of all salmon in the Kodiak area show peaks in the 1990s averaging about 21.3 million fish; since 2000 the average has been about 23.4 million fish, with a general increase apparent over the past 100 years (Figure 76, Panel F).

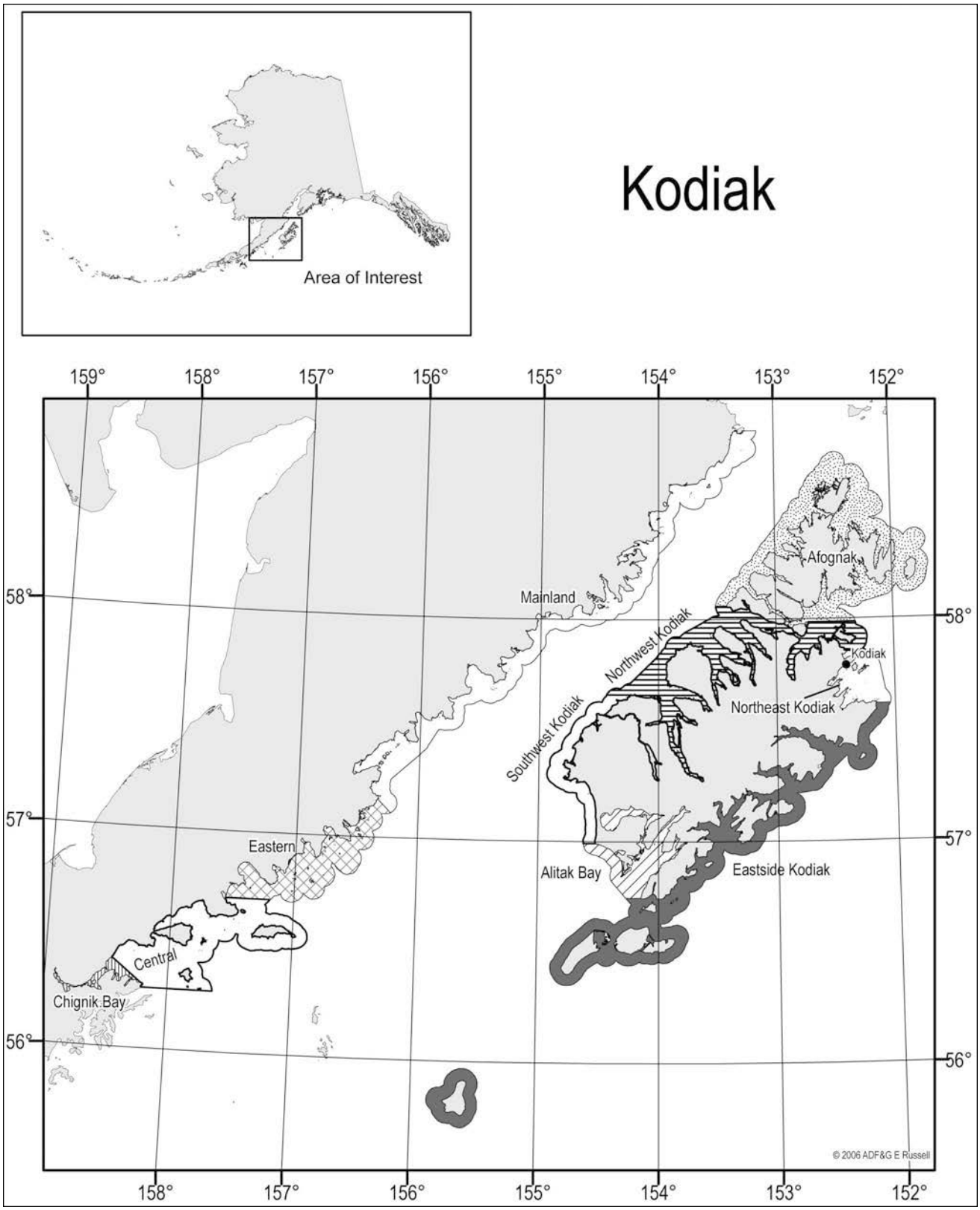

Figure 75. Kodiak area commercial salmon fishery.

Other Salmon Harvests

Salmon are harvested for subsistence use in the Kodiak area. The ADF&G Division of Commercial Fisheries manages the Kodiak subsistence salmon fishery; during the 5-year period from 2000 to 2004, management staff issued 8 emergency orders specific to salmon subsistence fisheries in the Kodiak area. Documented harvests from 1985 to 2003 averaged about 31,000

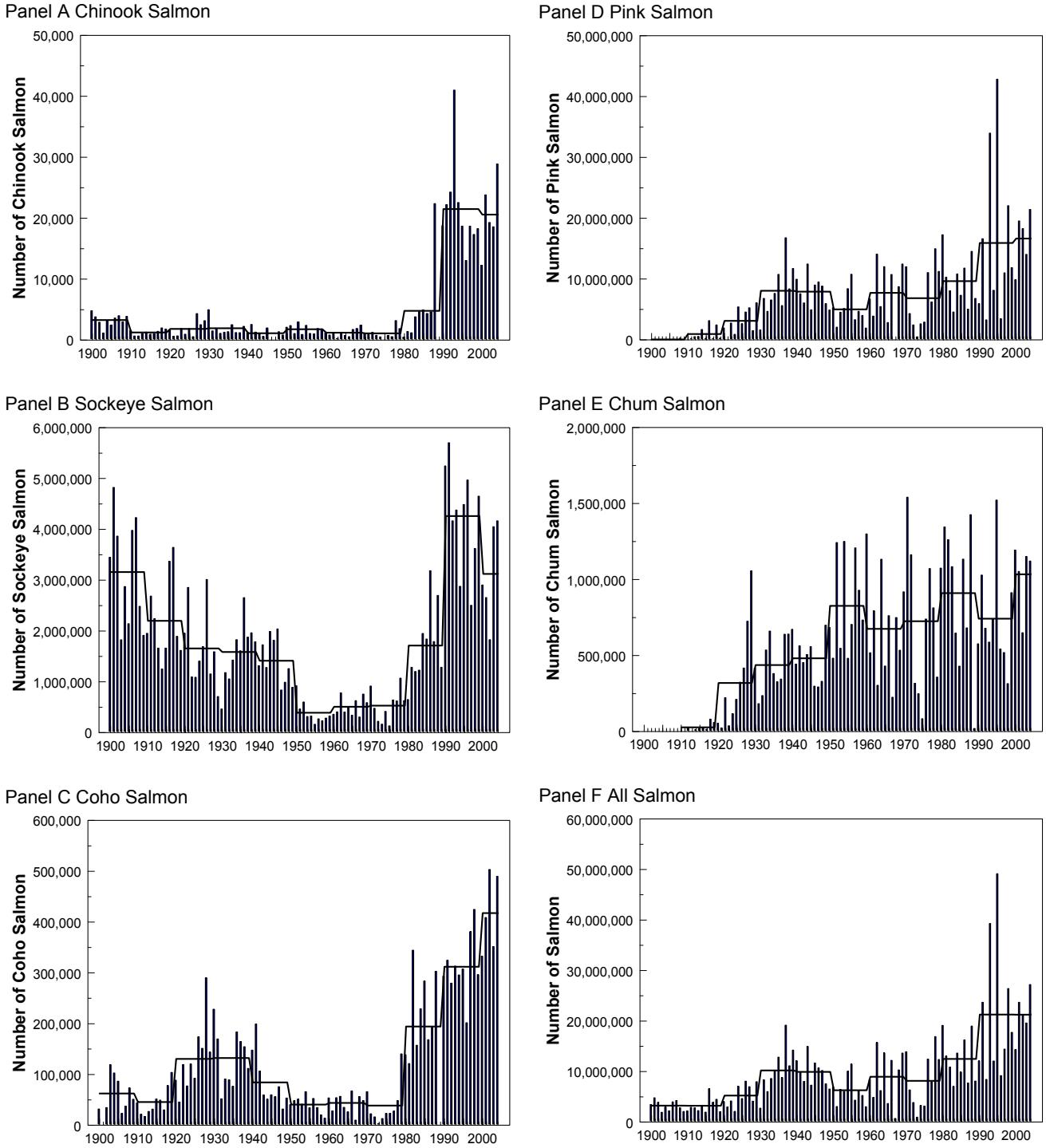

Figure 76. Commercial salmon harvests in Kodiak from 1900–2004; bars provide annual catches and lines provide decade averages.

salmon annually, and ranged from about 16,000 salmon in 1988 to over 40,000 salmon in 1997, 2001, 2002, and 2003 (Figure 77). About 71% of the subsistence harvest was comprised of sockeye salmon, 21% of coho salmon, 5% of pink salmon, 2% of chum salmon and 1% of Chinook salmon. The subsistence harvest is minor in comparison to the commercial harvest; the ratio of commercial to subsistence harvests during the period of 1985 to 2003 was about 600:1 overall; and by species, was about 70:1 for Chinook salmon, 160:1 for sockeye salmon, 50:1 for coho salmon, 8,500:1 for pink salmon, and 1,500:1 for chum salmon.

Sport fishing harvests in the Kodiak area have been increasing. Sport harvests in the Kodiak area averaged about 36,000 fish during the 1980s, about 40,000 fish in the 1990s, and about 66,000 fish since 2000 (Table 23). Most sport effort is directed at Chinook, coho, and sockeye salmon. Overall, the sport harvest of salmon is small in comparison to the commercial harvest, with the ratio of commercial to sport harvest since 2000 at about 300:1. The sport harvests of sockeye salmon, pink salmon and chum salmon are minor compared to commercial harvests, with ratios of the commercial to sport harvests since 2000 being about 250:1 for sockeye salmon, 1,800:1 for pink salmon and 1,600:1 for chum salmon. Sport harvests of Chinook salmon have been rapidly increasing over the past 25 years and the commercial to sport harvest ratio since 2000 is about 2:1. The sport fishery for coho salmon has also been increasing and the commercial to sport harvest ratio since 2000 is about 10:1.

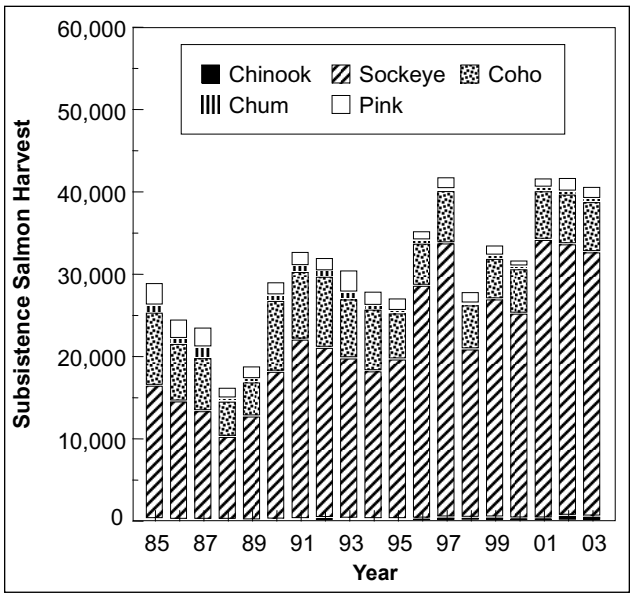

Figure 77. Harvests of salmon in subsistence fisheries in the Kodiak area, 1985–2003.

Table 23. Average annual harvest of salmon in the Kodiak area sport fishery.

Species	1980–1989	1990–1999	2000–2004
Chinook	819	3,772	8,648
Sockeye	4,531	8,053	12,366
Coho	14,906	18,335	35,027
Pink	14,823	9,260	9,222
Chum	856	708	637
Total	35,935	40,128	65,900

Commercial Salmon Fishery Users

As of August 31, 2005, there were 593 limited entry permits valid for salmon fishing in the Kodiak area; 374 (63%) were purse seine permits, 188 (32%) were set gillnet permits, and the remaining 31 (5%) were beach seine permits (Table 4). Participation in the commercial salmon fishery by the purse seine gear group has decreased significantly over the last 30 years (Figure 78) and less than half of the valid permits have been used annually since 2000. Participation by the beach seine gear group has decreased even more; beach seines were last used to commercially harvest salmon in the Kodiak area in 2000. On the other hand, set gillnet user group participation in the Kodiak commercial salmon fishery has been relatively stable with about 80% of the valid permits being used annually

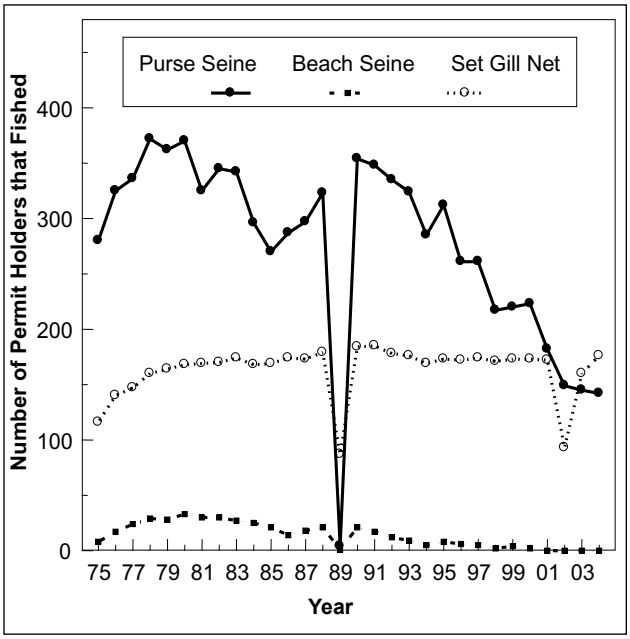

Figure 78. Number of permit holders that participated in Kodiak area commercial salmon fisheries, 1975–2004.

since the early 1980s except in 1989, when few fishermen participated in the Kodiak commercial salmon fishery due to the Exxon Valdez oil spill.

Exvessel Value

The average annual exvessel value of the commercial salmon fishery in the Kodiak area from 1985 to 2004 was about $34.5 million, ranging from a low of about $14 million in 2002 to a high of about $105 million in 1988. Adjusted for inflation and expressed in 2004 dollars, the average annual exvessel value was about $47 million. Inflation-adjusted exvessel value ranged from a low of about $14.7 million in 2002 when about 21 million salmon were harvested to a high of about $167 million in 1988 when about 19 million salmon were harvested (Figure 79). As elsewhere in Alaska, exvessel value has trended downward during the last 15 years, although a minor upward trend is apparent since 2002. From 1985 to 2004, sockeye salmon accounted for 61% of the inflation adjusted total exvessel value, followed by pink salmon (29%), chum salmon (7%), coho salmon (3%), and Chinook salmon (less than 1%).

A substantial portion of the reduction in the exvessel value of the commercial salmon fishery over the past 15 years is due to a large reduction in the price paid per pound to fishermen when they sell their catch. For instance, in 1988 when exvessel value for sockeye salmon peaked in the Kodiak commercial fishery, fishermen were paid an average of $2.71 per pound, whereas in 2002 when the lowest exvessel value occurred, fishermen were only paid an average price of $0.62 per pound (Figure 80).

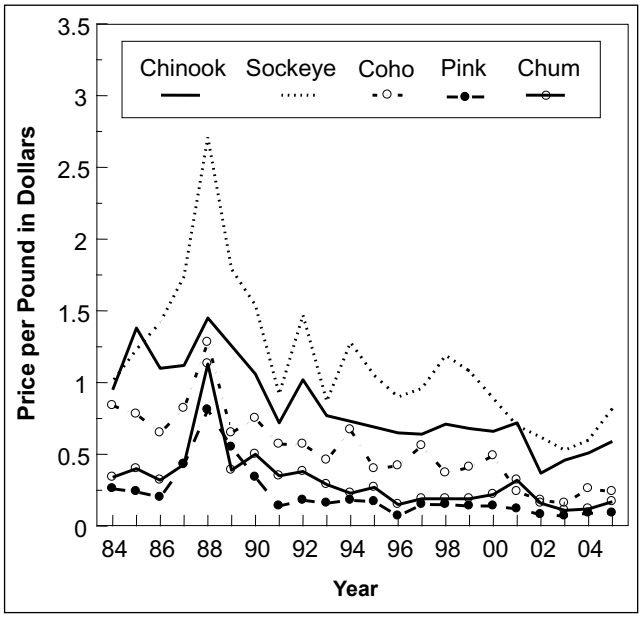

Figure 80. Average price per pound for salmon commercially harvested in the Kodiak area, 1984–2005.

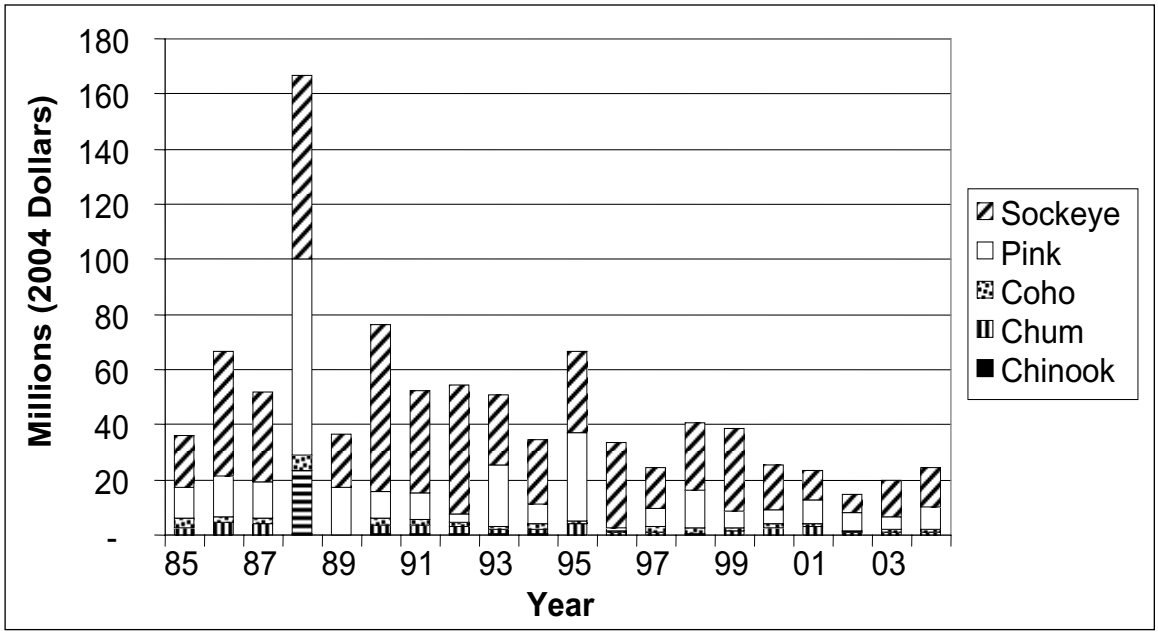

Figure 79. Exvessel value of the Kodiak commercial salmon fishery, 1985–2004, adjusted for inflation into 2004 dollars.

Exvessel value of the commercial salmon fishery by the Kodiak purse seine gear group averaged about $25 million from 1984 to 2003 and represented about 75% of the total exvessel value (Figure 81). The set gillnet gear group exvessel value of the Kodiak salmon fishery from 1984 to 2003 averaged about $8.3 million and represented about 25% of the total exvessel value. The corresponding average for the beach seine gear group was about $134 thousand and represented less than 1% of the total exvessel value.

Management

The Kodiak area commercial salmon fisheries is managed by ADF&G with the goal of achieving and maintaining sustained production. A large number of management plans have been developed for Kodiak salmon fisheries by the Alaska Board of Fisheries. These plans are used for both conservation and allocative purposes. Allocative plans include both issues relating to salmon harvests within the Kodiak area gear groups and issues relating to salmon harvests between Cook Inlet, Chignik, and Kodiak user groups. Salmon management plans currently in effect for the Kodiak commercial salmon fishery include: (1) the Cape Igvak Salmon Management Plan initiated in 1978, (2) the Alitak Bay District Salmon Management Plan initiated in 1987, (3) the Westside Kodiak Management Plan initiated in 1990, (4) the North Shelikof Sockeye Salmon Management Plan initiated in 1990, (5) the Crescent Lake Coho Salmon Management Plan initiated in 1990, (6) the Spiridon Lake Sockeye Salmon Management Plan initiated in 1993, (7) the Eastside Afognak Management Plan initiated in 1993, (8) the Eastside Kodiak Salmon Management Plan initiated in 1995, (9) North Afognak/Shuyak Island Salmon Management Plan initiated in 1995, and (10) the Mainland District Salmon Management Plan initiated in 1999. Salmon managers at ADF&G in Kodiak use their emergency order authority to carry out these regulatory management plans to allocate salmon to competing users and to conserve the salmon resource. Over the 5-year period from 2000 to 2004, the Kodiak area salmon management staff issued an average of 38 emergency orders per year to regulate commercial salmon fisheries, ranging from 30 in 2001 to 44 in 2003. Annual management reports written by ADF&G staff since the early 1960s provide extensive and detailed fishery data and insight into the Kodiak salmon management program and fishery, see Dinnocenzo (2006). These annual management reports provide details associated with each emergency order. Reports by ADF&G to the Alaska Board of Fisheries provide additional insight into the salmon fishery management regime, See Brennan (2004).

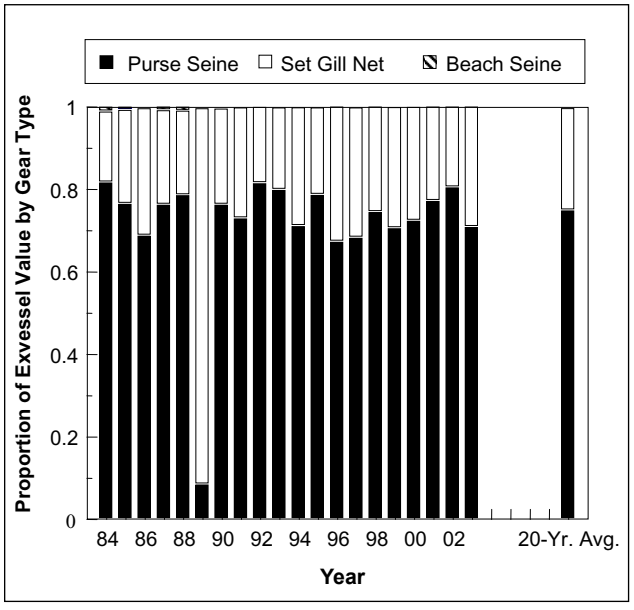

Figure 81. Exvessel value of the Kodiak commercial salmon fishery by gear group, 1984–2003.

Management of Kodiak area salmon fisheries is complex. When decisions must be made, annual run sizes are often uncertain. Salmon stock composition is often unknown and must be assumed. Many inseason management decisions for the Kodiak area commercial salmon fisheries are based upon estimated salmon run abundance and timing indicators. Catch data, catch per effort data, test fish data, catch composition data, and escapement information from a variety of sources is used to assess stock strength inseason. Escapements of several important stocks of salmon are monitored continuously with weirs, while aerial and ground-based surveys index escapement abundance of other stocks of salmon in the Kodiak area. Inseason run timing models are used to predict escapement levels using historic run passage information. These various data and predictions, along with Board of Fisheries management plans, are used to adjust fishing areas and times to achieve escapement targets and allocative criteria set by the Board of Fisheries.

An active salmon fishery enhancement program exists in the Kodiak area. The first salmon hatchery in the Kodiak area was built by cannery operators at the Karluk River in 1891. Lack of knowledge about early life history and poor fish culture practices resulted in the almost complete failure of early salmon hatchery programs. Two salmon hatcheries are currently operated in the Kodiak management area by the

Kodiak Regional Aquaculture Association. The Kitoi Bay Hatchery is located on the east side of Afognak Island and produces primarily pink salmon although sockeye, coho and chum salmon are also produced. Pillar Creek Hatchery is located in Monashka Bay, north of the City of Kodiak, and is used primarily as an incubation facility for sockeye salmon that are outplanted—although some Chinook and coho salmon are also reared. Brennan (2004) provided estimates of the number of salmon commercially harvested that resulted from the Kodiak Regional Aquaculture Association enhancement activities during the 10-year period of 1995 to 2004. Commercial harvests of enhanced salmon ranged from about 1.5 million fish in 1996 to about 13.7 million fish in 2001 (Figure 82). From 1995 to 2004, an estimated 26% of the Kodiak area commercial salmon harvest was produced by the Kodiak Regional Aquaculture Association (Figure 83). By species, the proportions were about 11% for sockeye salmon, 34% for coho salmon, 29% for pink salmon, and 19% for chum salmon. Estimates of the contributions of enhanced fish to the Chinook salmon commercial fishery harvests are not available.

The past performance of the Kodiak area salmon management program can be judged based on past levels of sustained salmon harvests and the ability to consistently achieve escapements. Sustainable harvest levels of salmon in the Kodiak area have increased over the past 100 years (Figure 76, Panel F). In the Kodiak area, ADF&G has 2 biological escapement goals in place for Chinook salmon, 6 biological and 6 sustainable escapement goals in place for sockeye salmon, one biological and 3 sustainable escapement goals in place for coho salmon, one biological and one sustainable escapement goal in place for pink salmon, and 6 sustainable escapement goals in place for chum salmon (Nelson et al 2005).

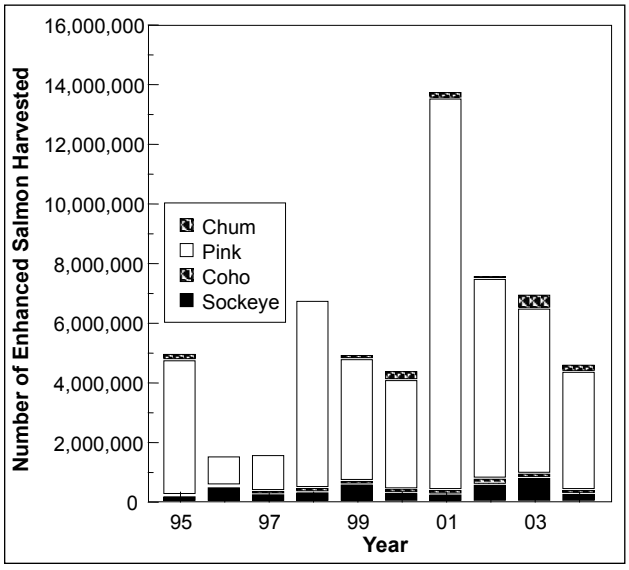

Figure 82. Numbers of enhanced salmon harvested in the Kodiak commercial salmon fishery from 1995–2004.

Chinook salmon

The biological escapement goal for the stock of Chinook salmon that spawns in the Karluk River is 3,600 to 7,300 fish. Karluk River Chinook salmon escapements have met or exceeded the lower end of the goal range each year since 1976 (Figure 84).

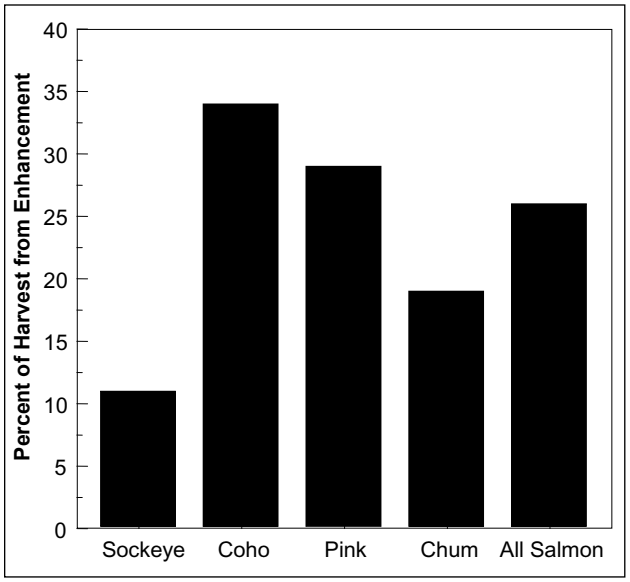

Figure 83. Proportion of the average 1995–2004 commercial salmon fishery harvest that was from enhancement activities.

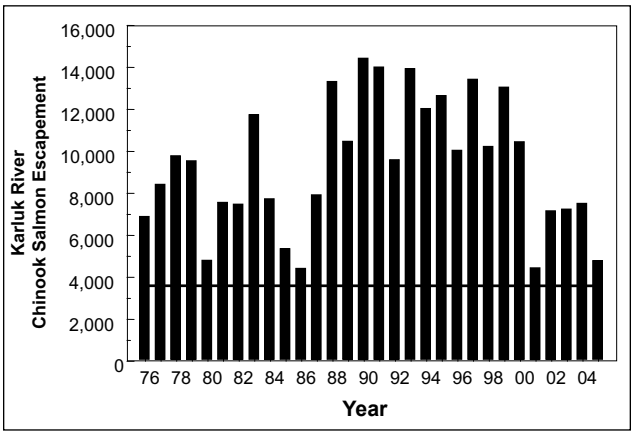

Figure 84. Chinook salmon escapement counts from 1976–2005 in the Karluk River and the lower end of the biological escapement goal range of 3,600–7,300.

The biological escapement goal for Ayakulik River Chinook salmon is 4,800 to 9,600 fish. The Ayakulik River Chinook salmon escapements have met or exceeded the lower end of the goal range each year since 1983 (Figure 85).

Sockeye salmon

The biological escapement goal for sockeye salmon returning to the Afognak River is 20,000 to 50,000 fish. Sockeye salmon counts in the Afognak River in 2002 were 19,520 fish and in 2004 were 15,181 fish, both somewhat short of the lower end of the escapement goal range. Escapements in all other years since 1978 exceeded the lower end of the escapement goal range (Figure 86).

The stock of sockeye salmon that returns to the Karluk River has both an early-run and a late-run escapement goal. The early-run biological escapement goal range is from 100,000 to 210,000 fish. This goal has been met or exceeded every year since 1976, except in 1981 when the escapement was 97,937 fish (Figure 87). The late-run biological escapement goal range is from 170,000 to 380,000 fish. This goal has been met or exceeded every year since 1985 (Figure 88). However, from 1976 to 1984, only about half of the annual escapements of late-run Karluk sockeye salmon met or exceeded the current goal range.

The stock of sockeye salmon returning to the Ayakulik River has a sustainable escapement goal range of 200,000 to 500,000 fish. Annual escapements of sockeye salmon in the Ayakulik River during the 21-year period from 1963 to 1983 exceeded 200,000 fish in only 7 of those years (33%). Since 1984, escapements of sockeye salmon have exceeded 200,000 fish

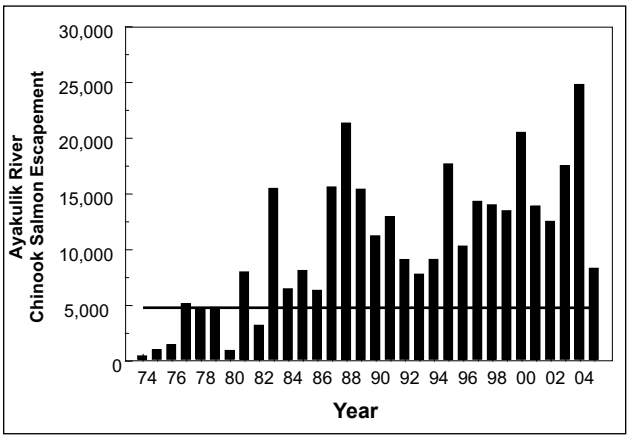

Figure 85. Chinook salmon escapement counts from 1974–2005 in the Ayakulik River and the lower end of the biological escapement goal range of 4,800–9,600.

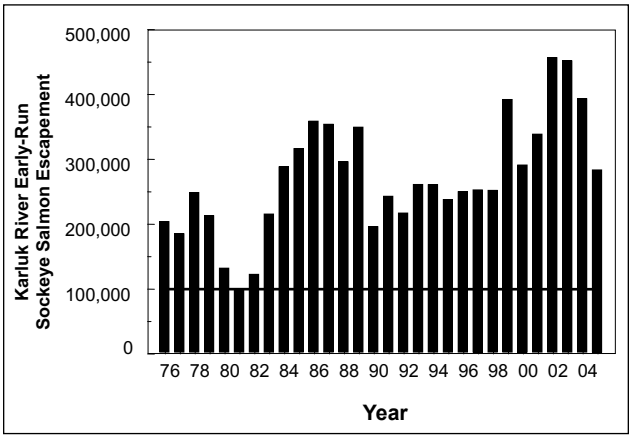

Figure 87. Early-run sockeye salmon escapement counts in the Karluk River from 1976–2005 and the lower end of the biological escapement goal range of 100,000–210,000.

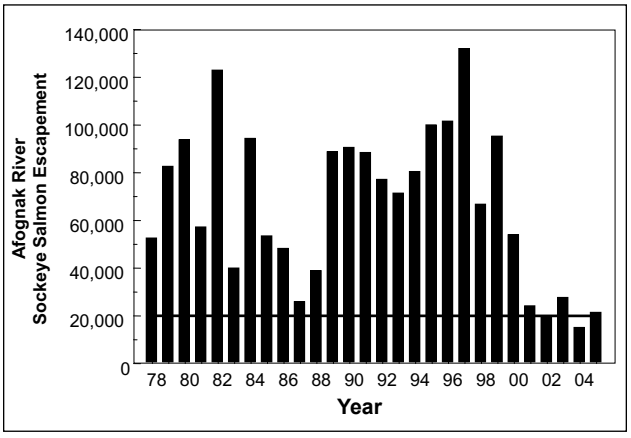

Figure 86. Afognak sockeye salmon escapement counts from 1978–2005 and the lower end of the biological escapement goal range of 20,000–50,000.

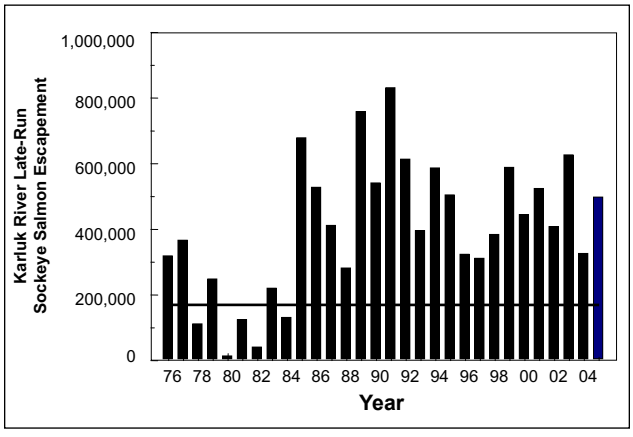

Figure 88. Late-run sockeye salmon escapement counts in the Karluk River from 1976–2005 and the lower end of the biological escapement goal range of 170,000–380,000.

in 21 of the 22 years (Figure 89). The single exception since 1984 was in 2003 when the count was 197,892 fish, which was very near the lower end of the sustainable escapement goal range.

The stock of sockeye salmon that returns to Upper Station has a sustainable escapement goal range of 30,000 to 65,000 for early-run fish and a biological escapement goal range of 120,000 to 165,000 for late-run fish. All annual early-run escapements of sockeye salmon since 1993 have met or exceeded the escapement goal range. Annual escapements since 1969 have met or exceeded the current goal range in 30 of the 37 years with 1969, 1970, 1973, 1975, 1977, 1985, and 1992 being the exceptions (Figure 90). Annual late-run escapements have met or exceeded the biological goal range each year since 1982, with the exception of 2001 when the count was 74,408 (Figure 91). Most of the annual late-run escapements from 1966 to 1981 were less than the current goal range.

After construction of the fishway in 1956, the biological escapement goal for sockeye salmon returning to the Frazer River is 70,000 to 150,000 fish. Sockeye salmon were introduced into Frazer Lake and have since become a sustained population. Counts of sockeye salmon in the Frazer River have exceeded the lower end of the goal range each year since 1976 with the exceptions of 1984, when the counts were 53,524 fish, and 1987, when the counts were 40,544 fish (Figure 92).

The biological escapement goal for sockeye salmon returning to the Saltery River is 15,000 to 30,000 fish. Counts of sockeye salmon in the Saltery River have exceeded the lower end of the goal range each year since 1986 (Figure 93).

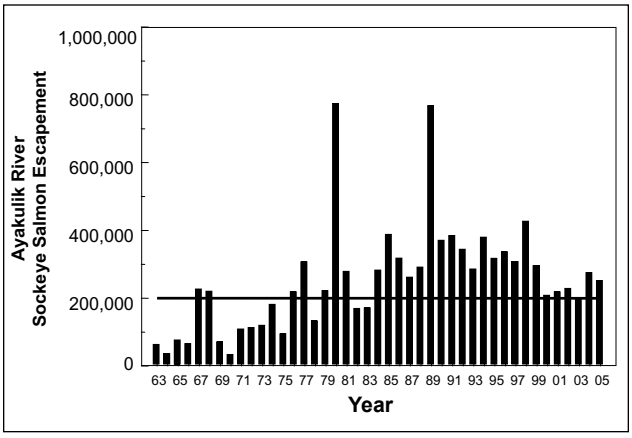

Figure 89. Sockeye salmon escapement counts from 1963–2005 in the Ayakulik River and the lower end of the sustainable escapement goal range of 200,000–500,000.

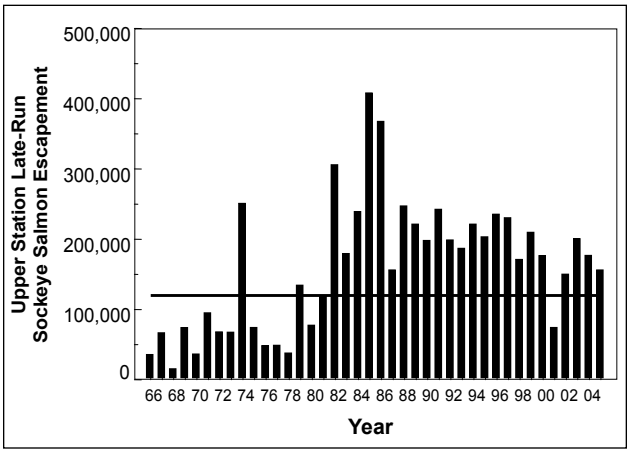

Figure 91. Upper Station counts of late-run sockeye salmon from 1966–2005 and the lower end of the biological escapement goal range of 120,000–165,000.

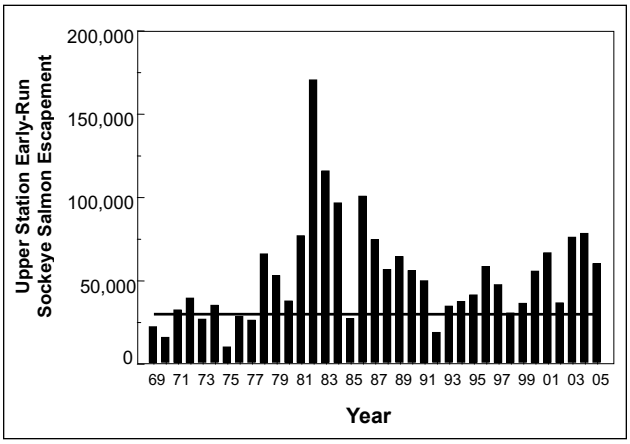

Figure 90. Upper Station counts of early-run sockeye salmon from 1969–2005 and the lower end of the sustainable escapement goal range of 30,000–65,000.

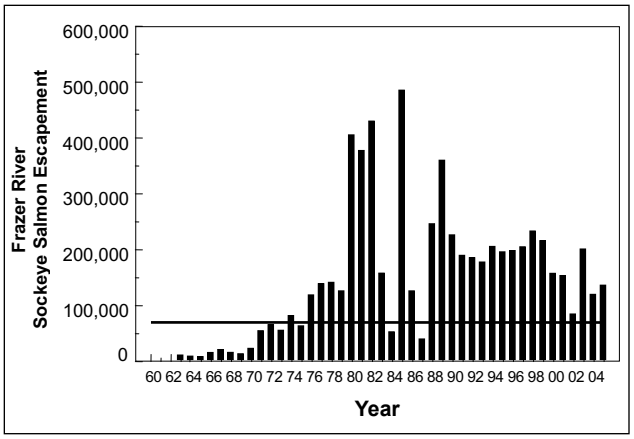

Figure 92. Counts of sockeye salmon in the Frazer River from 1960–2005 and the lower end of the biological escapement goal range of 70,000–150,000.

There are 4 other stocks of sockeye salmon (Malina, Paul's, Buskin, and Pasagshak) in the Kodiak area with sustainable escapement goals. Escapement counts were not made for the Malina stock in 2003 or for the Paul's Lake stock in 2005. Over the 10-year period of 1996 to 2005, observed escapements exceeded sustainable escapement goals for these 4 spawning populations of sockeye salmon in 37 of the 38 (97%) possible cases (Figure 94). The exception was for the Pasagshak River escapement in 1998 when the count was 1,850 fish; the sustainable escapement goal range is 3,000 to 12,000 fish. In about half of the cases, the observed escapements exceeded the escapement goal ranges.

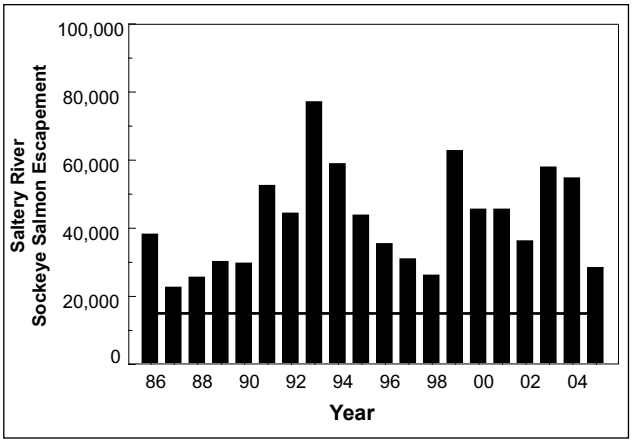

Figure 93. Counts of sockeye salmon in the Saltery River from 1986–2005 and the lower end of the biological escapement goal range of 15,000–30,000.

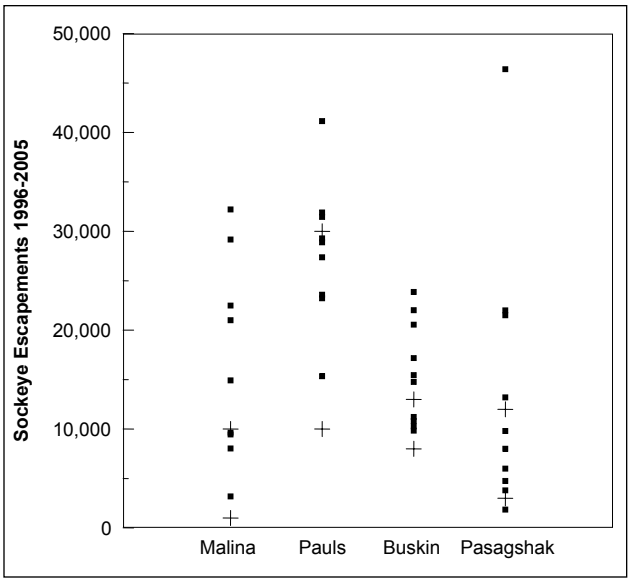

Figure 94. Sockeye salmon escapements from 1996–2005 for 4 stocks with sustainable escapement goals (annual escapements shown as solid squares, lower and upper ends of sustainable escapement goal range shown as + signs).

Coho salmon

The biological escapement goal for coho salmon returning to the Buskin River is 3,200 to 7,200 fish. Counts of coho salmon in the Buskin River have exceeded the lower end of the goal range every year since 1985 (Figure 95).

There are 3 other stocks of coho salmon in the Kodiak area with sustainable escapement goals. The sustainable escapement goal ranges are 400 to 900 fish for the American River, 1,000 to 2,200 fish for the Olds River, and 1,200 to 3,300 fish for the Pasagshak River. Over the 10-year period of 1996 to 2005, observed escapements exceeded sustainable escapement goals for these 3 spawning populations of coho salmon in 24 of the 30 (80%) possible cases (Figure 96). Observed escapement was less than the goal in the Olds River in 2002, and was less than the goal in the American River in 1996, 1999, 2000, 2001, and 2005.

Chum salmon

There are 6 threshold sustainable escapement goals for chum salmon in the Kodiak area. These escapement goals, if not achieved over several consecutive years, would trigger conservative fishery management actions. The threshold goal for the Mainland District is 153,000 fish, a level of spawning abundance not achieved until 1977, and exceeded almost every year from 1977 to 1992, and exceeded in about half of the years since 1993 (Figure 97). Five threshold sustainable escapement goals have been defined for chum

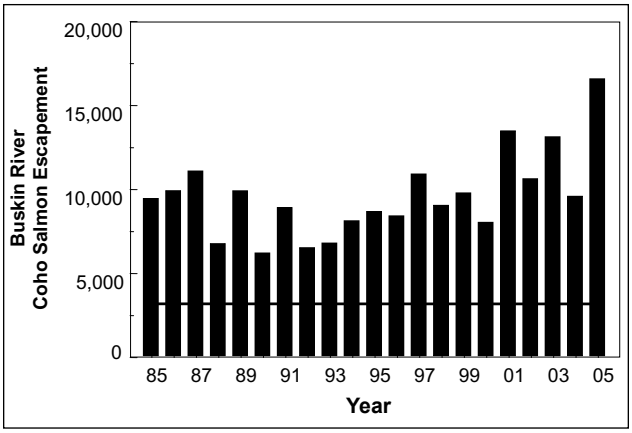

Figure 95. Counts of coho salmon in the Buskin River from 1985–2005 and the lower end of the biological escapement goal range of 3,200–7,200.

salmon stocks spawning in streams in the Kodiak Archipelago: (1) 53,000 fish in the Northwest District, (2) 7,300 fish in the Southwest District, (3) 28,000 fish in the Alitak District, (4) 50,000 fish in the Eastside District, and (5) 9,000 fish in the Northeast District. In the 10-year period from 1996 to 2005, these threshold spawning levels have been exceeded in 51% of the cases for the 5 districts (Figure 98), about the same level of success over that period that has occurred in the Mainland District.

Pink salmon

There are 2 sustainable escapement goals for pink salmon in the Kodiak area. The escapement goal range for pink salmon in the Kodiak Archipelago is 2 million to 5 million fish and escapement counts have exceeded the lower end of the range each year since 1984 (Figure 99). In addition to the Archipelago-wide escapement goal, ADF&G has set management objectives for each fishing district to ensure an adequate distribution of

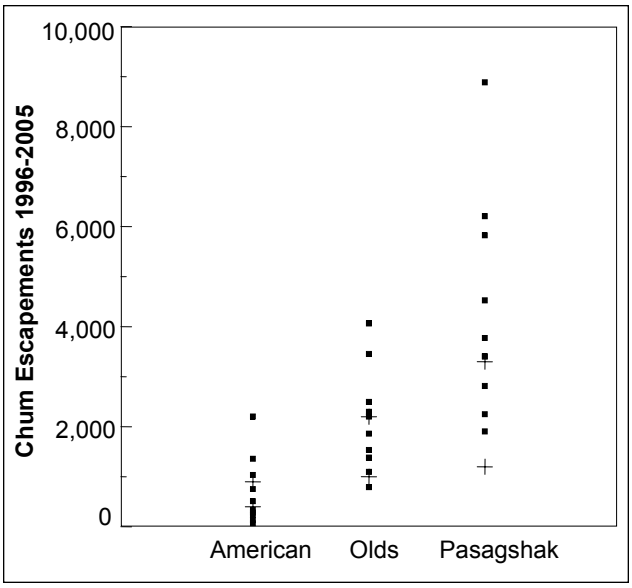

Figure 96. Coho salmon escapements from 1996–2005 for 3 stocks with sustainable escapement goals (annual escapements shown as solid squares, lower and upper ends of sustainable escapement goal range shown as + signs).

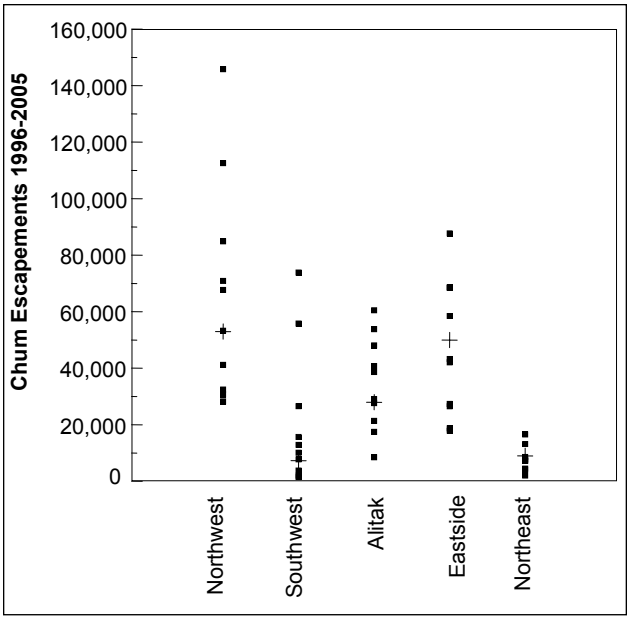

Figure 98. Chum salmon escapements from 1996–2005 for 5 Kodiak Archipelago stocks with sustainable escapement thresholds (annual escapements shown as solid squares, threshold sustainable goals shown as + signs).

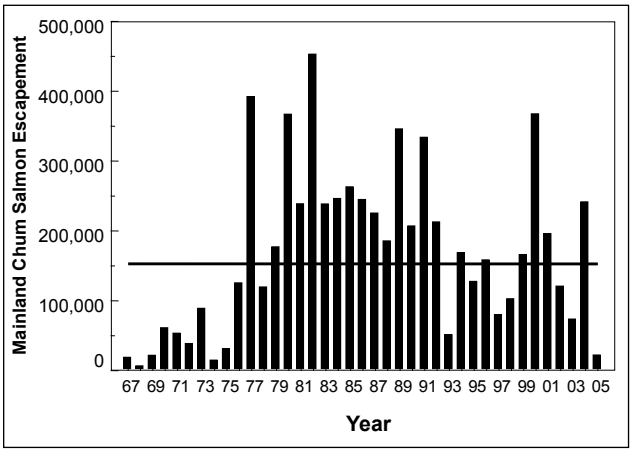

Figure 97. Mainland chum salmon escapement counts from 1967–2005 and the sustainable escapement threshold of 153,000.

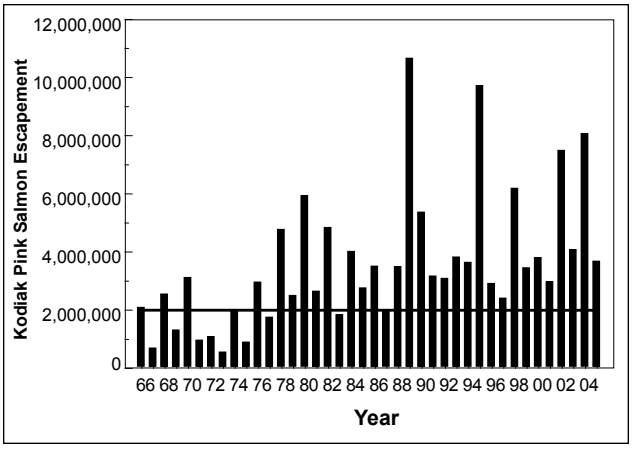

Figure 99. Kodiak Archipelago pink salmon escapement counts from 1966–2005 and the lower end of the sustainable escapement goal range of 2,000,000–5,000,000.

spawning pink salmon among the many spawning streams. The escapement goal range for pink salmon in the Mainland District is 250,000 to 750,000 fish and escapement counts have exceeded the lower end of the range each year since 1983, with the exception of 2005 when the count was 226,450 fish (Figure 100).

Budget History and Fiscal Support

In FY 05, the Division of Commercial Fisheries operational budget for Kodiak salmon totaled about $734,000, including about $326,000 (44% of total) for salaries of the management staff. Of the remaining $408,000, about $30,000 was used for stream surveys to index abundance of spawners and to sample a few of these escapements, about $225,000 was used to support 5 weir projects where salmon escapements were counted and sampled, about $62,000 was used for sampling the commercial harvest, about $57,000 was used for support costs for the fishery management program, and about $34,000 was used for a test fishing effort in the Alitak District. The expenditure of about $734,000 used to manage the Kodiak salmon fishery in FY 05 can be thought of as an annual 2% investment needed to ensure the continuation of a commercial industry whose annual inflation-adjusted exvessel value since 1985 has averaged about $47 million annually, and has been comprised of about 400 small businesses since 1988. This management investment is intended to ensure that these small businesses leave adequate numbers of spawning salmon of all 5 species in the 800 streams in Kodiak and neighboring areas to support future fisheries and provide access to surplus production to support the current business activity. Given the diversity of geography, remoteness, and magnitude of the salmon resource in the Kodiak area, the level of budget support for management is small. Substantial increases in funding support for the Kodiak area salmon management program can be easily justified and would likely equate to increased sustainable harvests.

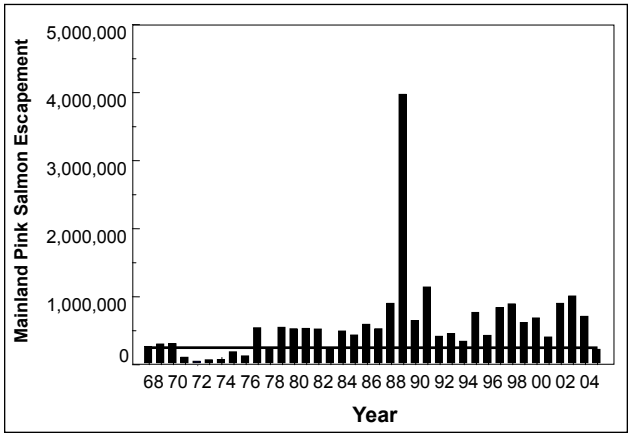

Figure 100. Mainland pink salmon escapement counts from 1968–2005 and the lower end of the sustainable escapement goal range of 250,000–750,000.

The Kodiak area salmon still present several fishery management challenges. Retaining adequate fiscal support for the salmon management and stock assessment program in the Kodiak area has been a problem for ADF&G. The program in the Kodiak area would benefit from the addition of several more on-the-grounds escapement assessment projects. Many stocks of salmon spawn in the area, yet the Division of Commercial Fisheries is currently only able to fiscally support 5 weir projects where spawning escapements of salmon are directly counted. The ability of ADF&G to estimate and implement biological escapement goals in the Kodiak area is limited due to the lack of scientific catch allocation estimates. In many cases, salmon are harvested as mixed stocks, and while current-day genetics-based stock identification is fully feasible if implemented, lack of adequate funding has largely prevented use of this technology in the Kodiak area. The addition of about $500,000 of operational funding in the Kodiak area to improve management of the commercial salmon fishery is fully justified and if available, about half could be used for additional escapement enumeration efforts while the other half could be used for scientifically-based catch allocations. If such fiscal support were available on an annual basis over a period of years, additional biological escapement goals could be developed, leading to optimal escapement levels for several stocks of salmon and a subsequent higher level of sustainable yield.

CHIGNIK COMMERCIAL SALMON FISHERY

Area Description and Gear Types

The Chignik area comprises all coastal waters and inland drainages on the south side of the Alaska Peninsula between Kilokak Rocks (boundary with the Kodiak area) and Kupreanof Point (boundary with the Alaska Peninsula area). The area includes 5 commercial fishing districts: Eastern, Central, Chignik Bay, Western, and Perryville (Figure 101). These districts are further divided into 14 sections and 25 statistical reporting areas. The predominant salmon producing stream in the Chignik area is the Chignik River which drains Chignik Lake. Black Lake lies above Chignik Lake and drains into it.

Since 1955, only seine gear has been used for commercial harvest of salmon in the Chignik area

History of the Commercial Salmon Fishery

Commercial exploitation of salmon in the Chignik area began in 1888. Pile traps were the primary harvest gear and sockeye salmon were the primary target species. Much of the historic harvest was taken in Chignik Lagoon and Chignik Bay. In the years from 1895 to 1954, from 4 to 37 fish traps were used each year to commercially harvest salmon in the Chignik area (Dahlberg 1979). Seines and gillnets were used to catch salmon in only 6 of the 44 years (14%) from 1895 to 1938 (1896, 1897, 1900, 1932, 1933, and 1936). Fish traps were last used to commercially harvest salmon in the Chignik area in 1954. A weir was installed in the Chignik River to count salmon escapement in 1922. Except for 1938, 1940 to 1948, and 1951, a weir has been used as an aid to count salmon escapements every year since 1922. Associated with the escapement enumeration efforts has been a significant research effort over the last 80 years, started by the U.S. Bureau of Fisheries and continued by the University of Washington and ADF&G. The commercial salmon fishery in the Chignik area still targets mostly sockeye salmon bound for the Chignik River system.

Relatively small numbers of Chinook salmon are commercially harvested in the Chignik area. Decadal averages ranged from about 600 to 1,100 fish from the 1910s through the 1970s. Commercial harvests increased in the 1980s to about 3,800 fish per year, then increased again to about 6,700 fish per year in the 1990s, and have averaged about 2,700 fish per year since 2000 (Figure 102, Panel A). Almost all of the Chinook salmon are caught in the Chignik, Central and Western fishing districts.

The prestatehood peak harvest of sockeye salmon in the Chignik area occurred from 1900 to 1909 when about 1.4 million fish were caught per year (Figure 102, Panel B). Commercial harvests of sockeye salmon decreased continuously over the next several decades reaching a low level of only about 320,000 fish per year in the 1950s. Harvests of sockeye salmon increased following statehood, reaching an all time peak decadal average of about 1.7 million fish in the 1990s. Harvests since 2000 have averaged about 1.2 million fish in the Chignik area. Most of the sockeye salmon commercially harvested in the Chignik area are caught in the Chignik Bay District (Figure 103). The Central District, located adjacent to the Chignik District but to the northwest, also supported large sockeye salmon harvests prior to 2002. The marked shift of the sockeye salmon harvest to the Chignik Bay District since 2002 is largely because of the cooperative fishery that has been implemented since that year.

During the first 70 years of the 1900s, the average commercial harvests of coho salmon in the Chignik area ranged from about 4,000 to 31,000 fish per year (Figure 102, Panel C). Commercial use of coho salmon increased substantially in the 1980s when about 157,000 fish were harvested per year. The average coho salmon harvest in the 1990s was about 185,000 fish and since 2000 the harvests have averaged about 70,000 fish per year. The primary fishing districts where coho salmon are caught are the Western, Central, and Chignik fishing districts.

Commercial use of pink salmon in the Chignik area has shown substantial year-to-year variability. Peak decadal harvests occurred in the 1960s when about 1 million fish were caught per year and in the 1990s when about 1.1 million fish were caught per year (Figure 102, Panel D). Commercial harvests in the Chignik area since 2000 have averaged about 400,000 fish per year. Unlike sockeye salmon harvest patterns, most pink salmon are commercially harvested in the Central and Western fishing districts with very few caught in the Chignik Bay District (Figure 104).

While year-to-year variations in the harvest of chum salmon in the Chignik area have occurred, decadal averages have been reasonably stable over the last 100 years (Figure 102, Panel E). Average annual chum salmon harvests in the Chignik area in the 1980s and 1990s were about 200,000 fish. Since 2000, the average harvest has been about 75,000 chum salmon. The primary fishing districts where chum salmon are caught are the Central, Western, and Perryville fishing districts, with very few caught in the Chignik District.

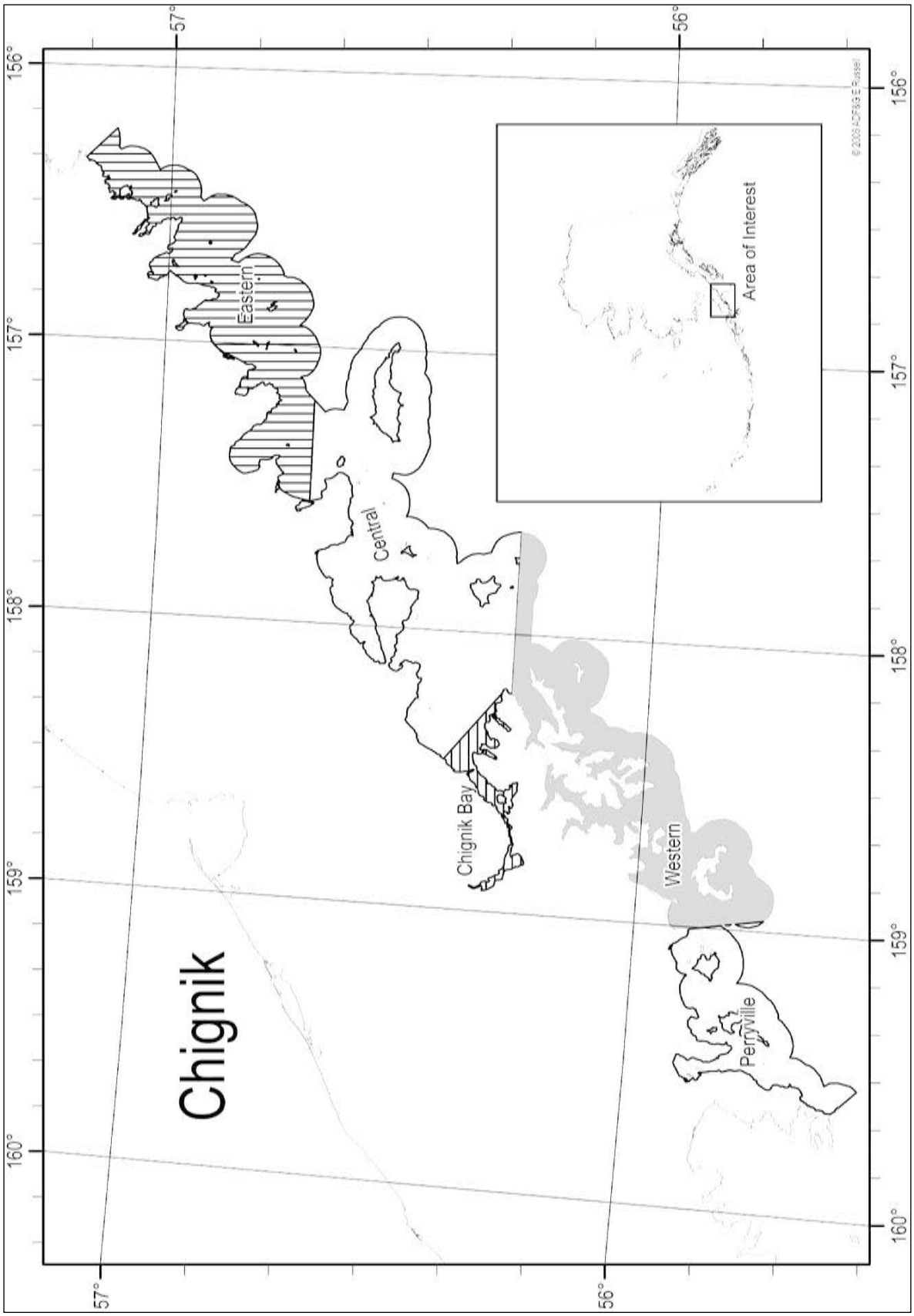

Figure 101. Chignik area commercial salmon fishery.

Across all 5 species of Pacific salmon, the annual harvests in the Chignik area averaged about 1.4 million salmon from 1900 to 1950. Harvests declined in the 1950s to about 800,000 salmon then increased each decade until reaching a 10-year average of about 3.2 million fish during the 1990s (Figure 102, Panel F). Commercial harvests of salmon since 2000 have averaged about 1.8 million salmon.

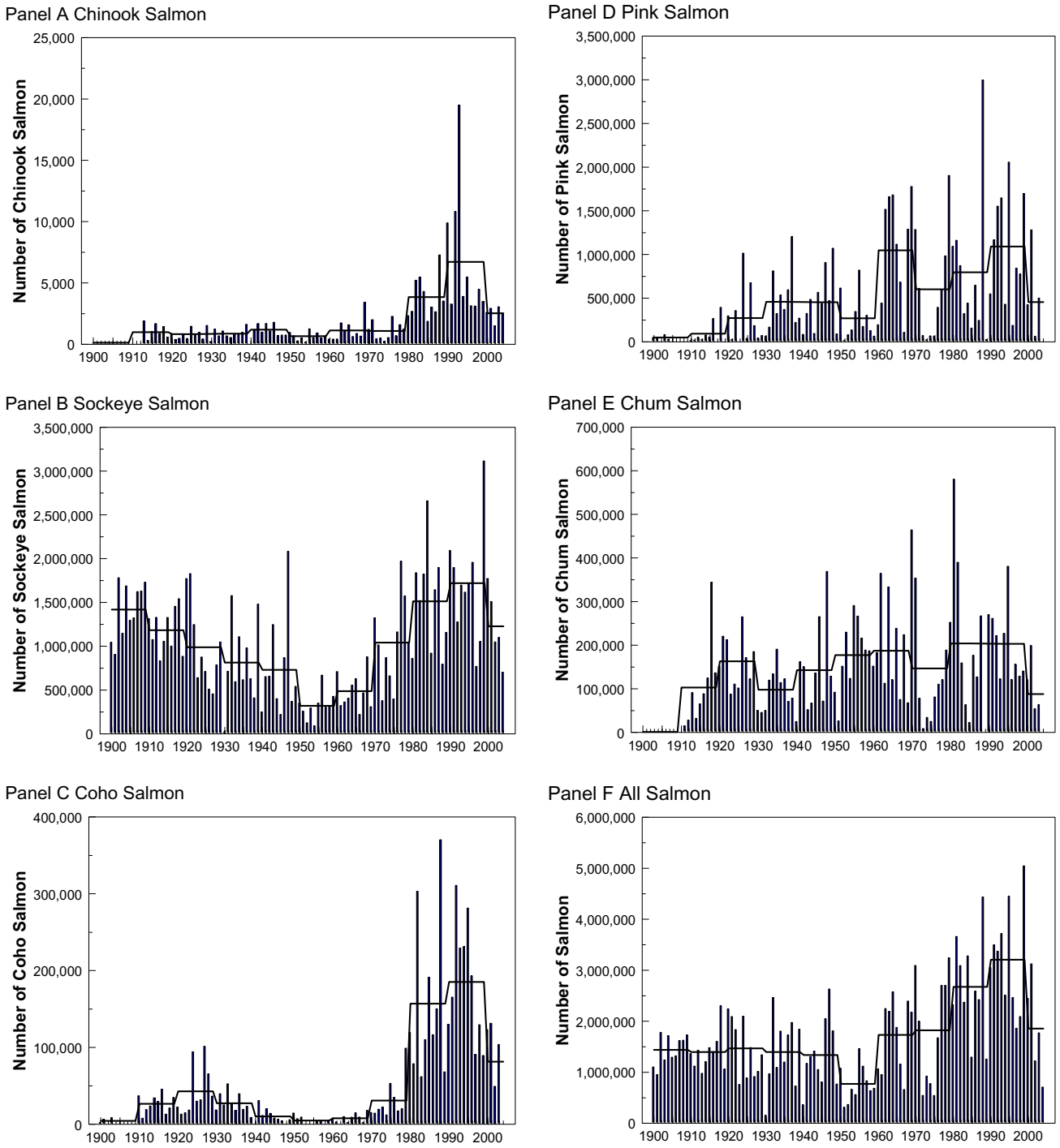

Figure 102. Commercial salmon harvests in Chignik from 1900–2004; bars provide annual catches and lines provide decade averages.

Other Salmon Harvests

Salmon are harvested for subsistence use in the Chignik area. Documented harvests from 1976 to 2003 averaged about 11,000 fish, ranging from about 2,000 fish in 1981 to about 20,000 fish in 1993 and 1994 (Figure 105). From 1990 to 2003, about 75% of the subsistence harvest was comprised of sockeye salmon, followed by coho salmon (13%), pink salmon (9%), chum salmon (2%), and Chinook salmon (1%). The subsistence harvest is minor in comparison to the commercial harvest. Ratios of commercial to subsistence harvests during the period of 1990 to 2003 were about 210:1 overall; and by species, were about 45:1 for Chinook salmon, about 160:1 for sockeye salmon, about 90:1 for coho salmon, about 3,200:1 for pink salmon, and about 150:1 for chum salmon.

A minor level of sport harvest of salmon takes place in the Chignik area; since 2000, the annual harvests have only been a few hundred fish (Table 24). The ratio of the commercial to sport harvest of salmon in the Chignik area since 2000 is about 5,000:1.

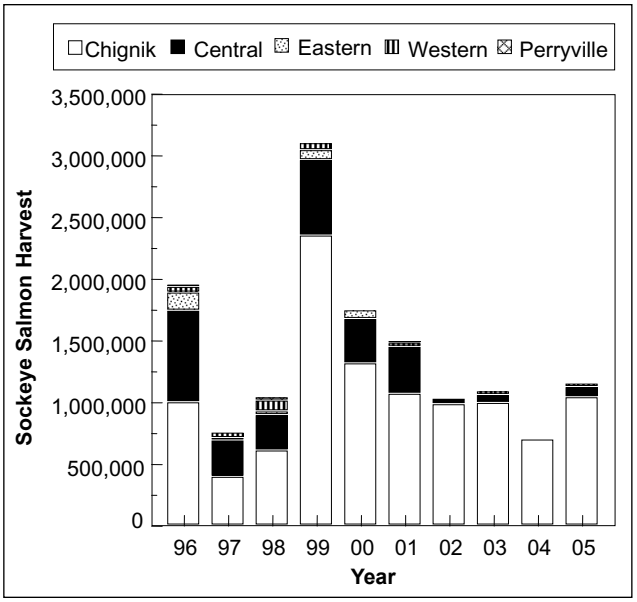

Figure 103. Commercial sockeye salmon harvests by fishing district in the Chignik area from 1996–2005.

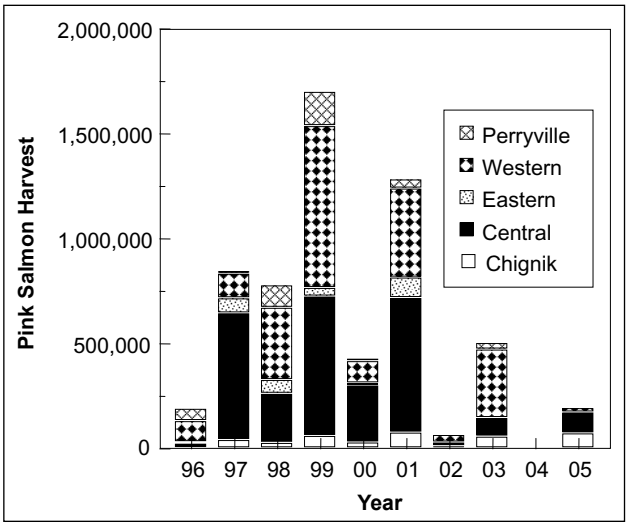

Figure 104. Commercial pink salmon harvests by fishing district in the Chignik area from 1996–2005.

Commercial Salmon Fishery Users

As of August 31, 2005, there were 99 limited entry permits valid for commercial salmon fishing in the Chignik management area (Table 4) and 97 of the permit holders participated in the fishery. Unlike many other areas of Alaska, participation in the fishery has not decreased over the last 20 years as salmon prices plummeted (Figure 106).

An innovative approach to fishery participation has been used in the Chignik area since 2002. Participants

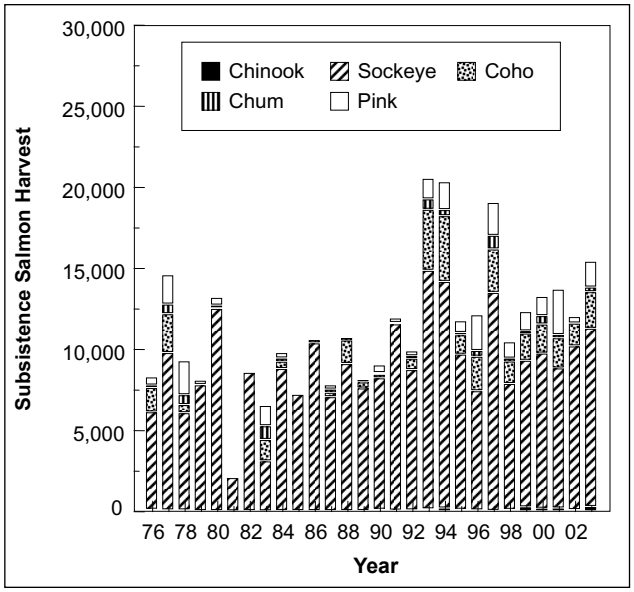

Figure 105. Salmon harvests in subsistence fisheries in the Chignik area, 1976–2003.

Table 24. Average annual harvest of salmon in the Chignik area sport fishery.

Species	1980–1989	1990–1999	2000–2004
Chinook	87	148	186
Sockeye	101	35	78
Coho	13	74	77
Pink	56	9	0
Chum	0	1	0
Total	257	267	341

in the Chignik salmon fishery proposed a cooperative fishery to decrease overhead associated with the cost of fishing, increase product quality, and improve the price paid for the product. The Alaska Board of Fisheries adopted the Chignik Area Cooperative Purse Seine Salmon Fishery Management Plan (5 AAC 15.359) in the spring of 2002 (Bouwens 2005). The plan was amended by the Board of Fisheries in the fall of 2002, 2003, and 2004, repealed in the spring of 2005 and an amended plan implemented before the 2005 salmon season. The purpose of the plan was to establish criteria and management measures for a cooperative salmon fishery. In essence, those permit holders wanting to participate in the cooperative fishery had to decide to do so before the season began. The plan provided for separate allocations to the cooperative fishery and to permit holders who wanted to participate as competitive fishermen. During the years from 2002 to 2005, from 76% to 87% of the Chignik area salmon permit holders participated in the cooperative fishery (Figure 106). Allocations of the harvestable surplus to the cooperative fishery from 2002 to 2005 ranged from 69% to 87% depending upon how many permit holders participated in the cooperative. In 2005, a large portion of the harvest by the cooperative fleet was delivered to processors as live fish with minimal handling, thus increasing product quality.

Exvessel Value

The average annual exvessel value of the Chignik commercial salmon fishery from 1985 to 2004 was about $13.4 million, ranging from a low of about $3.6 million in 2004 to a high of about $27.8 million in 1988. The exvessel value of the Chignik salmon fishery in 2005 was about $6.4 million, the highest value since 2001. Adjusted for inflation and expressed in 2004 dollars, the 1985 to 2004 average annual exvessel value was about $18.7 million. Inflation-adjusted exvessel value ranged as high as about $45.5 million in 1987 when about 2.4 million salmon were harvested—of which almost 1.9 million were high-value sockeye salmon (Figure 107). As elsewhere in Alaska, value has trended downward since the late 1980s. From 1985 to 2004, sockeye salmon accounted for 86% of the inflation-adjusted total exvessel value, followed by coho salmon (6%), pink salmon (5%), chum salmon (2%), and Chinook salmon (1%).

The large reduction in the exvessel value of the commercial salmon fishery since the late 1980s is due to a large reduction in the price paid per pound to fishermen when they sell their catch. For instance, in the late 1980s, fishermen were paid as much as $2.50 per pound for sockeye salmon, while since 2000 the average price paid per pound for sockeye salmon has only been about $0.80 (Figure 108).

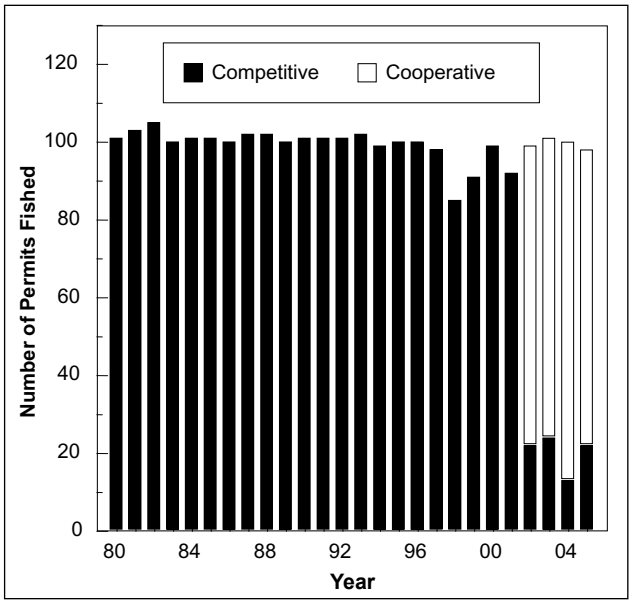

Figure 106. Number of commercial permits that participated in the Chignik salmon fishery, 1980–2005.

Management

The Division of Commercial Fisheries manages the commercial and subsistence salmon fisheries in the Chignik area with the goal of achieving and maintaining sustained production. This is accomplished by actively regulating time and area openings of commercial salmon fisheries in a manner that ensures escapement goals are met. Managers also implement measures to ensure Alaska Board of Fisheries allocative objectives are achieved. Management is through emergency order authority by biologists stationed in Chignik during the salmon fishing season. During the winter, these management biologists are stationed in Kodiak. Chignik sockeye salmon represent one of the best studied and understood salmon stocks in North America. Annual management reports for the Chignik area, written by ADF&G staff since the early 1960s, along with special reports to the Alaska Board of Fisheries, provide extensive and detailed fishery data and insight into the management program and fishery. For an example, see Bouwens and Poetter (2006).

Chinook salmon

Management of Chignik sockeye salmon is relatively precise due to high quality information available from daily weir counts and the ability of the management staff to adjust fishing time and area

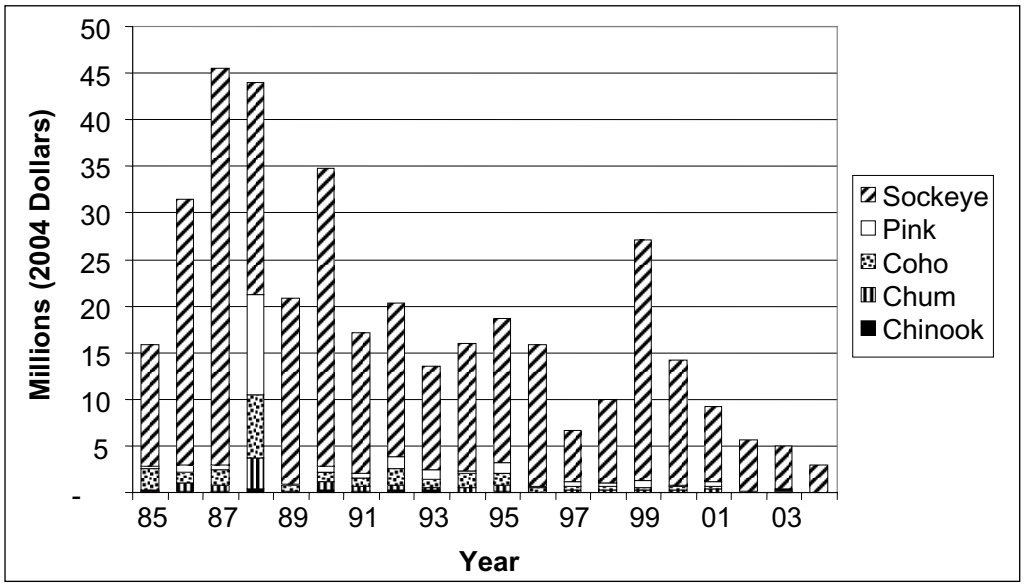

Figure 107. Exvessel value of the Chignik commercial salmon fishery, 1985–2004, adjusted for inflation into 2004 dollars.

through emergency orders. Management of salmon fisheries in the Chignik area is based upon 2 plans; the Chignik Salmon Management Plan (5 AAC 15.357) and the Cooperative Purse Seine Plan previously described. However, sockeye salmon bound for the Chignik watershed are allocated in 2 additional management plans; the Cape Igvak Salmon Management Plan (5 ACC 18.360) and the Southeastern District Mainland Salmon Management Plan (5 ACC 09.360). Historic migratory timing information is used each year to set daily escapement objectives for sockeye salmon at the Chignik weir and fisheries are regulated to meet these objective criteria.

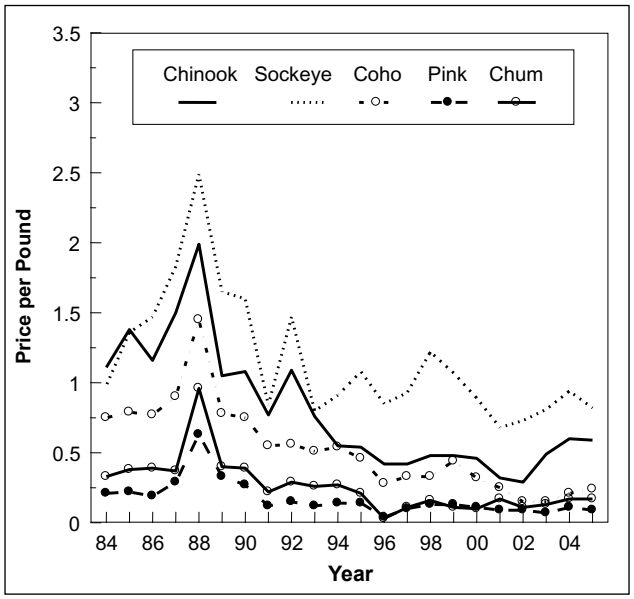

Figure 108. Average price per pound for salmon commercially harvested in the Chignik area, 1984–2005.

Inseason management of Chignik commercial fisheries for other salmon species is based upon run abundance and timing indicators. Catch data, catch per effort data, test fish data, catch composition data, and escapement information is used to assess stock strength on an inseason basis. Escapements of major stocks of salmon spawning in the Chignik area are monitored through surveys to index abundance. Inseason run timing models are used to predict abundance levels using historic run information. These various data and predictions are used to adjust fishing areas and times to achieve escapement objectives and management targets, as well as allocative criteria set by the Board of Fisheries. From 2000 to 2004, ADF&G Division of Commercial Fisheries managers issued an average of 38 emergency orders per year to regulate Chignik salmon harvests, ranging from 30 in 2004 to 42 in 2002 (Table 8). Descriptions of each emergency order and the reasons for their issuance are provided in annual management reports. For the 2002 salmon season, see Bouwens and Poetter (2006).

Escapement goals currently in effect for management of salmon fisheries in the Chignik area are fully described in Witteveen et al. (2005). There are 3 biological escapement goals and 3 sustainable escapement goals in effect in the Chignik area. While goals in effect for both pink and chum salmon are for the entire area, each is accompanied with management objectives that are used to ensure an appropriate distribution of

spawning salmon among streams in the Chignik area. The escapement data sets that accompany each of the escapement goals in the Chignik area are described in the following paragraphs.

The biological escapement goal for the stock of Chinook salmon that spawns in the Chignik River is 1,300 to 2,700 fish. Chignik River Chinook salmon escapements have met or exceeded the lower end of the goal range each year since 1981 (Figure 109).

Sockeye salmon

Sockeye salmon returning to the Chignik River are comprised of both an early run and a late run. Early-run sockeye salmon migrate past the Chignik River weir during June and July and pass upstream into the Black River to spawn in the upper watershed of Black Lake. Late-run sockeye salmon migrate past the weir in July and August and spawn in Chignik Lake and tributaries. Late-run fish rear in Chignik Lake whereas early-run fish rear in Black Lake or migrate downstream and rear in Chignik Lake. The sustainable escapement goal for early-run Chignik sockeye salmon is 350,000 to 400,000 fish; the lower end of the goal range has been met or exceeded every year since 1975 (Figure 110). The sustainable escapement goal for late-run Chignik sockeye salmon is 200,000 to 250,000 fish; the lower end of the goal range has been met or exceeded every year since 1970, except for 1994 when the escapement was 197,444 fish (Figure 111). Total run estimates are available for both of the Chignik River sockeye salmon runs, and as a result, annual harvest rates exerted on the 2 stocks can be estimated. Harvest rates exerted on early-run sockeye salmon from 1990 to 2005 averaged 64% and annually ranged from 37% to 82% while harvest rates exerted on late-run sockeye salmon averaged 70% and ranged from 47% to 87% (Figure 112).

Pink salmon

The Chignik area biological escapement goal for even-year pink salmon is 327,000 to 737,000 fish. Escapements of even-year pink salmon in the Chignik area have met or exceeded the lower goal range each year since 1976 (Figure 113). The biological escapement goal for odd-year pink salmon is 541,000 to 1,177,000 fish; the lower goal range has been met or exceeded each year since 1989 (Figure 114). In addition to Chignik area-wide biological escapement goals for pink salmon, management objectives for each district for both even-year and odd-year runs have been defined to ensure adequate distribution of spawning pink salmon throughout the management area (Witteveen et al. 2005).

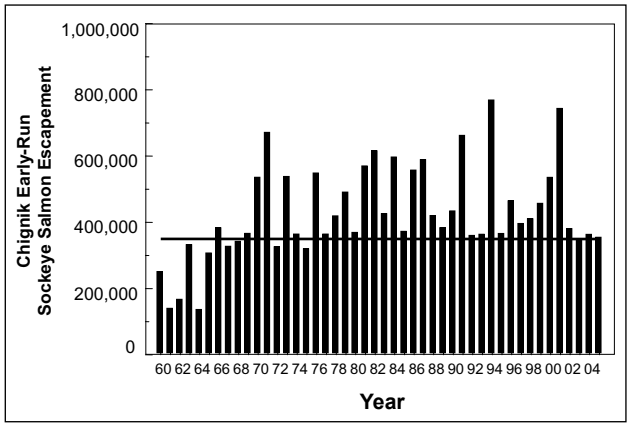

Figure 110. Early-run sockeye salmon escapements in the Chignik River from 1960–2005 and the lower end of the sustainable escapement goal range of 350,000–400,000.

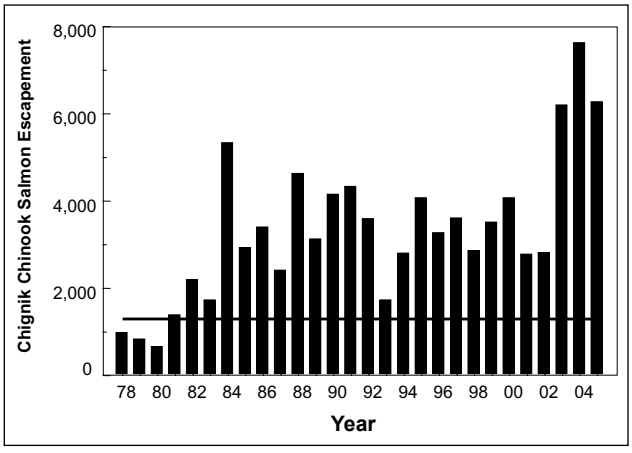

Figure 109. Chinook salmon escapements in the Chignik River from 1978–2005 and the lower end of the biological escapement goal range of 1,300–2,700.

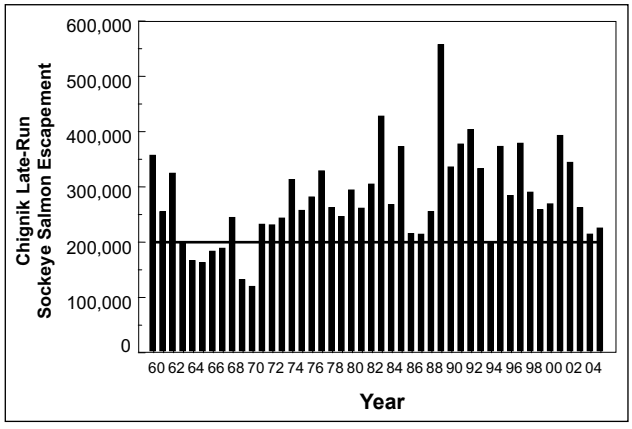

Figure 111. Late–run sockeye salmon escapements in the Chignik River from 1960–2005 and the lower end of the sustainable escapement goal range of 200,000–250,000.

Chum salmon

The Chignik area sustainable escapement goal for chum salmon is a threshold value of 50,400. Chum salmon escapements have exceeded the threshold value each year since 1962 (Figure 115). Like pink salmon escapement goals, management objectives specific to chum salmon escapement for each district have been defined to ensure adequate distribution of spawning chum salmon throughout the management area (Witteveen et al. 2005).

Budget History and Fiscal Support

Several fishery management challenges remain associated with the Chignik area salmon fishery. It has been difficult for ADF&G to retain adequate fiscal support for the salmon management and stock assessment program in the Chignik area. In FY 05, the Division of Commercial Fisheries allocated about $160,000 in general funds for support costs to the Chignik fishery managers to operate the Chignik weir, to assess other salmon escapements in the management area, and to monitor the salmon fisheries throughout the management area. Low prices paid for salmon, particularly for sockeye salmon in the early 1990s—even when coupled with strong annual harvests—have strained the business-related features of the fishery. Legal challenges to the cooperative fishery have resulted in Alaska Board of Fishery actions each year since 2002 with resultant uncertainty in how the fishery would be managed. Can the industry and fishery be restructured for long-term stability? Can the product be harvested and processed so that value increases, improving the economic viability of the Chignik commercial salmon fishery?

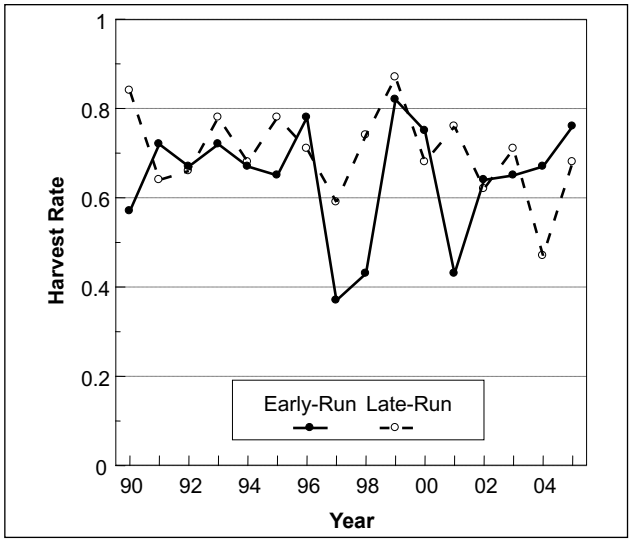

Figure 112. Harvest rates exerted on early-run and late-run Chignik River origin sockeye salmon from 1990–2005.

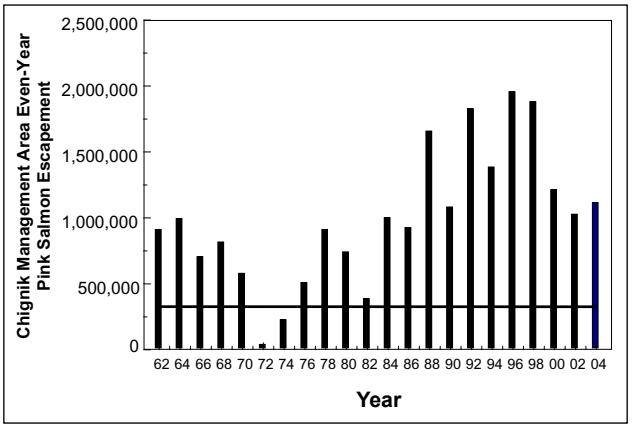

Figure 113. Even-year pink salmon escapement counts in the Chignik management area from 1962–2004 and the lower end of the biological escapement goal range of 327,000–737,000.

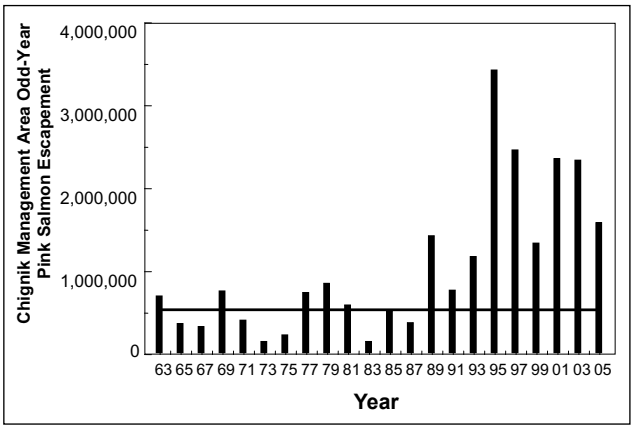

Figure 114. Odd-year pink salmon escapement counts in the Chignik management area from 1963–2005 and the lower end of the biological escapement goal range of 541,000–1,177,000.

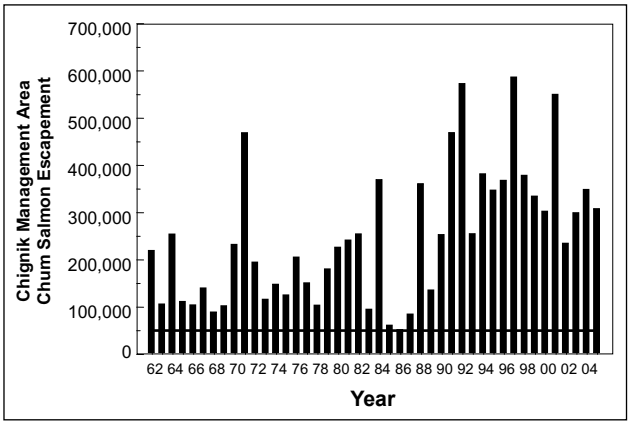

Figure 115. Escapements of chum salmon in the Chignik management area from 1962–2005 and the sustainable escapement threshold goal of 50,400.

PENINSULA–ALEUTIANS COMMERCIAL SALMON FISHERY

Area Description and Gear Types

The Alaska Peninsula and Aleutian Islands management areas (collectively referred to as Area M) and the Atka–Amlia management area (Area F) are divided into 4 subareas. The 4 subareas are: (1) the North Peninsula, consisting of Bering Sea waters extending west from Cape Menshikof to Cape Sarichef on Unimak Island, (2) the South Peninsula, consisting of Pacific Ocean waters extending west of Kupreanof Point to Scotch Cap on Unimak Island, (3) the Aleutian Islands, consisting of Bering Sea and Pacific Ocean waters of the Pribilof Islands and the Aleutian Islands west of Unimak Island but exclusive of the Atka–Amlia area, and (4) the Atka–Amlia area consisting of Bering Sea and Pacific Ocean waters extending west of Seguam Pass and east of Atka Pass (Figure 116).

Prior to statehood, fish traps were commonly used to commercially harvest salmon along the Alaska Peninsula. Commercial fishing gear since then has been limited to purse seines, drift gillnets, and set gillnets.

History of the Commercial Salmon Fishery

Commercial salmon fisheries along the Alaska Peninsula first occurred in 1882 when canneries were constructed at Orzinski Bay and Thin Point Cove, but the earliest catch records only go back to 1906. The first commercial salmon catches recorded in the Aleutians occurred in 1911. Early harvests in the Peninsula–Aleutians were primarily sockeye salmon. Salmon harvested in the Peninsula–Aleutians commercial fishery include both local stocks and stocks passing through the area as they migrate to natal streams in both Asia and North America. The Russell Creek Hatchery, located near Cold Bay, was built during the 1980s and was intended as a chum salmon production facility, but the facility was closed in 1992.

The peak prestatehood decadal harvest of Chinook salmon in the Peninsula–Aleutians commercial fishery occurred in the 1910s when about 19,500 fish were caught per year (Figure 117, Panel A). The peak poststatehood decadal harvest of Chinook salmon occurred in the 1980s when about 30,000 fish were caught per year. Average commercial harvests of Chinook salmon were about 20,800 fish in the 1990s, and about 10,800 fish since 2000.

Sockeye salmon commercial harvests during the 1960s in the Peninsula–Aleutians averaged about 827,000 fish (Figure 117, Panel B). Commercial harvests of sockeye salmon averaged about 1.2 million fish in the 1970s, about 4 million fish in the 1980s, about 5.1 million fish in the 1990s, and about 3.5 million fish since 2000 (Figure 117, Panel B). Only small numbers of sockeye salmon have been commercially harvested in the Aleutian Islands or Atka–Amlia areas. From 1990 to 2004, the average annual harvest of sockeye salmon in the Aleutian Islands area was about 16,000 fish, while the average annual harvest for the Atka–Amlia area was only about 20 fish. From 1990 to 2004, on the other hand, the average annual harvests of sockeye salmon in the North and South Peninsula areas were about 2.2 million fish each (Figure 118).

Based upon tagging studies, a substantial portion of the sockeye salmon harvested in South Peninsula commercial fisheries in June are fish migrating to spawning grounds in Bristol Bay. From 1975 to 1999, the June fishery was managed based upon a percentage of the Bristol Bay sockeye salmon forecast (Unimak quota was 6.8% and Shumagin quota was 1.5%). It is believed that the harvest rates exerted on Bristol Bay sockeye salmon by the June South Peninsula fishery were less than 5% in most of those years, ranging from 0.8% to 7.2%.

The post-June fishery harvest of sockeye salmon likely includes substantial harvests of Chignik-origin fish. The Southeast District Management Plan is used to allocate the catch of Chignik-origin sockeye salmon between the South Peninsula and Chignik areas prior to July 25.

Annual average commercial harvests of coho salmon in the Peninsula–Aleutians ranged from about 23,000 to 163,000 fish from the 1910s to the 1970s (Figure 117, Panel C). Commercial harvests of coho salmon increased substantially since the 1970s with average harvests of 450,000 fish in the 1980s, 400,000 fish in the 1990s, and about 250,000 fish since 2000.

The peak prestatehood annual average commercial harvest of pink salmon in the Peninsula–Aleutians was about 5.8 million fish in the 1930s. Commercial harvests dropped to an average level of about 2 million pink salmon per year in the 1950s, 1960s, and 1970s. Average annual harvest of pink salmon was about 6.5 million fish in the 1980s, about 8.2 million fish in the 1990s, and about 5.1 million fish since 2000 (Figure 117, Panel D). From 1990 to 2004, the Atka–Amlia area commercial harvest of pink salmon averaged about 600 fish while the average for the Aleutian Islands area was about 100,000 fish. Lack of markets has limited the harvest. Most of the commercially harvested pink salmon have been taken in the South Peninsula area with the 1990 to 2004 average being about 6.7 million fish (Figure 119). From 1990 to 2003, the

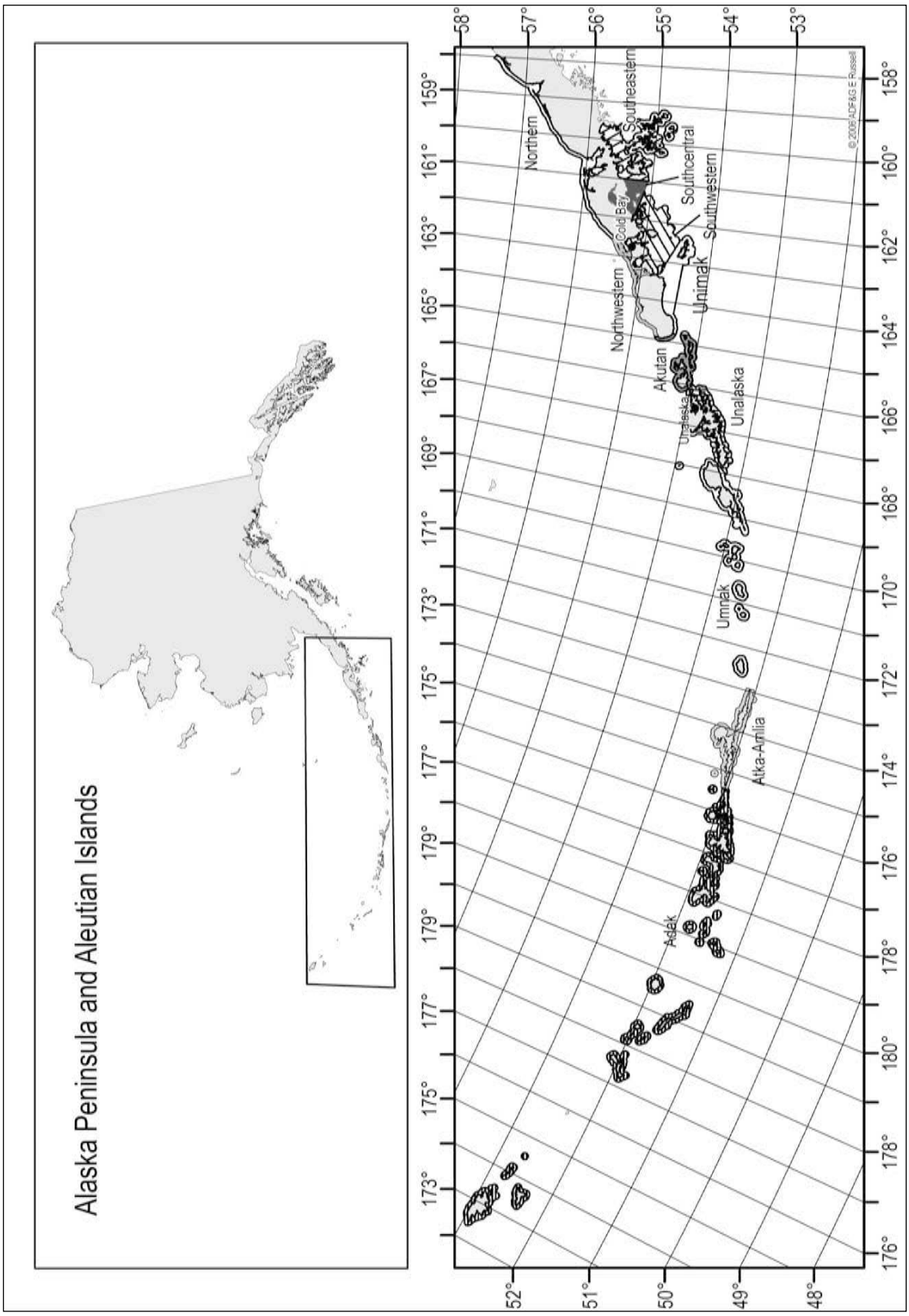

Figure 116. Peninsula–Aleutians area commercial salmon fishery.

commercial harvest of pink salmon from the North Peninsula area averaged only about 80,000 fish.

The peak prestatehood decadal annual average commercial harvest of chum salmon in the Peninsula–Aleutians was about 1.6 million fish in the 1930s. Thereafter, average harvest levels continued to decline until reaching about 620,000 fish per year in the 1970s (Figure 117, Panel E). Average annual harvests of chum salmon were about 2.1 million fish in the 1980s, about 1.3 million fish in the 1990s, and about 900,000 fish since 2000 (Figure 117, Panel E). From 1990 to 2004, the Atka–Amlia area commercial harvest of chum salmon only averaged about 60 fish while the average for the Aleutian Islands area was only about 200 chum salmon. Most of the commercially harvested chum salmon have been taken in the South Peninsula area, averaging about 1.1 million fish (Figure 120) from 1990 to 2004. Stock identification studies of the June chum salmon harvest in the South Peninsula area—in the 1980s with tags and in the 1990s with genetic based technology—demonstrated that the harvest was comprised of a wide mix of stocks from Asia and North America (Washington, Canadian, Southeast Alaska, Central Alaska, and Western Alaska). From 1990 to 2003, the commercial harvest of chum salmon from the North Peninsula area averaged only about 110,000 fish.

The all species commercial harvests of salmon in the Peninsula–Aleutians prior to statehood peaked in the 1930s at about 10 million fish (Figure 117, Panel F). Salmon harvests decreased to levels of about 3.6 million fish in the 1960s and about 4 million fish in the 1970s. Harvests from the Peninsula–Aleutians have been about 13.1 million fish in the 1980s, about 15.1 million fish in the 1990s and about 9.7 million fish since 2000 (Figure 117, Panel F).

Over the last several decades, the commercial salmon fishery in the Peninsula–Aleutians has become one of the most heavily regulated salmon fisheries in Alaska. Salmon fisheries in this part of Alaska have been intensely scrutinized and regulated through the Alaska Board of Fisheries process due to concerns from various user groups from other parts of Alaska. They are concerned because so many stocks of salmon pass through the area and are potentially subject to interception by these fisheries. For instance, for many years, the sockeye salmon harvests in the month of June were limited to a percentage of the annual forecast of abundance of Bristol Bay sockeye salmon. As another example, for many years a limit on the numbers of chum salmon that could be annually harvested was placed on the fishery due to concerns for chum salmon in other parts of Western Alaska. The ADF&G Division of Commercial Fisheries salmon managers in the Peninsula–Aleutians carefully track salmon harvest and escapement trends and regulate these fisheries according to Alaska Board of Fisheries approved management plans on an inseason basis. These salmon managers issue more emergency orders than any other salmon fishery in Alaska. From 2000 to 2004, these managers issued an average of 148 emergency orders per year for inseason management of Peninsula–Aleutian salmon fisheries, ranging from 111 emergency orders issued in 2004 to 173 emergency orders issued in 2002.

Other Salmon Harvests

The ADF&G Division of Commercial Fisheries manages the Peninsula–Aleutians subsistence salmon fishery. The commercial fishery management staff issued one emergency order specific to the salmon subsistence fishery in the Peninsula–Aleutians area during the 5-year period from 2000 to 2004. Documented harvests from 1985 to 2003 averaged about 30,000 fish and ranged from about 18,000 fish in 1985 to about 38,000 fish in 1997 (Figure 121). About 55% of the subsistence harvest was comprised of sockeye salmon, followed by coho salmon (22%), pink salmon (14%), chum salmon (8%), and Chinook salmon (1%). The subsistence harvest is minor in comparison to the commercial harvest; ratios of commercial to subsistence harvests during the period of 1985 to 2003 were about 430:1 overall; and by species, were about 50:1 for Chinook salmon, about 250:1 for sockeye salmon, about 60:1 for coho salmon, about 1,500:1 for pink salmon, and about 600:1 for chum salmon.

A minor level of sport harvest of salmon takes place in the Peninsula–Aleutians. Sport harvests in the Peninsula–Aleutians averaged about 11,000 fish during the 1980s and 1990s. Sport harvests in the Peninsula–Aleutians since 2000 averaged about 8,000 fish (Table 25). The ratio of commercial to sport harvest of salmon in the Peninsula–Aleutians since 2000 has been about 1,000:1, and by species, has been about 20:1 for Chinook salmon, about 1,500:1 for sockeye salmon, about 70:1 for coho salmon, and about 3,000:1 for both pink and chum salmon.

Commercial Salmon Fishery Users

As of August 31, 2005, there were 396 Area M limited entry permits valid for salmon fishing in the Peninsula–Aleutians, 162 (41%) drift gillnet permits, 119 (30%) purse seine permits, and 115 (29%) set gillnet permits (Table 4). Participation by all 3 gear groups

has decreased since the 1980s (Figure 122). Average participation since 2000 for the purse seine gear group was only 45%, for the drift gillnet participation was 80% and for the set gillnet gear groups participation was 94%.

After statehood, an Alaska Peninsula–Bristol Bay overlap area was created. It consisted of specific waters of the North Peninsula including the Cinder River commercial fishing section, the Inner Port Heiden

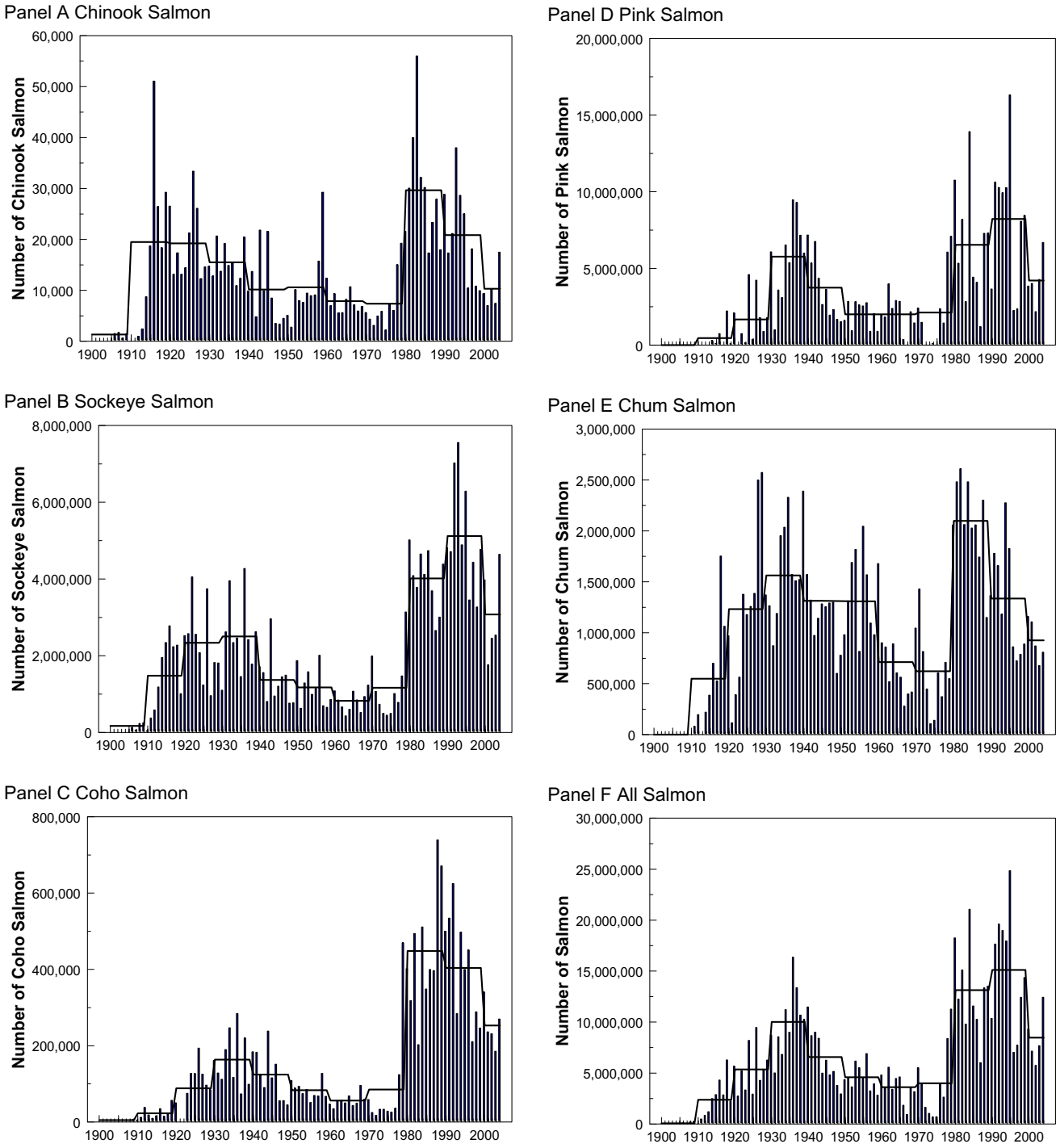

Figure 117. Commercial salmon harvests in the Peninsula–Aleutians from 1900–2004; bars provide annual catches and lines provide decade averages.

commercial fishing section, and Ilnik Lagoon. These parts of the North Peninsula Fishing District represent an area where commercial fishermen with permits for Bristol Bay are allowed to commercially fish for salmon in the North Peninsula area. Except for the month of July, Bristol Bay fishermen are allowed to fish in the Inner Port Heiden and Cinder River sections. In August and September, Bristol Bay fishermen are allowed to fish in Ilnik Lagoon. Participation by Bristol Bay commercial fishermen in these areas was as high as 102 drift gillnet permits fished in 1992 and 21 set gillnet permits fished in 1981. Average participation in the 1980s was 39 drift gillnet permits and 14 set gillnet permits fished. Bristol Bay commercial fishermen participation in the Peninsula–Aleutians area since 2000 is much less, about 23% of the 1980s level for drift gillnet fishermen and about 7% of the 1980s level for set gillnet fishermen (Figure 123).

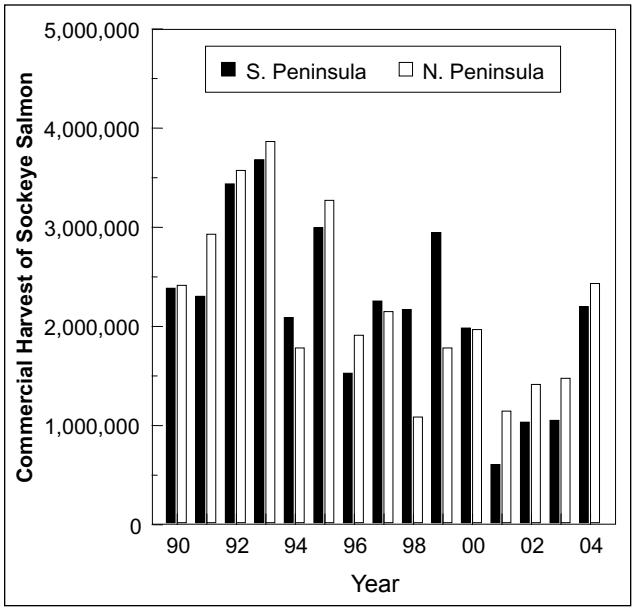

Figure 118. Commercial sockeye salmon harvests in the South Peninsula area and in the North Peninsula, 1990–2004.

Exvessel Value

The average annual exvessel value of the commercial salmon fishery in the Peninsula–Aleutians from 1985 to 2004 was about $36 million, ranging from a low of about $9 million in 2001 to a high of about $82 million in 1988. Adjusted for inflation and expressed in 2004 dollars, the average annual exvessel value was about $50.5 million. Inflation-adjusted exvessel value ranged from a low of about $9.5 million in 2001 when about 7.1 million fish were harvested to a high of about $131 million in 1988 when about 13.4 million fish were harvested (Figure 124). As elsewhere in Alaska, value has trended downward during the last 15 years, although a minor upward trend is apparent since 2001. From 1985 to 2004, sockeye salmon accounted for 74% of the inflation adjusted total exvessel value, followed by pink salmon (12%), chum salmon (8%), coho salmon (5%), and Chinook salmon (1%).

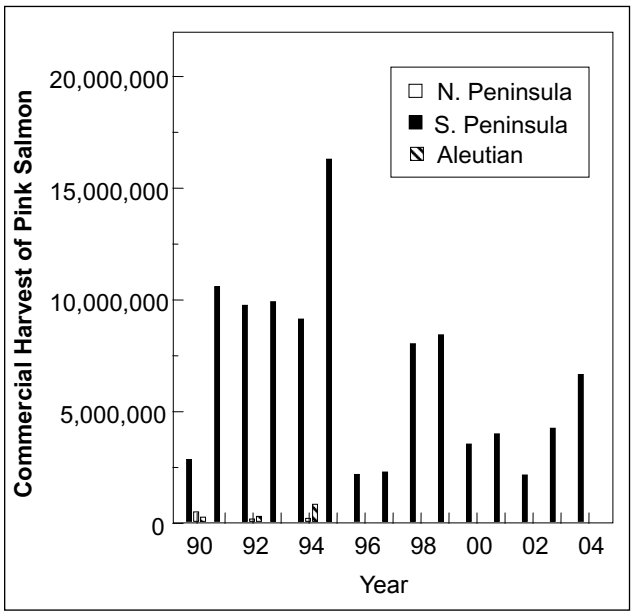

Figure 119. Commercial pink salmon harvests in the South Peninsula, North Peninsula, and Aleutians, 1990–2004.

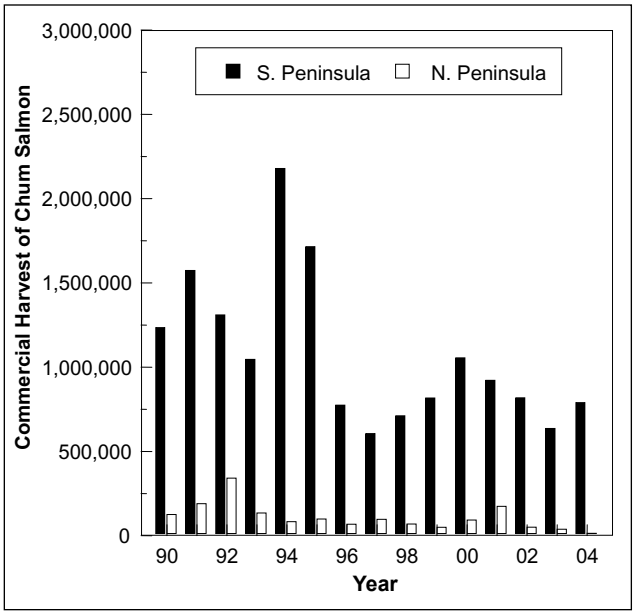

Figure 120. Commercial chum salmon harvests in the South Peninsula and in the North Peninsula, 1990–2004.

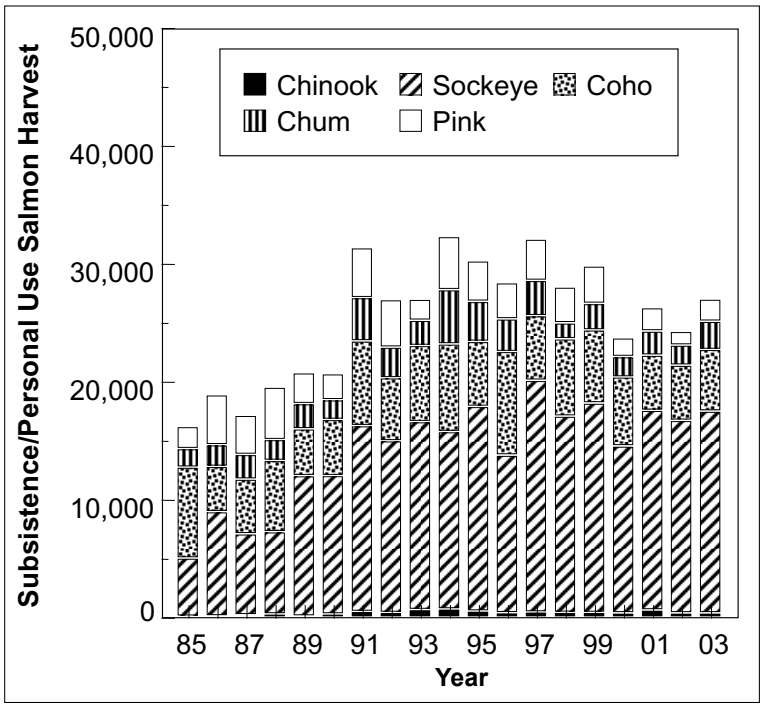

Figure 121. Peninsula–Aleutians subsistence and personal use harvests of salmon, 1985–2003.

A substantial portion of the reduction in the exvessel value of the commercial salmon fishery over the past 15 years is due to a large reduction in the price paid per pound to fishermen when they sell their catch. For instance, in 1988 when exvessel value for sockeye salmon peaked in the Peninsula–Aleutians commercial fishery, fishermen were paid an average of $2.25 per pound, whereas in 2001 when the lowest exvessel value occurred, fishermen were only paid an average price of $0.54 per pound (Figure 125).

Exvessel value of the commercial salmon fishery by the Peninsula–Aleutians purse seine gear group averaged about $14.7 million from 1984 to 2003 and represented about 40% of the total exvessel value. The drift gillnet gear group exvessel value of the Peninsula–Aleutians salmon fishery from 1984 to 2003 averaged about $16.2 million and represented about 44% of the total exvessel value. The corresponding average for the set gillnet gear group was about $5.8 million and represented about 16% of the total exvessel value. Over the last 20 years, the proportion of exvessel value of the Peninsula–Aleutians fishery taken by the purse seine gear group has decreased, the set gillnet proportion has increased and the drift gillnet proportion has stayed relatively constant (Figure 126).

Table 25. Average annual harvests of salmon in the Peninsula–Aleutians sport fishery.

Species	1980–1989	1990–1999	2000–2004
Chinook	488	510	541
Sockeye	1,568	1,721	1,960
Coho	2,036	3,417	3,689
Pink	6,745	4,970	1,410
Chum	369	203	335
Total	11,206	10,821	7,935

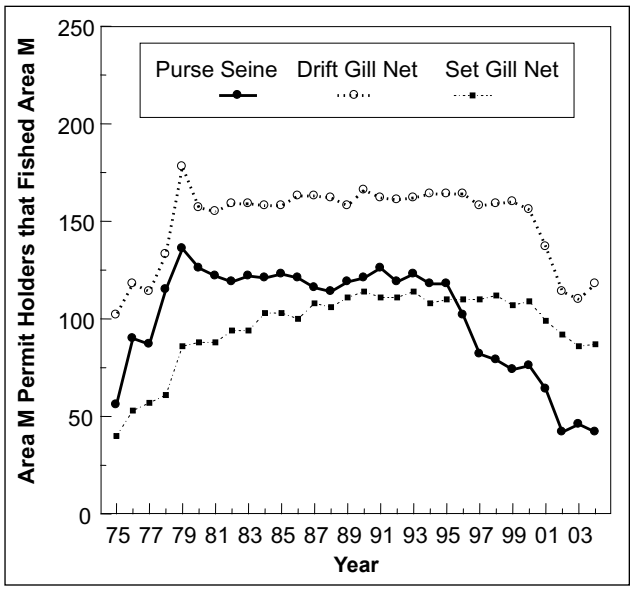

Figure 122. Number of Area M permits fished per year in the Peninsula–Aleutians commercial salmon fishery, 1975–2004.

Management

Fishery management staff are seasonally stationed in offices in Sand Point, Cold Bay, and Port Moller to manage salmon fisheries. During the winter, these staff members work out of the Kodiak regional office. Annual management reports, written by ADF&G staff since the early 1960s provide extensive and detailed fishery data and insight into the management program and fishery. See Burkey et al (2005) for details concerning South Peninsula salmon fisheries, Murphy et al (2005) for details concerning North Peninsula salmon fisheries, and Shaul and Dinnocenzo (2005) for information concerning the overall Peninsula–Aleutians area.

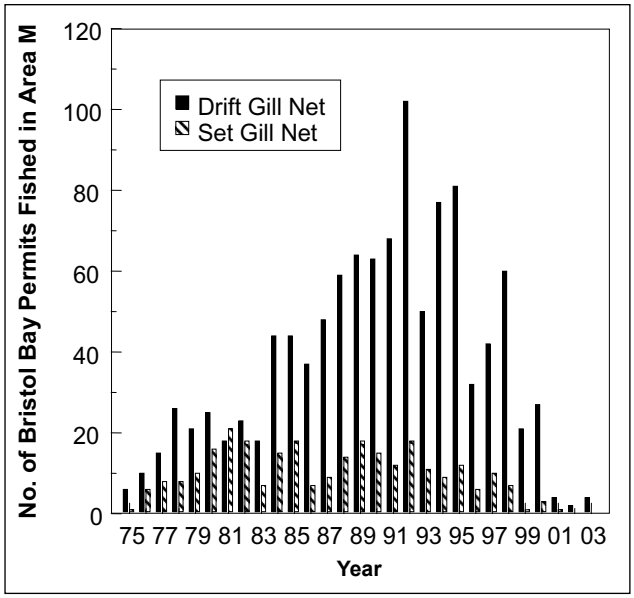

Figure 123. Number of Bristol Bay permit holders that fished in North Peninsula waters, 1975–2004.

Commercial salmon fishery management in the Peninsula–Aleutians is difficult due to the remoteness and geographic size of the area and because of the large number of stocks of salmon that spawn in the area or that pass through on their way to spawn in other areas. Annual run sizes are often uncertain when decisions must be made and salmon stock composition is often unknown. A large number of emergency orders are announced each fishing season to implement inseason management of Peninsula–Aleutian commercial salmon fisheries. The emergency orders are based upon estimated salmon run abundance and timing indicators. Catch data, catch per effort data, test fish data, catch composition data, and escapement information from a variety of sources is used to assess stock strength on an inseason basis. Escapements of several important stocks of salmon are monitored continuously with the aid of weirs, but most spawning stocks of salmon in the Peninsula–Aleutians are monitored by aerial surveys to index escapement abundance. For some stocks, inseason run timing models are used to predict subsequent escapement levels using historic run passage information. These various data and predictions are used along with management plans adopted by the Board of Fisheries that adjust fishing areas and times to achieve escapement targets and allocative criteria set by the Alaska Board of Fisheries.

For stocks of salmon that spawn in the Peninsula–Aleutians, the ADF&G has one biological escapement

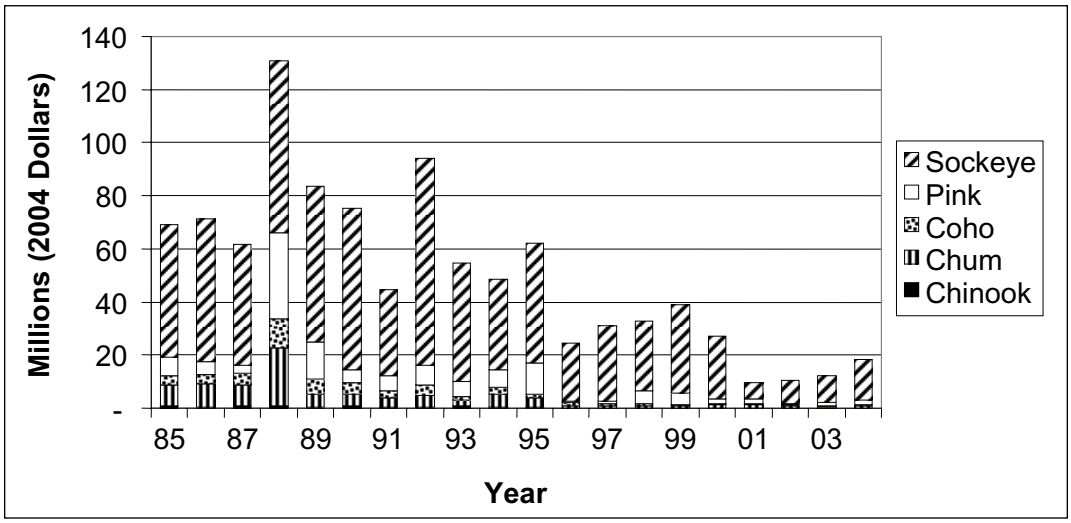

Figure 124. Exvessel value of the Peninsula–Aleutians commercial salmon fishery, 1985–2004, adjusted for inflation into 2004 dollars.

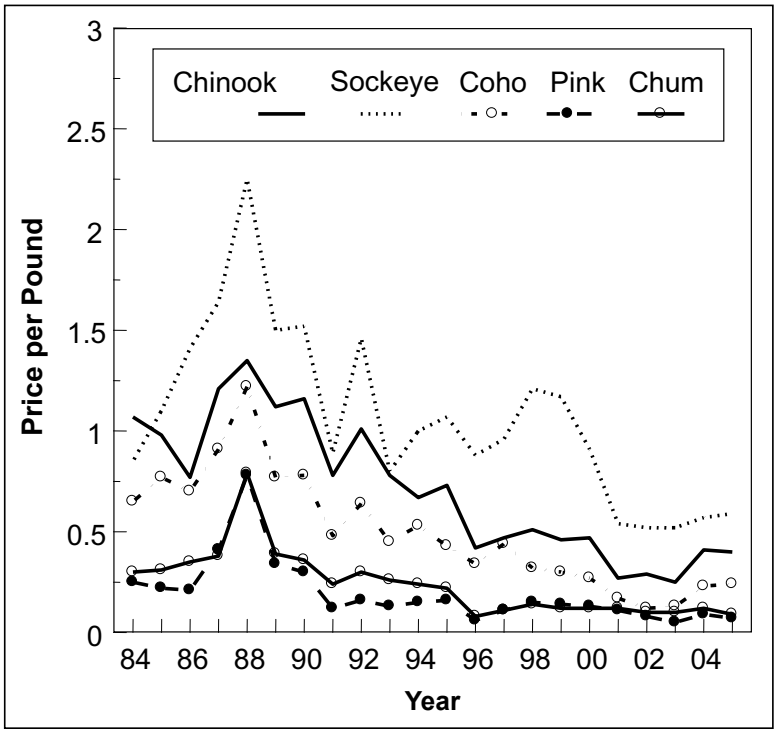

Figure 125. Average price per pound for salmon commercially harvested in the Peninsula–Aleutians, 1984–2005.

goal in place for Chinook salmon, one biological and 12 sustainable escapement goals in place for sockeye salmon, 2 sustainable escapement goals in place for coho salmon, 2 biological and 2 sustainable escapement goals in place for pink salmon, and 2 biological and 4 sustainable escapement goals in place for chum salmon (Nelson et al 2006). The next few paragraphs will present trends in escapements in relation to these goals.

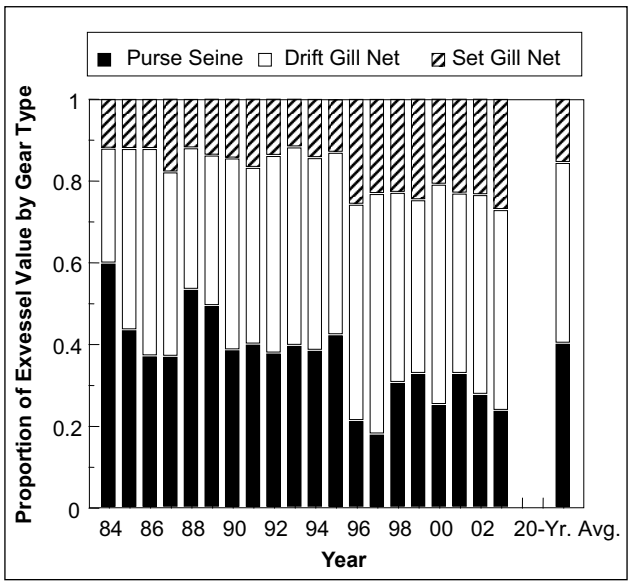

Figure 126. Exvessel value proportion by gear group for the Peninsula–Aleutians commercial salmon fishery, 1984–2003.

Chinook salmon

The biological escapement goal for the stock of Chinook salmon that spawns in the Nelson River is 2,400 to 4,400 fish. Nelson River Chinook salmon escapements have met or exceeded the lower end of the goal range each year since 1996 (Figure 127). The

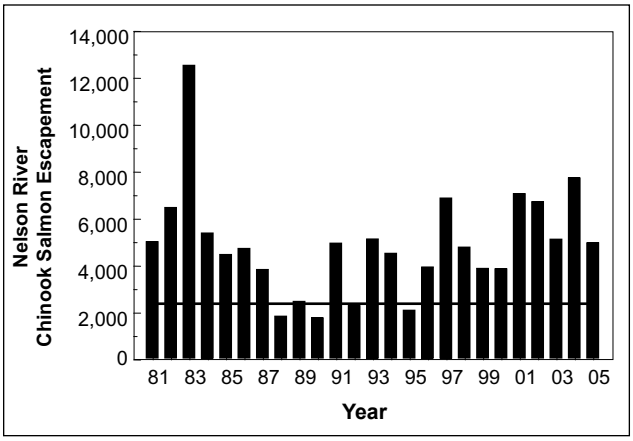

Figure 127. Escapements of Chinook salmon in the Nelson River from 1981–2005 and the lower end of the biological escapement goal range of 2,400–4,400.

current goal has been met or exceeded in 21 of the 25 years (84%) from 1981 to 2005.

Sockeye salmon

The biological escapement goal for the stock of sockeye salmon that spawns in the Nelson River is 97,000 to 219,000 fish. Nelson River sockeye salmon escapements have met or exceeded the lower end of the goal range each year since 1975 (Figure 128).

The sustainable escapement goal for the stock of sockeye salmon that spawns in the Bear River is 293,000 to 488,000 fish. This sustainable escapement goal is split into an early-run goal of 176,000 to 293,000 fish and a late run goal of 117,000 to 195,000 fish. Bear River sockeye salmon escapements prior to 1978 seldom met the current escapement goal (Figure 129). Since 1978, Bear River escapements of sockeye salmon have met or exceeded the goal in 24 of the 28 years (86%).

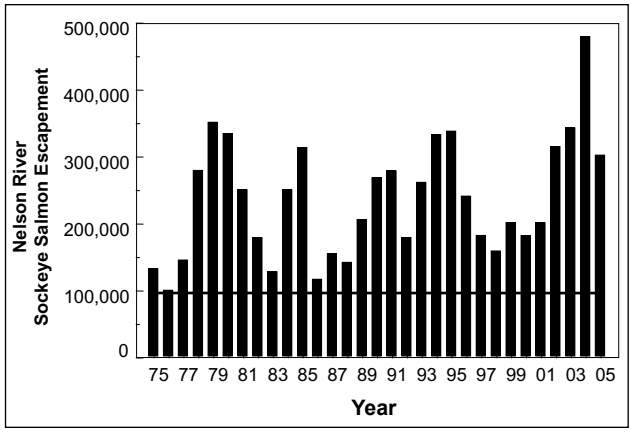

Figure 128. Escapements of sockeye salmon in the Nelson River from 1975–2005 and the lower end of the biological escapement goal range of 97,000–219,000.

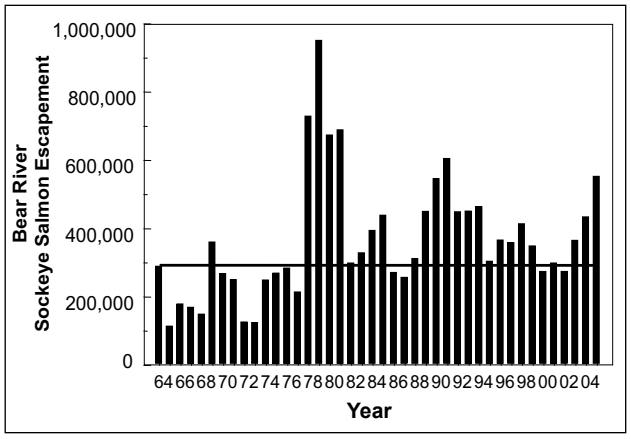

Figure 129. Escapements of sockeye salmon in the Bear River from 1964–2005 and the lower end of the sustainable escapement goal range of 293,000–488,000.

There are 11 other stocks of sockeye salmon in the Peninsula–Aleutians area with sustainable escapement goals. Seven of these stocks spawn in streams along the North Peninsula and the sustainable escapement goals for those stocks are: (1) from 4,400 to 8,800 fish in North Creek, (2) from 6,000 to 12,000 fish in the Cinder River, (3) from 8,000 to 16,000 fish in Swanson Lagoon, (4) from 10,000 to 20,000 fish in the Meshik River, (5) from 25,000 to 50,000 fish in Christianson Lagoon, (6) from 40,000 to 60,000 fish in the Sandy River, and (7) from 40,000 to 60,000 fish in the Ilnik River. Four of the stocks spawn in streams along the South Peninsula and the sustainable escapement goals for those stocks are: (1) from 15,000 to 20,000 fish in Orzinski Lake, (2) from 14,000 to 28,000 fish in Thin Point Lake, (3) from 3,200 to 6,400 fish in Mortensens Lagoon, and (4) from 16,000 to 32,000 fish in Middle Lagoon. During the 10-year period from 1996 to 2005, escapement counts of sockeye salmon were made in each of these 11 locations except for the Cinder River in 1996 and the Meshik River in 1997, thus providing 108 observations. In 95 of the cases (88%), observed escapements met or exceeded the sustainable escapement goal ranges (Figure 130). In the 5-year period from 2001 to 2005, escapement objectives were met or exceeded in 53 of the 55 cases (96%). In several locations such as the Meshik and Cinder rivers, all observed escapements since 1996 have been well in excess of established escapement goals.

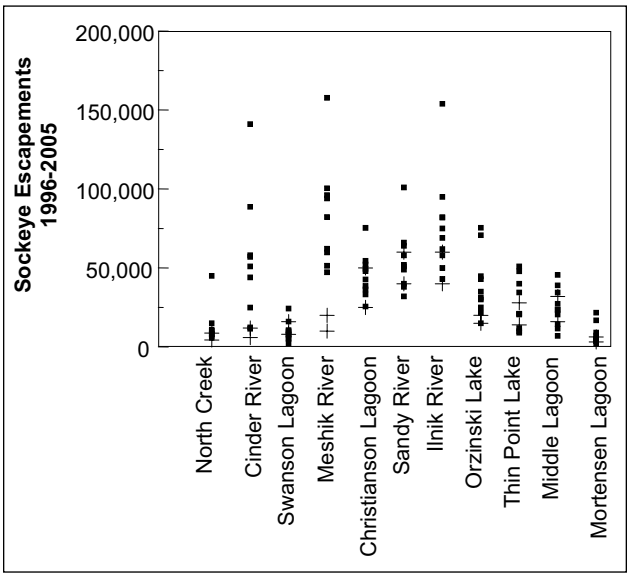

Figure 130. Sockeye salmon escapements from 1996–2005 for 11 Alaska Peninsula stocks with sustainable escapement goals (annual escapements shown as solid squares, lower and upper ends of sustainable escapement goal ranges shown as + signs).

The threshold sustainable escapement goal for the stock of coho salmon that spawns in the Nelson River is 18,000 fish. The current threshold goal for coho salmon was seldom met prior to 1984 (Figure 131). Since 1984, the goal has been met or exceeded in 18 of the 22 years (82%).

The threshold sustainable escapement goal for the stock of coho salmon that returns to Thin Point Lake is 3,000 fish. The current threshold goal for coho salmon was seldom met prior to 1988 (Figure 132). Since 1988, the goal has been met or exceeded in 17 of the 18 years (94%).

Coho salmon

The threshold sustainable escapement goal for the stock of pink salmon that spawns in streams tributary to Bechevin Bay on the North Peninsula during even years is 31,000 fish and during odd years is 1,600 fish. The even-year threshold goal for Bechevin Bay pink salmon has been met or exceeded in 6 of the 9 years (67%) since 1988 (Figure 133). The odd-year goal for Bechevin Bay pink salmon has been met or exceeded in 6 of the 10 years (60%) since 1987 (Figure 134).

Pink salmon

The biological escapement goal for the stock of pink salmon that spawns in streams along the South Peninsula during even years is 1,864,600 to 3,729,300 fish and during odd years is 1,637,800 to 3,275,700 fish. The current even-year goal for South Peninsula pink salmon stock was not achieved prior to 1978 (Figure 135). Since 1978, the goal has been met or exceeded in 12 of the 14 years (86%). The current odd-year goal was seldom achieved prior to 1977 (Figure 136). Since 1977, the South Peninsula pink

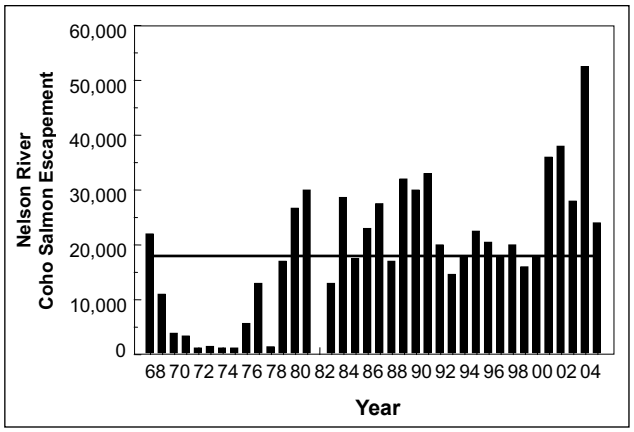

Figure 131. Escapements of coho salmon in the Nelson River from 1968–2005 and the threshold sustainable escapement goal of 18,000 (escapement not counted in 1982).

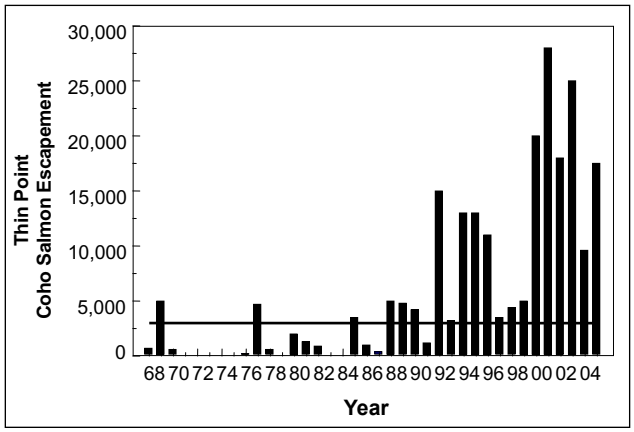

Figure 132. Thin Point escapements of coho salmon from 1968–2005 and the threshold sustainable escapement goal of 3,000 (escapements not counted in 1971–1972, 1974, 1979, and 1983–1984).

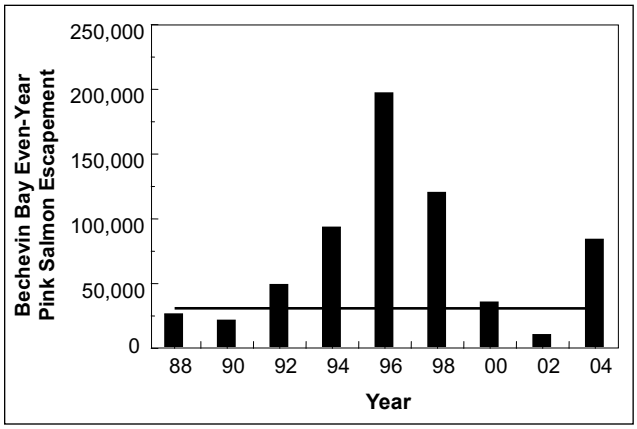

Figure 133. Escapements of even-year pink salmon in Bechevin Bay from 1988–2004 and the threshold sustainable escapement goal of 31,000.

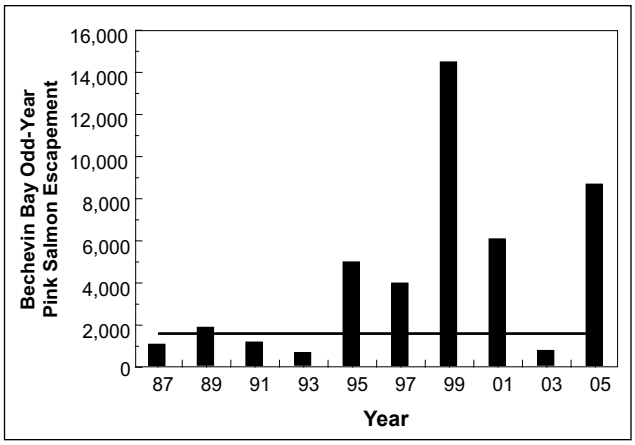

Figure 134. Escapements of odd-year pink salmon in Bechevin Bay from 1987–2005 and the threshold sustainable escapement goal of 1,600.

salmon goal has been met or exceeded in 12 of the 15 years (80%). In addition to the biological escapement goals for pink salmon that spawn in streams along the South Peninsula, management objectives have been established to ensure distribution of spawning pink salmon among streams in the area.

The biological escapement goal for chum salmon that spawn in streams in the Northwestern District along the North Peninsula is 100,000 to 215,000 fish. Since 1980, escapements of chum salmon have met or exceeded the goal every year (Figure 137).

Chum salmon

The biological escapement goal for chum salmon that spawn in streams in the Northern District along the North Peninsula is 119,600 to 239,200 fish. Escapements of chum salmon in the Northern District have met or exceeded the current escapement goal in 21 of the 26 years (81%) since 1980 (Figure 138).

There are 4 sustainable escapement goals for chum salmon that spawn in streams along the South Peninsula. The sustainable escapement goal for chum salmon in the Unimak District is 800 to 1,800 fish; annual counts of escapement have met or exceeded the goal in less than half of the years since 1987 (Figure 139). Sustainable escapement goals for stocks of chum salmon that spawn in the streams of the South Peninsula are substantially larger and are 89,800 to 179,600 fish in the Southcentral District, 106,400 to 212,800 fish in the Southeastern District, and 133,400 to 266,800 fish in the Southwestern District. Observed escapements met or exceeded sustainable escapement goals for these 3 stocks of chum salmon in 27 of the 30 cases (90%) during the 10-year period from 1996 to 2005 (Figure 140). In most of the cases, escapements

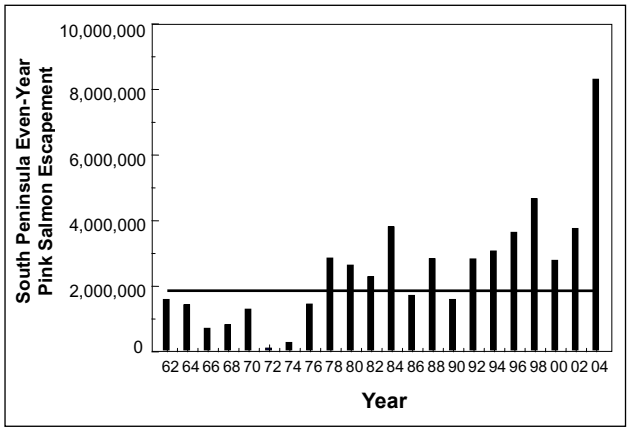

Figure 135. Escapements of even-year pink salmon in the South Peninsula area from 1962–2004 and the lower end of the biological escapement goal range of 1,864,600–3,729,300.

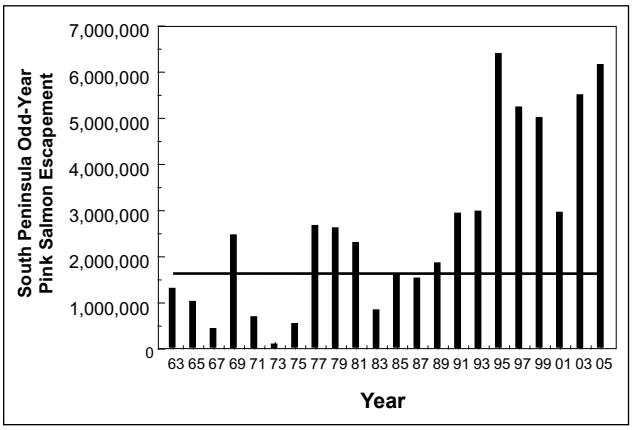

Figure 136. Escapements of odd-year pink salmon in the South Peninsula area from 1963–2005 and the lower end of the biological escapement goal range of 1,637,800–3,275,700.

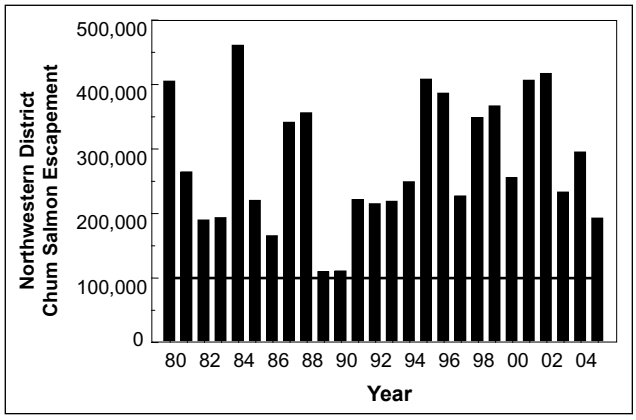

Figure 137. Escapements of chum salmon in the Northwestern District from 1980–2005 and the lower end of the biological escapement goal range of 100,000–215,000.

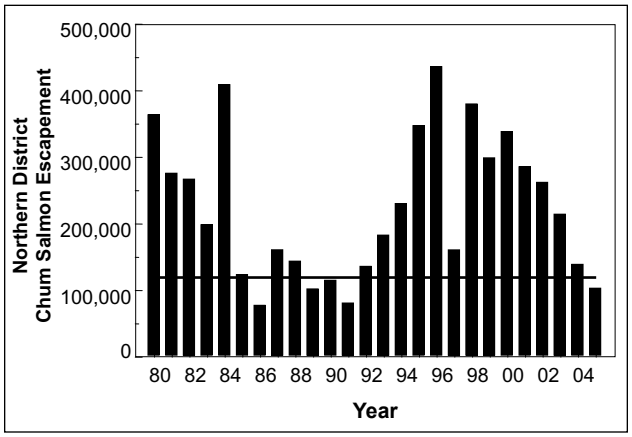

Figure 138. Escapements of chum salmon in the Northern District from 1980–2005 and the lower end of the biological escapement goal range of 119,600–239,200.

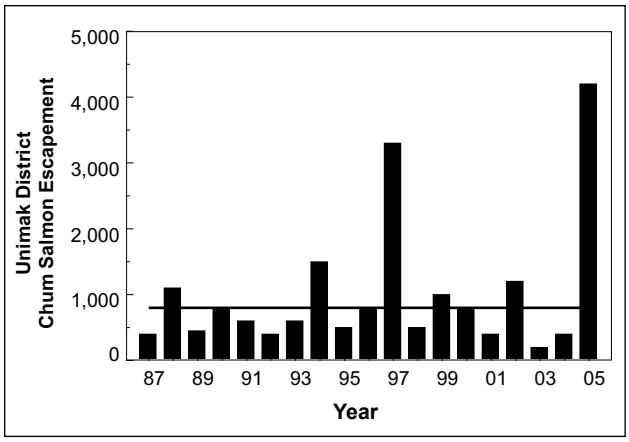

Figure 139. Escapements of chum salmon in the Unimak District from 1987–2005 and the lower end of the sustainable escapement goal range of 800–1,800.

exceeded the established escapement goals in the 10-year period from 1996 to 2005.

Budget History and Fiscal Support

The Division of Commercial Fisheries operational budget for the Peninsula–Aleutians in FY 05 totaled about $962,000. Costs just for the salaries of the 5 management staff members was about $456,000, or 47% of the total. About $506,000 was used for operational costs to manage the salmon fisheries, including about $217,000 for management support and office-related expenses at Cold Bay, Sand Point, and Port Moller. About $74,000 was used for commercial fishery catch sampling, about $147,000 was used to operate weirs to count and sample salmon at Bear River, Ilnik River, and Sandy River, and about $68,000 was used for test fishing along the North Peninsula and in the Shumagin Islands. Given the diversity of geography, remoteness, and magnitude of the salmon resource in the Peninsula–Aleutians, the level of budget support for management is very small and represents only 2.6% of the long-term inflation-unadjusted exvessel value of the fishery. Substantial increases in funding support for the Peninsula–Aleutians salmon management program are needed and can be fully justified.

There is not adequate fiscal support for the Peninsula–Aleutians salmon fishery management and stock assessment program. Funding is needed to operate additional on-the-grounds escapement enumeration and sampling projects so that managers have better information upon which to base their inseason management actions. Weirs or towers are needed to completely count and sample salmon escapements in the Cinder River, Meshik River, Christianson Lagoon, Thin Point Lake, and Middle Lagoon. In addition, temporal extensions of existing escapement monitoring of Nelson River and Orzinski Lake salmon populations are needed. Operational costs for these activities likely would total about $400,000 per year.

Another important and largely unfunded need is the annual documentation of stock composition of the commercial harvests of sockeye and chum salmon. The commercial fishery harvests sockeye salmon migrating to Bristol Bay and Chignik, but because of the lack of scientifically-based stock composition estimates in these fisheries, managers in the Peninsula–Aleutians and the other management areas have to make unverified assumptions concerning stock composition. Stock composition of the Peninsula–Aleutians chum salmon harvests have been a major issue in Alaska for the past 20 or so years. Because of the lack of annual scientific stock composition estimates, allocation issues and concerns among areas about stock status of chum salmon is often brought forth during Alaska Board of Fisheries meetings and other regulatory forums. An annual program to provide the stock composition estimates for these fisheries would require the addition of about $150,000 a year to the current catch sampling project and an additional approximate $500,000 a year for genetic analysis of collected samples.

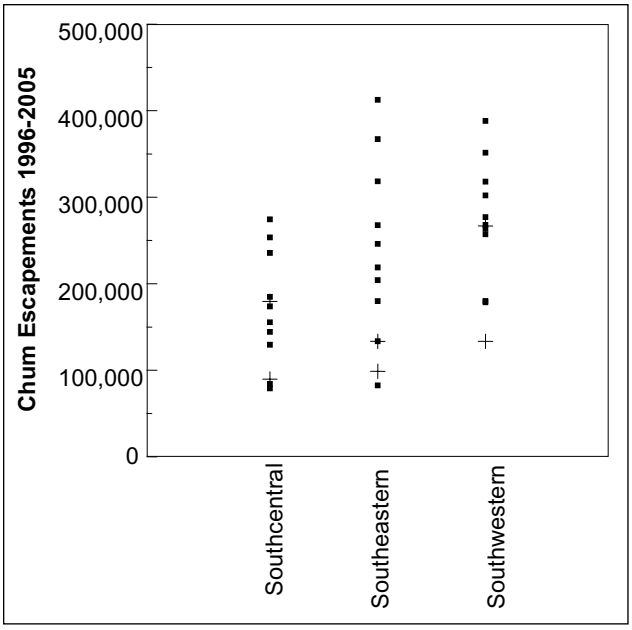

Figure 140. Chum salmon escapements from 1996–2005 for 3 South Alaska Peninsula districts with sustainable escapement goals (annual escapements shown as solid squares, lower and upper ends of sustainable escapement goal ranges shown as + signs).

BRISTOL BAY COMMERCIAL SALMON FISHERY

Area Description and Gear Types

The Division of Commercial Fisheries manages the commercial and subsistence salmon fisheries in Bristol Bay with the goal of achieving and maintaining sustained production. Salmon management in Bristol Bay is primarily directed at sockeye salmon that are commercially harvested by set and drift gillnet fishermen in the 5 discrete commercial fishing districts of Bristol Bay: the Ugashik, the Egegik, the Naknek–Kvichak, the Nushagak, and the Togiak (Figure 141). Chinook, chum, pink, and coho salmon are also harvested in Bristol Bay, but sockeye salmon are the mainstay of the fishery. There are no salmon hatcheries in Bristol Bay; a state hatchery operated for a few years in the late 1970s and early 1980s at Snake Lake, produced a few sockeye salmon and was subsequently closed. Unlike several of the other salmon fisheries, annual federal contracts to support major stock assessment and fishery management activities has not taken place to a significant degree in Bristol Bay.

History of the Commercial Salmon Fishery

The Bristol Bay salmon fishery is one of the most important commercial salmon fisheries in the world. Annual commercial harvests of salmon in Bristol Bay since statehood have averaged about 17 million sockeye salmon (91.2% of all salmon), about 880,000 chum salmon (4.7%), about 550,000 pink salmon (3.0%), about 120,000 coho salmon (0.6%), and about 100,000 Chinook salmon (0.5%). Total annual commercial salmon harvests have averaged almost 19 million fish since 1959 ranging from a low of about 1.5 million salmon in 1973 to a high in 1995 of about 45 million salmon. Commercial harvests of sockeye salmon in Bristol Bay since 1959 have represented about 56% of the statewide commercial harvest of that species, ranging from a low of 17% in 1973 to a high of 81% in 1965. Annual management reports for Bristol Bay, written by ADF&G staff since the early 1960s provide extensive and detailed fishery data and insight into the management program and fishery. See Westing et al. (2005).

The prestatehood peak decadal commercial harvest of sockeye in Bristol Bay was in the 1910s when an annual average of about 17 million sockeye salmon was harvested. Average harvest of sockeye decreased to about 6 million in the 1950s. Average sockeye salmon harvests has been about 22 million fish in the 1980s, 28 million fish in the 1990s, and about 17 million fish so far in the 2000s (Figure 142, Panel B).

Harvests of Chinook salmon in Bristol Bay predominantly occur in the Nushagak District because one of the largest runs of Chinook salmon in Alaska spawns in the Nushagak River. Harvests of Chinook increased from the 1940s through the mid-1980s and since then have generally decreased (Figure 142, Panel A), partially as a result of low prices. The price per pound in 1987 was $1.17, and the price per pound in 2004 was $0.37. Coho salmon are underused in Bristol Bay because these fish return in the fall after most commercial fishing has ceased. Further, prices paid for coho salmon are low, and the area transportation costs are high in this remote area. Harvest trends for coho salmon reflect market conditions, but are not reflective of abundance (Figure 142, Panel C). In the 1980s, prices paid for coho salmon were relatively high—the price per pound in 1988 was $1.40—and harvest substantially increased. In 2004, fishermen were paid an average price of $0.31 per pound for coho salmon, which is only 22% of the price paid in the late 1980s. Bristol Bay supports large even-year pink salmon returns; escapements in the millions occur in rivers such as the Nushagak and Alagnak in some years. However, pink salmon are underused due to market conditions and low prices paid to fishermen—$0.09 per pound in 2004. Like coho salmon, pink salmon harvest trends (Figure 142, Panel D) are not indicative of abundance. Decadal average harvests of chum salmon in Bristol Bay have increased from a level of about 300,000 fish in the 1950s to a peak of about 1.4 million fish in the 1980s (Figure 142, Panel E). Harvests in the 1990s averaged about 820,000 fish and in the first half of the 2000s averaged about 670,000 fish. Fishermen were only paid $0.09 per pound for chum salmon in 2004.

Other Salmon Harvests

The salmon subsistence fishery in Bristol Bay is one of the largest salmon subsistence fisheries in the State of Alaska (Figure 9). The recent 20-year average annual harvest in the Bristol Bay subsistence fishery was about 153,000 fish (Table 26). There has been a gradual reduction in the number of salmon harvested in the Bristol Bay subsistence fishery across the 20-year time period from 1983 to 2004 (Figure 143). Sockeye salmon represent about 80% of the subsistence harvest. While by Alaska standards the Bristol Bay subsistence fishery is large, the harvest is minor in comparison to the commercial harvest. The ratio of commercial harvest to subsistence harvest for Bristol Bay salmon during the last 20 years is about 160:1; sockeye salmon

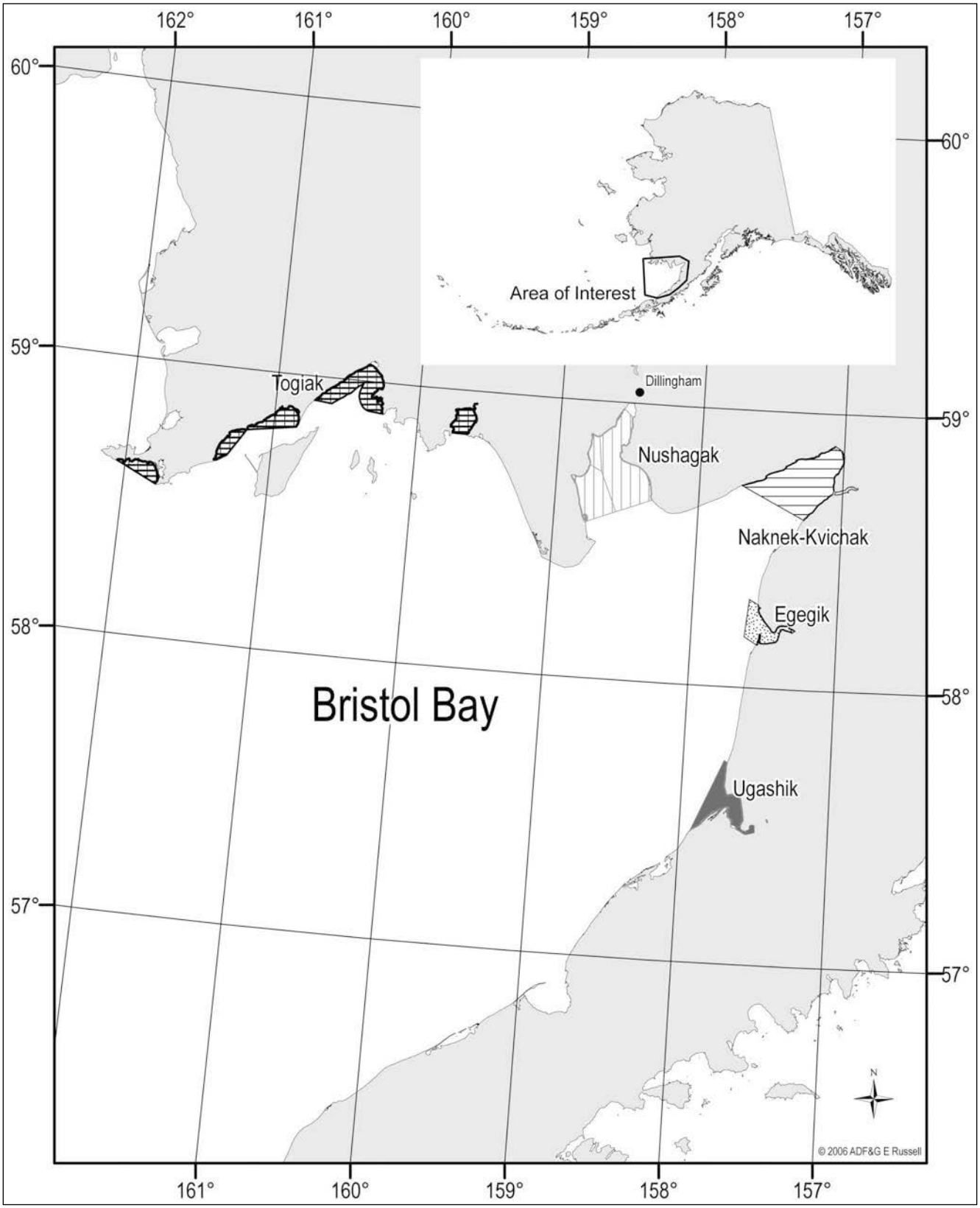

Figure 141. Bristol Bay area commercial salmon fishery.

have the highest species ratio at about 200:1 and Chinook salmon the lowest ratio at about 5:1.

Sport harvests of salmon in Bristol Bay have increased over the last 25 years (Table 27). While sport fishermen in Bristol Bay harvest sockeye salmon, Chinook and coho salmon are preferred. Like the subsistence fishery in Bristol Bay, the sport fishery harvest level is minor in comparison to the commercial harvest. The ratio of commercial harvest to sport harvest for Bristol Bay salmon during the last 25 years

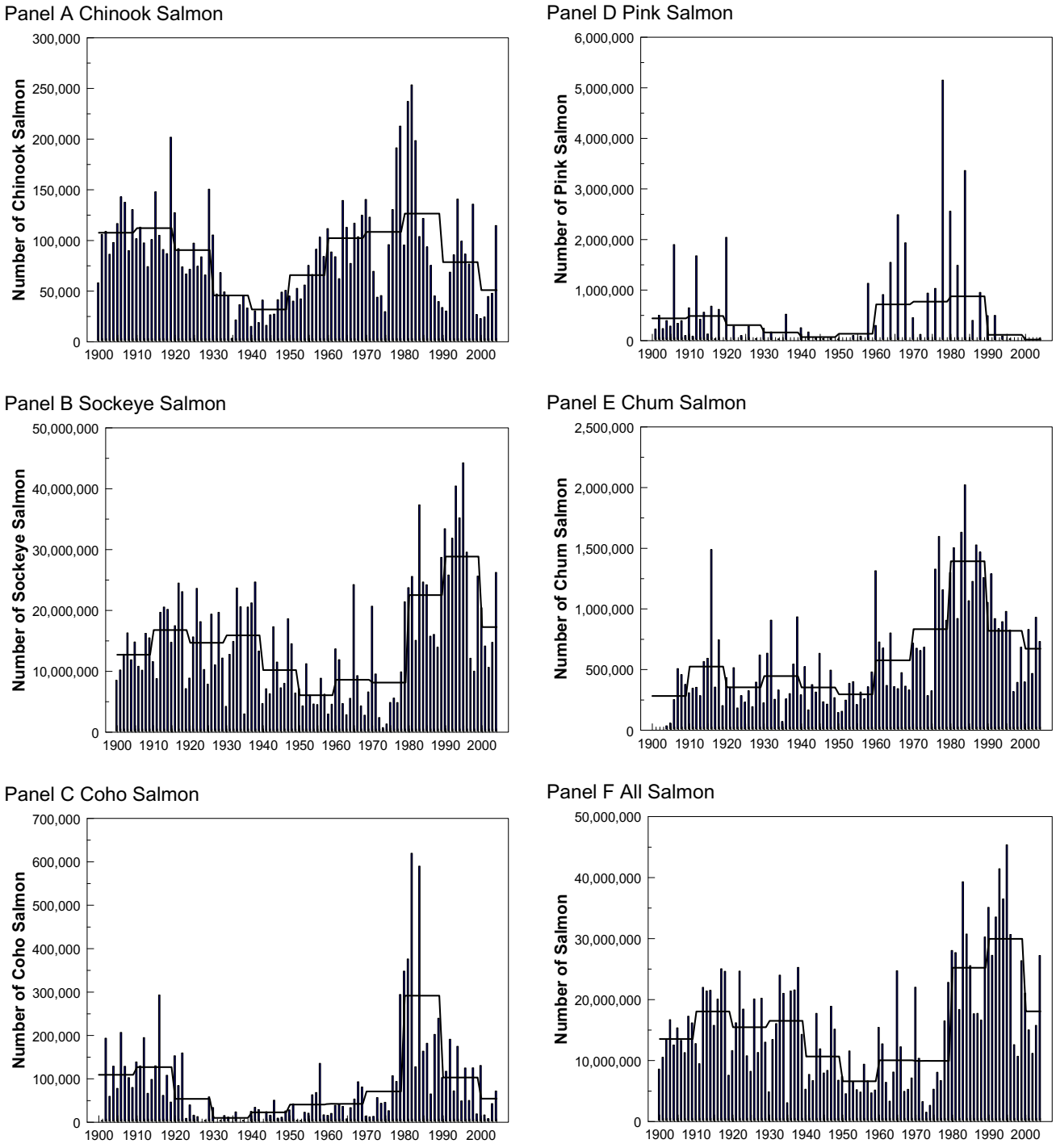

Figure 142. Commercial salmon harvests in Bristol Bay from 1900–2004; bars provide annual catches and lines provide decade averages.

is about 750:1; sockeye salmon have the highest ratio at about 1,700:1 and Chinook salmon the lowest ratio at about 7:1.

Commercial Salmon Fishery Users

As of August 31, 2005, there were 1,878 drift gillnet limited entry permits and 988 set gillnet permits issued for the Bristol Bay salmon fishery. Not all permits are actively used each year. In 2004, 2,187 of the limited entry permits in Bristol Bay were fished (Table 28) representing about 77% of the 2,849 permits that were issued and could have been legally used in that year. Each of the permits fished in a given year represents an independent small business and the commercial salmon fishery in Bristol Bay represents a major component of the overall economy in that part of rural Alaska.

Table 26. Average annual harvests of salmon in the Bristol Bay subsistence fishery (rounded to the nearest 1,000 fish).

Species	1985–2004 Average	Annual Minimum	Annual Maximum
Chinook	15,000	10,000	21,000
Sockeye	121,000	81,000	163,000
Coho	9,000	6,000	14,000
Pink	1,000	–	8,000
Chum	7,000	3,000	13,000
Total	153,000	100,000	219,0

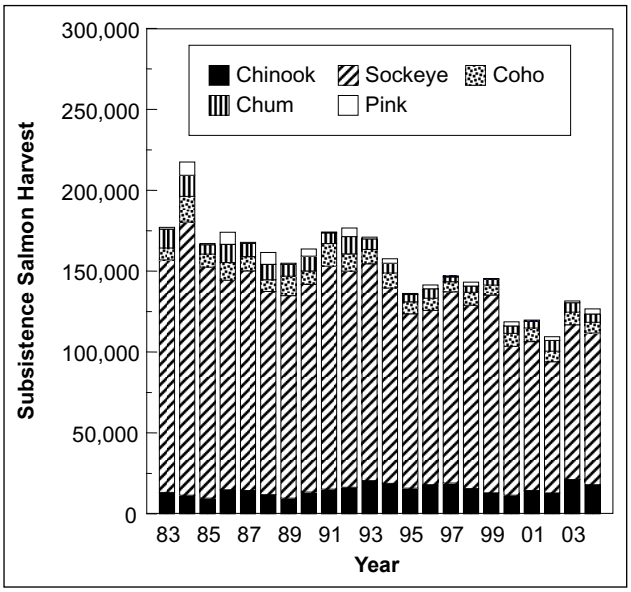

Figure 143. Subsistence salmon harvests in Bristol Bay from 1983–2004.

Table 27. Average annual harvests of salmon in the Bristol Bay sport fishery.

Species	1980–1989	1990–1999	2000–2004
Chinook	8,775	11,160	10,086
Sockeye	9,402	18,213	12,007
Coho	5,888	7,201	13,178
Pink	1,637	673	1,386
Chum	1,020	1,771	2,022
Total	26,722	39,018	38,679

Exvessel Value

The average annual exvessel value of the commercial salmon fishery in Bristol Bay from 1985 to 2004 was about $129 million, ranging from a low of about $32 million in 2001 to a high of about $213 million in 1990. Once adjusted for inflation and expressed as buying power in 2004 dollars, the annual average was about $176 million. Inflation-adjusted exvessel value ranged from a low of about $34 million in 2002 when 11.2 million fish were harvested to a high of about $318 million in 1989 when about 30.3 million fish were harvested—almost a 10-fold level of variation in exvessel value over this 20-year period (Figure 144). During the same 20-year period, the average price paid per pound for sockeye salmon in Bristol Bay decreased (Figure 145); price varied from a high of about $2.00 per pound in 1988 to a low of about $0.40 in 2001. From 1985 to 2004, sockeye salmon accounted for 97.6% of the inflation adjusted total exvessel value, chum salmon for 1.1%, Chinook salmon for 0.7%, coho salmon for 0.5% and pink salmon for 0.1%.

Management

Commercial salmon fisheries in Bristol Bay are managed strictly on an emergency order basis from late-June through mid-July. The intent is to achieve biological escapement objectives in key river systems that produce large annual runs of sockeye salmon including the Ugashik, Egegik, Naknek, Branch, Kvichak, Igushik, Wood, Nushagak, Nuyakuk, and Togiak rivers. The regulatory framework is that commercial fishing is closed during this time period and can only take place if Division of Commercial Fisheries area

Table 28. Number of salmon limited entry permits fished in Bristol Bay, 2000–2004.

Year Year	Drift Gillnet Permits Fished	Set Gillnet Permits Fished	Total Permits Fished	Total Permits Issued
2000	1,823	921	2,744	2,811
2001	1,566	834	2,400	2,717
2002	1,183	680	1,863	2,558
2003	1,389	714	2,103	2,581
2004	1,426	761	2,187	2,849

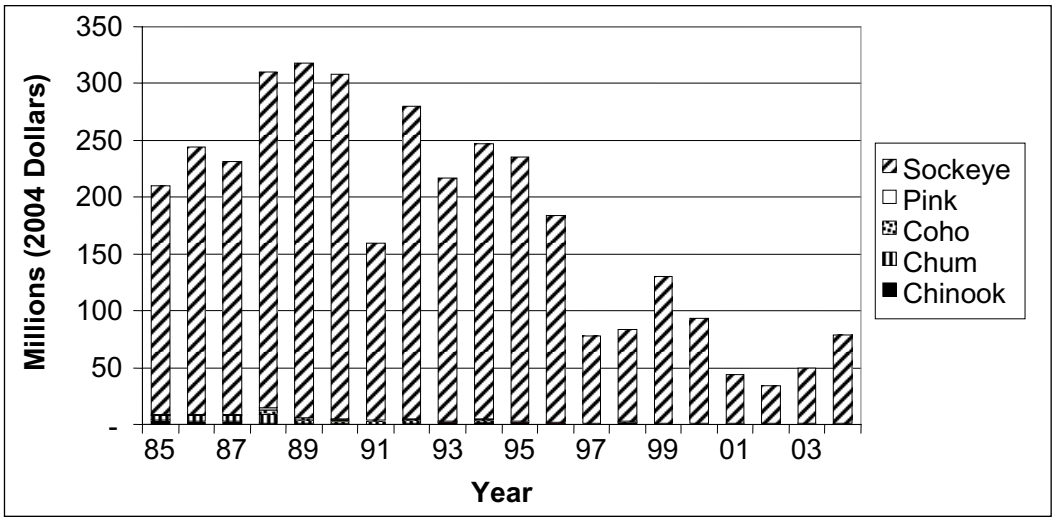

Figure 144. Exvessel value of the Bristol Bay commercial salmon fishery, 1985–2004, adjusted for inflation into 2004 dollars.

management biologists open the fishery in specific locations and for specific periods of time. During these few weeks, millions of sockeye salmon enter Bristol Bay fishing districts as they pass upstream to freshwater streams and lakes. As chum salmon run timing is coincident with sockeye salmon run timing, fishery management for both species is largely coincidental. Chinook salmon run timing is earlier, so early season fishery management decisions relative to time and area openings of the commercial fishery are often based upon status of Chinook salmon runs, particularly in the Nushagak District. Pink and coho salmon run timing is typically later than that for sockeye salmon, and as a result time and area openings for the commercial fishery in the latter parts of the season are often based upon status of pink and coho salmon runs rather than the status of sockeye salmon runs. The fishing districts, subdistricts, and fishery management strategies are designed to be as species- and stock-specific as is practical.

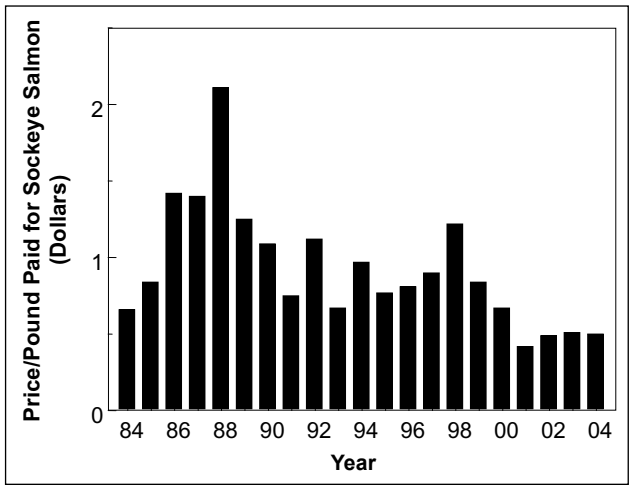

Figure 145. Average price paid per pound for sockeye salmon harvested in the Bristol Bay commercial salmon fishery, 1984–2004.

Timely catch and escapement data is essential in the high volume, short duration sockeye salmon fishery occurring from mid-June through mid-July. Attaining both the escapement goals and the Board of Fisheries directed gear allocations among set gillnet and drift gillnet user groups is achieved by emergency order adjustments of fishing time and area. Early in the fishing season, fishery management decisions are based upon preseason forecasts of abundance. At the same time, stock assessment data that is collected inseason is used to update and supplant the preseason forecast. Inseason fishery management depends on timely inseason run strength data and stock analysis, which is provided by an array of stock assessment projects. Such assessment efforts include test fishing, catch analysis, run modeling, aerial surveys, tower counts and sonar-based estimates of escapement, and age composition estimates from sampled catches and escapements. Rapid inseason analysis of this data provides managers the capability and response time to continuously adjust fishing time and area to attain escapement objectives for component spawning stocks of salmon, while still allowing commercial fishing at an adequate level to harvest salmon surplus to reproductive needs. Typically, several emergency orders are announced in Bristol Bay per day during the salmon fishing season, each defining and adjusting fishing time and area (Table 29).

Total abundance by stock and age for major sockeye salmon runs that spawn in Bristol Bay river systems has been monitored by ADF&G since state-

Table 29. Number of emergency orders issued by Division of Commercial Fisheries area managers in 2000–2004 for inseason management of commercial and subsistence salmon fisheries.

District	2000	2001	2002	2003	2004
Ugashik	13	14	12	18	16
Egegik	29	27	30	34	29
Naknek–Kvichak	25	26	18	23	33
Nushagak	47	36	46	41	48
Togiak	12	14	12	10	8

hood using postseason analysis of documented catches, escapements, and age compositions of catches and escapements. Escapements into major sockeye salmon-producing river systems are annually monitored through a total enumeration program using towers erected along river banks. Migrating fish are counted on a 10-minute-per-hour subsampling basis (Ugashik, Egegik, Naknek, Branch, Kvichak, Igushik, Wood, Nuyakuk, and Togiak rivers) or through sonar counts made in the lower Nushagak River. Both spawning escapements and harvests are sampled to estimate annual age, sex, and size composition. About 50,000 salmon are sampled for age composition a year. Age composition has historically been used to help estimate stock composition in the Naknek–Kvichak and Nushagak fishing districts where harvests are comprised of several sockeye salmon stocks. These stock and age specific catch and escapement data have been the basis for development of long-term brood tables used for both preseason forecasting capability and for scientific estimation of escapement goals. These efforts have provided the basis for about a 45-year set of paired estimates of escapements and subsequent recruitments for the major stocks of sockeye salmon returning to Bristol Bay. The Bristol Bay sockeye salmon fishery is one of the few salmon fisheries in the world with a long-term total stock monitoring program and a long-term set of brood tables by stock.

The total inshore run of sockeye salmon from 1960 to 2004 averaged about 28.6 million fish and ranged from a low of about 2.5 million to a high of about 61.1 million, a level of variation of almost 25-fold (Figure 146). Over those 45 years, escapements ranged from a low of about 1.7 million to a high of about 34.7 million, a level of variation of about 20-fold. Commercial harvests averaged about 17.1 million and ranged from about 0.8 million to 44.3 million sockeye salmon, a level of variation of almost 60-fold. Harvest rates exerted on sockeye salmon were higher in years with larger runs (Figure 147). However, in some years, commercial fishing strikes held harvest rates lower than otherwise would have occurred, and processing capacity limited the ability to fully utilize surplus production in years with large runs. Runs in the early 1970s were typically low and management held harvest rates to lower levels in these years. The large runs in 1956, 1965, 1970, and 1975 were due to high cycle abundance of Kvichak sockeye salmon (Figure 146). Runs since the 1980s were generally high, production was spread across more stocks with less reliance on the Kvichak stock, and management provided fishing opportunities resulting in larger harvest rates.

While accuracy and precision of estimated annual catches, annual escapements counted through tower projects, and annual age compositions of both escapements and catches is considered to be excellent on a postseason basis, the allocation methodology used to apportion sockeye salmon catches to component stocks in Bristol Bay represents but a crude approximation of the actual catch by stock. A series of largely untested assumptions is used to allocate stock composition in some districts. For example, in the Ugashik District,

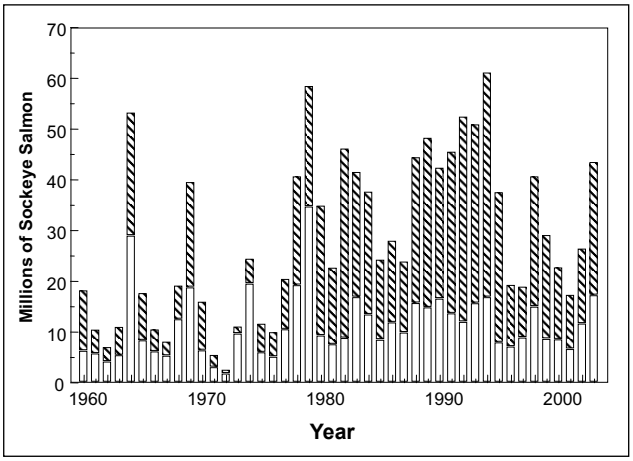

Figure 146. Total inshore returns of Bristol Bay sockeye salmon from 1960–2004, light bars = escapement and striped bars = commercial harvest.

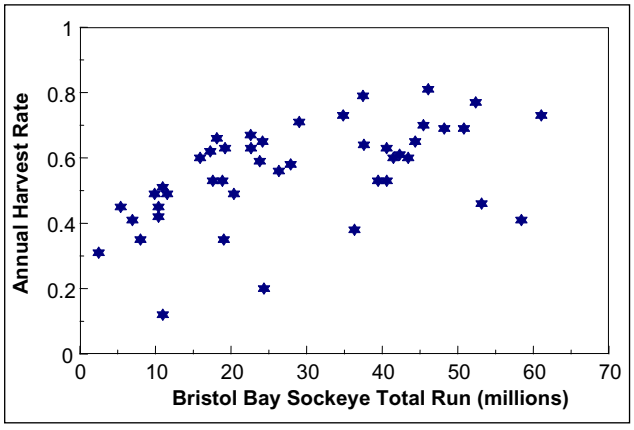

Figure 147. Commercial harvest rates exerted on Bristol Bay sockeye salmon from 1960–2004.

the assumption is made that all sockeye salmon caught in this fishing district are of Ugashik origin. While ADF&G biologists know that this assumption is not necessarily true, it has been hoped that the biases associated with the catch allocation assumptions are not large and that to some extent, these biases are balanced by similar assumptions in other fishing districts. In fishing districts with 2 or more major contributing stocks, age compositions of the communal catch and the separate spawning escapement populations are used to make stock allocation estimates under the assumption that harvest rates by age in the mixed stock fishing district are similar across all contributing stocks. Sporadic efforts in the 1980s and 1990s were made to implement better fishery science for making catch allocations, but budget cuts, logistics, and technical concerns resulted in reverting to historic methodologies. As a result, catch allocation methods have not improved much in the last 50 years. This is a technical area of the current stock assessment program that needs improvement. Recent advances in DNA-based genetic stock identification methodologies provide the potential to develop accurate and precise scientifically-based stock composition estimates. In FY 06, with a new increment of general funds, the Division of Commercial Fisheries has $250,000 per year to implement genetic stock identification of sockeye salmon in Bristol Bay to improve the scientific basis of catch allocations. Successful preliminary results using archived scales for DNA samples indicate the potential to scientifically reestimate historic catch allocations, reducing uncertainty associated with existing brood tables for Bristol Bay sockeye salmon. Although more developmental work in this area is needed, such scientific methodology has the potential to make a substantial improvement in the stock assessment program in Bristol Bay, provided that funding for this work is continued in the future.

The Nushagak River in Bristol Bay is unlike other major salmon producing river systems in the bay—it is very large and the water in the lower river is too turbid to visually count salmon from a tower, and it supports large numbers of all 5 species of salmon. Likely escapements of sockeye salmon and chum salmon in the Nushagak River average in the mid-100,000s, pink salmon escapements sometimes number in the millions, Chinook salmon escapements likely exceed 100,000, and the river supports large numbers of coho salmon. A side scan sonar-based salmon enumeration program has been used since 1979 to estimate salmon escapements into the Nushagak River near Portage Creek during the summer. Test fishing on site is used to apportion sonar-based counts by species. While information from this stock assessment effort is used for fishery management in the Nushagak District, the escapement estimates have never been verified. It is known that significant migration by Chinook salmon takes place further from shore than the sonar beam reaches, so it is certain that Chinook salmon escapements as estimated by the assessment effort are biased low. An improved Chinook salmon stock assessment effort is needed. Efforts to verify the sonar-based estimates of sockeye and chum salmon escapement strength is also needed. If market conditions for pink and coho salmon improve in Bristol Bay, estimating escapement strength of these species in the Nushagak River will also be important.

On a preseason basis, ADF&G uses available data (brood table information) to predict likely returns of sockeye salmon to Bristol Bay by stock (preseason forecasts). These analyses assume that past productive potential by stock and escapement level will be indicative of future production trends. These forecasts are helpful to industry and to fishery users in preseason planning. Preseason forecasts are also useful to ADF&G fishery managers during the early portions of the fishing season for determining time and area openings of the fishery.

From the 1960s to the 1980s, efforts were made to count smolt outmigrations in major Bristol Bay river systems (Ugashik, Egegik, Naknek, Kvichak, Wood, and Nuyakuk). Smolt production information was wanted for 2 purposes: (1) improving forecasting ability by modeling freshwater and oceanic life history phases separately, and (2) improving estimates of biological escapement goals by removing the effect of variable oceanic survival. Budget reductions starting in the 1990s halted these efforts, resulting in extended time series of data available for only a few systems. As a result, the improvements sought to better forecast and set biological escapement goals for Bristol Bay sockeye salmon based upon the smolt stock assessment efforts have now been lost for most of these river systems. Given that about half of all the sockeye salmon harvested in Alaska come from a handful of Bristol Bay river systems, the lost stock assessment program needs to be restored with a secure long-term funding source.

Inseason information in Bristol Bay is used on a daily basis from mid-June through mid-July to update preseason stock forecasts in an effort to better gauge run strengths and make appropriate decisions regarding openings and closures of the commercial fishery on a district or subdistrict basis (inseason management). Much of the stock assessment program in Bristol Bay over the past 50 years was designed to facilitate scientifically-based inseason fishery management. These programs are very important, and are the cornerstone for

the fishery management practices that have sustained the runs while still allowing extensive commercial fishing for sockeye salmon. Improvements in the current stock assessment program can provide immediate benefits to commercial salmon fishermen, the industry, and the economy of the State of Alaska. The loss of operational funding buying power within the Bristol Bay salmon fishery management and stock assessment program since the 1980s (Table 3 and Figure 5) has resulted in a loss of inseason assessment capability and has undoubtedly resulted in some loss of commercial fishing opportunity. For example, a delay in the opening of a fishing district by as much as one day during the peak of the Bristol Bay salmon run can easily result in the lost opportunity for fishermen to harvest a million or more sockeye salmon—more sockeye salmon than are harvested in a year in many other commercial salmon fisheries.

The postseason assessment involves analyzing this information to update brood tables and determine if management met stock escapement objectives, while still allowing sufficient fishing opportunity to harvest salmon surplus to escapement needs. After the commercial fishery is over, staff biologists edit catch reports, make final catch allocations, complete the aging of all sampled fish, edit and review data collected from escapement counting sites and update the brood table data set. From an annual cycle basis, this is the last step in utilizing the extensive stock assessment data collections that occurred for the year.

There are 3 escapement goals for Chinook salmon, 10 goals for sockeye salmon, 3 goals for coho salmon, and one goal for pink salmon in Bristol Bay. Fair et al. (2004) provides information concerning escapement goals for salmon in Bristol Bay along with updated analysis and recommendations for changes. Only escapement trends and goals for major sockeye salmon stocks will be reviewed in this paper.

The most recent escapement goal for Ugashik sockeye salmon was set in 1997 and is stated as a range from 500,000 to 1,200,000 fish (Figure 148). Tower count based escapements of sockeye salmon in the Ugashik increased drastically in the 1980s over prior levels and escapements have been maintained for 26 continuous years above the lower end of the current escapement goal range.

The most recent escapement goal for Egegik sockeye salmon was also set in 1997 and is stated as a range from 800,000 to 1,400,000 fish (Figure 149). Tower count based escapements of sockeye salmon in the Egegik increased in the 1980s over prior levels, but not as much as occurred in the Ugashik. Escapements have been maintained for 23 continuous years at or above the lower end of the current escapement goal range.

The most recent escapement goal for Naknek sockeye salmon was set in 1984 and is stated as a range from 800,000 to 1,400,000 fish. Escapements are counted with the aid of a tower and escapements have been maintained for 31 continuous years at or above the lower end of the current escapement goal range (Figure 150).

Escapements of sockeye salmon in the Alagnak River were counted by tower from 1956 to 1976 and from 2002 to 2005. Aerial surveys were used to index escapement strength in the intervening years. Clark (2005) developed total escapement estimates for the years when only aerial surveys took place (Figure 151). The current escapement goal set by ADF&G

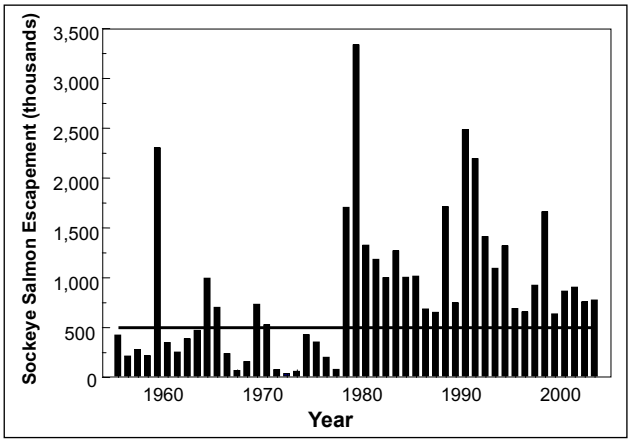

Figure 148. Annual escapements of sockeye salmon in the Ugashik River from 1956–2004 (bars) and the lower end of the current ADF&G biological escapement goal range (line).

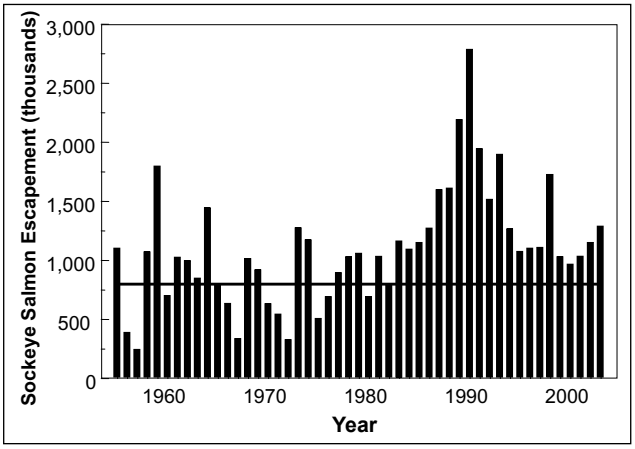

Figure 149. Annual escapements of sockeye salmon in the Egegik River from 1956–2004 (bars) and the lower end of the current ADF&G biological escapement goal range (line).

was from 170,000 to 200,000 fish and dates back to the 1970s. However, the goal has no biological basis (Clark 2005). Escapements of sockeye salmon in the Alagnak have skyrocketed in the last few years, probably at least partially as a result of reduced commercial fishing in the Naknek–Kvichak District. These recent huge escapements have resulted in a conundrum. With documented escapements of 3.7 million fish in 2003, 5.4 million fish in 2004, and 4.2 million fish in 2005, how can the commercial fishery be managed to access surplus Alagnak-origin sockeye salmon while still providing adequate protection to Kvichak-origin sockeye salmon? This remains a major challenge to the commercial fishery management program.

Escapement of sockeye salmon in the Kvichak River is counted with the aid of towers. The most recent ADF&G escapement goals for Kvichak sockeye salmon were set in 1997. The Kvichak off-cycle year goals are stated as 2 million to 10 million fish and the pre- and peak-year goals are stated as 6 million to 10 million fish. The history of the Kvichak sockeye salmon run includes cycles with extremely large runs at the high point of the cycle and very low runs in other years (Figure 152). Starting in the early 1980s, ADF&G attempted to even out the cycle by revising goals to push abundance down in peak years and elevate abundance up in off-cycle years. While the cycle was dampened, overall production decreased as well. The various minimum escapement goals used for fishery management since 1984 show minimum escapement objectives have only been achieved in 4 of the last 10 years (Figure 150). The Kvichak stock of sockeye salmon is currently listed as a stock of concern and extensive management measures have been taken over the last several years to conserve the stock. Such measures have included moving the drift gillnet fleet out of the traditional fishing waters of the Naknek–Kvichak District and into the Naknek River and closing traditional set gillnet beaches to commercial fishing. Currently, the biggest challenge for the Bristol Bay commercial fishery management program is to better understand dynamics of the Kvichak stock and to determine what specific management measures rebuild this vitally important stock.

The most recent escapement goal for Wood River sockeye salmon was set in 2000 and is stated as a range from 700,000 to 1,500,000 fish. Wood River system escapements of sockeye salmon have been counted since 1956 as they pass a tower. Escapements have been maintained continuously for the last 27 years above the lower end of the current escapement goal range (Figure 153).

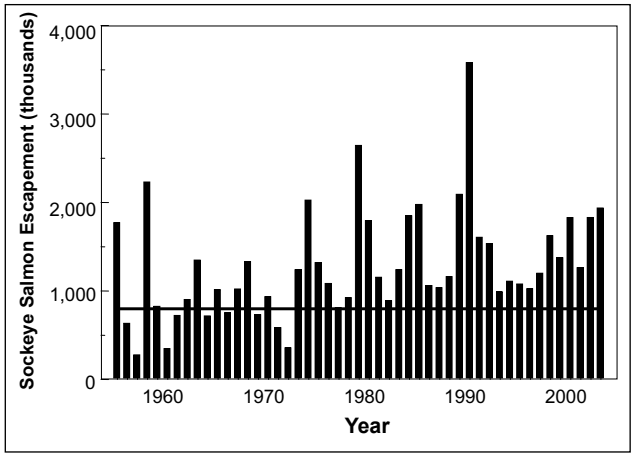

Figure 150. Annual escapements of sockeye salmon in the Naknek River from 1956–2004 (bars) and the lower end of the current ADF&G biological escapement goal range (line).

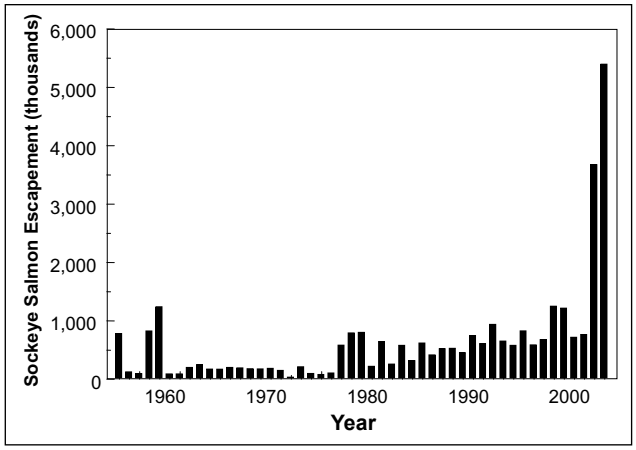

Figure 151. Annual escapements of sockeye salmon in the Alagnak River, 1956–2004.

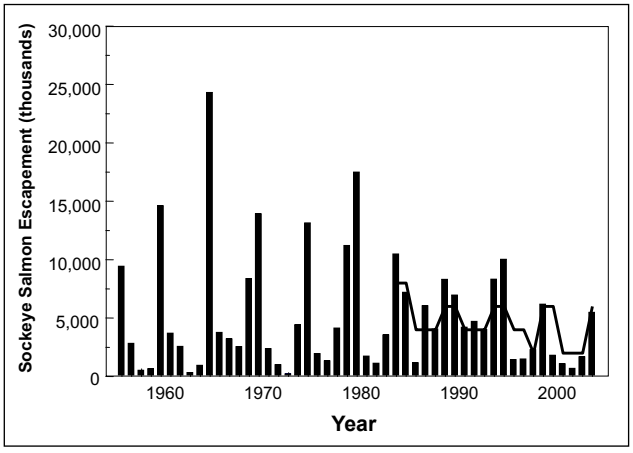

Figure 152. Annual escapements of sockeye salmon in the Kvichak River from 1956–2004 (bars); the lower ends of the ADF&G variable biological escapement goal ranges since 1984 are shown as a line.

The most recent escapement goal for Igushik River sockeye salmon was set in 2000 and is stated as a range from 150,000 to 300,000 fish. Igushik River system escapements of sockeye salmon have been counted since 1956 as they pass a tower. Prior to 1997, escapements were continuously maintained for 19 years above the lower end of the current escapement goal range. However, since 1996, escapements have exceeded the minimum escapement goal in 5 of the 8 years (Figure 154).

The most recent escapement goal for Togiak sockeye salmon was set in 1997 and is stated as a range from 100,000 to 300,000 fish. Togiak River escapements of sockeye salmon have been counted since 1956 as they pass a tower. Escapements have been maintained above the lower end of the current escapement goal range continuously for 32 years (Figure 155).

Budget History and Fiscal Support

The Division of Commercial Fisheries faces several challenges in Bristol Bay. The Bristol Bay commercial salmon fishery is one of the largest and most important fisheries in Alaska, yet the Division has had difficulty maintaining adequate fiscal resources needed to implement the intense inseason management effort. Additional fiscal resources are needed to provide inseason management support, to improve assessment of salmon stocks in the Nushagak River and to reinitiate the smolt program. The Division of Commercial Fisheries needs to both better understand the stock dynamics of Kvichak River system sockeye salmon and improve management tools to increase the probability of escapement goals being met for this stock. Also related—can surplus Alagnak River sockeye salmon returning to this river be harvested without causing harm to comingled Kvichak River system sockeye salmon?

The commercial fishing industry in Bristol Bay faces other challenges as well. Low prices paid for sockeye salmon over the past 10 years, even when coupled with strong annual harvests, result in business failures for both fishermen (low exvessel prices) and processors (low first wholesale prices). Can the industry and fishery be restructured, can the fishery management regime be modified, and can the product be harvested and processed so that value increases—with the end result being improved economic viability of the Bristol Bay commercial salmon fishery?

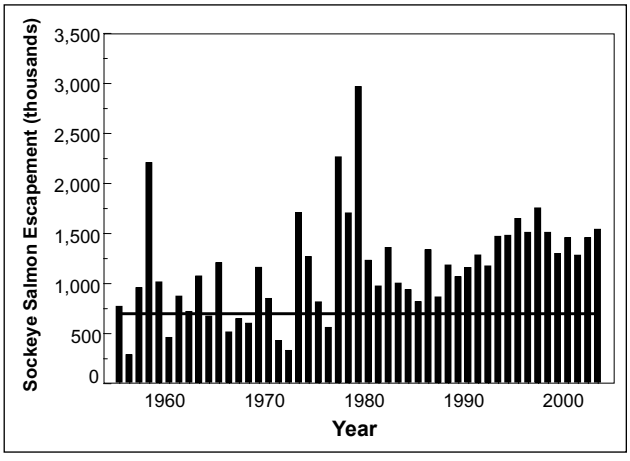

Figure 153. Annual escapements of sockeye salmon in the Wood River from 1956–2004 (bars) and the lower end of the current ADF&G biological escapement goal range (line).

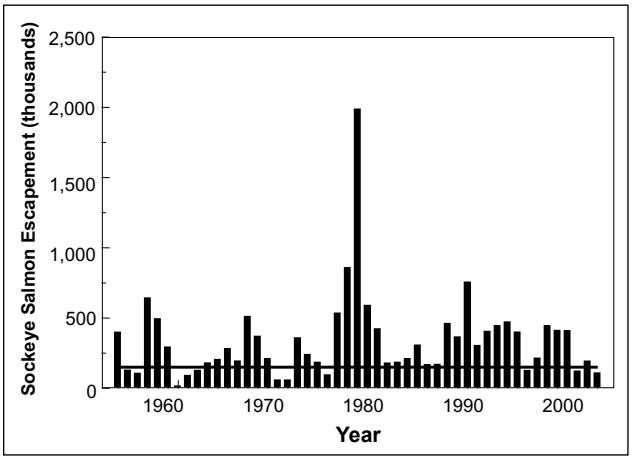

Figure 154. Annual escapements of sockeye salmon in the Igushik River from 1956–2004 (bars) and the lower end of the current ADF&G biological escapement goal range (line).

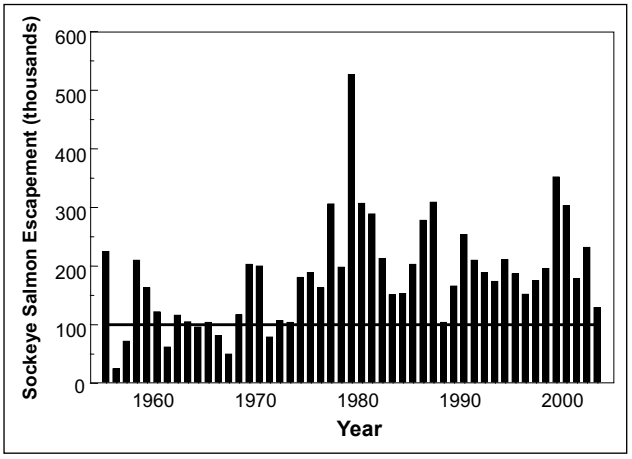

Figure 155. Annual escapements of sockeye salmon in the Togiak River from 1956–2004 (bars) and the lower end of the current ADF&G biological escapement goal range (line).

KUSKOKWIM COMMERCIAL SALMON FISHERY

Area Description and Gear Types

Significant numbers of all 5 species of Pacific salmon return to the Kuskokwim area and at statehood, commercial fishing districts were established. District 1, the lower Kuskokwim District, is located in the lower 125 miles of the Kuskokwim River from Eek Island upstream to Bogus Creek. District 2 is about 50 miles in length and is located in the middle Kuskokwim River from above District 1 to the Kolmakov River near Aniak. An upper Kuskokwim River fishing district, District 3, was defined at Statehood, but has been closed to commercial fishing since 1966. Salmon returning to spawn in the Kuskokwim River are targeted by commercial fishermen in District 1 and 2. District 4, the Quinhagak fishing district, is a marine fishing area that encompasses about 5 miles of shoreline adjacent to the village of Quinhagak. The Kanektok and Arolik Rivers are the primary salmon spawning streams that enter District 4. District 5, the Goodnews Bay fishing district, a second marine fishing area, was established in 1968. District 5 encompasses the marine waters within Goodnews Bay and the Goodnews River is the major salmon spawning stream that enters District 5 (Figure 156). Commercial salmon fishing gear throughout the Kuskokwim area is limited to gillnets.

History of the Commercial Salmon Fishery

Although fishermen first commercially harvested salmon in the Kuskokwim area in 1913, the commercial salmon fishery did not mature until statehood. Small mild-cure commercial salmon operations were conducted in or near Kuskokwim Bay while the Kuskokwim River fishery remained virtually undeveloped. During the 1930s when dog teams were used extensively for freight hauling, a "quasi-commercial" fishery operated in the McGrath area of the Kuskokwim River for the sale of dried, subsistence-caught salmon for dog food. This fishery declined as the use of dog teams for freight declined, and the Kuskokwim area experienced little commercial fishing effort until after Statehood (Jonrowe et al. 1983).

During the 1960s and 1970s the commercial salmon fisheries in the Kuskokwim area were considered experimental. The adaptive fishery management approach was to increase commercial use while monitoring subsistence use and obtaining information on the relationship between catches and returns (Jonrowe et al. 1983). In the 1980s, the management strategy changed from one of commercial harvest guidelines to an escapement objective-based strategy. Harvest levels generally increased until the mid-1990s. Since then, the commercial salmon fishery has been characterized by lower fishing effort levels, lower harvests, and collapsing salmon prices. The intent of the current commercial salmon fisheries management program is to sustain the runs, ensure subsistence needs are met, and with a precautionary approach, provide some opportunity for commercial fishermen to harvest available surpluses. Annual management reports written by ADF&G staff for the Kuskokwim area since the 1960s, provide detailed fishery data and insight into the management program. See Ward et al. (2003).

Commercial harvests of Chinook salmon in the Kuskokwim area peaked in the 1980s when the 10-year annual average harvest was about 70,000 fish (Figure 157, Panel A). Average harvests in the 1990s dropped to about 45,000 fish, while harvests since 2000 have dropped further still to about 22,000 fish. Commercial harvests of sockeye salmon from the Kuskokwim area increased from the 1960s through the 1990s with decadal annual averages increasing from about 5,000 fish in the 1960s to 15,000 fish in the 1970s to 110,000 fish in the 1980s to about 160,000 fish in the 1990s (Figure 157, Panel B). Annual commercial harvests of sockeye salmon since 2000 have averaged about 70,000 fish. Kuskokwim area coho salmon commercial harvests increased each decade, from about 40,000 fish in the 1960s to 150,000 fish in the 1970s to 500,000 fish in the 1980s to about 550,000 fish in 1990s (Figure 157, Panel C). Annual commercial harvests since 2000 have averaged about 300,000 coho salmon. Kuskokwim area chum salmon commercial harvests increased from the 1960s to the 1970s and subsequently peaked in the 1980s when about 560,000 fish were caught per year (Figure 157, Panel E). Decadal annual commercial harvests of chum salmon averaged about 330,000 fish in the 1990s and since 2000 have averaged about 60,000 fish. Abundance of chum salmon in the 1990s and 2000s was less than it was the 1980s. In more recent years, little processor interest coupled with very low prices has had a great impact on chum salmon commercial harvests. Few pink salmon are commercially harvested in the Kuskokwim area. Peak harvest levels occurred in the 1970s and 1990s when average annual harvest levels were about 20,000 fish (Figure 157, Panel D). Cumulative commercial harvests in the Kuskokwim area since 2000 are about the same as occurred in the 1970s and represent about 40% of the harvest levels that took place in the 1980s and 1990s (Figure 157, Panel F).

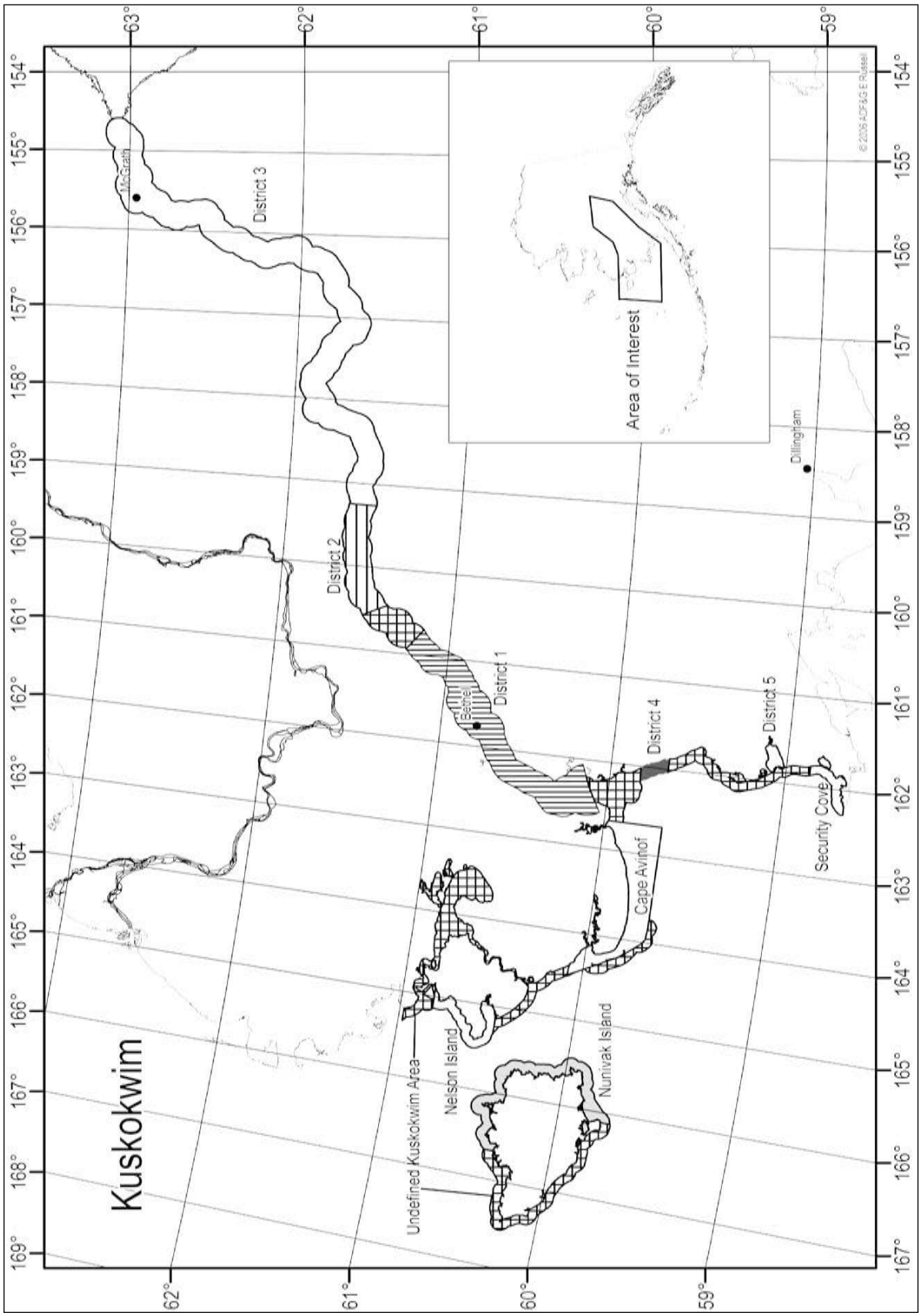

Figure 156. Kuskokwim area commercial salmon fishery.

Other Salmon Harvests

The subsistence salmon fishery in the Kuskokwim is one of the largest subsistence salmon fisheries in North America. The Kuskokwim area contains 38 communities consisting of about 4,500 households and about 1,700 of those households participate in the annual subsistence salmon fishery (Ward et al. 2003). Harvest of salmon for subsistence use is as high as 650 pounds of salmon per capita in some Kuskokwim area communities.

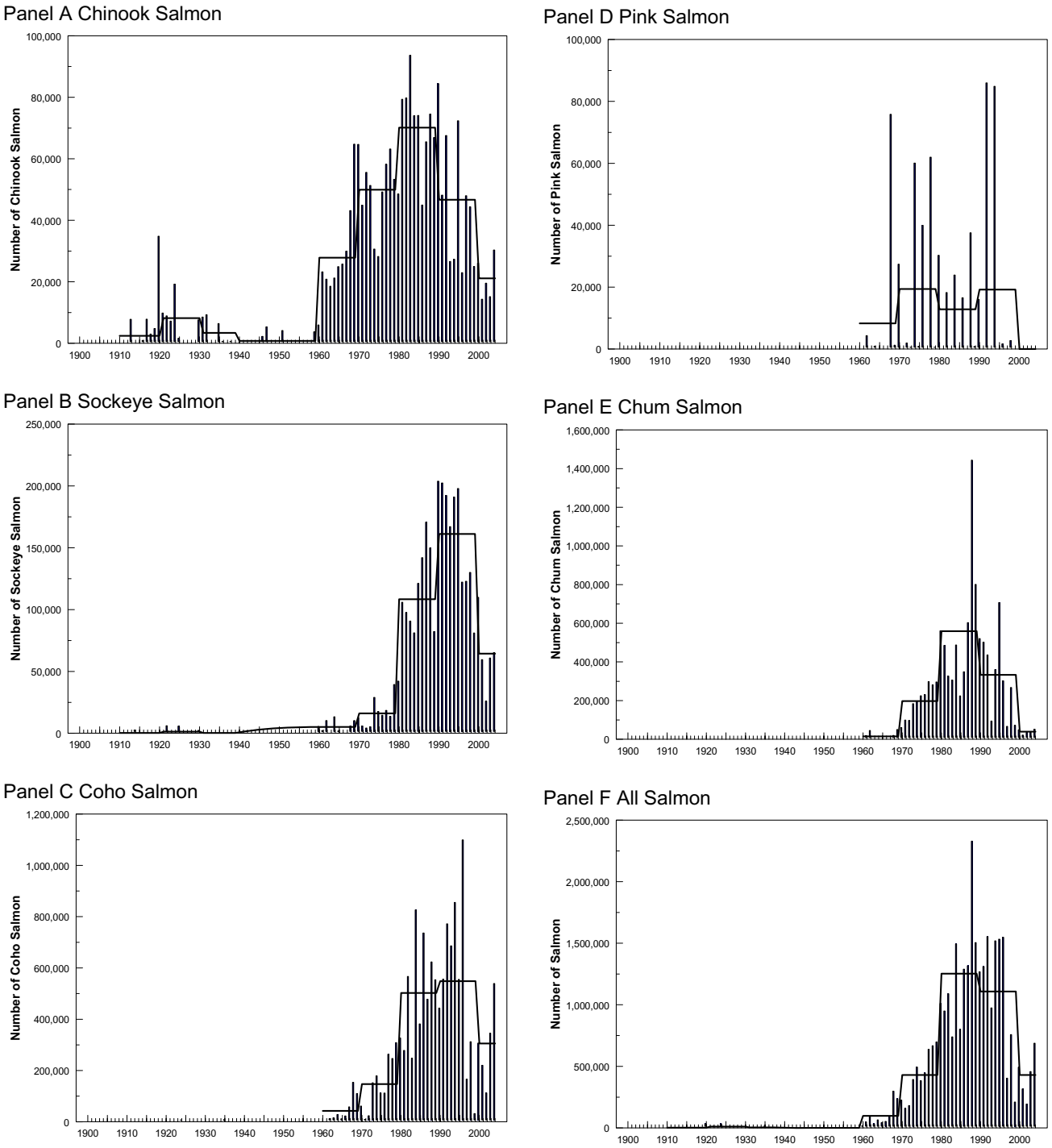

Figure 157. Commercial salmon harvests in the Kuskokwim from 1900–2004; bars provide annual catches and lines provide decade averages.

Residents in the Kuskokwim area have depended upon fishery resources, including salmon, as a source of food for centuries. Traditional fishing methods and materials available to fishermen such as spears, dip nets, fish traps, and willow or caribou strip gillnets limited the historic harvest, were slowly supplanted by more efficient gear such as linen gillnets, thus enabling the fishery to expand. Since statehood, continued improvements in fishing gear, particularly the use of nylon gillnets, have further improved subsistence salmon fishing efficiency. Peak subsistence salmon harvests in the Kuskokwim area occurred during the 1930s coincident with peak activity of the "quasi-commercial" McGrath fishery when annual harvests were as high as 750,000 fish (Jonrowe 1983). The largest annual documented subsistence harvest of salmon in the Kuskokwim area since statehood was in 1964 when about 440,000 fish were taken. Estimated annual subsistence harvests of salmon in the Kuskokwim area averaged about 300,000 fish in the 1960s, 240,000 fish in the 1970s, 250,000 fish in the 1980s, 240,000 fish in the 1990s, and about 200,000 fish since 2000. Chinook, sockeye, coho, and chum salmon are all important components of the Kuskokwim area subsistence salmon harvest (Figure 158). During the past 15 years, the annual subsistence harvest has remained relatively stable while the commercial harvests have been significantly reduced (Figure 159).

Relatively small numbers of salmon are harvested from the Kuskokwim area by sport fishermen. Estimated sport harvests of salmon from the Kuskokwim area since 1980 average from 6,000 to 7,000 fish per year with the harvest trend relatively stable (Table 30). The primary species harvested by sport fishermen have been Chinook and coho salmon. Since 2000, the sport fishery has accounted for less than 1% of the documented salmon harvests in the Kuskokwim area.

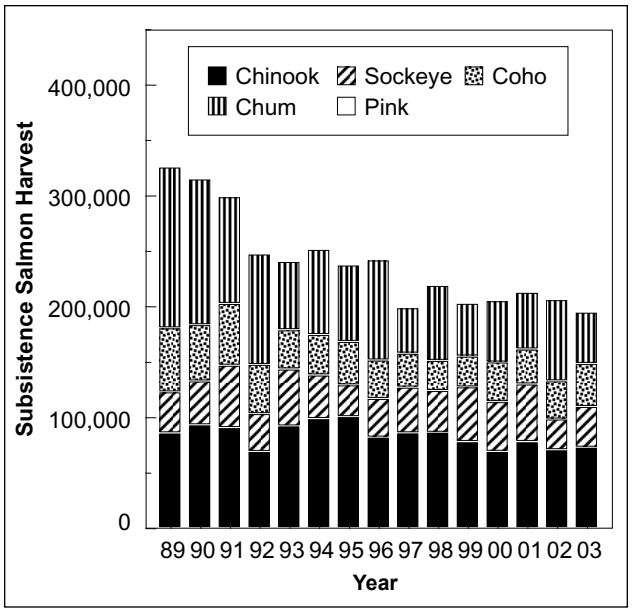

Figure 158. Subsistence harvests of salmon in the Kuskokwim area, 1989–2003.

Commercial Salmon Fishery Users

As of August 2005, a total of 770 limited entry gillnet permits were valid for commercial fishing in the Kuskokwim area. While most available commercial fishing permits were fished through the mid-1990s, only a portion of the commercial salmon permits have been fished since then (Figure 160). Annual numbers of permits fished in 2002 (407), 2003 (438), 2004 (467), and 2005 (484) were about 60% of those legally eligible.

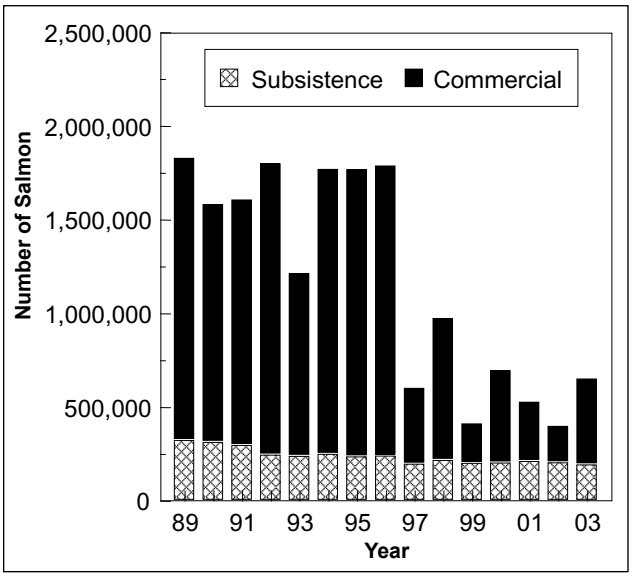

Figure 159. Subsistence and commercial harvests of salmon in the Kuskokwim area, 1989–2003.

Table 30. Average annual harvest of salmon in the Kuskokwim sport fishery.

Species	1980–1989	1990–1999	2000–2004
Chinook	1,381	1,861	1,179
Sockeye	323	756	462
Coho	2,899	3,147	4,885
Pink	231	145	125
Chum	1,094	740	263
Total	5,928	6,649	6,914

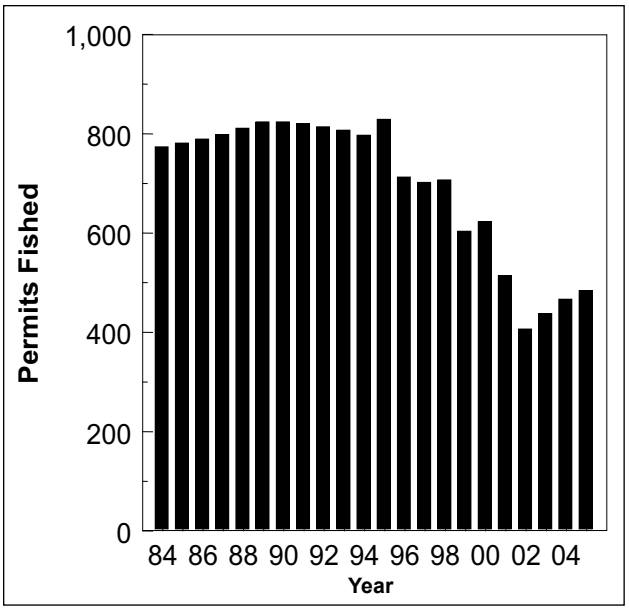

Figure 160. Number of commercial salmon gill net permits actually fished in the Kuskokwim area in the years 1984–2005.

Exvessel Value

As the commercial salmon fishery in the Kuskokwim area developed after statehood, it provided a valuable source of increasing annual income to residents in rural Alaska through the 1980s. The exvessel value of the Kuskokwim area commercial salmon fishery, adjusted for inflation to 2004 dollars, peaked in 1988 when the fishery provided in excess of $20 million (Figure 161), providing an important source of income to a cash poor rural area of Alaska. Since the late 1980s, sporadic market demand for salmon from rural areas of Alaska and lower prices paid for those salmon commercially harvested has eroded the exvessel value of the commercial fishery in the Kuskokwim area. Value of the annual harvests during the first half of the 1990s were always in excess of $5 million (adjusted for inflation to 2004 dollars), but during the latter part of the 1990s, the value decreased to levels as low as $2 million. The lowest value occurred in 2002 when the exvessel value of the fishery was only about $750,000. Values since then have increased with the 2005 commercial salmon fishery exvessel value being in excess of $1.1 million.

While lower catch levels certainly contributed to the lower exvessel value of the Kuskokwim area commercial salmon fishery, a significant portion of the loss in value was because fishermen have been paid much less per pound for salmon that have been sold. In 1988, for instance, commercial fishermen in the Kuskokwim area were paid an average price of $1.30 per pound for Chinook salmon and in 2005, fishermen were only paid $0.59 per pound, a decrease of 55% (Table 31). In 1988, fishermen were paid $0.40 per pound for chum salmon; since then, the price per pound for commercially caught chum salmon in the Kuskokwim area steadily decreased to a price per pound of $0.05 in 2005 (Table 31), about 12% of the price per pound paid in the late 1980s.

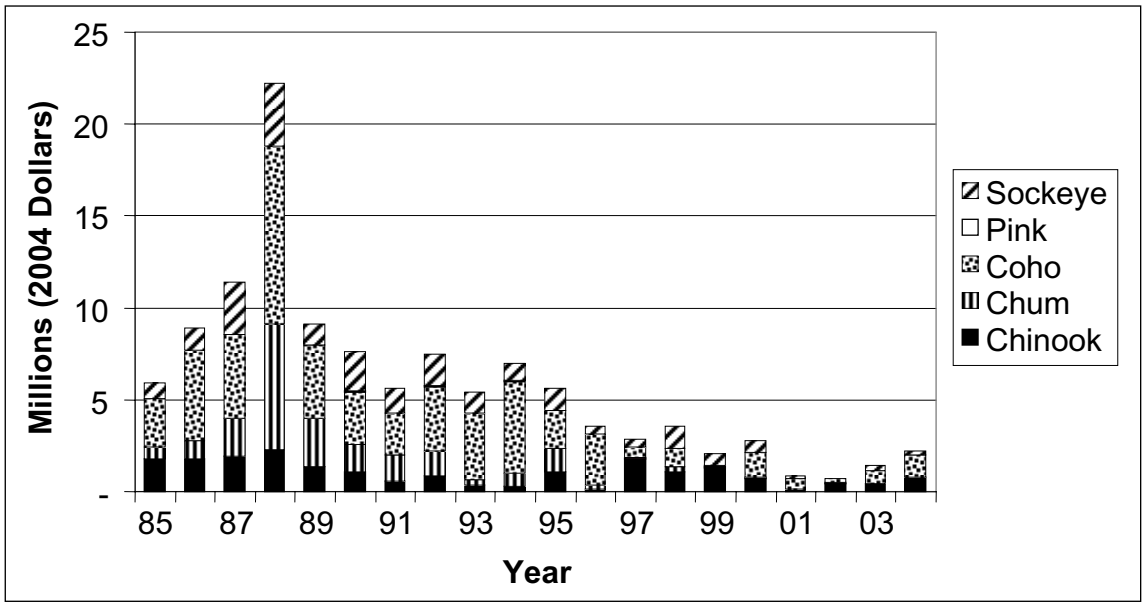

Figure 161. Exvessel value of the Kuskokwim commercial salmon fishery, 1985–2004, adjusted for inflation into 2004 dollars.

Table 31. Average price paid per pound of salmon commercially harvested in the Kuskokwim area.

Species	1988	1994	2000	2005
Chinook	$1.30	$0.51	$0.39	$0.59
Sockeye	$1.42	$0.53	$0.55	$0.55
Coho	$1.25	$0.57	$0.28	$0.27
Chum	$0.40	$0.21	$0.10	$0.05
Pink	$0.15	$0.08	$0.10	$0.05

Exvessel income per permit fished in the Kuskokwim area in 1988, expressed in nominal dollars, was in excess of $15,000. However, as prices and market interest in commercial salmon fisheries in rural Alaska have dropped, the income per permit fished has markedly decreased (Figure 162). In 2002, the average income per permit fished in the Kuskokwim area was only about $800—a 95% reduction from the peak income in 1988. The income per permit fished has increased since 2003, but only to between $2,000 and $3,000. Were the Kuskokwim area commercial fishery to generate the same level of exvessel income at the current time as the levels in the late 1980s, the commercial harvests would have to be more than 3-fold the peak harvest levels to simply compensate for the reduced price for commercially sold salmon at the current time.

Management

Management of Kuskokwim area salmon fisheries is complex. Annual run sizes and timing is often uncertain when decisions must be made, mixed stocks are often harvested several weeks and hundreds of miles from their spawning grounds, allocative issues divide downriver and upriver users as well as subsistence, commercial, and sport users, and the Kuskokwim area itself is immense. In 1988, the Board of Fisheries formed the Kuskokwim River Salmon Management Working Group in response to users seeking a more active role in management of fisheries (Whitmore and Martz 2005). Working group members represent the various interests and geographic locations throughout the Kuskokwim River who are concerned with salmon management. The Working Group has become increasingly active in the preseason, inseason, and postseason management of Kuskokwim River salmon fisheries. The Working Group meets 10 to 15 times per year to review available information and provide advice and input into the active management of Kuskokwim River salmon fisheries. Working Group meetings provide a valuable forum for area fishermen, user representatives, community representatives, advisory committee and council members, and State and Federal fishery managers to come together to discuss issues relevant to sustained yield fishery management and how to provide for the subsistence priority.

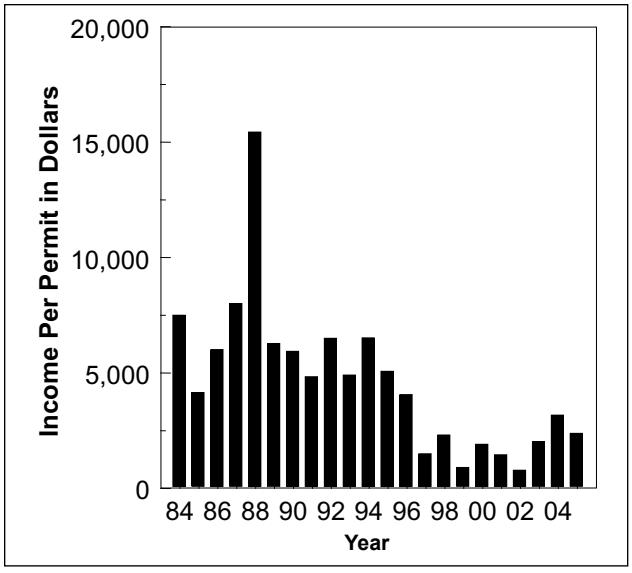

Figure 162. Average exvessel income for commercial salmon permits fished in the Kuskokwim area in the years 1984–2005.

Inseason management of the various Kuskokwim area salmon fisheries is based upon salmon run abundance and timing indicators, including data obtained through the Bethel test fishery, subsistence harvest reports, tributary escapement monitoring projects, and when available, commercial catch per unit of effort data. Inseason run timing models are used to predict subsequent escapement levels using historic run passage information. With the advent of the Working Group process, management of the Kuskokwim River fisheries has become more and more precautionary, and is much more conservatively managed than other areas in Alaska. Various Federal agencies and local tribal organizations collaborate with ADF&G staff in a wide variety of data collections pertinent to salmon management. The Board of Fisheries designated Kuskokwim River Chinook and chum salmon as stocks of yield concern in 2000 based upon perceived lower run sizes.

Over the last 10 to 20 years, the fishery management program in the Kuskokwim area has become both more precautionary and more complex with the addition of several Board of Fisheries management plans, improved inseason and postseason stock status information, and more intensive inseason user group reviewing management of the salmon fisheries. From 2000 to 2004, ADF&G Division of Commercial Fisheries managers issued from 25 to 50 emergency orders per

year to regulate these salmon harvests (Figure 163).

Over the last 10 years, as increasing concern for Kuskokwim area salmon developed, several large-scale funding sources have been used to improve the salmon monitoring program. The historic run monitoring program in the Kuskokwim area consisted of documenting commercial harvests, monitoring subsistence harvests, and tracking trends in salmon escapement largely through aerial surveys. The only long-term, on-the-grounds, escapement monitoring projects in the Kuskokwim area during the 1980s were efforts to count salmon as they passed into the Goodnews, Kanektok, Holitna, and Aniak rivers. Currently, ADF&G, either on its own or in collaboration with other organizations, conducts detailed, on-the-grounds, escapement monitoring of salmon in more than a dozen locations in the Kuskokwim area. These more recent efforts, made possible with new funding sources, have focused on obtaining accurate counts of salmon into spawning streams through the use of weirs, towers, sonar, and or mark–recapture techniques. The information obtained from these efforts has greatly improved the short-term data base for salmon resources in the Kuskokwim area and, if funded over a time frame of several decades, will provide an improved set of information for documentation of stock status of Kuskokwim area salmon.

Escapement goals currently in effect for management of salmon fisheries in the Kuskokwim area are listed in ADF&G (2004). There are 12 sustainable escapement goals in effect for Chinook salmon, 3 for sockeye salmon, 3 for coho salmon, and 4 for chum salmon. A few of the better data sets available for tracking Kuskokwim area salmon escapement trends follow.

The Kogrukluk River is a tributary of the Holitna River and has the most extensive salmon escapement data in the Kuskokwim area. The Kogrukluk River joins the Holitna River 138 miles upstream of the Holitna River's confluence with the Kuskokwim. The Holitna River and the Kuskokwim River join 335 miles upstream from the mouth of the Kuskokwim River. A tower was used to count salmon escapements from 1969 to 1978. Starting in 1976, a weir was installed downstream from the tower location and since then, annual salmon escapements have been counted at this site. Through this project, high quality counts of Chinook, chum and coho salmon escapements have been made. The Chinook salmon escapement goal is from 5,300 to 14,000 fish. Escapements in each of the last 5 years have been within or above this level, and spawning abundance of Chinook salmon in this river is as high now as has been documented historically. Only in 2 of the last 18 years (11%) has the escapement been below or close to the lower bound of the escapement goal (Figure 164). The chum salmon escapement goal is 15,000 to 49,000 fish. Escapements in each of the last 5 years have been within or above this level and spawning abundance of chum salmon in this river is as high now as has been documented historically. Only in 3 of the last 18 years (17%) has the escapement been below the lower bound of the escapement goal (Figure 165). The 2005 escapement of chum salmon

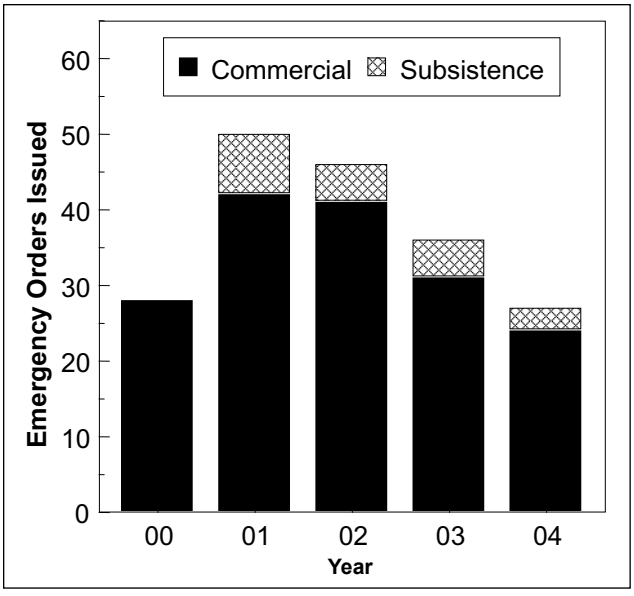

Figure 163. Number of emergency orders issued for management of Kuskokwim area commercial and subsistence fisheries, 2000–2004.

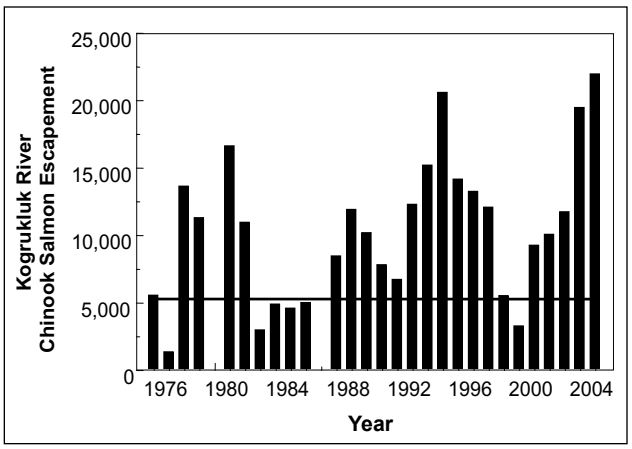

Figure 164. Weir-based counts of the Chinook salmon escapements in the Kugrukluk River from 1976–2005 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 5,300–14,000 (line). Note: counts were not successfully conducted in 1980 and 1987.

in the Kogrukluk River was almost 200,000 fish, about 4-fold the upper end of the escapement goal range. The coho salmon escapement goal is 13,000 to 28,000 fish. Escapements in each of the last 6 years have been within or above this level, and spawning abundance of coho salmon in this river is as high now as has been documented historically. Only in 1 of the last 14 years (7%) has the escapement been below the lower bound of the escapement goal (Figure 166).

The Aniak River joins the Kuskokwim River 225 miles above the mouth of the Kuskokwim River. Chum salmon escapements in the Aniak River have been counted since 1980 with the aid of sonar at a site located about 12 miles above the confluence. This set of data provides the second-longest term, on-the-grounds, salmon stock assessment effort in the Kuskokwim River. The Aniak River chum salmon escapement goal is 210,000 to 370,000 fish. Escapements in each of the last 4 years have been within or above this level, and spawning abundance of chum salmon in this river is as high now as has been documented historically. During the 26 years from 1980 to 2005, chum salmon escapements have been successfully assessed in 19 of those years and in 14 of those years (74%) the escapement level has been within or exceeded the escapement goal. Only once in the last 10 years, in 2000, has the escapement level been less than the goal (Figure 167). The 2005 chum salmon escapement of almost 1.2 million fish exceeded the upper end of the goal range by more than 3-fold.

Since the 1970s, ADF&G has conducted aerial surveys of Chinook salmon in various tributaries of the Kuskokwim River and has established escapement goals for several of these spawning populations. In the lower portion of the Kuskokwim River drainage, escapement goals of 580 to 1,800 fish for the Kwethluk River, and 400 to 1,200 fish for the Kisaralik River, counted during peak surveys, have been established. In the middle portion of the Kuskokwim River drainage, escapement goals of 330 to 1,200 fish for the Salmon (Aniak) River, and 970 to 2,100 fish for the Holitna River, counted during peak surveys, have been established. In the upper portion of the Kuskokwim River drainage, escapement goals of 300 to 830 fish for the Gagarayah River, 340 to 1,300 fish for the Cheeneetnuk River, and 470 to 1,600 fish for the Salmon

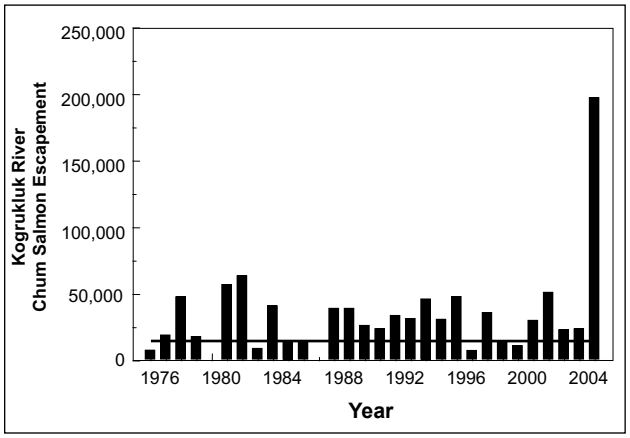

Figure 165. Weir-based counts of the chum salmon escapements in the Kugrukluk River from 1976–2005 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 15,000–49,000 (line). Note: counts were not successfully conducted in 1980 and 1987.

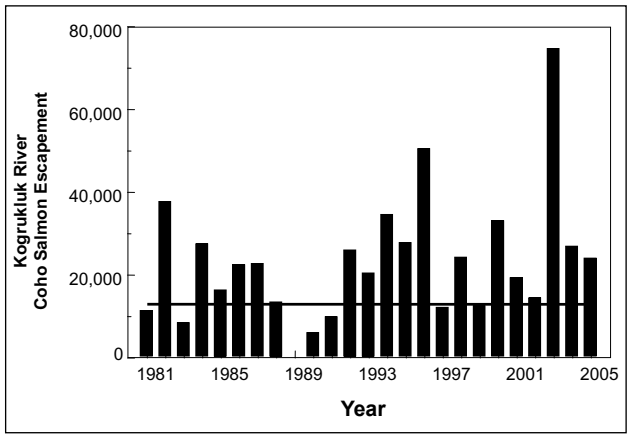

Figure 166. Weir-based counts of the coho salmon escapements in the Kugrukluk River from 1981–2005 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 13,000–28,000 (line). Note: a count was not successfully conducted in 1989.

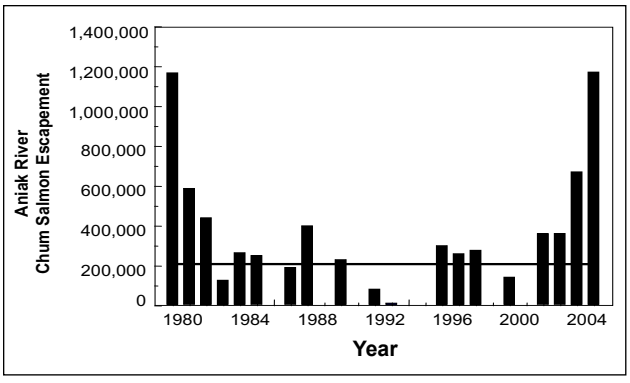

Figure 167. Sonar-based counts of the chum salmon escapements in the Aniak River from 1980–2005 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 210,000–370,000 (line). Note: counts were not successfully conducted in 1986, 1989, 1991, 1994, 1995, 1999, and 2001.

(Pitka) River, counted during peak surveys, have been established. In the last 5 years from 2001 to 2005, successful aerial surveys have occurred in 30 of the possible 35 stream-year cells (7 streams × 5 years) and in only one of those cases (3%) —the Aniak River count in 2001—was the observed escapement less than the lower end of the escapement goal range for these 7 spawning stocks of Kuskokwim River Chinook salmon (Figure 168).

A weir located on the Middle Fork of the Goodnews River has been used to assist with salmon escapement enumeration since 1991. From 1981 to 1990, escapement estimates were taken at the same site based on tower counts. The Chinook salmon escapement goal is 2,000 to 4,500 fish; escapements in each year since 1993 have been within or above this level. In only 3 of the last 25 years (12%) has the escapement been below the lower bound of the escapement goal (Figure 169). The sockeye salmon escapement goal is 23,000 to 50,000 fish. In only 4 of the last 25 years (16%) has the escapement been below the lower bound of the escapement goal (Figure 170). Escapements in 2001 and 2002 were close to the lower bound of the escapement goal range, while escapements since 2003 have been well in excess of this level. The coho salmon escapement goal is a threshold level of 12,000 fish. The 1997 escapement was below the threshold, the 1999 escapement was very close to the threshold level and all other escapements since 1997 have been above the threshold (Figure 171). The chum salmon escapement goal is also a threshold level of 12,000 fish. Chum salmon escapement levels since 1991 have all exceeded the goal (Figure 172). Only in 3 of the last 25 years (12%) has the chum salmon escapement been below the threshold.

The long-term escapement enumeration programs in the Kuskokwim area provide similar stock status information. Salmon escapements in the Kuskokwim area are as abundant as documented historically and the vast majority of escapements documented over the

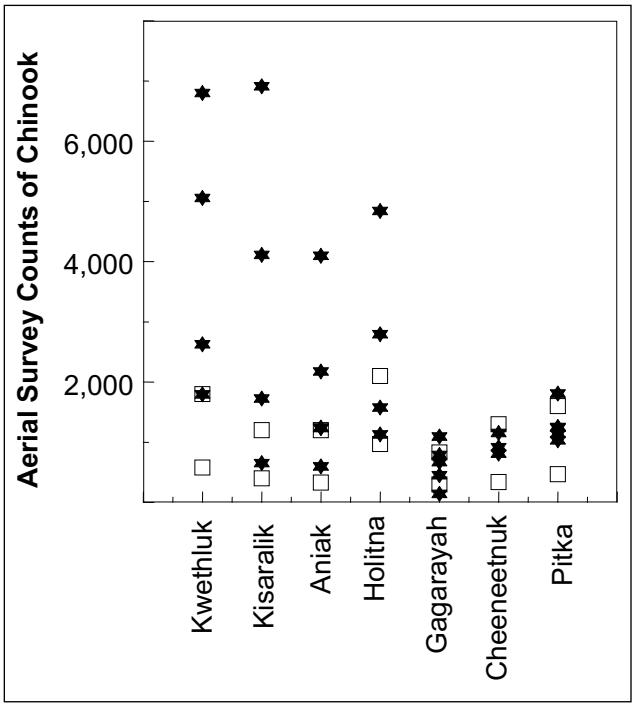

Figure 168. Aerial survey counts of Chinook salmon in 7 tributaries of the Kuskokwim River from 2001–2005 (stars) and the lower and upper sustainable escapement goal ranges for these 7 stocks of salmon (open squares).

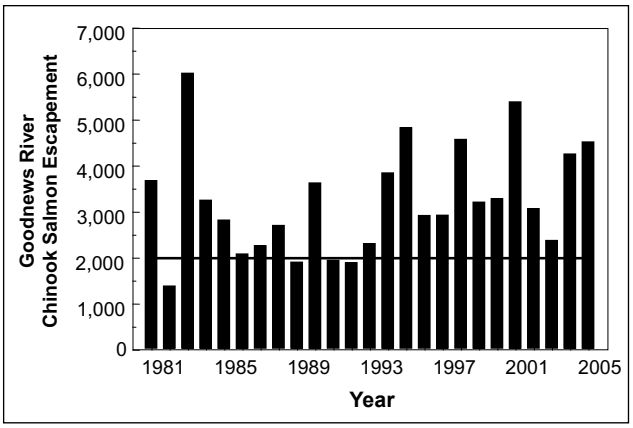

Figure 169. Escapement counts of Chinook salmon in the Goodnews River from 1981–2005 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 2,000–4,500 (line).

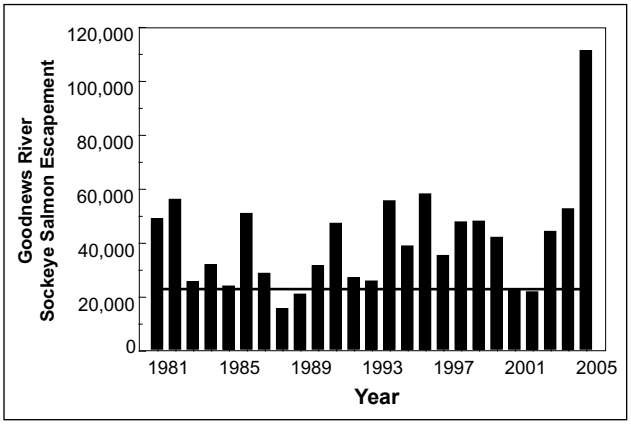

Figure 170. Escapement counts of sockeye salmon in the Goodnews River from 1981–2005 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 23,000–50,000 (line).

past 25 years have met or exceeded established escapement goals. Salmon stocks in this area are healthy and could support additional fishing. Were additional fishing opportunity provided, it could economically benefit rural residents in a cash-poor area of Alaska.

Budget History and Fiscal Support

General funds allocated and used by the Division of Commercial Fisheries to manage salmon in the Kuskokwim area totaled about $960,000 in FY 05. This level of funding commitment by the State of Alaska represents a substantial increase over funding provided for management of these fisheries as they were being developed during the first 30 years after statehood. Over the last 10 years, the Division of Commercial Fisheries has worked with other resource agencies and with nongovernmental organizations with interests in the Kuskokwim area to plan and implement a variety of additional salmon stock assessment activities using nonstate moneys (mostly federal) to further augment the scientific information available for salmon stocks in the Kuskokwim area. Notable funding entities involved with these additional salmon stock assessment efforts include the Office of Subsistence Management and the Arctic–Yukon–Kuskokwim Sustainable Salmon Initiative. Often, these additional salmon stock assessment activities are carried out by mixed crews from partner agencies and organizations.

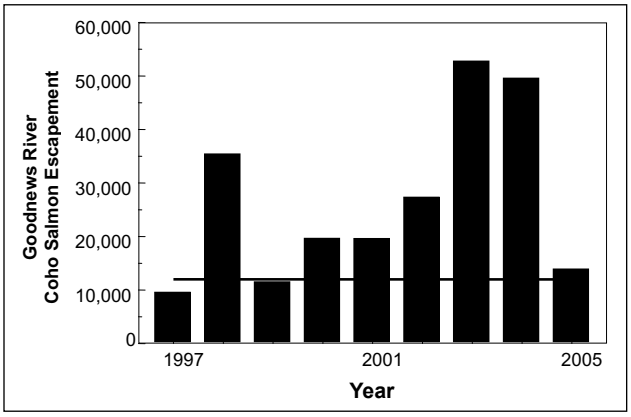

Figure 171. Escapement counts of coho salmon in the Goodnews River from 1997–2005 (bars) and the threshold sustainable escapement goal of 12,000 (line). Prior to 1997, the project was not conducted late enough to count coho salmon during the fall.

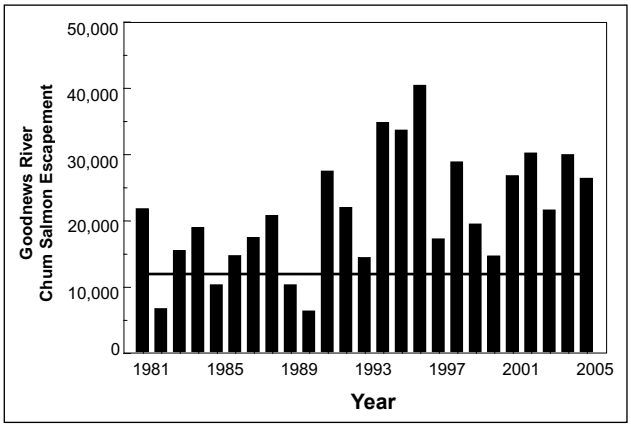

Figure 172. Escapement counts of chum salmon in the Goodnews River from 1981–2005 (bars) and the threshold sustainable escapement goal of 12,000 (line).

The Division of Commercial Fisheries and the salmon fishermen in the Kuskokwim area face several challenges. The Division of Commercial Fisheries is committed to managing fisheries on a sustained yield basis and the subsistence fishery has priority over the commercial fishery. The salmon stocks of the Kuskokwim area have been sustained at a high level and the large subsistence fishery has been sustained, although recently with substantial additional regulation. On the other hand, the commercial salmon fisheries of the Kuskokwim area have been greatly reduced as a result of the conservative precautionary management approach that has been implemented over the last 15 years.

The cost to the State of Alaska for the fishery management program currently in place in the Kuskokwim area is very high relative to the exvessel value of the commercial fishery. The State FY 05 direct management cost is about $960,000, and the 2005 salmon exvessel value is about $1.1 million. The current stock assessment program cannot be implemented without major nonstate funding support. If market interest in commercial salmon fisheries in the Kuskokwim area improves, significant additional commercial fishing could occur from a biological standpoint. However, if commercial markets for Kuskokwim area salmon do not result in improved prices paid to fishermen, a revised commercial fishery would not be likely to generate substantial improvement in the local rural economy. A major challenge to fishermen in the Kuskokwim area is developing niche markets to substantially increase the value of commercial landings of salmon, allowing them to increase earnings from commercial fishing. A major challenge to the Division of Commercial Fisheries is to continue to garner fiscal support for the comprehensive salmon stock assessment program currently implemented by agencies and nongovernmental organizations. Unless the commercial salmon fishery in the Kuskokwim area is managed in a less conservative and precautionary manner, there is little scientific and policy rationale for the extensive stock assessment program currently in place.

YUKON COMMERCIAL SALMON FISHERY

Area Description and Gear Types

The Yukon River is the largest river in Alaska, originating in British Columbia and flowing 2,300 miles to the Bering Sea. The Yukon River drainage encompasses about 330,000 square miles, or about one-third of the land mass of Alaska. The Yukon area includes all waters of the U.S. Yukon River drainage and all coastal waters from Point Romanof southward to the Naskonat Peninsula. Commercial fishing for salmon is allowed along the entire 1,200 mile length of the main stem Yukon River in Alaska and in the lower 225 miles of the Tanana River. The Yukon area includes 7 districts, 10 subdistricts, and 28 statistical areas which were established in 1961 and redefined in later years. The Coastal District was established in 1994, redefined in 1996, and is open for subsistence salmon fishing only. The lower Yukon area (Districts 1, 2, and 3) includes some coastal waters adjacent to the series of mouths of the Yukon River and extends upstream to river mile 301 (the break between Districts 3 and 4). The upper Yukon area (Districts 4, 5 and 6) is that portion of the Yukon above river mile 301 extending to the U.S.–Canada border and includes the lower Tanana River (Figure 173).

Significant runs of Chinook, chum, and coho salmon return to the Yukon River and are harvested in Alaska by subsistence, commercial, personal use, and sport fishermen as well as in Canada in aboriginal, commercial, sport, and domestic fisheries. Spawning populations of Chinook salmon occur throughout the Yukon River drainage in tributaries from as far downstream as the Archuelinuk River, located approximately 80 miles from the mouth, to as far upstream as the headwaters of the Yukon River in Canada, over 2,000 miles from the mouth. Chum salmon in the Yukon are comprised of 2 distinct types, summer-run fish and fall-run fish. Summer chum salmon are characterized by earlier run timing, rapid maturation in freshwater, and smaller size. They tend to spawn in runoff streams in the lower 500 miles of the drainage and in the Tanana River drainage. Fall chum salmon are characterized by later run timing, robust body shape, and larger size. They tend to spawn in spring-fed streams including portions of the Tanana, Porcupine, and Chandalar River drainages as well as in various streams in the Yukon Territory including the main stem Yukon River. Coho salmon spawn discontinuously throughout the Alaska portion of the Yukon River drainage, primarily in tributaries in the lower 700 miles of the drainage and in the Tanana River drainage. Sockeye salmon are uncommon in the Yukon River drainage. Although pink salmon return to the lower part of the drainage, few are utilized in fisheries.

Commercial fishing is conducted in the lower Yukon with set gillnets and drift gillnets, while in the upper Yukon, fish wheels are used in addition to set and drift gillnets. Subsistence fishing is primarily conducted with the same gear types and many of the subsistence fishermen are also commercial fishermen.

History of the Commercial Salmon Fishery

The first recorded commercial harvest of salmon in the Alaskan portion of the Yukon River drainage occurred in 1918. Relatively large harvests of Chinook, chum, and coho salmon occurred from 1919 to 1921. Much of that harvest occurred outside of the river mouth due to restrictions within the Yukon River itself. The commercial fishery was closed from 1925 to 1931 because of concerns for the existing inriver subsistence fishery. Commercial fishing for Chinook salmon was again allowed in 1932 at a reduced level and has continued since that time. Commercial utilization of chum and coho salmon resumed in 1952 and occurred from 1952 to 1954, 1956, and since 1961.

The peak decadal harvest of Chinook salmon occurred in the 1980s when almost 130,000 fish were commercially harvested per year (Figure 174, Panel A). Commercial harvests averaged about 97,000 fish in the 1990s, and about 27,000 fish since 2000. During the 1980s and 1990s, the Alaska Board of Fisheries implemented guideline harvest ranges for Yukon River Chinook salmon of 60,000 to 120,000 fish caught in District 1 and 2, 1,800 to 2,200 fish caught in District 3, 2,250 to 2,850 fish caught in District 4, 2,400 to 2,800 fish caught in District 5A, 5B, and 5C, 300 to 500 fish caught in District 5D, and 600 to 800 fish caught in District 6. Concerns for possible overharvest of annual Chinook salmon runs resulted in some reduction in annual harvests starting in the late 1980s and continuing through the mid- to late 1990s. Poor runs in the late 1990s and early 2000s resulted in very restrictive management of Yukon River Chinook salmon commercial fisheries, culminating with the complete closure of the commercial fishery in 2001 and very conservative management since then.

Sockeye salmon have only been commercially harvested in the Yukon River fishery in 8 of the years since 1960 and the cumulative harvest in those years was only 48 fish. Coho salmon have sometimes been an important component of the Yukon River commercial fishery but have been primarily taken incidentally to the directed fall chum salmon harvests. Commercial harvests of coho salmon in the Yukon peaked in the

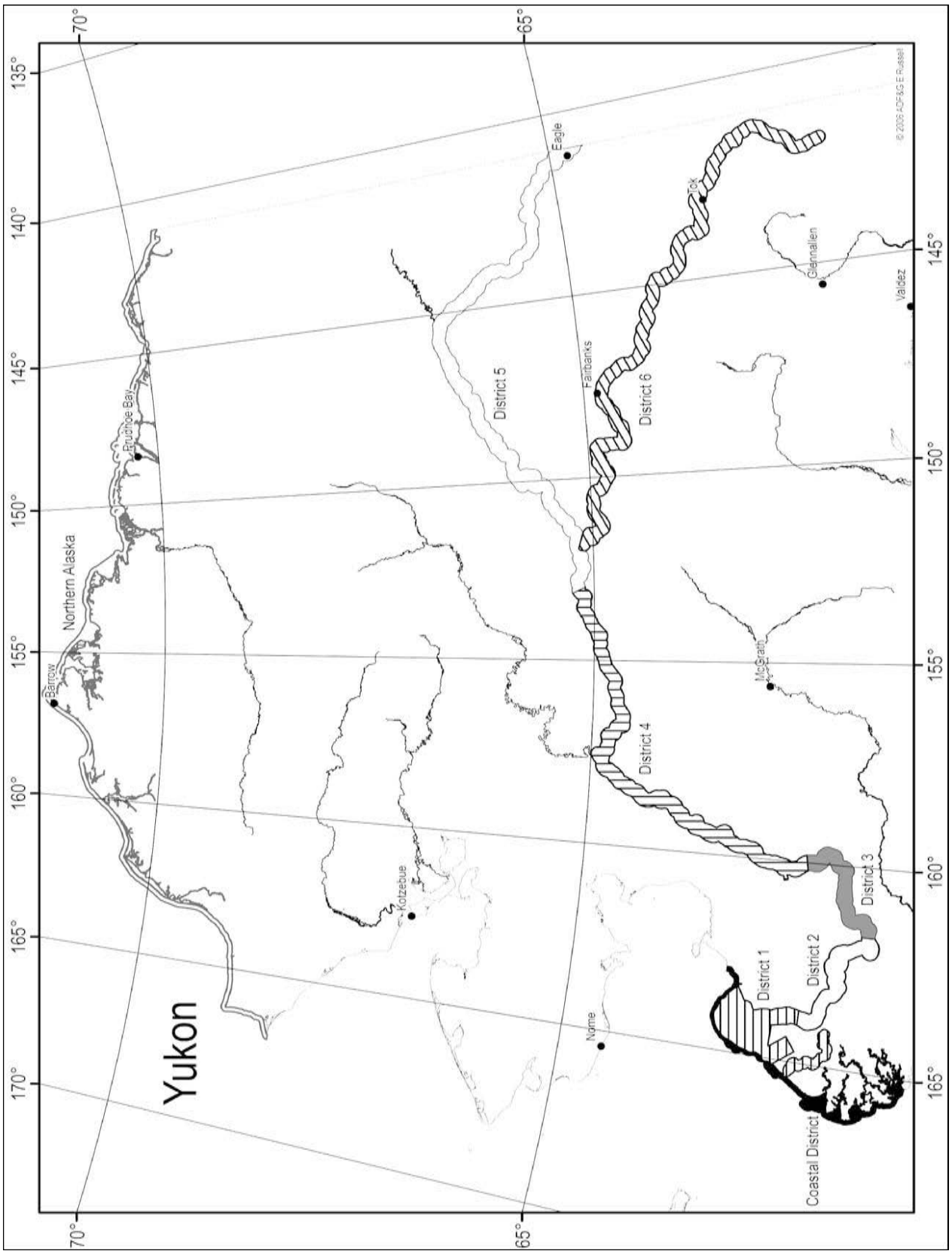

Figure 173. Yukon area commercial salmon fishery.

1980s when about 44,000 fish per year were harvested (Figure 174, Panel B). Annual harvests have been sporadic and averaged about 30,000 fish per year in the 1990s and 17,000 fish per year since 2000. The Alaska Board of Fisheries established the Yukon Drainage Coho Salmon Management Plan in 1998, which allows a directed coho salmon commercial fishery under special and unique conditions that are unlikely to be met. Commercial harvests of pink salmon in the Yukon River have been small due to an extremely limited market. Since statehood, commercial sales of pink salmon from the Yukon River only occurred from 1988 to 1990 with annual harvests being 1,057 fish in 1998, 17 fish in 1989, and 743 fish in 1990.

Commercial chum salmon fishing in the Yukon area peaked in the 1980s when harvests averaged about 1.3 million fish per year (Figure 174, Panel C). Average annual harvests in the 1990s were about 480,000 fish and since 2000 were about 48,000 fish.

Summer chum salmon harvests in the commercial fishery peaked in the 1980s when about 1.1 million fish per year were harvested (Figure 175). The substantial increase in catch over levels observed in the 1970s was due to less restrictive gillnet mesh regulations, earlier openings of the fishery, greater availability of processing facilities, higher exvessel prices, and the occurrence of several very large runs. Commercial harvests of summer chum salmon averaged about 390,000 fish per year in the 1990s, and 15,000 fish per year since 2000. Summer chum salmon run sizes decreased in the early 1990s. Exvessel prices for chum salmon decreased in the 1990s and beginning in 1994, declining flesh markets severely limited the commercial harvests. In 1994, the Alaska Board of Fisheries adopted the Anvik River Chum Salmon Fishery Management Plan establishing regulations allowing for a commercial summer chum salmon roe fishery in the Anvik River. Low harvests of summer chum salmon for roe have occurred since 1997 because summer chum salmon runs to the Anvik River have been less than half that of the prior 15 years.

The directed commercial fishery for fall chum salmon began in 1961. Fall chum salmon harvests in the commercial fishery peaked in the late 1970s and 1980s when about 235,000 fish per year were harvested (Figure 176). Commercial harvests of fall chum salmon averaged about 88,000 fish per year in the 1990s, and about 32,000 fish per year since 2000. Lower fall chum salmon escapements in the mid-1980s resulted in more conservative management and reduced commercial harvests after 1986. In 1994, the Alaska Board of Fisheries adopted the Yukon Drainage Fall Chum Salmon Management Plan which has been has been modified several times since then. The plan calls for commercial fishing only when annual run size is projected to exceed 675,000 fall chum salmon. This ensures spawning escapement needs are met, as well as needs associated with Alaska subsistence fisheries and Canadian harvests. Because of this plan, commercial fisheries have only occurred in some years and harvest have been quite variable depending upon total run strength.

Total commercial salmon harvests in the Yukon peaked in the 1980s when about 1.5 million fish per year were harvested (Figure 174, Panel D). Commercial harvests of salmon have decreased substantially since then, averaging about 607,000 fish per year in the 1990s and about 92,000 fish per year since 2000.

Other Salmon Harvests

There are about 21,000 people living in rural portions of the Yukon River drainage and about 84,000 people living in the greater Fairbanks urban area. Many of the rural residents fish for salmon under subsistence regulations. Only a small portion of the urban residents fish for salmon under personal use regulations. Rural residents in the Yukon area have depended upon fishery resources, including salmon, as a source of food for centuries. Rural residents also use salmon as food for their dogs, which were used traditionally as draft animals. During the 1930s, airplanes began replacing dogs as primary mail and supply carriers, and during the 1960s, snow machines became more popular. In the 1980s, a renewed interest in the recreational use and racing of sled dogs caused an increase in subsistence utilization of salmon in the Yukon area. However, dependence upon salmon for dog food since the 1980s has decreased, although a large proportion of the coho, summer chum, and fall chum salmon harvested in subsistence fisheries is still used for dog food. A large portion of the Chinook salmon harvested by subsistence fishermen is used as human food. Subsistence and personal use harvests of salmon from 1975 to 2004 averaged about 325,000 fish per year. Subsistence and personal use of salmon in the Yukon averaged about 435,000 fish per year in the 1980s, 300,000 fish per year in the 1990s, and 175,000 fish per year since 2000 (Figure 177). Since 1975, Chinook salmon have comprised about 13% of the harvest, coho salmon about 9%, and summer and fall chum salmon each about 39%. Over the last 30 years, the annual subsistence harvests have remained relatively stable while the commercial harvests have been significantly reduced (Figure 178). The ratio of commercial to subsistence harvests in the Yukon area from 1975 to 1997 averaged about 3:1, and since 1998 the ratio has been about 0.33:1.

Relatively small numbers of salmon are harvested from the Yukon area by sport fishermen (Table 32). Estimated sport harvests of salmon from the Yukon area since 1980 average about 3,300 fish per year. The ratio of the commercial to sport harvests of salmon in the Yukon area over the past 25 years is about 400:1, ratios by species are about 75:1 for Chinook salmon, about 25:1 for coho salmon, and about 650:1 for chum salmon.

Commercial Salmon Fishery Users

As of August 31, 2005, there were 893 limited entry permits valid for salmon fishing in the Yukon; 758 (85%) were gillnet permits and the remaining 135 (15%) were fish wheel permits (Table 4). Participation by both gear groups has decreased since the 1980s, particularly participation by fish wheel fishermen (Figure 179). Compared to the 1980s, average participation since 2001 for the lower-river gillnet fishermen gear group was 84%, for the upper-river gillnet fishermen gear group the participation rate was 21%, and for the fish wheel gear group the participation rate was 13%.

Exvessel Value

The average annual exvessel value of the Yukon River commercial salmon fishery from 1985 to 2004 was about $5.5 million, ranging from zero in 2001 when the commercial fishery was closed to a high of about $12.9 million in 1988. Adjusted for inflation and expressed in 2004 dollars, the average annual exvessel value was about $7.75 million. Inflation-adjusted exvessel value ranged as high as about $20.5 million in 1988 when about 1.94 million salmon were harvested (Figure 180). As elsewhere in Alaska, value has trended downward during the last 15 years, although a minor upward trend is apparent since 2001. Unlike several other commercial salmon fisheries in Alaska, the reduction in exvessel value of the Yukon

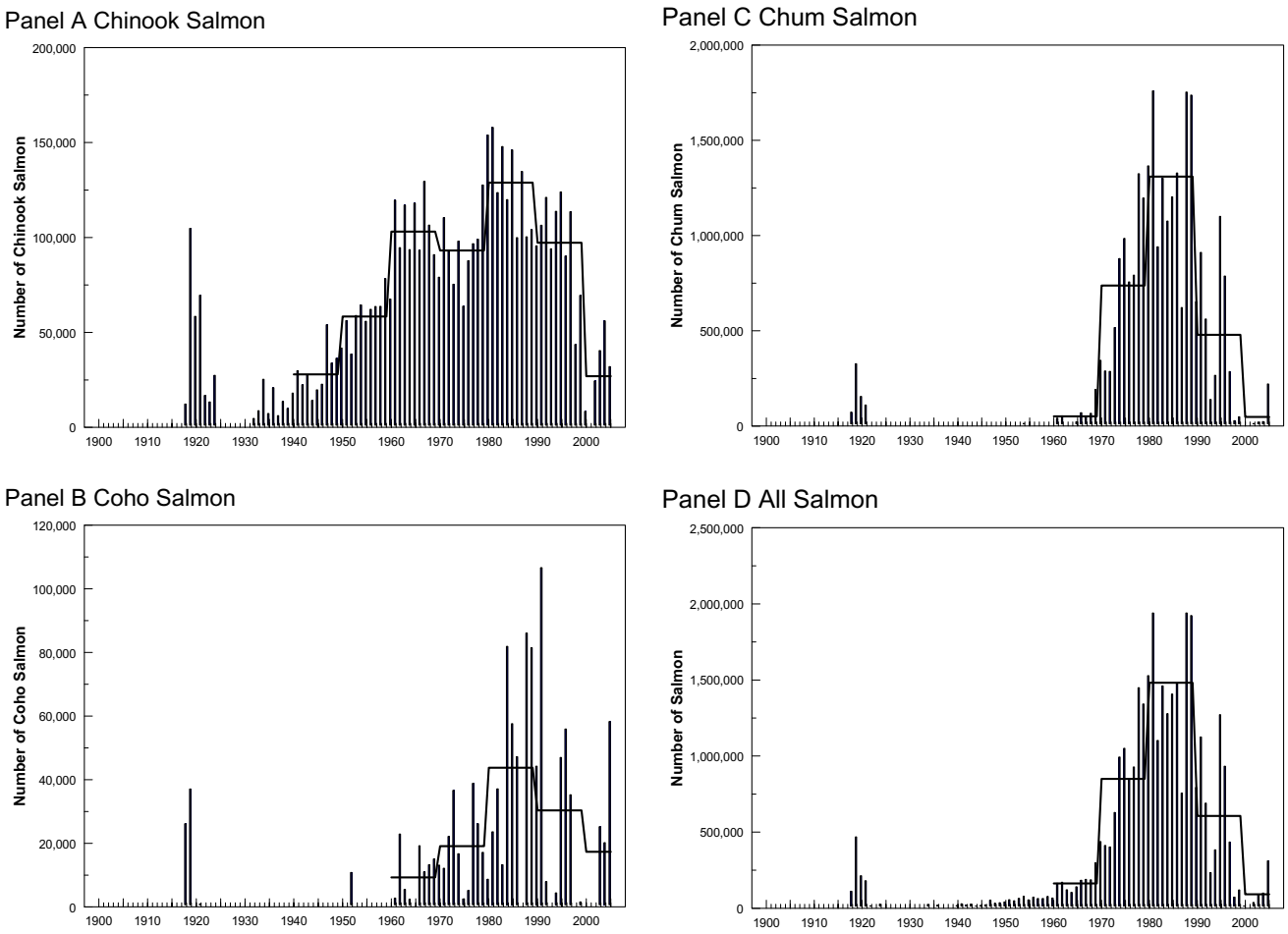

Figure 174. Commercial salmon harvests in the Yukon from 1900–2005; bars provide annual catches and lines provide decade averages.

commercial fishery since the mid-1990s is mostly due to seriously reduced catch levels for Chinook salmon and the almost complete loss of markets for some of the other species. Reduced prices paid for chum and coho salmon has played a much lesser part in reduced exvessel value of the Yukon commercial fishery than is the case for most other Alaskan salmon fisheries. From 1985 to 2004, Chinook salmon accounted for 77% of the inflation adjusted total exvessel value, followed by chum salmon (20%), and coho salmon (3%).

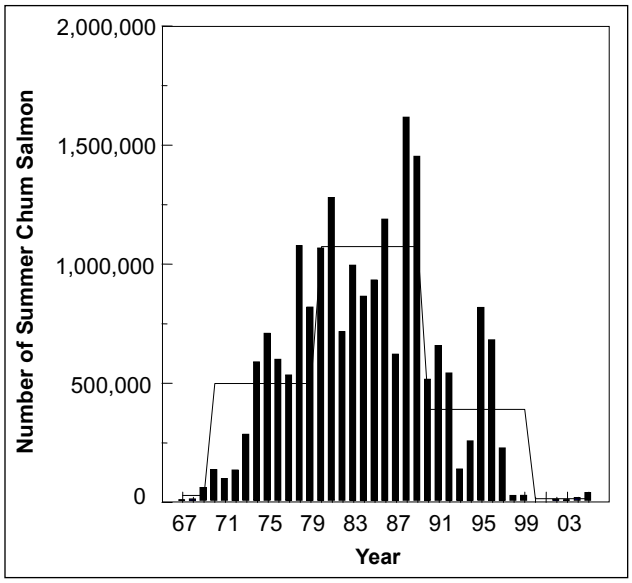

Figure 175. Commercial harvests of summer chum salmon in the Yukon from 1967–2005; bars provide annual catches and lines provide decade averages.

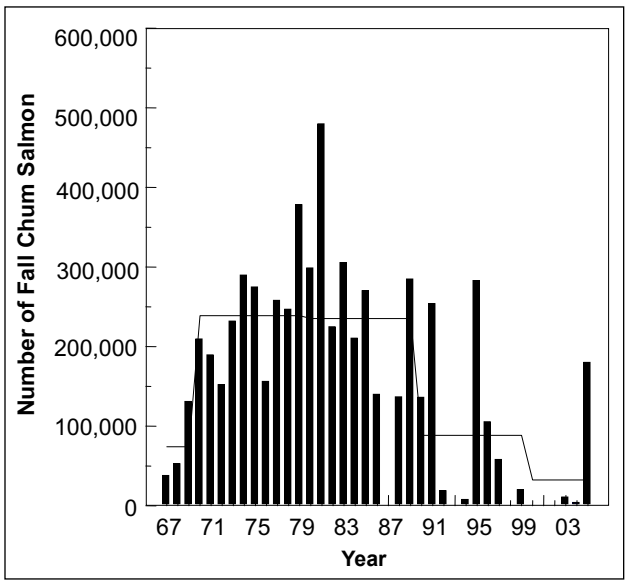

Figure 176. Commercial harvests of fall chum salmon in the Yukon from 1967–2005; bars provide annual catches and lines provide decade averages.

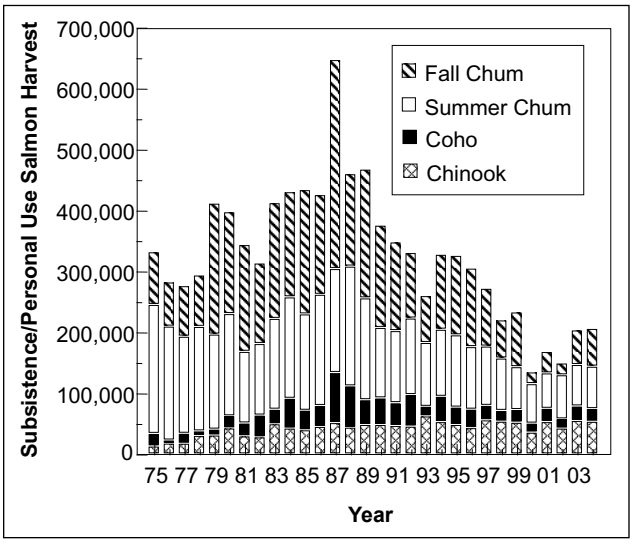

Figure 177. Subsistence and personal use harvests of salmon in the Yukon area, 1975–2004.

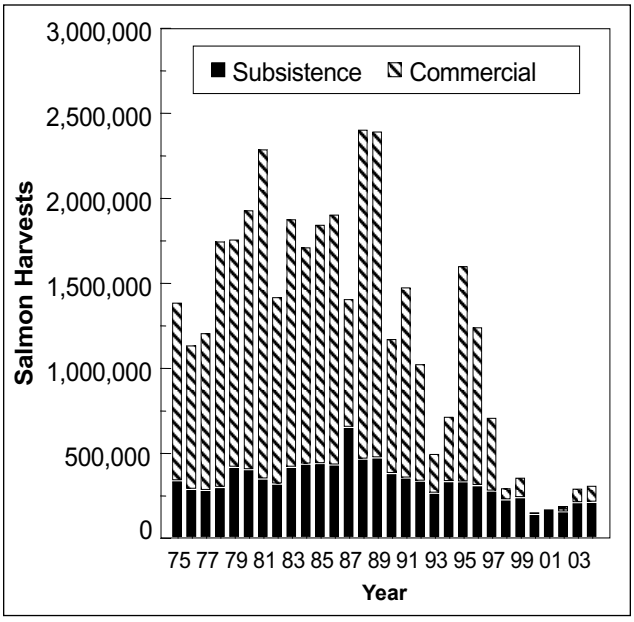

Figure 178. Subsistence and personal use versus commercial harvests of salmon in the Yukon area, 1975–2004.

Table 32. Average annual harvest of salmon in the Yukon sport fishery.

Species	1980–1989	1990–1999	2000–2004
Chinook	880	1,595	1,135
Sockeye	0	31	33
Coho	920	1,502	1,199
Pink	25	14	11
Chum	963	841	494
Total	2,788	3,983	2,872

Unlike prices paid to commercial fishermen in many salmon fisheries in Alaska, the price paid for Chinook salmon in the Yukon has not markedly decreased over the past 20 years (Figure 181). Prices paid for Chinook salmon in the Yukon in 2004 and 2005 are about the same as was the case in the late 1980s when prices paid for commercially harvested salmon across Alaska were at peak levels. On the other hand, prices paid for coho and chum salmon harvested in the Yukon has substantially decreased. In 1988, for instance, commercial fishermen in the lower Yukon were paid $0.66 per pound for summer chum salmon, $1.01 per pound for fall chum salmon, and $1.04 per pound for coho salmon. In 2004, the average price paid for chum salmon was $0.10 per pound, and the average price paid for coho salmon was $0.33 per pound.

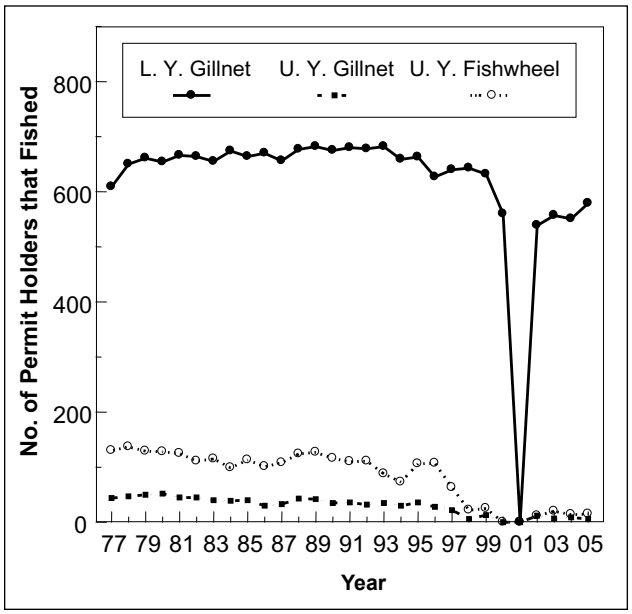

Figure 179. Number of limited entry permits that participated in commercial fisheries in the Yukon from 1977–2005 (L.Y. Gillnet = gillnet permits fished in the Lower Yukon River, U.Y. gillnet = gillnet permits fished in the Upper Yukon River, and U.Y. Fishwheel = fishwheel permits fished in the Upper Yukon River).

Management

The Yukon commercial and subsistence fisheries are managed by ADF&G with the goal of achieving and maintaining sustained production. Distinguishing between commercial and subsistence harvests of salmon is sometimes difficult with development of commercial salmon fisheries in which fishermen extract and sell only the roe and then use the stripped carcasses to meet subsistence needs. Management of the Yukon salmon fishery is difficult and complex because of the frequent inability to determine stock specific abundance and timing, overlapping multispecies salmon runs, increasing efficiency of the fishing fleet, the gauntlet nature of Yukon fisheries, allocation issues between lower-river and upper-river Alaskan fishermen, allocation and conservation issues between Alaska and Canada, and the immense size of the drainage. Salmon fisheries within the Yukon River may harvest stocks that are up to several weeks and over a thousand miles from their spawning grounds. Since the Yukon River fisheries are largely mixed stock fisheries, some tributary populations may be under- or overexploited in relation to

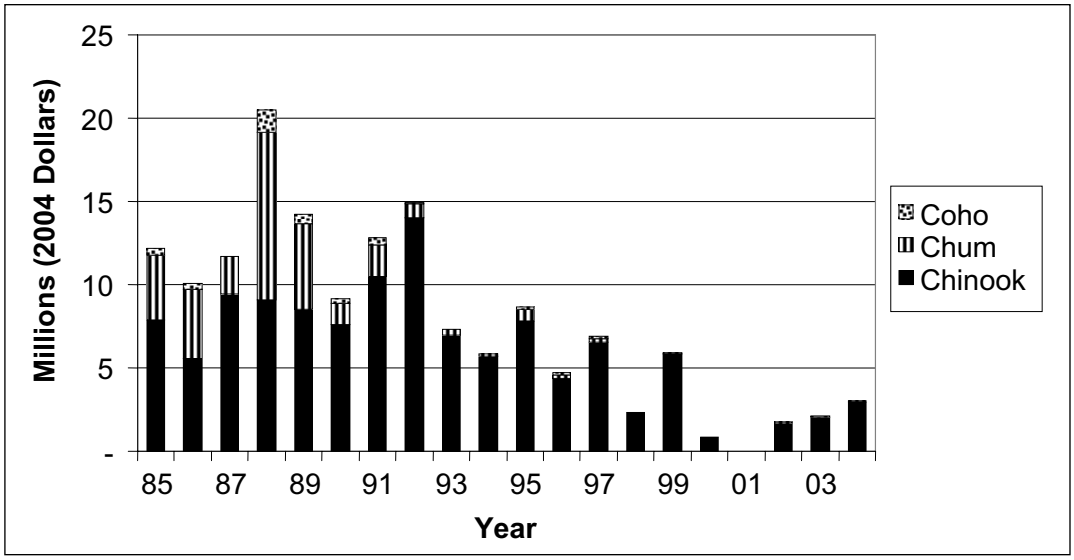

Figure 180. Exvessel value of the Yukon commercial salmon fishery, 1985–2004, adjusted for inflation into 2004 dollars.

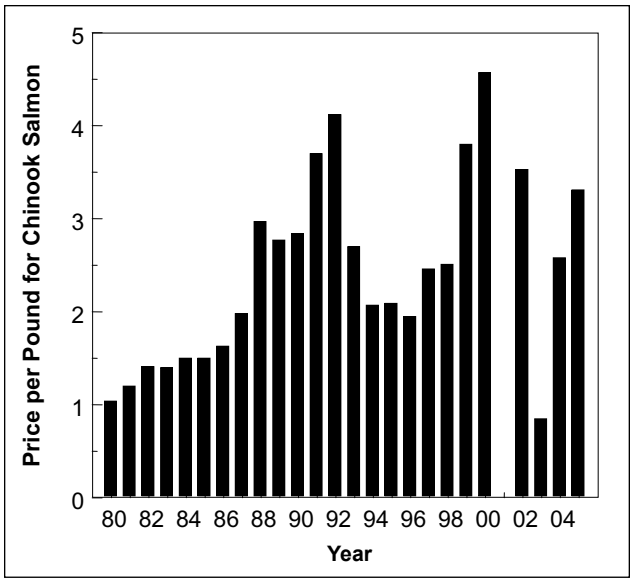

Figure 181. Average price per pound paid to commercial fishermen for the sales of Chinook salmon harvested from the Yukon, 1980–2005.

abundance. In Alaska, subsistence fisheries have priority over other types of use, and it is not possible to manage for individual stocks in most areas where commercial and subsistence fisheries occur. Agreements between the U.S. and Canada are in effect that commit ADF&G to manage Alaskan fisheries in a manner that provides adequate passage of salmon into Canada to both support Canadian fisheries and achieve desired spawning levels. In order to maintain the subsistence priority, meet U.S. and Canadian commitments, and provide for adequate spawning escapements, Alaskan Yukon River commercial salmon fisheries have to be managed conservatively.

Fishery management in the Yukon area by the Division of Commercial Fisheries is directly implemented by 2 area biologists and 2 assistant positions. One area biologist is directly responsible for management of the summer stocks (Chinook and summer chum salmon) and the other is directly responsible for management of the fall stocks (fall chum and coho salmon). As the respective stocks enter the Yukon River, each of the management biologists initially works out of the Emonak field office in the lower Yukon River assessing the runs and managing commercial and subsistence fisheries. As the runs move upriver, the area biologists relocate to the Fairbanks office located in the upper Yukon River and continue to assess and manage the salmon stocks. During the winter, these fishery management staff members work out of either the Fairbanks or Anchorage offices. Annual management reports, written by ADF&G staff since the early 1960s provide extensive and detailed fishery data and insight into the management program and fishery. See Vania et al (2002).

The commercial and subsistence salmon fisheries in the Yukon River are managed based upon perceived run strength and fishery management plans approved by the Alaska Board of Fisheries. During the fishing season, management is based upon both preseason and inseason run strength assessment information. Preseason information involves run forecasts based upon historic performance of parent spawning abundance and is generally expressed as runs that will be below average, average, or above average. Inseason run assessment includes abundance indices from test fishing, sonar counts of passing fish, mark–recapture estimates of run abundance, various escapement assessment efforts in tributaries, commercial and subsistence catch data, and catch per effort data from monitored fisheries. Several federal agencies, ADF&G, the Canadian Department of Fisheries and Oceans, Native organizations, and various organized groups of fishermen operate salmon stock assessment projects throughout the Yukon River drainage. The Division of Commercial Fisheries salmon fishery managers use this information to manage the Alaskan Yukon salmon fisheries. During the years from 2000 to 2004, based upon run strength information, Yukon fishery managers announced an average of 44 emergency orders per year (Table 33). These emergency orders implemented a combination of time and area openings and closures and gillnet mesh restrictions. Detailed information concerning each emergency order can be found in Yukon area management reports. For example, see Vania et al 2002.

Total utilization of Yukon River Chinook salmon represents the total harvest of these fish in the Yukon drainage in all Alaskan and all Canadian fisheries. Over the 44-year period from 1961 to 2004, total utilization of Chinook salmon in the Yukon averaged about 146,000 fish, ranging from a low of about 50,000 fish in 2000 to a high of about 220,000 fish in 1980 (Figure 182). From 2000 to 2004, mark–recapture estimates were implemented to estimate Chinook salmon passage past Russian Mission, and by accounting for both

Table 33. Number of emergency orders issued by Division of Commercial Fisheries Yukon area fishery managers for inseason management of Yukon salmon fisheries, 2000–2004.

Fishery	2000	2001	2002	2003	2004	Averages
Commercial	5	0	22	25	29	16
Subsistence	18	39	31	24	22	27
Personal Use	2	3	2	0	0	1
Totals	25	42	55	49	51	44

harvests in downstream fisheries and for escapements of Chinook salmon in tributaries downstream of Russian Mission, total annual run strength of Yukon River Chinook salmon can be estimated for those 5 years. Estimated in this manner, total runs of Yukon River Chinook salmon from 2000 to 2004 averaged about 303,000 fish and ranged from about 147,000 fish in 2000 to about 439,000 fish in 2001, about a 3-fold level of variation (Figure 182). The subtraction of total utilization from estimates of total runs provides annual estimates of total Yukon River escapements of Chinook salmon. Estimated in this manner, Yukon Chinook salmon escapements from 2000 to 2004 averaged about 218,000 fish and ranged from about 97,000 fish in 2000 to about 376,000 fish in 2001 (Figure 182). Annual harvest rates exerted on Chinook salmon by Yukon River fisheries from 2000 to 2004 averaged about 30%, ranging from about 15% in 2001 to about 39% in 2004 (Figure 183). These harvest rates are low in comparison to harvest rates exerted on most populations of Chinook salmon in Alaska and reflect the conservative fishery management regime in place.

The Pilot Station sonar assessment project successfully estimated annual passage of summer chum salmon in 1995 and from 1997 to 2005. An approximate estimate of the total run of summer chum salmon in the Yukon River can be obtained by adding (1) the sonar-based estimates of summer chum salmon passage at Pilot Station, (2) total utilization of summer chum salmon in Districts 1 and 2, and (3) chum salmon escapements in the East Fork of the Andreafsky River. The estimate is approximate because some of the harvest in District 2 takes place above Pilot Station and some other stocks of summer chum salmon spawn below Pilot Station. However, the Pilot Station counts are so much larger than the total catch and the monitored escapement that the total estimate is mostly based upon the sonar count (Figure 184). The total run of Yukon River summer chum salmon estimated in this manner averaged about 1.4 million fish annually in the 9-year period of 1995 and 1997 to 2004, ranging from a low

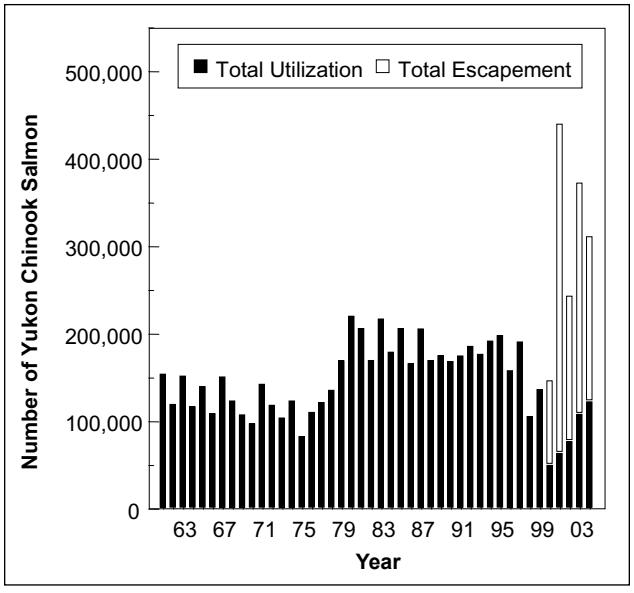

Figure 182. Total annual utilization (all Alaskan and Canadian harvests) of Yukon River Chinook salmon from 1961–2004 and total annual Yukon River Chinook escapements and total runs from 2000–2004.

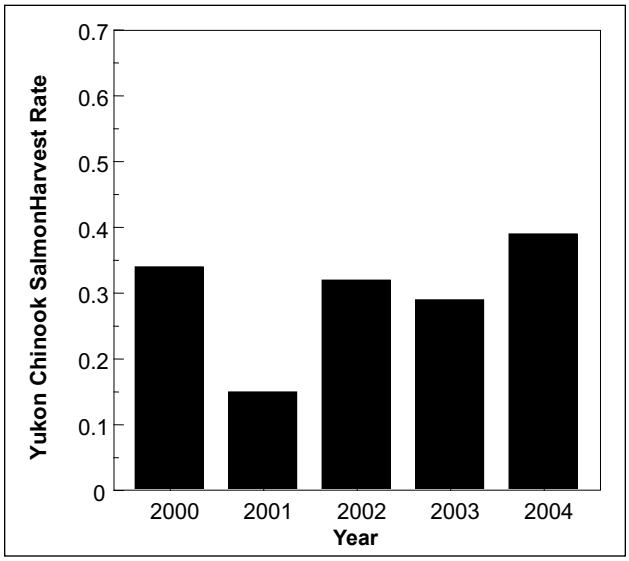

Figure 183. Estimated harvest rates exerted on Yukon Chinook salmon from 2000–2004.

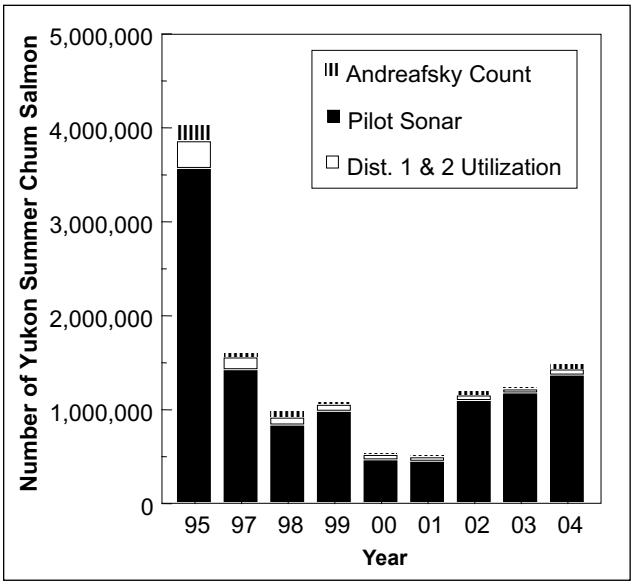

Figure 184. Approximate total runs of summer chum salmon in the Yukon River, 1995 and 1997–2004.

of about 515,000 fish in 2001 to about 4 million fish in 1995, almost an 8-fold level of variation. These annual total run estimates can be coupled with total annual inriver utilization to estimate harvest rates exerted on Yukon summer chum salmon for the years 1995 and 1997 to 2004 (Figure 185). Total harvest rates exerted by Yukon fisheries on summer chum salmon over those 9 years averaged about 12% and ranged from about 7% from 2002 to 2004 when the total runs averaged about 1.3 million fish to about 23% in 1995 when the total run was about 4 million fish. These harvest rates are low in comparison to harvest rates exerted on most Alaska salmon populations and reflect the combination of the conservative fishery management regime in place and the recent lack of summer chum markets.

Run reconstruction methods have been used to estimate total annual runs of fall chum salmon to the Yukon River for the years from 1974 to 2004. In 2005, Yukon River fall chum salmon escapement was estimated to have been in excess of 1.8 million fish, and the Alaska commercial harvest was about 180,000 fish. Complete Alaska subsistence and Canadian harvest estimates are not yet complete as of this writing and thus a minimum estimate of the total run in 2005 is about 2 million fall chum salmon. This minimum estimate is included in some of the averages that follow. Over the 32-year period from 1974 to 2005, the annual Yukon fall chum run averaged about 840,000 fish and ranged from a low of about 240,000 fish in 2000 to in excess of 2 million fish in 2005, a level of variation in excess of 8-fold (Figure 186). This level of overall annual run variation is not extreme in Alaska. For example, the annual run variation associated with Bristol Bay sockeye salmon over the 45-year period from 1960 to 2004 is about 25-fold, about 3 times that of the Yukon fall chum salmon runs over the past 32 years. The variation in annual runs of Kotzebue chum salmon is about 6-fold over the 43-year period from 1962 to 2004, ranging from about 264,000 fish to about 1.7 million fish (Eggers and Clark 2006), a level of annual run variation similar to that observed for Yukon fall chum salmon. The time series estimates of total runs for Yukon summer chum salmon is short, however, the level of variation of about 8-fold is similar to that for the fall chum salmon runs over the 32-year period from 1974 to 2005.

The run reconstruction data can be used to estimate harvest rates exerted on Yukon fall chum salmon for the years from 1974 to 2004 (Figure 187; Eggers 1999). Harvest rates over the 31-year period from 1974 to 2004 averaged about 37% and ranged from a low of about 7% in 2000 to a high of about 67% in 1982. Harvest rates exerted on Yukon fall chum salmon averaged about 49% in the 1970s and 1980s, about 30% in the 1990s, and about 11% since 2000. These harvest rates are low in comparison to harvest rates exerted on most Alaska salmon populations, especially the rates exerted since 1990, which reflect the conservative fishery management regime in place. Because coho salmon run timing is similar to fall chum salmon, and because for the most part, coho salmon are caught as an incidental species while fishermen target fall chum salmon, the pattern of harvest rates estimated for fall chum salmon

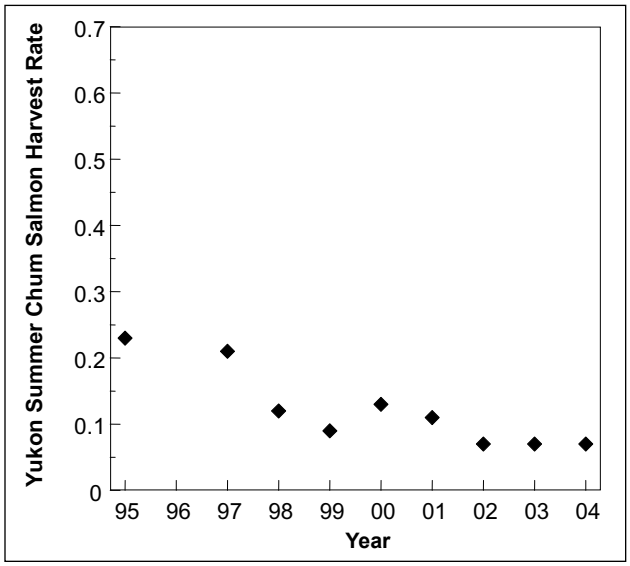

Figure 185. Estimated harvest rates exerted on Yukon fall chum salmon in 1995 and 1997–2004.

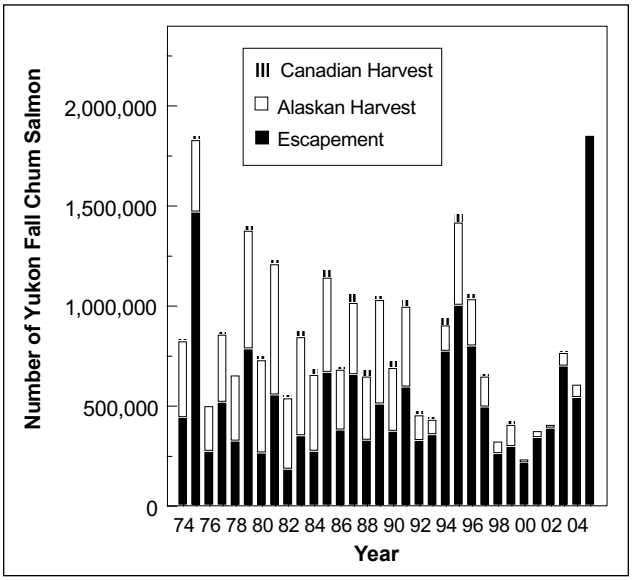

Figure 186. Total runs of fall chum salmon in the Yukon River, 1974–2005 (total harvests not yet available for 2005).

are probably reasonably representative of the harvest rate pattern exerted on Yukon coho salmon.

Escapement goals currently in effect for management of salmon fisheries in the Yukon area are listed in ADF&G (2004). In the Yukon River drainage, ADF&G has established 2 biological escapement goals and 5 sustainable escapement goals for Chinook salmon. The biological escapement goal for the stock of Chinook salmon that spawns in the Chena River is 2,800 to 5,700 fish. In the 19 years from 1986 to 2004, only in 1989 did the Chena River stock of Chinook salmon fail to meet the established escapement goal (Figure 188). The annual escapement of Chinook salmon in the Chena River in 2005 was not assessed. The Salcha River stock of Chinook salmon has a biological escapement goal of 3,300 to 6,500 fish. The Salcha River Chinook salmon escapement goal has been met in 17 of the past 19 years (89%). Escapements in 1989 and 2001 failed to meet the goal (Figure 189).

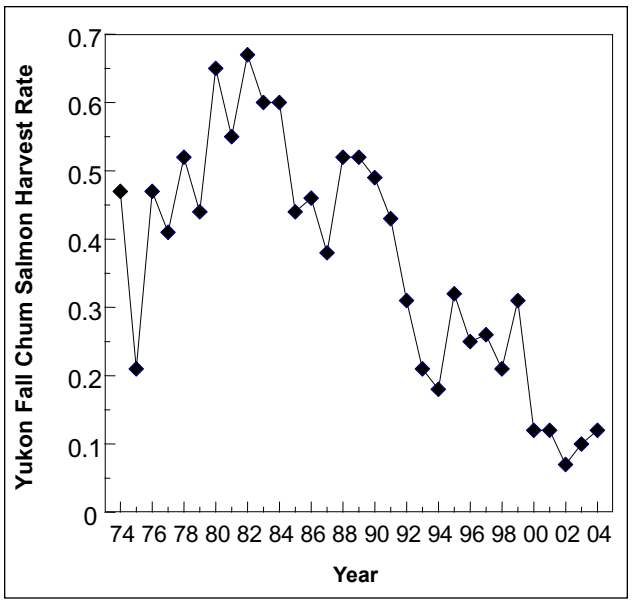

Figure 187. Estimated total harvest rates exerted on Yukon fall chum salmon, 1974–2004.

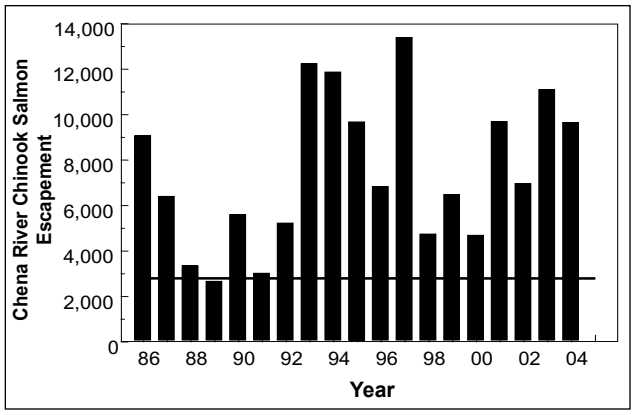

Figure 188. Chena River Chinook salmon escapements from 1986–2004 (bars) and the lower end of the ADF&G biological escapement goal range of 2,800–5,700 (line). Escapement not assessed in 2005.

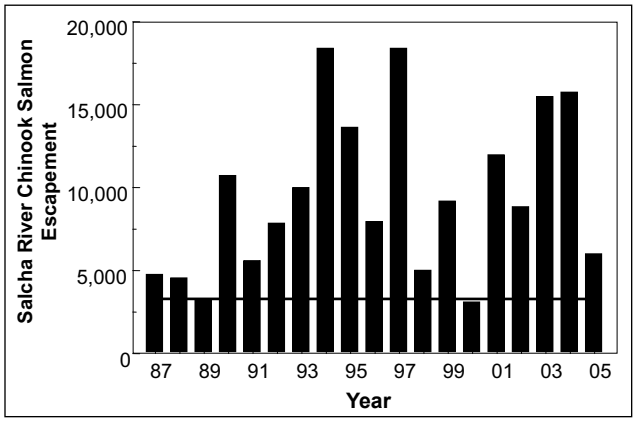

Figure 189. Salcha River Chinook salmon escapements from 1986–2005 (bars) and the lower end of the ADF&G biological escapement goal range of 3,300–6,500 (line).

Chinook salmon

There are 5 stocks of Chinook salmon in the Yukon River whose escapements are indexed by aerial surveys and where each has an established sustainable escapement goal. Figure 190 shows escapement observations for these 5 stocks over the period from 1996 to 2005. The East Fork of the Andreafsky River supports a spawning Chinook salmon population and has a sustainable escapement goal of 960 to 1,700 fish; escapement observations were not obtained in 1996, 1999, and 2003. The West Fork of the Andreafsky Chinook salmon population has a sustainable escapement goal of 640 to 1,600 fish; escapement observations were not obtained in 1998 and 1999. Chinook salmon spawn in the Anvik River and the sustainable escapement goal is 1,100 to 1,700 fish; escapement observations were not obtained in 1998, 1999, and 2003. The Chinook salmon sustainable escapement goal in the Nulato River is 940 to 1,900 fish; escapement observations were not obtained in 1996, 1997, 1999, 2000, 2003, and 2004. The Gisasa Chinook salmon population has a sustainable escapement goal of 420 to 1,100 fish; escapement observations were not obtained from 1996 to 2000 and 2003. Thus, there are 30 escapement observations out of the possible 50 stream by year cells from 1996 to 2005. In 25 of the 30 cases (83%), escapements met or exceeded the escapement goal.

Chum salmon

Two biological escapement goals have been established by ADF&G for summer chum salmon in the Yukon River drainage. The summer chum salmon spawning population in the East Fork of the Andreafsky River has a sustainable biological escapement goal of 65,000 to 130,000 fish. Assessment of the annual escapements occurred in 17 of the 25 years since 1981 (Figure 191). The escapement goal has been achieved in 9 of the 17 years (53%) and was last met in 1998. The Anvik River population of summer chum salmon has a biological escapement goal of 350,000 to 700,000 fish. The goal has been met or exceeded in 23 of the 26 years (88%) since 1980 (Figure 192), the 3 years when the goal was not met all occurred since 2000.

Seven biological escapement goals have been established by ADF&G for fall chum salmon in the Yukon River drainage, and several involve the same fish because some of the goals are nested. The overall biological escapement goal for the Yukon River drainage fall chum salmon is 300,000 to 600,000 fish (Figure 193). The goal has been met or exceeded in 25 of the 32 years (78%) since 1974; the goal was not met in 1976, 1980, 1982, 1984, and 1998 to 2000. The 2005 escapement was in excess of 1.8 million fall chum salmon and was the highest level of escapement

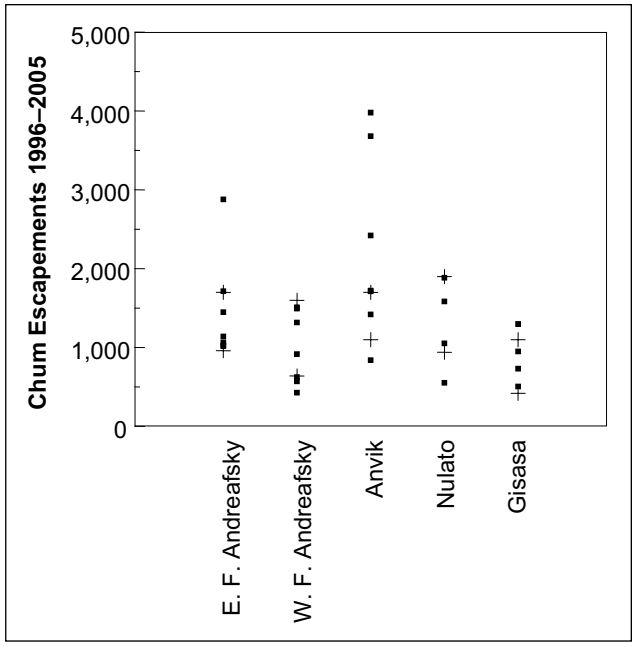

Figure 190. Chinook salmon escapements from 1996–2005 for 5 Yukon stocks assessed by aerial survey that have sustainable escapement goals (annual escapements shown as solid squares, lower and upper ends of sustainable escapement goal ranges shown as + signs).

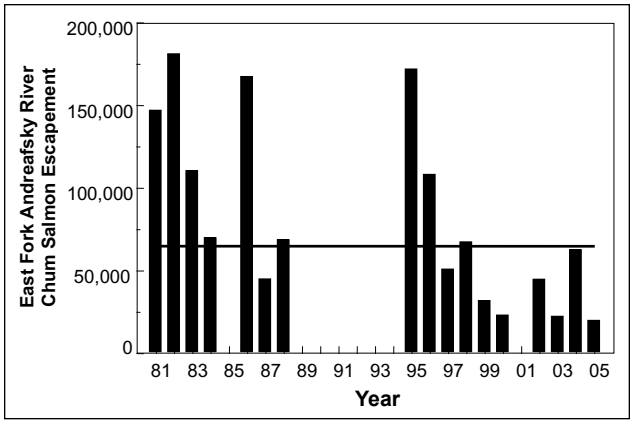

Figure 191. East Fork Andreafsky River summer chum salmon escapements from 1981–2005 (bars) and the lower end of the ADF&G biological escapement goal range of 65,000–130,000 (line). Escapement not assessed in 1985, 1989–1994, and 2001.

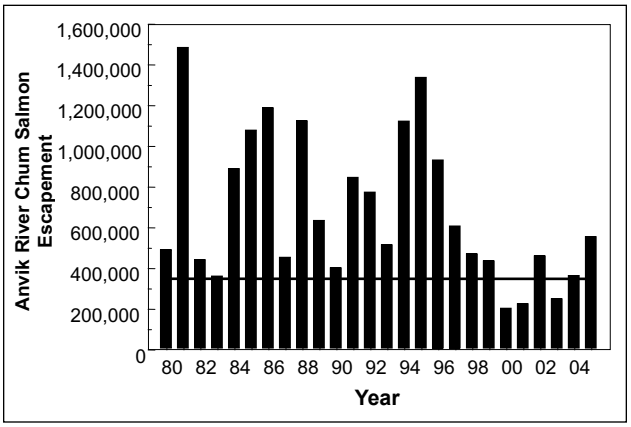

Figure 192. Anvik River summer chum salmon escapements from 1980–2005 (bars) and the lower end of the ADF&G biological escapement goal range of 350,000–700,000 (line).

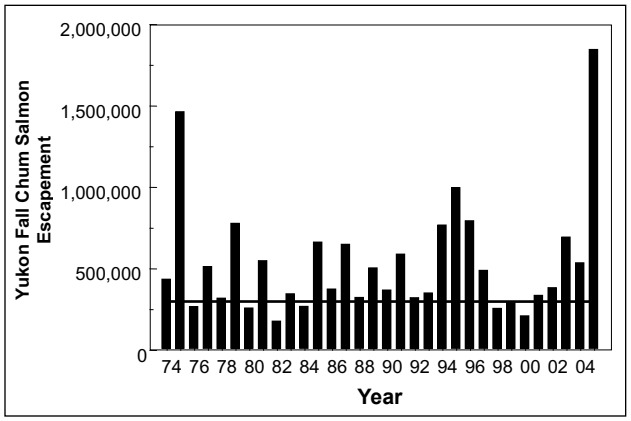

Figure 193. Run reconstruction estimates of the total Yukon fall chum salmon escapements from 1974–2005 (bars) and the lower end of the ADF&G biological escapement goal range of 300,000–600,000 (line).

ever observed. The biological escapement goal for fall chum salmon in the Tanana River is 61,000 to 136,000 fish. Annual escapements have met or exceeded the escapement goal in the Tanana River in 30 of the 32 years (94%) since 1974 (Figure 194); escapements did not achieve the goal in 1982 and 2000. Both the Delta River and the Toklat River are tributaries to the Tanana River. The biological escapement goal for the stock of fall chum salmon that spawns in the Delta River is 6,000 to 13,000 fish; the goal was met or exceeded in 29 of the 32 years (90%) since 1974. The annual escapements in 1980, 1982, and 2000 fell short of the goal (Figure 195). The biological escapement goal for the stock of fall chum salmon that spawns in the Toklat River is 15,000 to 33,000 fish; the goal was met or exceeded in 24 of the 32 years (75%) since 1974. The annual escapements in 1982, 1988, 1991, 1992, 1997, and 1999 to 2001 fell short of the goal (Figure 196). A biological escapement goal of 152,000 to 312,000 fish has been established for tributaries of the upper Yukon River; that goal has been met in 23 of the 32 years (72%) since 1974. Escapements in 1976, 1982, 1984, 1988, 1993, 1998 to 2000, and 2002 fell short of the current escapement goal (Figure 197). The biological escapement goal for fall chum salmon spawning in the Chandalar River is 74,000 to 152,000 fish, annual escapements since 1974 have met or exceeded the goal in 25 of the 32 years (78%). Escapements in 1976, 1978, 1982, 1984, 1988, 1993, and 2000 fell short of the goal (Figure 198). A biological escapement goal of 50,000 to 104,000 fish has been established for fish that spawn in the Sheenjek River; that goal has been met in 19 of the 32 years (60%) since 1974. Escapements in 1976, 1978, 1980, 1982, 1984, 1988, 1993, 1998 to 2000, and 2002 to 2004 fell short of the current escapement goal

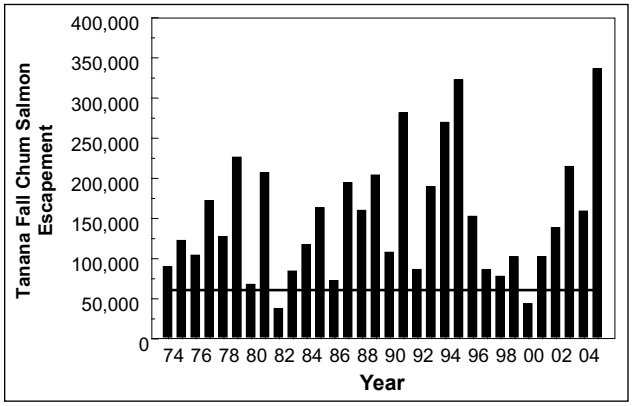

Figure 194. Mark–recapture estimates of the Tanana River fall chum salmon escapements from 1974–2005 (bars) and the lower end of the ADF&G biological escapement goal range of 61,000–136,000 (line).

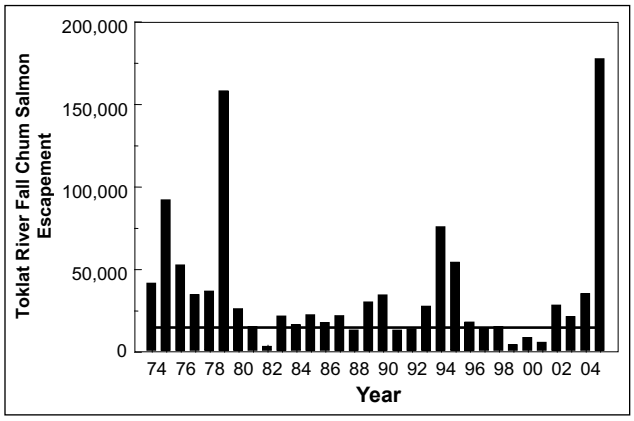

Figure 196. Estimates of the Toklat River fall chum salmon escapements from 1974–2005 (bars) and the lower end of the ADF&G biological escapement goal range of 15,000–33,000 (line).

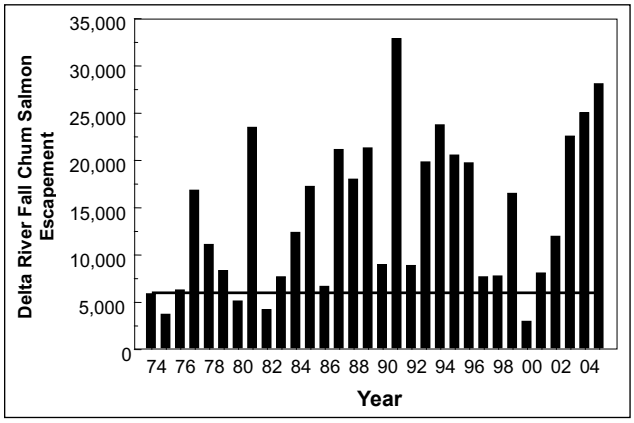

Figure 195. Estimates of the Delta River fall chum salmon escapements from 1974–2005 (bars) and the lower end of the ADF&G biological escapement goal range of 6,000–13,000 (line).

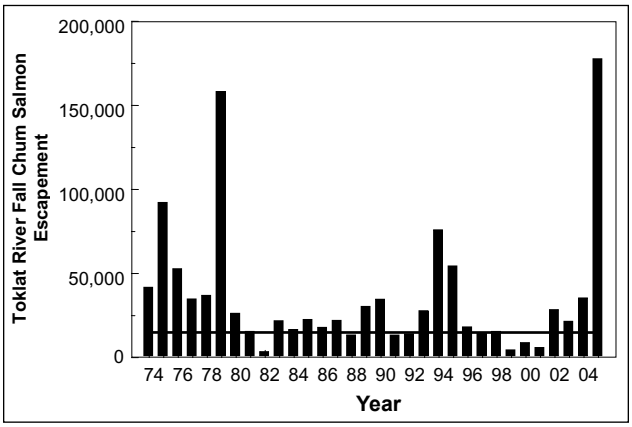

Figure 197. Estimates of the fall chum salmon escapements in tributaries of the upper Yukon from 1974–2005 (bars) and the lower end of the ADF&G biological escapement goal range of 152,000–312,000 (line).

(Figure 199). The escapement of fall chum salmon in the Sheenjek River in 2005 was almost 440,000 fish, the highest level ever observed.

There are 2 fall chum salmon passage goals that were negotiated in an agreement with Canada. The passage goal for the mainstem Yukon is 65,000 fish and this level has been observed in half of the years since 1974, but exceeded in each of the last 4 years (Figure 200). The passage goal for the Fishing Branch River is 15,000 fish and this level has been met or exceeded in 28 of the last 32 years (87%) including the last 3 years (Figure 201). The 2005 passage was in excess of 120,000 fall chum salmon, about 8-fold the goal and the second highest passage ever observed.

Coho salmon

The only escapement goal in place in the Yukon River drainage for coho salmon is for the Delta Clearwater River, a tributary to the Tanana River. The sustainable escapement goal for coho salmon in the Delta Clearwater River is 5,200 to 17,000 fish and that goal has been met or exceeded in 25 of the 32 years (78%) since 1992. Escapements fell short of the goal from 1974 to 1978, 1980, and 1992 (Figure 202). The annual escapements since 2001 have been exceptionally strong.

Budget History and Fiscal Support

In FY 05, the Division of Commercial Fisheries budget allocation for state funding for Yukon salmon was $1,038,100. Summer season management was $420,100 and fishery monitoring was $104,300. Fall season management was $365,300 and fishery monitoring was $79,600. Other state-funded activities included Anvik sonar assessment with an allocated budget of $49,800 and an allocation of $19,000 for

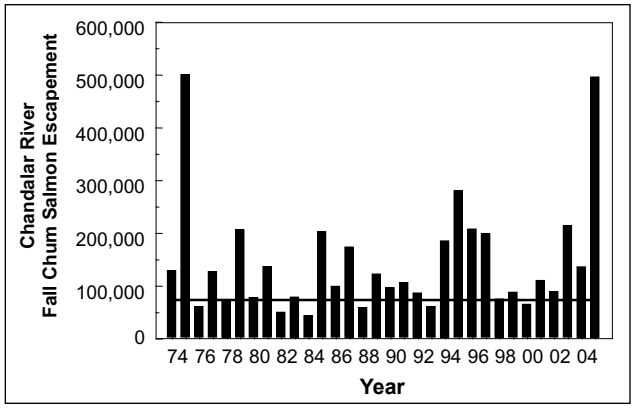

Figure 198. Sonar based estimates of the Chandalar River fall chum salmon escapements from 1974–2005 (bars) and the lower end of the ADF&G biological escapement goal range of 74,000–152,000 (line).

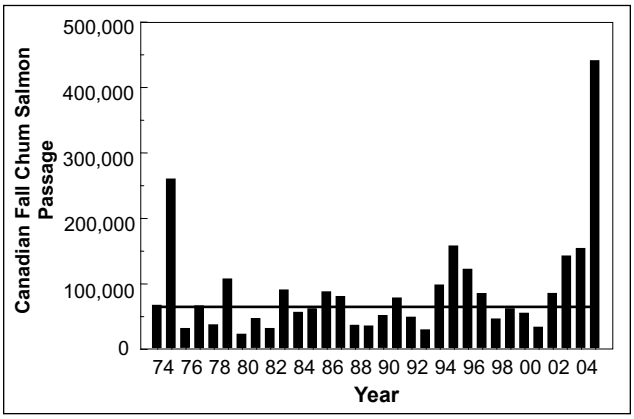

Figure 200. Estimates of the passage of fall chum salmon into Canada from 1974–2005 (bars) and the threshold value of 65,000 fish negotiated through treaty agreements.

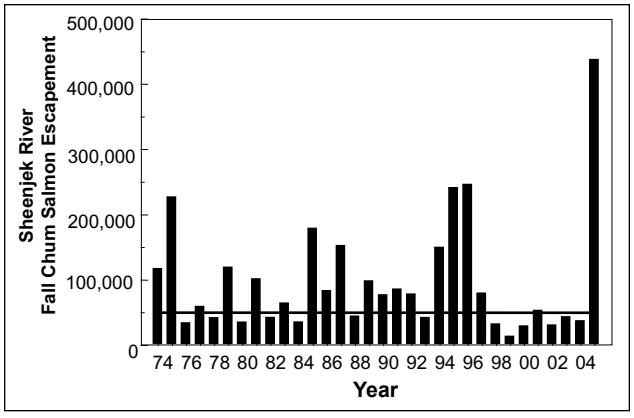

Figure 199. Sonar based estimates of the Sheenjek River fall chum salmon escapements from 1974–2005 (bars) and the lower end of the ADF&G biological escapement goal range of 50,000–104,000 (line).

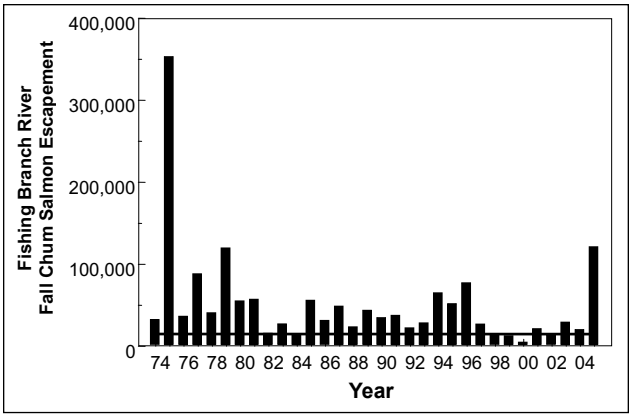

Figure 201. Weir based estimates of the Fishing Branch River fall chum salmon escapements from 1974–2005 (bars) and the threshold passage level of 15,000 fish negotiated through treaty agreements.

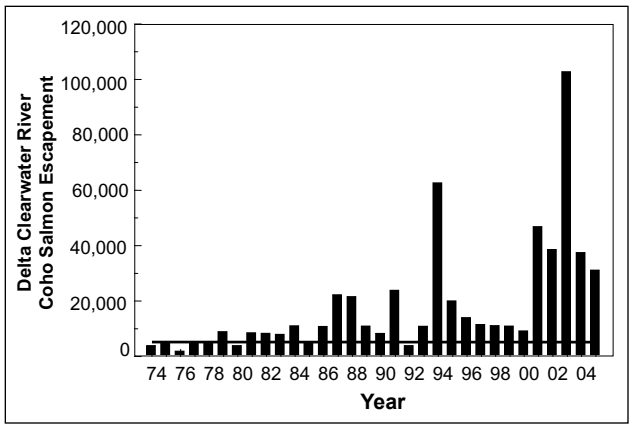

Figure 202. Counts of coho salmon in the Delta Clearwater River from 1974–2005 (bars) and the lower end of the ADF&G sustainable escapement goal range of 5,200–17,000 (line).

test fishing in the Upper Yukon. Additional state-funded stock assessment efforts were implemented and funded in FY 05, but were included within the AYK Regional Administrative unit, the Statewide genetics unit, or elsewhere. Federal funding of about $850,000 associated with the U.S.–Canada Yukon agreement was used by ADF&G for salmon stock assessment in the Yukon in fiscal year 2005. Other funding sources used for Yukon salmon stock assessment by ADF&G in fiscal year 2005 included grants from the Federal Office of Subsistence and grants from the AYK Sustainable Salmon Initiative. Various federal agencies, the Canadian Department of Fisheries and Oceans, Native organizations, nongovernmental organizations, and fishing groups used funding from a variety of sources to conduct salmon stock assessments in the Yukon River in FY 05. Due to the large number of participants involved with Yukon salmon stock assessment and the varied funding sources, it is difficult to get a total picture of the current annual cost of the Yukon salmon stock assessment and management program. However, clearly the cost was several million dollars and likely in the vicinity of about $5 million. Annual costs associated with assessment and management of Yukon salmon over the last several years has exceeded the exvessel value of the commercial fishery. Coordination and communication among the various participants involved with salmon stock assessment in the Yukon represents a significant work load for Yukon salmon management staff.

The Division of Commercial Fisheries faces several challenges associated with management of Yukon salmon fisheries. Long-term stock assessment information is needed to assess how various salmon stocks that spawn in the Yukon River drainage can support sustained fisheries. Little stock assessment information is available for Yukon salmon prior to statehood and most stock assessment information collected during the 1960s and 1970s consisted of aerial surveys that were conducted on a periodic basis and provide very crude estimates of spawning abundance. Long-term and accurate estimates of the abundance and composition of spawning stocks is needed along with estimates of the harvests of those salmon in the various fisheries of the Yukon drainage. Much progress toward these objectives has been made since the late 1980s, especially over the last decade. However, the time series for many such data sets is relatively short. Obtaining such information in the Yukon is expensive and difficult due to the remoteness of the area.

Although Chinook salmon are commercially the most valuable salmon in the Yukon, assessing total abundance of Chinook salmon has been one of the more challenging aspects of stock assessment in the Yukon River drainage. Assessment using sonar has been attempted over the last 20 years, but success in the lower river has been elusive. Recent efforts to assess Chinook salmon passage at Eagle, below the U.S.–Canada border, look promising, and coupled with genetic stock identification, may provide breakthrough, cost-effective technology for annual assessments of Chinook salmon in the Yukon River drainage. Reasonably complete assessment of summer chum salmon is feasible but expensive, and given commercial interest in the summer chum salmon stocks of the Yukon, may or may not be cost-effective. Reasonably complete assessment of fall chum salmon currently exists in the Yukon. A significant challenge for salmon management in the Yukon is using the various stock assessment efforts effectively to make the best possible decisions for managing the gauntlet of fisheries in the Yukon River drainage. An area for future research is development and implementation of fishery management models.

The commercial fishing industry in the Yukon faces other challenges. Over the past 10 years, low prices paid for chum salmon, and the relative lack of commercial enterprises interested in marketing these fish, has greatly limited the commercial fishery and its potential economic benefits in a cash poor rural area of Alaska. The challenge to fishermen in the Yukon is 2-fold: (1) developing niche markets to substantially increase the value of commercial chum salmon landings, allowing them to increase earnings from commercial salmon fishing; and (2) continuing support for comprehensive stock assessment programs implemented by agencies and nongovernmental organizations that ensure opportunity for commercial fishing that will not negatively affect salmon stock status nor subsistence utilization of salmon stocks in the Yukon River drainage.

NORTON SOUND COMMERCIAL SALMON FISHERY

Area Description and Gear Types

All 5 species of Pacific salmon are present in the Norton Sound area. In 1959 and 1960 Division of Commercial Fisheries biologists conducted resource inventories that indicated harvestable surpluses of salmon were available in several river systems of Norton Sound. The Division of Commercial Fisheries and Board of Fish and Game established regulations for development of commercial salmon fisheries in Norton Sound and encouraged processors to explore and develop these fisheries after statehood in an effort to provide economic benefits to this part of rural Alaska. Norton Sound was subdivided into 6 subdistricts: (1) subdistrict 1 or the Nome subdistrict, (2) subdistrict 2 or the Golovin subdistrict, (3) subdistrict 3 or the Moses Point subdistrict, (4) subdistrict 4 or the Norton Bay subdistrict, (5) subdistrict 5 or the Shaktoolik subdistrict, and (6) subdistrict 6 or the Unalakleet subdistrict (Figure 203). The Port Clarence district is located north of Norton Sound and south of the Kotzebue area and does not support a commercial fishing industry. Subsistence fishing for salmon does occur in Port Clarence and in this report those catches are combined with Norton Sound subsistence information.

Only gillnet gear is used for commercial salmon fishing in Norton Sound.

History of the Commercial Salmon Fishery

Commercial salmon fishing first began in Norton Sound in the Unalakleet and Shaktoolik areas in 1961. Most of the early interest in commercial fishing involved Chinook and coho salmon that were harvested, cleaned, and flown to Anchorage for further processing. A single freezer ship purchased and processed chum and pink salmon during 1961. In 1962, 2 floating cannery ships operated, and commercial fishing extended into Norton Bay, Moses Point, and Golovin Bay. The peak in salmon canning operations occurred in 1963. Since the early 1960s, markets have been sporadic, with fishermen in some subdistricts often being unable to attract buyers for the entire season. The most consistent markets are at Unalakleet and Shaktoolik. The intent of the commercial salmon fisheries management program is to sustain the runs, ensure subsistence needs are met and provide opportunity for commercial fishermen to harvest available surpluses. Annual management reports for the Norton Sound area, written by ADF&G staff since the 1960s provide detailed fishery data and insight into the management program and fishery. See Kohler et al. (2005).

Commercial harvests of Chinook salmon peaked in the 1980s when the 10-year annual average harvest was about 8,000 fish (Figure 204, Panel A). Average harvests in the 1990s dropped slightly to about 7,000 fish while harvests in the last few years dropped even more. Commercial harvests of sockeye salmon have always been minor. Only in 1988 were more than 1,000 sockeye salmon harvested, while most years the harvest has been less than 200 fish (Figure 204, Panel B). Coho salmon annual harvests in the 1980s averaged about 40,000 fish (Figure 204, Panel C). Harvests increased somewhat to an average annual level of about 55,000 fish in the 1990s but have decreased to about half that level since 2000. Pink salmon are abundant in Norton Sound, particularly in even-numbered years. Commercial harvests of pink salmon have been sporadic; in some years, recently no pink salmon have been commercially harvested, while in 1994, almost one million pink salmon were commercially harvested (Figure 204, Panel D). Commercial harvest of chum salmon in Norton Sound annually averaged about 150,000 fish in the 1970s and 1980s (Figure 204, Panel E). Management for fixed escapement goals in the 1990s resulted in reduced harvests in the 1990s, averaging only about one-third of the prior sustained level of about 40,000 fish. Average harvest levels since 2000 dropped to about 5,000 chum salmon. The overall pattern of commercial salmon harvests in the Norton Sound area is one of fishery development in the 1960s, increasing salmon harvests each decade through the 1990s, and a sharp reduction in harvests in the last few years (Figure 204, Panel F). Commercial salmon harvests in the 1980s and 1990s averaged a little over 300,000 fish annually.

Other Salmon Harvests

Annual subsistence harvests in Norton Sound and Port Clarence have averaged about 100,000 fish since 1994 with a low of about 65,000 fish in 1999 to a high of about 145,000 fish in 1996 (Figure 205). Pink salmon have represented about 46% of the subsistence harvest followed by chum salmon (25%), coho salmon (19%), Chinook salmon (6%), and sockeye salmon (4%). Subsistence use has declined over the last 10 years, although the decline in commercial harvests is more stark (Figure 206).

Sport fishermen also harvest salmon in Norton Sound (Table 34). Sport fishing harvests are stable, with reduction in the pink and chum salmon harvests compensated by increases in the harvest of Chinook, sockeye and coho salmon.

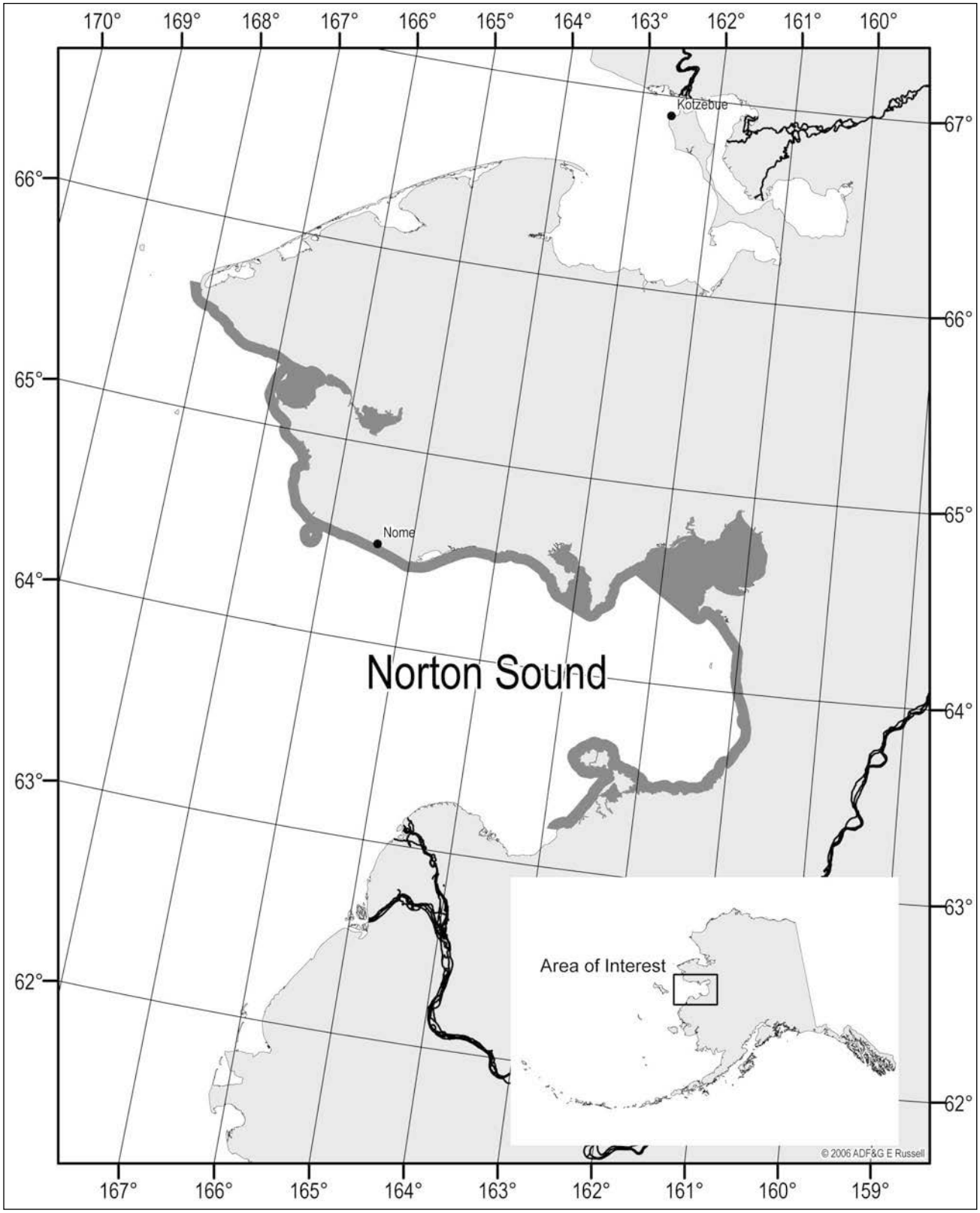

Figure 203. Norton Sound area commercial salmon fishery.

Commercial Salmon Fishery Users

As of August 2005, a total of 154 limited entry permits were valid for commercial fishing with gillnets in Norton Sound. Participation in the Norton Sound commercial salmon fishery has drastically declined since the mid-1980s (Figure 207). In 2002 only 12 fishermen participated in the fishery, in 2003 only 30 participated, and in 2004 only 36 participated—a fraction of the permits available, and only a small fraction of the number of permits fished in the mid-1980s.

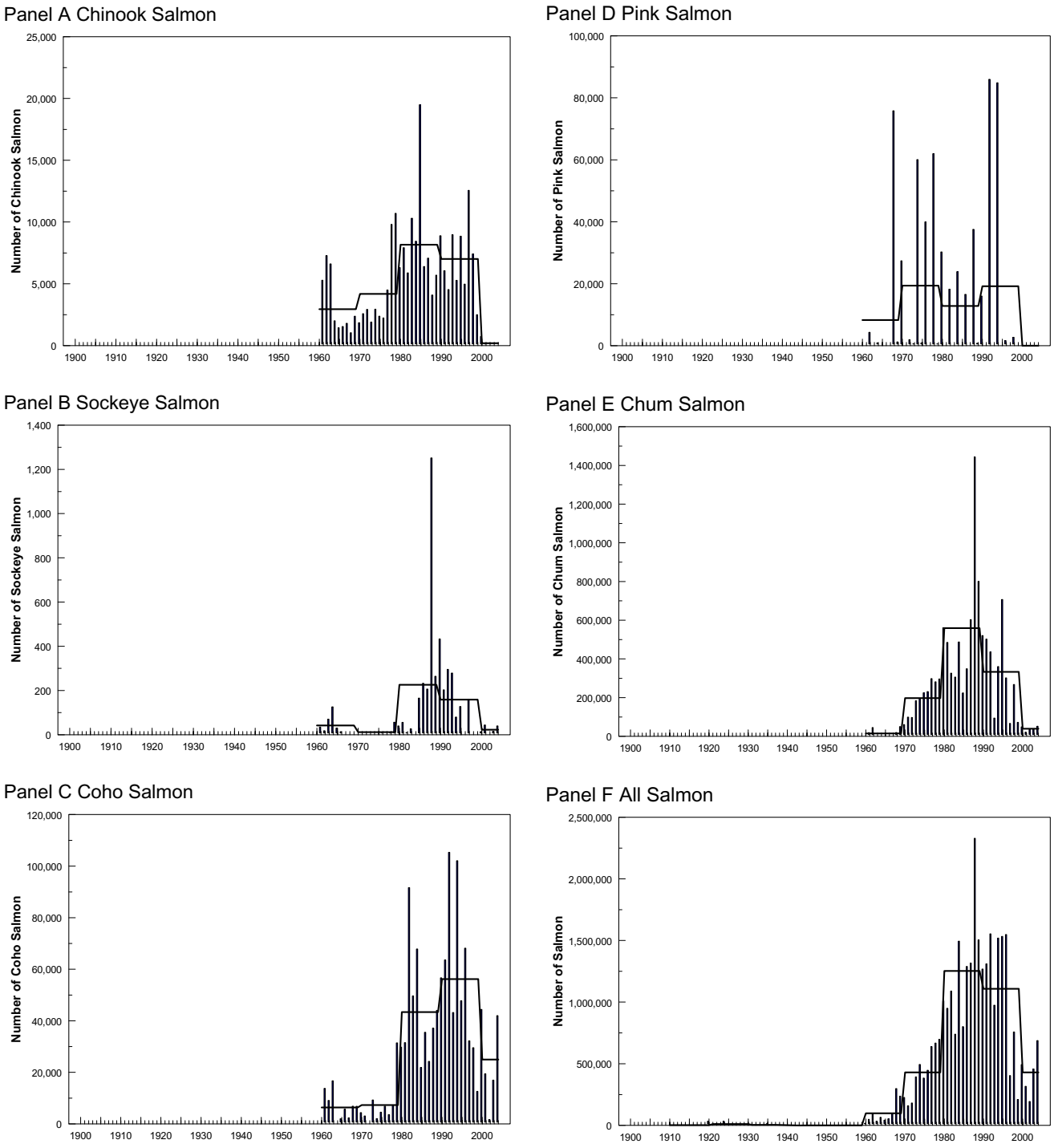

Figure 204. Commercial salmon harvests in Norton Sound from 1900–2004; bars provide annual catches and lines provide decade averages.

Exvessel Value

As the salmon fishery in Norton Sound developed after statehood, the commercial fishery provided a valuable source of income in a rural part of Alaska, where it was an important portion of the local economy. In 1985 for instance, the inflation-adjusted exvessel value of the commercial salmon fishery was about $1.9 million. Sporadic market demand for salmon from rural areas of Alaska, low prices paid for those salmon harvested, and weak chum salmon runs in Norton Sound over the past 10 years, have combined to result in the present-day fishery that contributes little to the local economy (Figure 208). In 2004 for instance, the exvessel value of the fishery totaled only about $125,000 (only about 6% of the 1985 exvessel value). In 1964, commercial fishermen in Norton Sound were paid almost $5.00 per pound for Chinook salmon; 40 years later in 2003, fishermen were only paid $0.64 per pound. Meanwhile, due to 40 years of inflation, operational costs to fishermen have increased substantially. In 1988, commercial fishermen in Norton Sound were paid $1.13 per pound for coho salmon whereas in 2004, they were only paid $0.39 per pound. In 1988, commercial fishermen in Norton Sound were paid $0.39 per pound for chum salmon whereas in 2004, they were only paid $0.14 per pound, about 35% of the price paid 16 years earlier when operating expenses were much less.

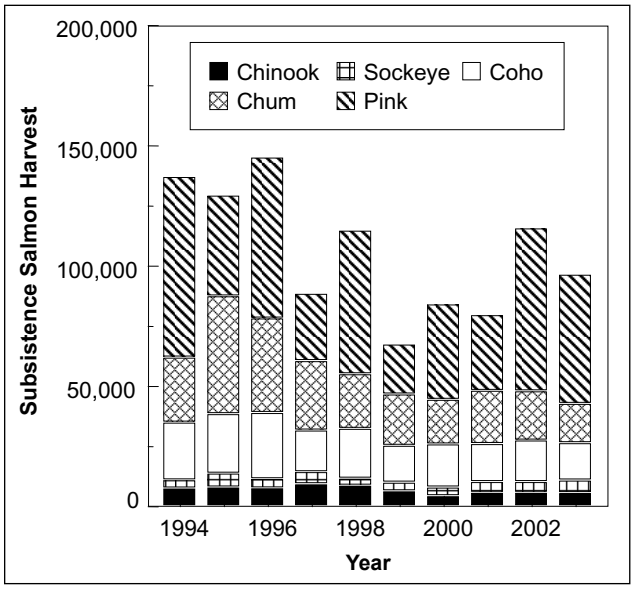

Figure 205. Subsistence salmon harvests in Norton Sound and Port Clarence from 1994–2003.

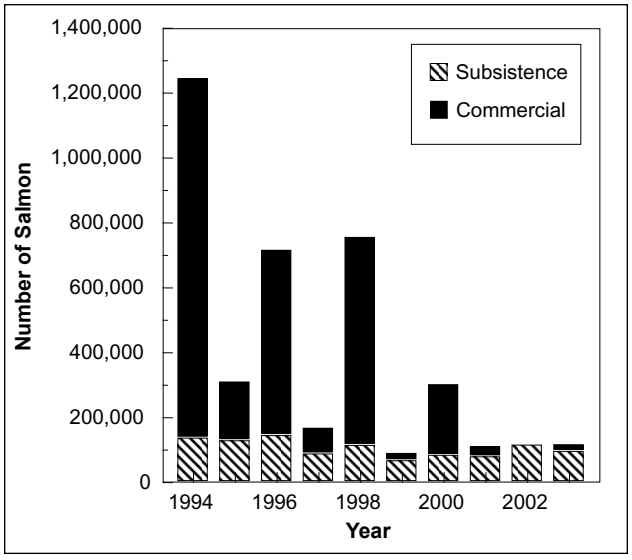

Figure 206. Subsistence and commercial harvests of salmon in the Norton Sound area from 1994–2003.

Management

A large tagging study of salmon in Norton Sound conducted in 1978 and 1979 found that salmon entered

Table 34. Average annual harvest of salmon in the Norton Sound sport fishery.

Species	1980–1989	1990–1999	2000–2004
Chinook	400	559	558
Sockeye	226	84	212
Coho	3,397	4,852	5,043
Pink	4,957	4,490	3,617
Chum	1,628	632	881
Total	10,608	10,617	10,311

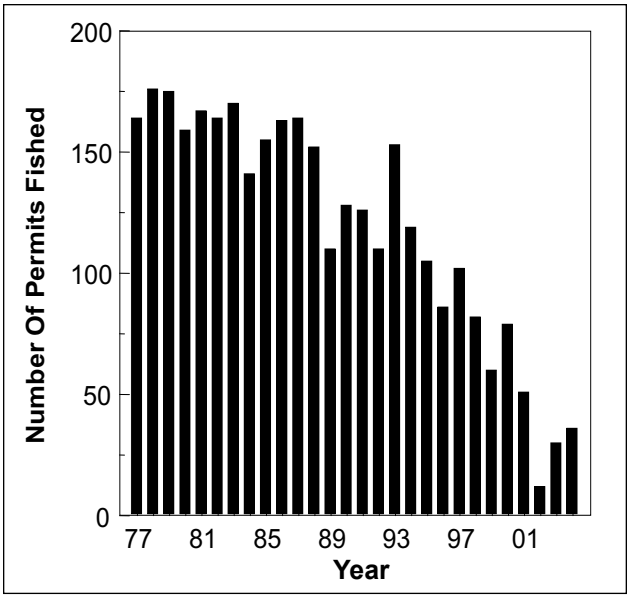

Figure 207. Number of commercial permits fished in Norton Sound, 1977–2004.

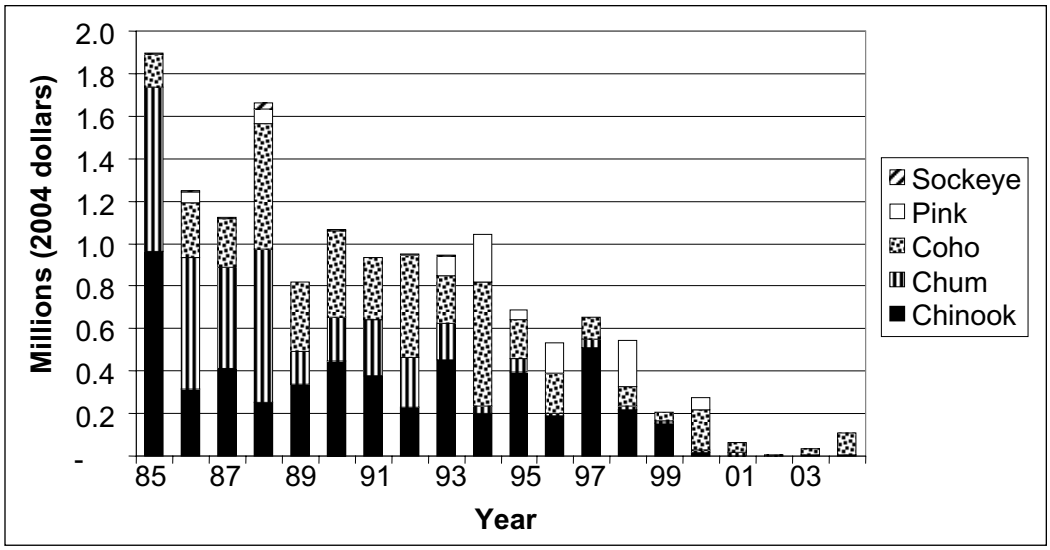

Figure 208. Exvessel value of the Norton Sound commercial salmon fishery, 1985–2004, adjusted for inflation into 2004 dollars.

Norton Sound and generally migrated in a clockwise fashion with various stocks of salmon entering spawning streams while other stocks, including Yukon origin salmon, attempted to pass through the various fishing districts (Gaudet and Schaefer 1982). Subdistrict commercial harvests of salmon in Norton Sound represent mixed stock harvests, and further, most subdistricts have multiple streams that support spawning salmon populations. The Division of Commercial Fisheries has managed the Norton Sound commercial fisheries since the late 1980s to achieve spawning targets in numerous Norton Sound streams. As this escapement-based management regime was implemented, commercial fisheries were increasingly restricted. Norton Sound salmon runs decreased in the 1990s, especially chum salmon. Less than average productivity, coupled with the escapement-based management regime implemented, has resulted in very low commercial harvests over the last several years.

The Board of Fisheries determined that the Nome, Golovin, and Moses Point subdistrict runs of chum salmon were stocks of concern in 2000. The Board of Fisheries determined the Shaktoolik and Unalakleet stocks of Chinook salmon were stocks of concern in 2004. Over the last 10 years, the fishery management program in Norton Sound has become more complex with the addition of several management plans, improved inseason and postseason stock status information, and more intensive inseason management of both the commercial and subsistence fisheries. In each of the last 5 years, Division of Commercial Fisheries managers have issued about 30 emergency orders per year to regulate these salmon harvests with the recent trend being more and more intensive management of subsistence fisheries (Figure 209).

Over the last several years, as increasing concern for stock status of salmon in Norton Sound developed, large-scale federal funding has been obtained to improve the salmon monitoring program. The historic run monitoring program in Norton Sound consisted of documenting commercial harvests, monitoring

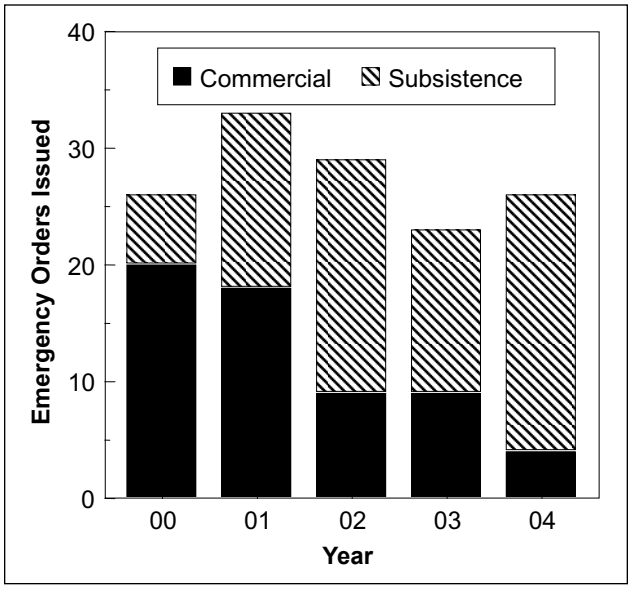

Figure 209. Number of emergency orders issued for management of Norton Sound commercial and subsistence fisheries, 2000–2004.

subsistence harvests, and tracking trends in salmon escapement largely through aerial surveys. The only long-term, on-the-grounds, escapement monitoring project in Norton Sound was the Kwiniuk River tower project that has been used since 1962. Various efforts have been made to reconstruct stock status using the aerial survey database to provide an improved understanding of salmon dynamics in Norton Sound. However, as is obvious, these efforts are based on a variety of assumptions. New funding sources have focused recent efforts on using weirs and towers to obtain good counts of salmon going into spawning streams. Information from these efforts has greatly improved the information base for salmon resources in Norton Sound.

Escapement goals currently in effect for management of salmon fisheries in Norton Sound are listed in ADF&G (2004). There are 3 escapement goals in effect for Chinook salmon, 2 for sockeye salmon, 3 for coho salmon, 5 for pink salmon, and 11 for chum salmon. With the exception of 3 biological escapement goals for chum salmon, the goals currently in effect are sustainable escapement goals, meaning they are expected to provide for sustained harvest but not necessarily provide for maximum sustained production. A few of the better data sets available for tracking Norton Sound salmon escapement trends are provided.

The Kwiniuk River is located in the Moses Point subdistrict and a tower has been used to count salmon escapements annually since the early 1960s. Counts of Chinook salmon were not made in 1964 and 1970 and the tower program may have not been in place early enough in the year during the 1960s and 1970s to obtain accurate escapement counts. The current sustainable escapement goal for Kwiniuk River Chinook salmon is a range of 300 to 550 fish. Chinook salmon escapements in excess of the lower end of the current goal range have been documented in 17 of the 22 years (77%) since 1984 (Figure 210). Weak escapements occurred from 1998 through 2001 while more recent Chinook salmon escapements have been substantially stronger.

Salmon Lake is in the Port Clarence district and escapement strength of sockeye salmon has been monitored with an aerial survey program since 1963. Successful surveys were not implemented in 1970, 1981, and 1982. Over the past 40 years, sockeye salmon escapements have increased dramatically in this river system (Figure 211). The current sustainable escapement goal for this stock is 4,000 to 8,000 fish observed during an aerial survey. Since 1995, only in 2002 was the peak survey less than the lower end of the escapement goal range; thus 91% of the escapements documented since 1995 (last 11 years) have been at or above the lower goal range.

The Niukluk River is in the Golovin subdistrict of Norton Sound and coho salmon escapements have been documented with aerial surveys since 1984 (Figure 212). Successful surveys were not completed in 1986, 1994, 1997, 2003, and 2004. The current sustainable escapement goal for this stock is 950 to 1,900 fish observed during an aerial survey. Escapements in excess of the lower end of the goal range have occurred in 9 of the 16 years (56%) since 1984 when successful surveys adequately documented escapement strength. These data indicate substantial variation in annual escapement strength of coho salmon in the Niukluk River, but a trend pattern is not obvious.

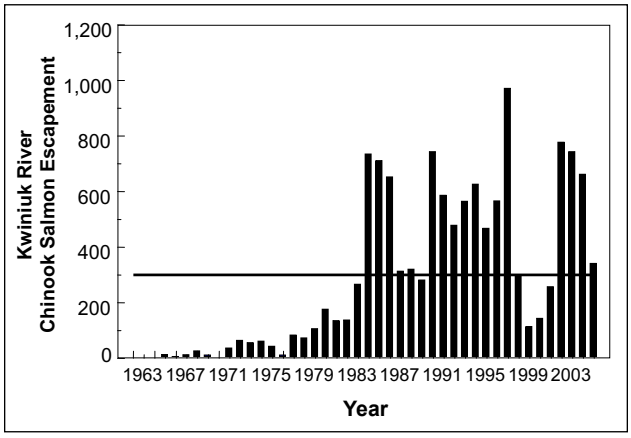

Figure 210. Annual tower counts of escapements of Chinook salmon in the Kwiniuk River from 1963–2005 (bars) and the lower end of the current ADF&G sustained escapement goal range of 300–550 (line).

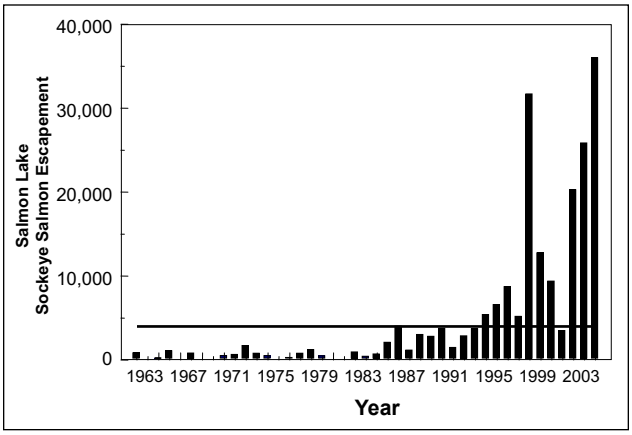

Figure 211. Annual peak survey counts of escapements of sockeye salmon in the Salmon Lake and Grand Central River from 1963–2005 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 4,000–8,000 (line).

The current sustainable escapement goal for the Kwiniuk River pink salmon stock is a threshold value of 8,400 fish. The stock shows a marked even-year dominance, particularly since the mid-1980s (Figure 213). The 2004 escapement was over 3 million fish and the 2005 escapement was almost 350,000 fish. Since 1968, only the 1987 and 1999 escapements were less than the current escapement goal, thus 95% of the last 37 annual escapements exceeded the threshold value of 8,400 fish, and in most of those years, the annual escapements were many times larger. The Kwiniuk River pink salmon stock, like most Norton Sound pink salmon populations, has virtually exploded in abundance over the last 40 years.

The Nome River is in the Nome subdistrict of Norton Sound and a weir has been used to count salmon escapements since 1993 (Figure 214). Like other Norton Sound pink salmon stocks, the run is even-year dominant and increasing. The current sustainable escapement goals for this stock are a threshold value of 3,200 fish during odd years and a threshold value of 13,000 fish during even years. The threshold escapement goals have been exceeded each year since 1993 except for the odd-year runs in 1999 and 2001. Although the 2001 escapement goal was not achieved, in 2003 the escapement was about 11,000 fish, exceeding the goal. The escapement in 2004 was over one million fish and the escapement in 2005 was over 275,000 fish; thus, recent escapements for both odd- and even-year runs of pink salmon were at record levels.

Run reconstructions using fishery data and aerial surveys for the composite stocks of chum salmon in the Nome subdistrict were used in 2000 to develop a biological escapement goal of 23,000 to 35,000 fish (Figure 215). This modeling effort provided a set of long-term data to evaluate overall stock status of chum

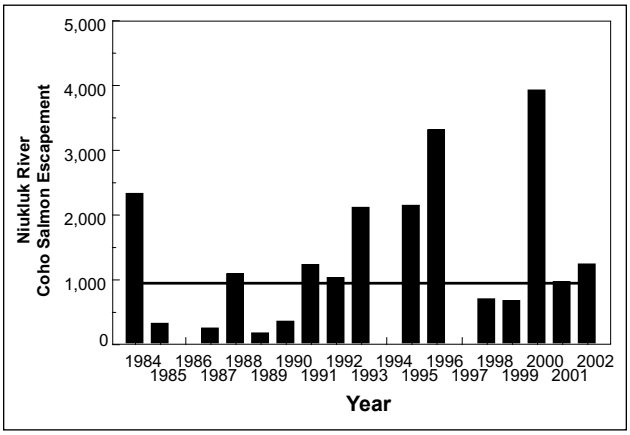

Figure 212. Annual peak survey counts of escapements of coho salmon in the Niukluk and Ophir Rivers from 1984–2002 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 950–1,900 (line).

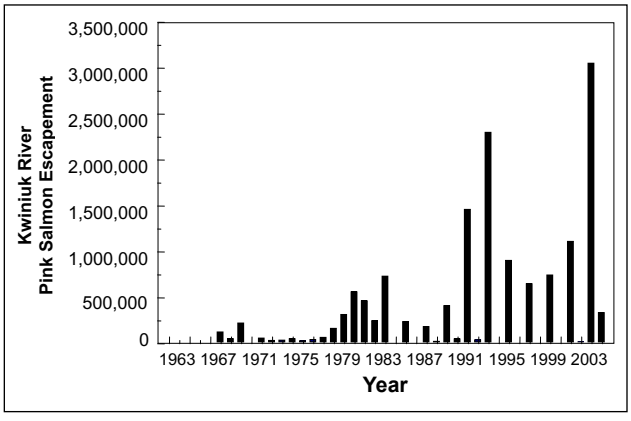

Figure 213. Annual tower counts of escapements of pink salmon in the Kwiniuk River from 1963–2005.

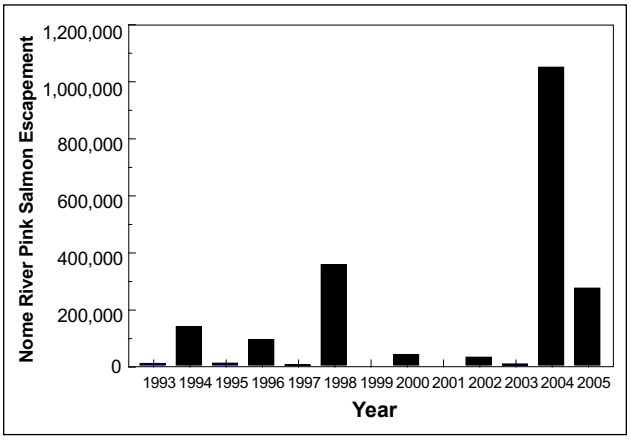

Figure 214. Annual weir counts of escapements of pink salmon in the Nome River from 1993–2005.

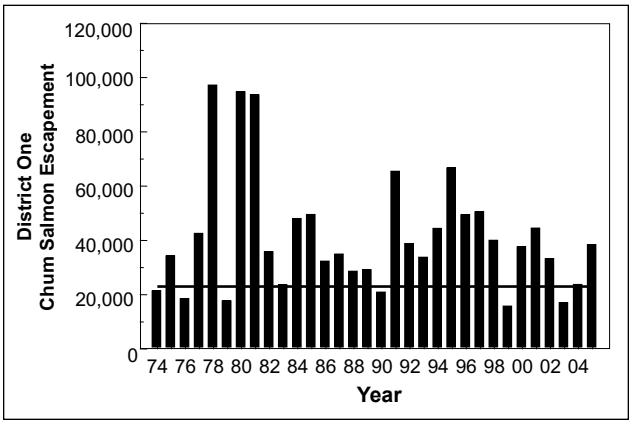

Figure 215. Estimated aggregate annual escapements of chum salmon in District One of Norton Sound from 1974–2005 (bars) and the lower end of the current ADF&G biological escapement goal range of 23,000–35,000 (line).

salmon in the Nome subdistrict of Norton Sound. While annual runs and escapements varied over the 30-year period, the level of variation was similar to what has been observed in other parts of Alaska. Since 1974, 26 of the 32 (82%) annual escapements have exceeded the lower escapement goal range. The time series of estimated escapements shows less variation through time, a result of management for escapement. However, early in the time series the Nome subdistrict supported a commercial chum salmon fishery, but commercial harvests in the subdistrict were absent during the latter part of the series.

Aerial surveys of chum salmon escapements in the Nome River represent a small component of Figure 215. Since 1993, a weir on the Nome River has provided more accurate information on escapement trends for these fish over the last 10 years (Figure 216). Escapements of chum salmon in the Nome River were low in 1998, 1999, 2002 and 2003. The current sustainable escapement goal for the Nome River is from 2,900 to 4,300 fish counted through the weir. Only in about half of the years that the weir has operated have Nome River chum salmon escapements been above the lower end of the escapement goal range.

Aerial surveys of chum salmon escapements in the Snake River represent another small component of Figure 215. Since 1995, a total escapement enumeration program using weirs or towers on the Snake River provided more accurate information on escapement trends for these fish (Figure 217). Chum salmon escapement in the Snake River was very low in 1999. The current sustainable escapement goal for the Snake River is 1,600 to 2,500 fish. Escapements from 1995 to 1998 were well above the lower end of the escapement goal range. Escapement in 1999 was substantially below the goal, and escapements from 2000 to 2005 were just barely above the lower end of the escapement goal range.

Since 1995, a tower has been used to count chum salmon escapements in the Niukluk River (Figure 218). The current escapement goal for this stock is a threshold value of 30,000 fish. Chum salmon escapements in the Niukluk River have decreased over the last 10 years, and from 2003 to 2005 were below the threshold.

Since 1963, the primary purpose of the Kwiniuk River tower project has been to count chum salmon escapements, resulting in a 40-year time series of information available (Figure 219). The data set shows years of relatively high escapement strength followed

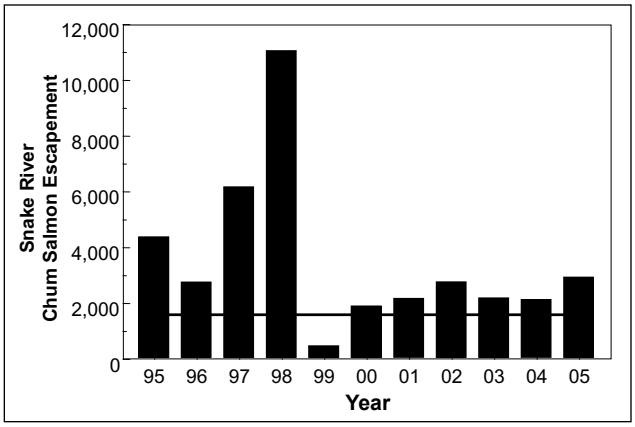

Figure 217. Annual weir counts of escapements of chum salmon in the Snake River from 1995–2005 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 1,600–2,500 (line).

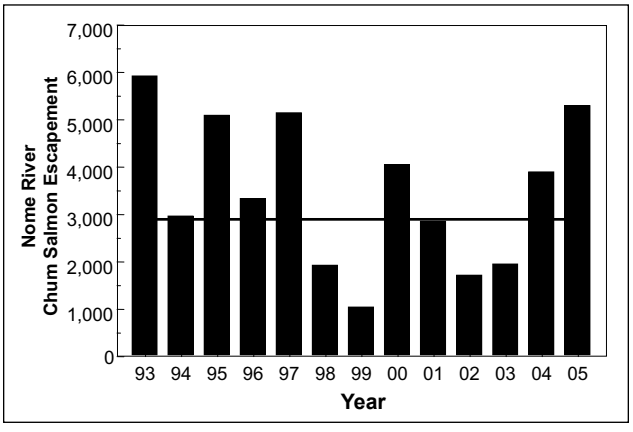

Figure 216. Annual weir counts of escapements of chum salmon in the Nome River from 1993–2005 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 2,900–4,300 (line).

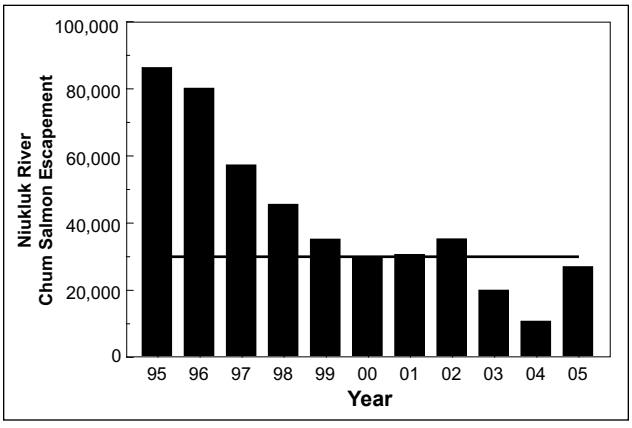

Figure 218. Annual tower counts of escapements of chum salmon in the Niukluk River from 1995–2005 (bars) and the current ADF&G sustainable threshold escapement goal range of 30,000 (line).

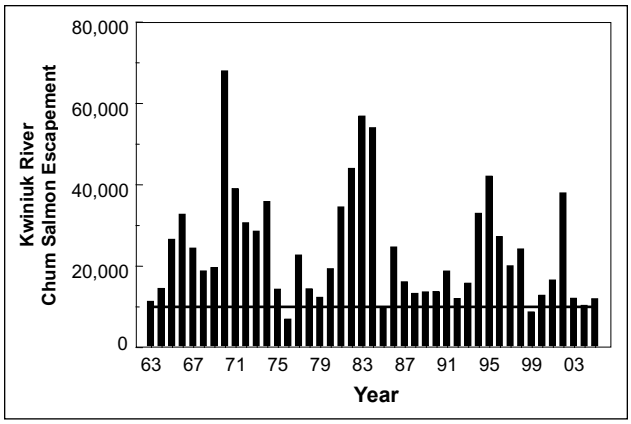

Figure 219. Annual tower counts of escapements of chum salmon in the Kwiniuk River from 1963–2005 (bars) and the lower end of the current ADF&G biological escapement goal range of 10,000–20,000 (line).

by years of relatively low escapement strength. Due to fishery management actions, through time the highs got lower and the lows got higher. The biological escapement goal for the Kwiniuk River chum salmon stock is 10,000 to 20,000 fish. Since 1963, only 3 of the annual escapements were less than the lower end of the current escapement goal range.

Trends in escapement for salmon stocks in Norton Sound are mixed. Escapements of sockeye salmon and pink salmon are substantially higher than the levels observed in the 1960s when the commercial fishery of Norton Sound was first developed. Pink salmon stocks have greatly increased in the last 20 years, with current escapements being several-fold higher than the levels observed in the 1960s and 1970s. Pink salmon are now commonly observed in abundance in streams where only few pink salmon were observed 40 years ago. While sockeye salmon are not widely distributed in Norton Sound, the stocks present increased substantially in the 1980s over levels observed in the 1960s and 1970s, and then greatly increased again several-fold since the 1980s. Long-term data is lacking for most Chinook and coho salmon stocks in Norton Sound; the available escapement data show variable escapement patterns but increasing or decreasing trends are not evident. Chum salmon escapement trends in Norton Sound demonstrate variable abundance over the last 40 years, with a level of variation not atypical of Alaska salmon stocks. Abundance of chum salmon in Norton Sound was noticeably lower in the 1990s than in the 1960s, 1970s and 1980s; the reason for lower productivity is unknown. However, the exploding abundance of pink salmon in these same streams leads to speculation concerning competition between the 2 species for spawning habitat and for early marine rearing. While abundance of chum salmon has decreased, escapements have been adequate to sustain the runs but often inadequate to provide enough surplus for continued commercial harvests.

Budget History and Fiscal Support

General funds allocated and used by the Division of Commercial Fisheries to manage salmon in Norton Sound totaled $800,800 in FY 03, $780,600 in FY 04, and $731,600 in FY 05. These levels of funding represent substantial increases over funding provided for management of these fisheries as they were being developed after statehood. Federal grants of $12,900 in FY 03, $19,100 in FY 04, and $6,600 in FY 05 were obtained and used for salmon stock assessment in Glacier and Salmon Lakes. The Division of Commercial Fisheries has worked with other resource agencies and with nongovernmental organizations with interests in Norton Sound to plan and implement a variety of salmon stock assessment activities that have been funded since 2000. The $5 million multiyear Norton Sound fishery disaster federal grant has helped improve understanding of salmon in the area. The Arctic–Yukon–Kuskokwim Sustainable Salmon Initiative federal grant program has also been used in the last 3 years to fund important stock assessment efforts in the Norton Sound area. Over the last decade ADF&G has worked with staff from federal agencies and nongovernmental organizations to implement an expanded monitoring program for salmon in Norton Sound. Often, specific salmon stock assessment activities are carried out by mixed crews from these agencies and organizations. A major challenge in the future will be funding these activities to continue the development of long-term data sets.

The Division of Commercial Fisheries and the salmon fishermen in Norton Sound face several challenges. The Division of Commercial Fisheries is committed to managing fisheries on a sustainable yield basis, but the subsistence fishery has priority over the commercial fishery. The salmon stocks of Norton Sound have been sustained, and the subsistence fishery has been sustained, although not without recent substantial inseason management. On the other hand, the commercial fishery of Norton Sound has been greatly reduced. The cost of the fishery management program in Norton Sound is high relative to exvessel value of the commercial fishery and the current stock assessment program could not be implemented without major federal funding. If productivity of chum salmon in Norton Sound improves or if significant market in-

terest in pink salmon develops, significant commercial fishing in Norton Sound could occur. But without the extensive stock assessment program now in place, management would be more conservative than it was 20 or 30 years ago. On the other hand, if commercial markets for Norton Sound salmon do not improve, even with improved productivity of chum salmon stocks, a revised commercial fishery would not generate much improvement in the local rural economy. The challenge to fishermen in Norton Sound is 2-fold: (1) developing niche markets to substantially increase the value of commercial salmon landings, allowing fishermen to increase earnings from commercial salmon fishing; and (2) supporting a comprehensive stock assessment program implemented by agencies and nongovernmental organizations to ensure opportunity for continued commercial fishing that will not negatively affect salmon stock status nor subsistence utilization of salmon stocks in Norton Sound.

KOTZEBUE COMMERCIAL SALMON FISHERY

Area Description and Gear Types

Kotzebue Sound supports the northernmost commercial salmon fishery in Alaska (Figure 220). Although a few Chinook, sockeye, and pink salmon have been caught in the fishery, over 99% of the salmon harvest has been comprised of chum salmon (Table 35). These harvests are believed to be supported almost entirely by runs of chum salmon that return each year to spawn in the Kobuk and Noatak Rivers.

Only set gillnet gear is used for commercial salmon fishing in the Kotzebue area; nets are limited to 150 fathoms.

History of the Commercial Salmon Fishery

The first commercial fishery in the Kotzebue area occurred in 1909 when native fishermen sold salmon to gold miners. A commercial fishery occurred from 1914 to 1918; salmon were canned and most of the product sold to miners working in the upper Kobuk drainage. Commercial salmon fishing did not occur during the next 40 years.

The inception of modern-day commercial fishery occurred in 1962. The commercial fishery became fully developed in the 1970s and the peak annual catch occurred in 1981 when about 680,000 chum salmon were commercially harvested. The fishery displayed a gradually declining pattern of overall run strength with multiyear cycles of stronger returns followed by weaker returns (Figure 221). Harvests were proportional to total runs prior to 1987. Management actions emphasized attaining escapement goals and harvests starting in 1987 and harvests thereafter are less indicative of run strength. Since 1995, poor market conditions caused harvests to fall far short of their potential. Harvest trends in the last 10 years or so have no relation to potential harvests but instead reflect processor interest and capacity. Annual management reports for the Kotzebue area, written by ADF&G staff since the 1960s provide detailed fishery data and insight into the management program and fishery. See Kohler et al. (2005).

Other Salmon Harvests

Subsistence use of salmon in the Kotzebue area centers on the harvest of chum salmon, which represent about 96% of the total salmon harvest (Table 36). Annual documented subsistence harvests in the area since 1962 have ranged from a high in excess of 600,000 fish in 1974 to low of about 17,000 fish in 2002. Subsistence harvests over the last decade averaged about 60,000 fish (Figure 222) or about 10% of the peak annual harvest in 1974, and show a continued trend of lesser use through time. Sport harvests of salmon in the Kotzebue area are minor, although increasing. The recent 5-year annual average was only about 700 chum salmon (Table 36).

In 1981, a chum salmon hatchery was built at Sikasuilaq Springs, a tributary of the Noatak River (Figure 2). The hatchery was closed in 1995. At peak production, the adult hatchery return was about 90,000 chum salmon and these fish contributed to commercial and subsistence fisheries in the Kotzebue area. Other than these hatchery produced chum salmon, the rest of the harvests are believed to be comprised of wild spawning fish that return to freshwaters in the Kotzebue area.

Commercial Salmon Fishery Users

Participation in the Kotzebue commercial salmon fishery has drastically declined over the past 30 years (Figure 223). Due to limited ability to sell salmon caught in the commercial fishery, very few of the 173 legal set gillnet permits in the Kotzebue commercial salmon fishery have been used in recent years. In 2002 only 3 permits were used, in 2003 only 4 permits were used, and 2004 only 43 fishermen participated in the fishery.

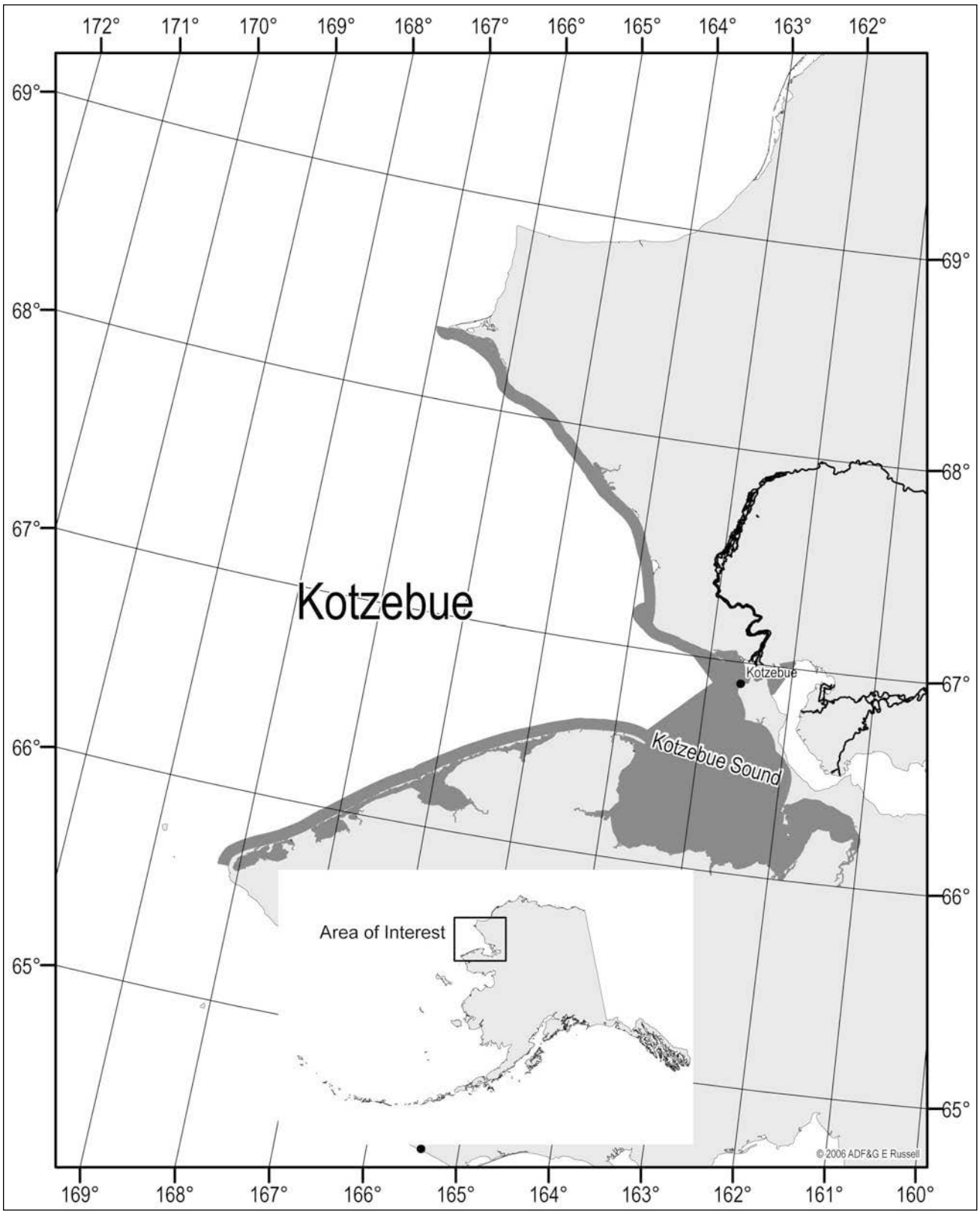

Figure 220. Kotzebue area commercial salmon fishery.

Exvessel Value

In the 1970s and 1980s the commercial salmon fishery in Kotzebue was important to the local economy and provided a valuable source of income in this rural part of Alaska. In 1985 for instance, the inflation-unadjusted exvessel value of the commercial salmon fishery was about $2.1 million. The loss of markets for chum salmon harvested in the Kotzebue area, coupled with low prices paid for those salmon harvested, have combined to result in a present day fishery that contributes little to the local economy (Figure 224).

Table 35. Species composition of the Kotzebue commercial and subsistence salmon harvests.

	Commercial Harvest (1900–2004)	Subsistence Harvest (1994–2003)
Chinook	0.017%	0.323%
Sockeye	0.001%	0.474%
Coho	0.000%	1.654%
Pink	0.115%	1.814%
Chum	99.867%	95.735%
Total	100.000%	100.000%

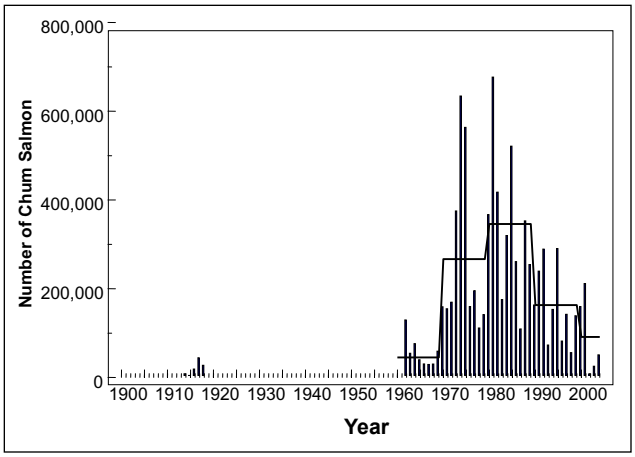

Figure 221. Commercial chum salmon harvests in the Kotzebue fishery from 1900–2004; bars provide annual catches and lines provide decade averages since the 1960s.

Table 36. Average annual harvest of salmon in the Kotzebue sport fishery.

Species	1980–1989	1990–1999	2000–2004
Chinook	14	3	9
Sockeye	2	0	0
Coho	6	5	37
Pink	18	51	13
Chum	298	271	739
Total	338	330	798

In 2004 for instance, the exvessel value of the fishery totaled only about $65,000 (less than 3% of the 1985 exvessel value). Fishermen in the Kotzebue area were paid $0.80 per pound for chum salmon in 1979, $0.10 per pound in 2002, $0.12 per pound in 2003, and $0.15 per pound in 2004 (Figure 225), only about 15% of the price per pound paid in 1979.

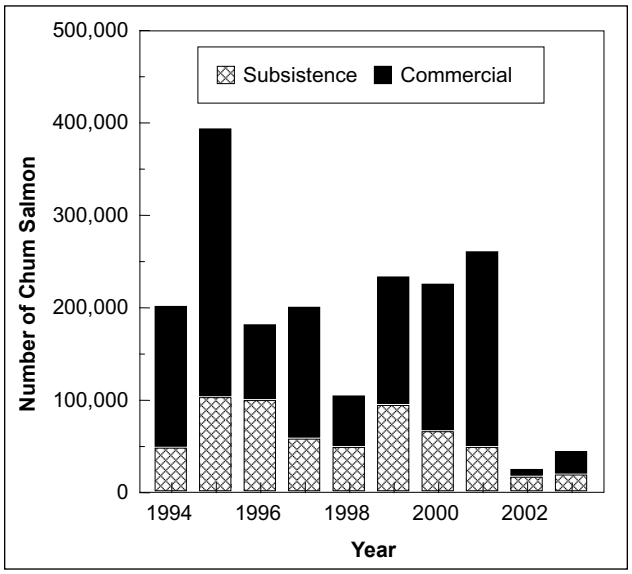

Figure 222. Subsistence and commercial harvests of chum salmon in the Kotzebue area from 1994–2003.

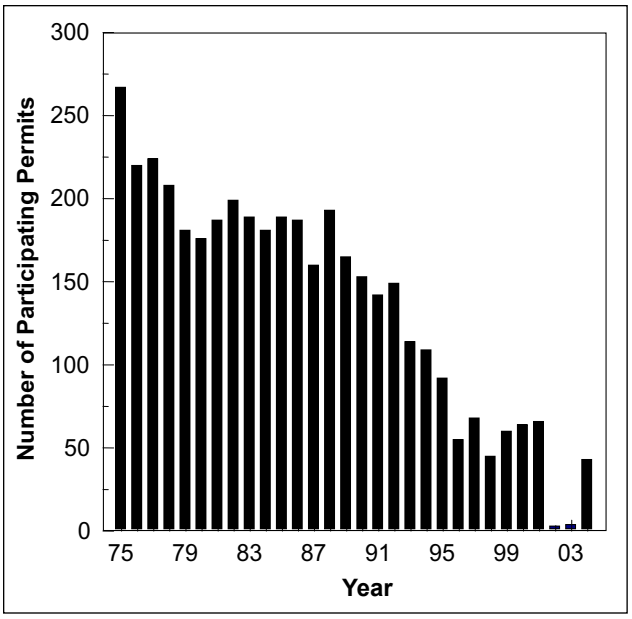

Figure 223. Participation in the Kotzebue commercial salmon fishery, 1975–2004.

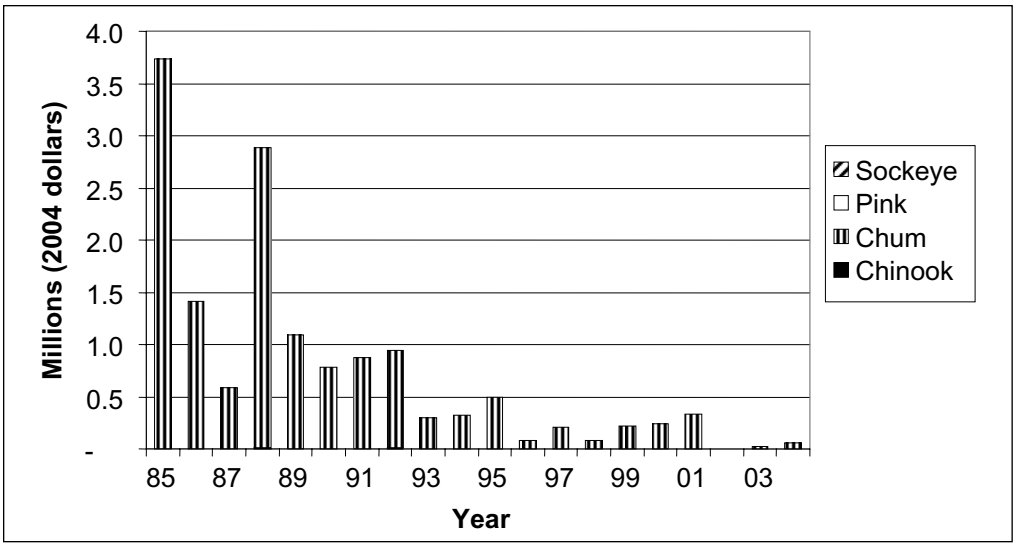

Figure 224. Exvessel value of the Kotzebue commercial salmon fishery, 1985–2004, adjusted for inflation into 2004 dollars.

Management

In recent years, very little inseason management of the Kotzebue commercial salmon fishery has been implemented by the Division of Commercial Fisheries due to the lack of processor interest in buying salmon. Since 2002, the Kotzebue area management biologist has issued one emergency order annually that has opened the commercial fishery on a continuous basis. The buyer has had limited capacity and has limited the harvest to low levels compatible with processor capacity. If and when the market for commercially harvested salmon in the Kotzebue area improves, the Division of Commercial Fisheries will need to implement an inseason management program aimed at ensuring spawning requirements are met, subsistence opportunity is provided, and that commercial fishing opportunity is provided to harvest surplus salmon in a sustainable manner.

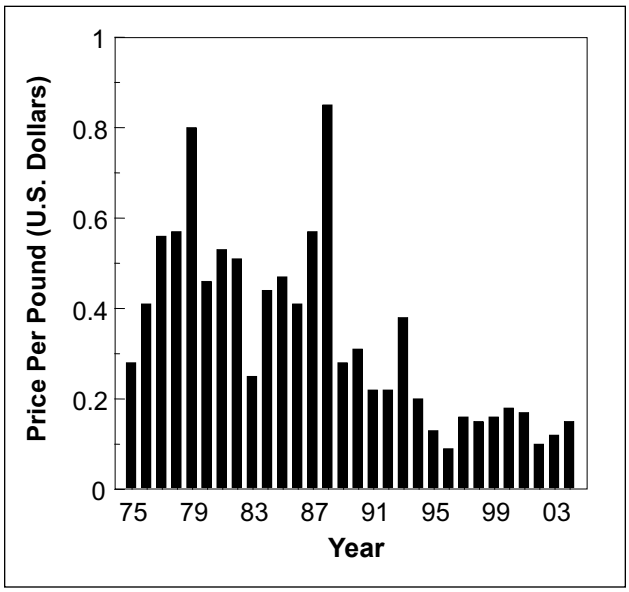

Figure 225. Average annual price paid per pound for chum salmon caught in the Kotzebue salmon fishery 1975–2004 (unadjusted for inflation).

Since 1963, the Division of Commercial Fisheries has attempted to document escapement strength and trends of chum salmon in the Kotzebue area with an aerial survey program. Three tributaries located in the lower portion of the Kobuk River drainage have been surveyed: (1) Salmon River, (2) Tutuksuk River, and (3) Squirrel River. Additionally a section of the upper Kobuk River has been surveyed (from Kobuk Village to Beaver Creek). A portion of the Noatak River has been surveyed to document escapement trends as well (Noatak River from mouth to Kelly Bar, including the Eli River). Sonar technology was used extensively to estimate chum salmon escapement in the Noatak River. However, various technical problems prevented successful implementation of an ongoing annual stock assessment program based on that technology. Although the Division of Commercial Fisheries has attempted to survey the Kobuk and Noatak spawning ground index areas several times each year since 1963, inclement weather and lack of aircraft have periodically prevented successful surveys, particularly in recent years. Successful surveys are those conducted from August 1 to August 31 for the lower Kobuk River tributaries, from August 20 to September 20 for the Upper Kobuk River, and from August 16 to September 16 for the

Noatak River. Further, successful or useable surveys are those that are not limited by poor weather or turbid water, both of which limit visibility. When multiple surveys of a given area during a given year have met those criteria, the peak or highest survey count has been used as the index value. Successful surveys as described have only been accomplished about 60% of the time in the Kotzebue area.

The Division of Commercial Fisheries has attempted to manage the salmon fisheries in the Kotzebue Area since 1987 with the dual goal of maintaining important fisheries and achieving desired escapement levels. Escapement objectives for the Kobuk and Noatak River chum salmon populations have been in effect over the past 20 years. However, the technical basis for these escapement goals has been simple escapement averaging methodology. For information concerning the 5 chum salmon sustainable escapement goals in use for management of the chum salmon fishery in Kotzebue, see ADF&G (2004). Escapement goals for chum salmon in the Kotzebue area will probably be revised by ADF&G before the 2007 salmon season (Eggers and Clark 2006).

The highest index escapement documented in the Noatak River was in 1996 when the index was about 5-fold the lower goal range (Figure 226). Escapement was not successfully indexed from 1997 to 2002; escapements were about 50% of the lower goal range in 2003 and 80% of the lower goal range in 2004. Escapement documentation since the mid-1980s has been sporadic, and as a result, trends in chum salmon escapement strength over the past 20 years are difficult to determine.

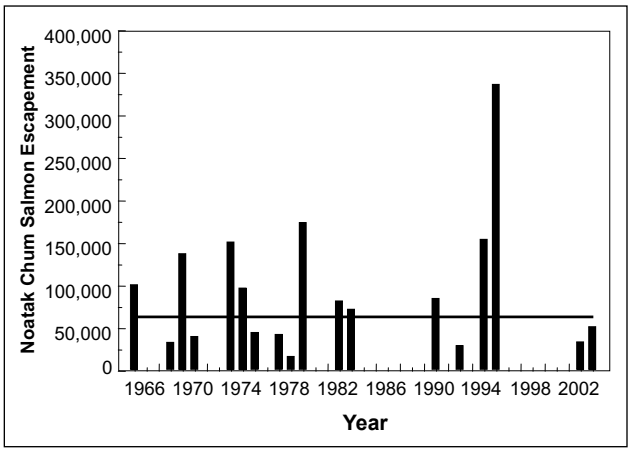

Figure 226. Annual aerial surveys of escapement of chum salmon in the Noatak and Eli Rivers from 1966–2004 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 64,000–128,000 (line).

The highest index escapement documented in the Kobuk and Selby Rivers was in 1996 when the index was about 9-fold the lower goal range (Figure 227). The escapement index in 2003 was about 50% higher than the lower goal range. The escapement index in 2004 was about 3-fold the lower goal range. Recent stock strength of chum salmon escapements in this index area of the Kobuk River drainage appears somewhat higher than historic stock strength.

The Squirrel River is a tributary of the Kobuk River. The highest index escapements documented in the Squirrel River occurred in the early 1970s (Figure 228). The 3 most recent documented escapements all exceeded the lower goal range. Only sporadic success at indexing stock strength of the Squirrel River chum

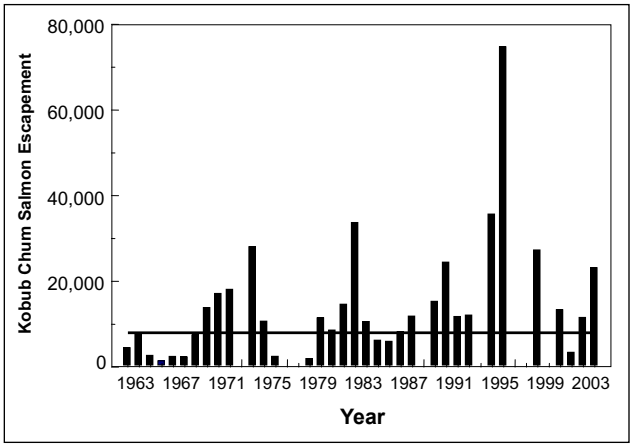

Figure 227. Annual aerial surveys of escapement of chum salmon in the Kobuk and Selby Rivers from 1963–2004 (bars) and the lower end of the current sustainable ADF&G escapement goal range of 8,000–16,000 (line).

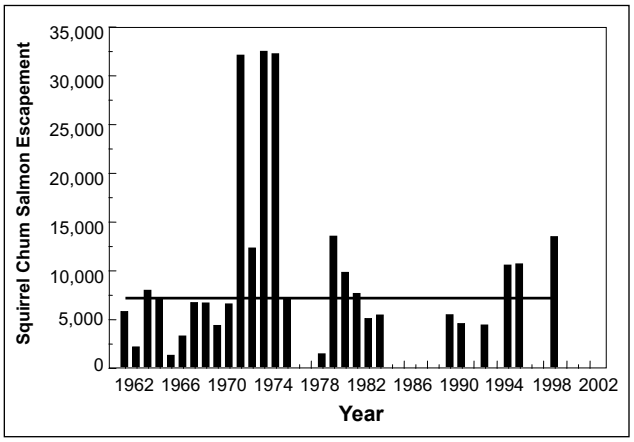

Figure 228. Annual aerial surveys of escapement of chum salmon in the Squirrel River from 1962–2004 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 7,200–14,400 (line).

salmon escapement has occurred since the mid-1980s, and as a result, trends in chum salmon escapement strength over the past 20 years are not well documented.

The Salmon River is another tributary of the Kobuk River. The 2 highest index escapements documented in the Salmon River occurred in 1974 and 1996; the 1996 escapement was more than 7-fold the lower goal range (Figure 229). The 4 most recent documented escapements all exceeded the lower goal range. Only one successful survey of the Salmon River has occurred since 1996 and as a result recent trends in chum salmon escapement strength are not well documented.

The Tutuksuk River is a third tributary of the Kobuk River. The highest index escapement documented in the Tutuksuk River occurred in 1996 and exceeded the lower goal range by about 18-fold (Figure 230). The most recent documented escapement in 1999 exceeded the lower goal range by about 2.5-fold. Only one successful survey of the Tutuksuk River has occurred since 1996 and as a result recent trends in chum salmon escapement strength in this river are not well documented.

Budget History and Fiscal Support

The Division of Commercial Fisheries and the commercial fishermen in the Kotzebue area face several challenges with the Kotzebue commercial salmon fishery. While the Kotzebue fishery is the northernmost commercial salmon fishery in Alaska and the species is at the extremity of its range, the resource is relatively large and capable of supporting a substantial fishery that has the potential to add significantly to the local economy of the area. However, current world market conditions have resulted in low prices paid to fishermen; coupled with high operational costs for both the fishermen and the processors, the combination has resulted in a fishery that is legally opened by the ADF&G but has extremely low participation, minor harvests, and low exvessel value that adds little to the local economy. The challenge to fishermen and the commercial fishery industry is to identify marketing niches so that the fishery can rebound and the economy in the area can benefit. As this challenge is met, the challenge to the ADF&G will be: (1) to improve salmon stock assessments so that escapement documentation improves, (2) to improve the basis for escapement goals, and (3) to provide inseason stock assessments and fishery management to ensure sustainability of both the commercial and subsistence fisheries. On the part of the Division of Commercial Fisheries, these actions, if and when needed, will require a significant increase in the level of budget (Table 37) and program support for the Kotzebue area.

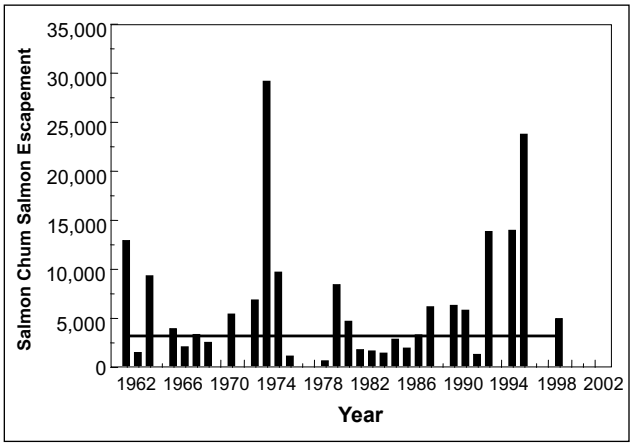

Figure 229. Annual aerial surveys of escapement of chum salmon in the Salmon River from 1962–2004 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 3,200–6,400 (line).

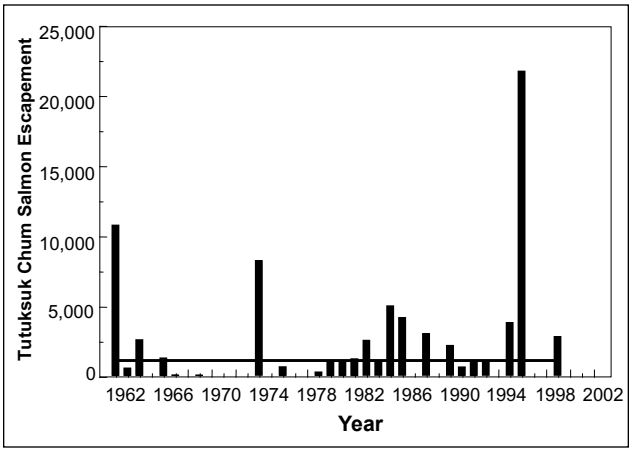

Figure 230. Annual aerial surveys of escapement of chum salmon in the Tutuksuk River from 1962–2004 (bars) and the lower end of the current ADF&G sustainable escapement goal range of 1,200–2,400 (line).

Table 37. Funding used by the Division of Commercial Fisheries for salmon in the Kotzebue area, FY 03–FY 05.

Funding Source	FY 03	FY 04	FY 05
State General Funds	$61,700	$62,600	$63,800
Other	none	none	none
Total	$61,700	$62,600	$63,800

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