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REVIEW OF THE NUSHAHGAK WATERSHED COHO SALMON FISHERIES AND STOCK STATUS, BRISTOL BAY

by

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INTRODUCTION

The Nushagak, Wood and Igushik Rivers drain into Nushagak Bay, one of five major estuaries that comprise Bristol Bay (Figure 1). Widely known for sockeye salmon production, the rivers of Bristol Bay support all five species of Pacific salmon. The Nushagak River produces the largest run of coho salmon in Bristol Bay; total runs of coho salmon to the Nushagak drainage have been estimated since 1980, and average approximately 189,000 fish (Table 1).

The coho runs to the Nushagak watershed are the focus of commercial, subsistence and sport harvests. Commercial landings of coho salmon have been documented in the Nushagak District since 1893 (Middleton 1983). Recent (1974-93) commercial harvests in the Nushagak District average approximately 83,000 coho, or 42% of the annual Bristol Bay coho salmon commercial harvest (Skrade 1994). Historically, coho salmon have provided a staple subsistence food for residents of the Nushagak watershed, harvested recently at an average (1984-93) annual rate of 7,255 fish. Sport harvest data are available since 1977; recent harvests average (1989-93) 825 coho salmon (Minard and Dunaway *in press*), or 8% of the total sport coho harvest for southwest Alaska.

The Nushagak coho stocks are currently managed to achieve a biological escapement requirement of 90,000 spawners in the Nushagak River. Exploitation in sport and subsistence fisheries upriver of the sonar counter necessitated the department to manage for an inriver abundance of 100,000 fish. The additional 10,000 fish provide for inriver harvests until the Board of Fisheries can address the issue.

Run timing overlap of sockeye, pink and coho salmon complicates management of the commercial fisheries in the Nushagak District. When run strength of one species is low, management action taken to conserve that species will directly affect the commercial exploitation and escapement rates of the others, resulting in loss of harvestable surplus of other species. Commercial restrictions implemented to conserve coho have resulted in some loss of harvestable surplus of sockeye salmon. Pink salmon run strength has recently been low, but in the event of a strong pink return, management action taken to conserve coho salmon could be extremely disruptive to the commercial pink salmon fishery.

Recently, poor production of Nushagak coho stocks has resulted in poor returns and severe restrictions in the commercial, sport and subsistence fisheries. Run strength was so poor in 1992, that the subsistence fishery was closed to the taking of coho salmon for the first time in the history of the fishery.

The primary purpose for this report is to provide background information to the Board of Fisheries to assist in developing a management plan for the Nushagak coho salmon stocks. The management plan should address resource priorities concerning the overlap of the coho, sockeye and pink salmon returns, allocate harvestable surplus among user groups, and state how the burden of conservation will be shared by the user groups. In addition, an inriver goal needs to

be established to accommodate the harvest taken by inriver fisheries.

STOCK STATUS

Coho stocks in the Nushagak drainage are currently at depressed levels (Table 1, Figure 2). Runs documented since 1991 have averaged 71,000 coho salmon, or 38% of the 1980-94 average run of 189,000 fish.

Annual run estimates varied throughout the period from 40,278 in 1987 to 593,072 in 1982 (Table 1). Coho runs to the Nushagak River were very high from 1980-1984 (ranging from 139,000 to 593,000 fish), and were significantly lower from 1985-1994 (ranging from 40,000 to 190,000 fish). It is unknown at this time whether the high production of coho salmon experienced in the early 1980's is sustainable or what levels of escapement produced the 1980-1983 returns.

Despite significant management action in the commercial, sport, and subsistence fisheries in recent years, the department has experienced a chronic inability to achieve escapement goals for coho salmon in the Nushagak River. Specifically, coho escapements in the Nushagak River have failed to reach the current biological escapement goal of 90,000 spawners during four of the last 13 years. Since 1984, coho escapement goals have been achieved in one of nine years for which escapement data exists. Significant restrictions have been placed on all fisheries, including closure of the subsistence fishery in 1993, to reduce exploitation on this stock.

Escapement Estimates

Coho salmon escapement in the Nushagak River was estimated by sonar from 1980-1991, and 1993-1994 (Table 2). Daily escapements were estimated through August 25 in most years. However, budget constraints have necessitated the sonar project to close in early August in some years, and special funding enabled the project to extend as late as September 12 in 1990. In odd numbered years, virtually the only species passing the site in August is coho salmon, but in even-numbered years sockeye, pink and coho runs greatly overlap.

Nushagak/Mulchatna escapements through 1993 averaged 108,458 coho, and are assumed by fishery managers to comprise the primary component of Nushagak watershed coho escapement. Information available for coho stock assessment for the Wood River system is limited to inriver sport and subsistence harvest data, and a pilot project to estimate coho salmon escapement from counting towers in 1994 (Brookover and Brannian, *in press*).

Escapement Goal History

An inriver goal of 150,000 coho salmon (range of 100,000 - 200,000) for the Nushagak River was established in 1984. The goal was based on very limited spawner and total run information

for 1980-1983. From 1984 and 1991, coho escapement consistently fell below the goal, averaging 127,200 fish for the period, and 88,300 fish from 1986-1991.

The current biological escapement goal (BEG) of 90,000 spawners was based on re-evaluation of spawner-return data in 1991 (Skrade, et al. 1992). Spawner-return analysis and a Ricker stock recruitment model were used to estimate the number of coho salmon spawners required to produce high sustainable yields. Results from the spawner-return analyses pointed towards a goal within the range of 70,000 to 100,000 spawners, and an estimate of 75,000 spawners from the Ricker stock-recruitment model supported the above range. Because of uncertainty in the data base and the decreasing trend in coho salmon returns since 1984, the department recommended a biological escapement goal of 90,000 coho salmon spawners.

The escapement goal was again re-evaluated in 1994. Estimates of coho salmon total returns by age were updated, as was the brood table summarizing number of spawners and total returns (Table 3). Spawner-return analysis and a Ricker stock recruitment model were applied to the data as in the 1991 evaluation.

Results of the 1994 evaluation supported the BEG of 90,000 spawners. Spawner-return data suggested a spawning escapement within the range of 76,000 to 109,000, which was consistent with the 1991 analysis. An estimate of 65,000 spawners from the Ricker stock-recruitment model was similar to the escapement levels estimated from the spawner-return analysis.

Spawner-return data for Nushagak River coho salmon were considered marginal for a Ricker curve analysis for the following reasons: 1) the data base was relatively short, eight brood years; 2) age composition data were incomplete; 3) the accuracy of sonar counts for odd versus even years probably differed because of mis-apportionment between pink and coho salmon; and 4) dates of sonar operations differed among years and were expanded to estimate coho escapement through August 25.

Although there were problems with the data base, it was decided that the data was sufficient to calculate an escapement goal based on average returns and average returns-per-spawner. In addition, results from the Ricker stock-recruitment model were used as supportive information.

An interim inriver escapement goal of 100,000 coho salmon was used during 1993 and 1994. The inriver goal includes the BEG of 90,000 spawners and an additional 10,000 fish to provide for inriver sport and subsistence fisheries. The inriver goal is included in the draft Nushagak Management Plan to be discussed at the January 1995 Board of Fisheries meeting.

FISHERY DESCRIPTIONS

Fishery exploitation on the Nushagak coho stocks averaged 53% from 1980-93 (Table 1). The commercial fishery accounted for 92% of the total harvest, while subsistence and sport fisheries

accounted for 7% and 1% from 1971-93.

Exploitation of Nushagak coho has been reduced in recent years in response to reduced run sizes. Annual harvests of Nushagak/Mulchatna coho salmon totaled 46,091 fish since 1989. Excluding 1992, when no estimate of escapement was available, recent exploitation on the Nushagak stocks totaled 27%. Harvests since 1989 were split between commercial (82%), subsistence (16%), and sport fishermen (2%). Commercial harvests have declined by nearly 50%, while subsistence harvests have increased slightly.

Total coho harvest in 1994 was the lowest since 1976. Combined harvest totaled 12,107 coho salmon, or 13% of the total run. Commercial harvests took 44%, followed by 42% taken for subsistence purposes, while the sport harvest was estimated at 2%.

Commercial Fishery

The late-season commercial salmon fishery in the Nushagak District is complicated by run timing overlap of sockeye, pink and coho salmon (Table 4, Figure 3). Sockeye harvests peak the earliest of the three species, and are 50% complete on July 6. Pink harvests typically peak July 27, approximately one week earlier than peak coho harvests. Commercial fishing may be directed at any one of the three species at any given time, depending on relative run strength, run timing, market conditions and fishing effort.

Recent harvests (1974-93) in the Nushagak District average 3.2 million sockeye, 1.3 million pink (even years only) and 83,000 coho salmon. Sockeye harvests have remained relatively stable, but pink and coho harvests have declined in recent years due to low abundance.

Ex-vessel value of the sockeye, pink and coho salmon fisheries is estimated at $22.0 million, $1.1 million and $478,000 to fishermen each year (Table 5). Price paid to fishermen averaged (1978-94) $.93/lb,$.68/lb and $.21/lb for sockeye, coho and pink salmon. Price has remained relatively stable for sockeye salmon and decreased slightly for coho salmon from 1978 through 1994, while pink salmon price has declined from $.33/lb in the late 1970's to $.04/lb in 1994. Ex-vessel value has performed similarly; value of the pink salmon fishery has declined dramatically.

Historical Performance

The late-season commercial fishery in the Nushagak District experienced a series of stages in its development (Table 6, Figure 4). Early records documented large annual harvests of coho salmon that increased until the early 1920's concurrent with the use of fish traps and extensive late-season fishing. With the elimination of traps in 1923 and the advent of late season closures for the protection of sockeye, the coho harvests were substantially reduced from 1923-53. Coho and pink salmon harvests from 1954 through 1976 remained low; most salmon were still canned at the time and the low volume of the coho catch did not economically warrant keeping large crews employed to run canning lines, especially in odd years when pink salmon were not

available.

Beginning in 1977, late season markets became available in the form of freezer-processor ships. Those vessels were able to move freely between districts, and a healthy market for frozen coho resulted in increased prices paid to the fishermen and an expanded fishing effort. Reduced interception on the high seas due to the Fishery Conservation and Management of 1976 (200 mile limit) and other negotiated treaties with the Japanese and an increase in natural production resulted in record coho catches Bristol Bay wide in the early 1980's; the harvest of 350,000 in 1982 is the largest annual commercial coho harvest of coho salmon in the Nushagak District (Table 6).

Management

Late-season commercial fishing occurred on a regular 5-day fishing schedule through the 1983 season. However, a low coho salmon run in 1983 coupled with the recent increase in fishing effort prompted concern for the coho run in 1984.

Beginning in 1984, the commercial fishery for coho salmon was managed for an escapement goal of 150,000 fish. The 5-day fishing schedule remained in regulation, and the department adjusted the schedule as necessary to achieve escapement goals for pink and coho salmon.

The coho return to the Nushagak district was large in 1984, and a large run of pink salmon returned that year as well. Fishing time was extended beyond the 5-day per week schedule due to the large pink run, but the large fleet (490 vessels) caused such a high rate of exploitation that a closure from August 8 to 23 was necessary to achieve the desired coho escapement goal.

From 1985 through 1989, the late-season fishing schedule was reduced, beginning July 25-30, from five to two or three days per week, once poor coho run strength became apparent. During most years in this period, schedule reductions were followed by closures implemented between July 30 and August 5. Commercial harvests during this period ranged from 13,300 to 77,100 coho salmon. Total runs of coho salmon during this period were larger than the escapement goal in only two years, and the escapement goal of 150,000 was not achieved in any of these years. Pink salmon returns were poor in 1986 and 1988, and the pink salmon escapement goal was not reached in either year.

The Board of Fisheries gave the department authority to specify mesh size by emergency order in 1987, to allow harvest of the stronger stock, while providing protection for weaker species. 1988 was the only year that mesh size was regulated in the late-season fishery for the protection of pink salmon. That management tool was effective; by requiring the use of 5 and 3/8 inch mesh or larger, the incidental harvest of pink salmon was held to only 249,000 from a total run of 743,000, a 33% exploitation rate. The staff was also given the authority to require the use of "pink gear", 4 and 3/4 inch mesh or less, to protect coho salmon, but that technique has not been employed to date and it is not known if it will be successful.

The Nushagak sonar project did not operate during the pink and coho runs in 1992. The commercial fishery was placed on a 4-day weekly schedule on July 20 and allowed to continue based on expected production from an adequate escapement level in the parent year (1988, 131,000 coho salmon). The schedule was reduced to three days per week, then closed on August 14.

In 1990, 1991 and 1993, the district was closed by emergency order between July 20 and 23 due to poor pink and coho outlooks. Two short-duration openings were held on July 23 and 27 in 1990, but run strength of both species remained low and no further fishing occurred. Despite the closures in 1991 and 1993, escapement goals were not achieved.

Subsistence Fishery

Historically, coho or silver salmon have been a staple within the wild resource harvests of all Nushagak watershed communities and continue to be an important subsistence food. Communities located within the Nushagak watershed include Aleknagik, Clarks Point, Dillingham, Ekuk, Ekwok, Koliganek, Manokotak, New Stuyahok, and Portage Creek. From 1960 to 1990 the region experienced a nearly three fold population increase, from 1,333 residents to 3,304 (Figure 5) (ADF&G 1992, Rollins 1978).

Household surveys conducted by the Division of Subsistence in the 1980s show that 50 to 80 percent of all surveyed households used coho salmon during the particular study year (Table 7). Coho salmon also played an important part within distribution and exchange networks. Coho salmon was received as gifts by at least one-quarter of all sampled households. Mean household harvests of coho salmon varied significantly by community. In Koliganek and Ekwok, about 200 pounds of coho were harvested by the average household. The remaining communities harvested between 50 and 90 pounds per household. Coho contributed from two percent to 8 percent of the overall subsistence harvest.

Regulations

Outside the Nushagak commercial district, subsistence fishing with up to 25 fathoms of set gill net is allowed seven days per week. The two exceptions when gill nets are restricted to 10 fathoms are: one, on the "Dillingham beaches;" and two, in the commercial district during emergency openings that occur during extended commercial closures. In addition, the Dillingham Beaches are restricted to three day per week fishing from July 2 to 17. Subsistence fishing in the commercial district is allowed only during commercial openings, unless opened for subsistence fishing by emergency order.

Due to poor coho returns, on August 19, 1991 an emergency order was issued restricting subsistence fishing in the Nushagak River and Bay to three 24-hour periods per week from August 19 to September 30. Two years later, on August 10, 1993 an emergency order was issued closing most of the Nushagak watershed to subsistence fishing until September 30. This year, from August 10 to 12, 1994 subsistence fishing was restricted in the Nushagak River and

Bay by emergency order to three 24-hour periods per week.

Methods of Harvest

In all Nushagak communities, the most common method of harvesting coho salmon for home use during 12-month study periods was with set gill nets (Table 8). For example, coho salmon taken from subsistence set nets ranged from 53 percent in Aleknagik to 92 percent in New Stuyahok. In some communities, removing coho from commercial harvests was another way to provide salmon for home use. For example, Dillingham procured 13 percent of its coho salmon in this manner. For Aleknagik, Clarks Point, and Manokotak commercial catches comprised approximately 20 percent of their coho harvest. In recent years, however, there has been a decreasing amount of time available for commercial coho fishing. A final method used to obtain coho salmon was rod and reel fishing. Aleknagik and Koliganek obtained approximately one quarter of their coho through rod and reel fishing.

Permit System

To document the harvest of salmon for subsistence, a permit system was gradually introduced throughout the region in the late 1960s and early 1970s. With a few exceptions, most subsistence fishermen in the Nushagak watershed are obtaining permits and reporting their harvests. However, reporting tends to be most accurate for chinook, sockeye, and chum. Those fish are usually caught early in the season, and are put up in large numbers, often at fish camps. Coho, caught later in the season and harvested in smaller numbers, are reported less consistently. Permit returns appear to underestimate subsistence coho harvests, and this is generally supported by subsistence harvest survey data for the watershed communities.

Timing and Location of Harvest

Most subsistence fishing for coho salmon occurs from late July to early September in a variety of locations. Within the Nushagak watershed, the highest concentration of effort occurs on the Dillingham beaches. The effort within the commercial district is relatively small. By the time coho arrive, most families have left their fish camps in the bay and returned to their winter villages. At the villages, coho are most commonly harvested within a few miles up or down river.

Based on subsistence salmon permit returns, 17 percent of the recent 10-year average coho harvest in the watershed occurred upriver, above the sonar. Three fourths of the average-(1988-94) harvest occurred on the Dillingham beaches.

Harvest

For the Nushagak watershed, the most recent 10-year average shows an increase in harvest to 6,900 coho per year compared to the 1975-1984 average, 5,500 (Table 1, Figure 5). The trend within this last decade has been one of overall stability marked by annual fluctuations. From

1985 to 1994, the lowest harvest of 5,000 coho was reported in 1993, a year when most of the watershed was closed to subsistence fishing on August 10. The highest coho harvest was documented in 1991 at 10,800 fish, a year when subsistence fishing was reduced to three days per week in much of the drainage on August 19. Increased harvest totals within the last decade are probably related to regional population growth.

While total harvests climbed, the number of fish taken by the average permit holder declined from the 1960s when the average permit holder harvested 36 coho salmon (Figure 5). The average number of coho harvested per permit from 1985 to 1994 was 15. This trend may be due to changing demographics, particularly in Dillingham. Many of the persons who have moved into Dillingham were not born in the region, were brought up with a different diet, and may not harvest coho salmon at the same levels as persons born locally. However, research (Fall et al 1986) demonstrates that newcomers to Dillingham are using and harvesting coho salmon, but they tend to harvest at lower levels than long-term residents. Another interesting finding was that as people stayed in Dillingham, their average wild resource harvest increased steadily. Those who lived in Dillingham for at least six years actually had a slightly higher per capita resource harvest than those residents who had been born in the Bristol Bay area.

Harvest Patterns by Residence

Until 1988 subsistence fishing in the Nushagak District was open to all state residents. Subsequent changes in the administration of the subsistence priority restricted subsistence fishing to rural residents beginning in 1988. From 1988 until July 1, 1990, only Nushagak watershed residents could participate in the subsistence fishery. Personal use fisheries were in place in 1988 and 1989, but coho harvests were negligible, with none reported in 1988 and only 136 in 1989. (In 1990, there was technically no personal use fishery because of the McDowell decision, but a few permits were issued early on and 65 coho were reported.) Since July 1, 1990 any state resident may obtain a permit for salmon fishing in the Nushagak District.

In the Nushagak watershed, from 1991 to 1994 non-residents of the watershed were responsible for an average of 9 percent of the permits (46 permits) and five percent (364 fish) of the total subsistence coho harvest. Of this non-local effort, 95 percent was harvested by non-residents of the Bristol Bay region.

Sport Fishery

Coho, or silver, salmon is a very popular sport fish species to Southwest Alaska's recreational fishing industry. Coho salmon fisheries occur from August through September with some isolated pockets of fish available into October.

The bag and possession limits for coho salmon are five salmon per day, no size limit; the same region wide limit that has been in effect since 1972. Some coho salmon runs, particularly in the central and western sections, have declined in recent years, precipitating occasional closures or reductions in bag limits for the sport anglers. Except for rare instances however, limitations on

sportsmen have been of little consequence to the health of the runs which are more heavily impacted by commercial harvests.

The Nushagak and Mulchatna rivers produce the largest return of coho salmon in Southwest Alaska. Within the drainage, four areas of concentrated recreational effort exist: the lower 12 miles of the Nushagak River, near the village of Portage Creek; the middle section of the Nushagak River, in the vicinity of the village of Ekwok; the mid section of the Mulchatna River, between the Stuyahok and Koktuli rivers; and the Nuyakuk River at its confluence with the Nushagak River. Although sport fishing for coho salmon does occur in some of the tributaries of the drainage, the overall harvest resulting from that activity is considered slight. Of the areas mentioned above, the lower portion of the Nushagak River and the mouth of the Nuyakuk River are the most significant. The lower Nushagak River provides fishing opportunity for early coho salmon in late July and early August, a time when other fisheries have not yet begun.

Historical Performance

The sport harvest of coho salmon in the Nushagak and Mulchatna drainages has never exceeded 2,000 fish in a year, and since 1989 has averaged 825 fish, or about 8% of the area's total sport harvest (Table 1). The total annual harvest of Nushagak/Mulchatna coho salmon since 1989 is split between commercial (82%), subsistence (16%), and sport fishermen (2%). At this time, and at these levels, the coho salmon sport fishery is considered to have negligible impact on the overall productivity of Nushagak and Mulchatna drainage coho stocks.

Management

Sport harvest and effort is estimated through the statewide harvest survey and reported by Mills (1979-1994). On site surveys are periodically scheduled, and provide information on the timing and extent of the fishery, the demographics of the anglers, and provide analysis of current regulations.

From 1984 to 1992, Nushagak coho salmon stocks were managed to achieve a biological escapement (BEG) of 150,000 fish, estimated by sonar at Portage Creek. Escapements during that period consistently fell short of the goal, averaging 120,026 fish for all years. Recent spawner-recruit analysis suggests the 150,000 fish goal is higher than necessary to manage for maximum sustained yield. In 1992, based on its findings, the department lowered the BEG to 90,000 spawners (ADF&G 1992). To achieve 90,000 spawners necessitated managing the commercial fishery to achieve an inriver abundance of 100,000 fish. The additional 10,000 coho salmon provided for subsistence and sport harvests above the sonar site at Portage Creek.

The present bag and possession limit for coho salmon on the Nushagak and Mulchatna drainage is five fish per day, no size limit. That is the same limit for the region, and has been in effect since 1972. The first adjustment to that limit occurred in 1991 when the daily bag and possession limit was reduced from five to two by emergency order.

1994 SEASON SUMMARY

Preseason projections for coho salmon returning to the Nushagak ranged from 15,000 to 137,000 fish depending on the method used. Given the uncertainty in the forecast, fishery managers entered the season cautiously.

The commercial fishery was closed July 20 due to the incidental harvest of 6,800 coho salmon. By July 15, 1994, sockeye escapement had exceeded goals in Wood and Igushik Rivers, and escapement in the Nushagak River was close to the goal for that system. Late-season daily sockeye catches remained large due to late run timing, but pink salmon catches were extremely low. The July 20 harvest totaled 47,600 sockeye, 2,100 pink and 3,300 coho. The commercial closure in 1994 was implemented earlier than any other year in recent history.

The sport fishery was monitored closely and on August 8, when escapement projections fell to less than 55,000 fish, closed by emergency order. Following an increase in passage by the sonar the fishery was reopened on August 12. Bag limits were restricted from five to three for the remainder of the season.

The subsistence fishery was restricted to a 3-day weekly schedule when escapement projections fell to less than 55,000 fish, on August 8. Restrictions became effective on August 10 and were lifted August 12 following an increase in the escapement passage rates, and the fishery continued in a normal manner for the remainder of the season.

The 1994 total run of coho salmon to the Nushagak River was approximately 94,126 fish, and was below the long term and recent five year averages for the system (Table 1). Early closure of the commercial fishery kept harvests down to 6,814 fish, one of the lowest harvests on record. Subsistence harvests were estimated to be 5,093 fish, or 68% of the recent (1989-93) average. The sport fishery probably harvested less than 500 fish in 1994 (Table 1). No creel surveys were conducted during the Nushagak River coho sport fishery.

Inriver passage by the sonar totaled 82,019 fish for the season, or approximately 82% of the inriver goal. What initially appeared to be a very poor return, resulted in a relatively good escapement due to the responsive management actions of the Department.

1995 OUTLOOK

The 1995 coho salmon return to the Nushagak drainage will be primarily the product of the 1991 parental escapement (Table 1). Escapement in 1991 totaled approximately 40,000 coho salmon. Combined harvests across all user groups was approximately 17,000 fish, far below the long and

short term averages. Based on parental run strength it is not likely the 1995 return will be sufficient to sustain normal commercial or sport fisheries.

Management action in each fishery will likely be dictated to some degree by the Board of Fisheries in the form of a Nushagak/Mulchatna coho salmon management plan. The Board is scheduled to consider a draft plan at the January meeting in Dillingham.

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Table 1. Coho salmon commercial, subsistence, and sport harvest plus escapement for the Nushagak drainage, 1971 to 1994.

	Harvest							
			Sport[c]					
Year	Commercial	Subsistence	Nush	Mul	Total	Total	Escapement[a]	Total Run
1971	8,036	2,300				10,336		
1972	3,654	1,000				4,654		
1973	28,709	2,200				30,909		
1974	12,569	4,700				17,269		
1975	7,342	4,300				11,642		
1976	6,778	2,100				8,878		
1977	52,562	4,500	65	90	155	57,217		
1978	44,740	2,500	126	113	239	47,479		
1979	129,607	5,200	212	0	212	135,019		
1980	147,726	5,100	379	129	508	153,334	232,000	385,334
1981	220,290	8,700	216	173	389	229,379		
1982	349,669	8,900	451	52	503	359,072	234,000	593,072
1983	81,338	5,200	849	524	1,373	87,911	51,000	138,911
1984	260,310	8,100	399	37	436	268,846	171,000	439,846
1985	20,230	6,100	0	130	130	26,460	89,500	115,960
1986	68,568	9,400	934	496	1,430	79,398	42,772	122,170
1987	13,263	6,200	595	0	595	20,058	20,220	40,278
1988	52,698	5,223	124	371	495	58,416	131,101	189,517
1989	77,077	8,679	1,586	364	1,950	87,706	84,707	172,413
1990	7,733	5,919	331	95	426	14,078	162,853	176,931
1991	5,574	10,784	415	437	852	17,210	39,595	56,805
1992	84,077	7,103	445	275	720	91,900		
1993	14,345	5,038	124	53	177	19,560	42,742	62,302
All Years								
Average	73,778	5,619	427	196	623	80,020	108,458	188,478
Percent	92%	7%			1%			
1989 to 1993								
5–Year Avg	37,761	7,505	580	245	825	46,091	82,474	128,565
Percent	82%	16%			2%			
1994	6,814[b]	5,093[b]			200[b]	12,107[b]	82,019	94,126
Percent	56%	42%			2%			

[a] Escapement is estimated by sonar at Portage Creek.
[b] Preliminary.

Table 2. Daily coho salmon escapement estimates and average run proportions, Nushagak River sonar, 1982 – 1994.

	Year												Average Proportions[1]	
Date	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1993	1994	Daily	Cum.
06/29	0	0	0	0	0	0	0	0	0	25	0	0	0.01	0.01
06/30	0	0	0	0	0	0	0	0	0	17	0	0	0.01	0.01
07/01	0	0	0	0	0	0	0	0	0	43	0	0	0.01	0.03
07/02	0	0	0	0	0	0	0	0	0	29	0	0	0.01	0.04
07/03	0	0	0	0	0	0	0	0	0	24	0	0	0.01	0.04
07/04	0	0	0	0	0	0	0	0	0	63	0	0	0.02	0.06
07/05	0	336	0	0	0	0	0	0	0	39	0	0	0.01	0.08
07/06	0	122	0	0	0	0	0	0	0	12	0	0	0.00	0.08
07/07	0	93	0	0	0	0	0	0	0	8	0	0	0.00	0.08
07/08	0	102	0	0	0	0	0	0	0	9	0	0	0.00	0.08
07/09	0	81	0	0	0	0	0	0	0	5	0	0	0.00	0.09
07/10	0	68	0	0	0	0	0	0	0	3	0	426	0.07	0.15
07/11	0	71	0	0	0	0	0	0	0	5	0	125	0.02	0.17
07/12	0	71	0	0	0	0	0	0	0	6	0	112	0.02	0.19
07/13	0	54	0	0	0	0	0	0	0	175	0	96	0.07	0.26
07/14	0	71	0	0	0	0	0	0	0	265	0	155	0.11	0.37
07/15	0	74	0	0	0	0	0	246	0	193	0	81	0.11	0.47
07/16	0	0	0	0	708	0	0	172	0	329	0	103	0.14	0.62
07/17	1,354	0	0	0	0	0	0	250	0	556	0	142	0.23	0.85
07/18	1,354	0	532	0	0	0	0	374	0	642	0	566	0.39	1.24
07/19	1,354	0	786	127	0	0	0	133	25	651	0	546	0.40	1.63
07/20	1,354	0	671	73	0	177	0	670	30	333	0	458	0.34	1.98
07/21	1,354	406	3,381	131	0	320	0	551	51	193	0	358	0.51	2.49
07/22	2,708	420	2,565	106	0	163	0	322	114	246	0	465	0.44	2.93
07/23	4,062	489	186	101	575	96	810	287	127	196	0	539	0.30	3.23
07/24	10,833	515	552	33	748	118	1,166	0	131	43	0	493	0.26	3.49
07/25	5,416	637	508	575	416	88	1,674	0	432	591	0	1,212	0.69	4.18
07/26	6,771	597	429	367	234	97	1,059	0	494	620	1,427	1,843	1.12	5.30
07/27	8,387	592	820	269	386	82	976	0	508	645	1,127	1,970	1.07	6.37
07/28	9,479	633	515	106	184	58	808	0	701	2,199	752	1,996	1.40	7.77
07/29	8,125	644	1,115	19	480	44	632	1,263	960	8,518	902	973	3.49	11.26
07/30	5,416	413	1,672	15	453	52	1,326	2,362	991	3,858	1,006	466	2.26	13.53
07/31	4,062	0	663	20	226	31	2,464	6,066	621	1,402	527	1,235	2.01	15.54
08/03	3,300	0	478	18	8,951	24	8,513	269	1,033	1,316	611	906	1.69	21.29
08/04	2,200	0	1,032	59	7,144	1,529	9,168	175	3,068	1,066	1,163	813	2.02	23.31
08/05	1,354	1,212	799	4,124	3,461	4,594	6,362	150	2,701	710	1,578	2,246	2.54	25.85
08/06	5,416	1,948	7,126	5,979	1,804	6,479	6,033	208	7,695	1,369	712	2,009	3.64	29.49
08/07	1,354	1,819	5,191	3,900	831	2,379	7,837	227	8,062	783	4,160	2,707	4.29	33.77
08/08	1,354	4,638	695	22,181	681	917	18,480	1,625	11,915	423	1,941	2,405	7.33	41.11
08/09	5,416	5,105	955	7,880	636	414	5,903	17,005	2,513	530	660	1,635	5.11	46.21
08/10	10,833	4,435	4,321	2,908	1,362	489	7,888	17,916	8,305	683	661	9,751	6.69	52.91
08/11	51,456	1,981	2,335	3,731	4,376	320	11,607	3,778	10,354	774	364	28,753	7.90	60.80

–continued–

Table 2. (Page 2 of 2)

Date	Year												Average Proportions[1]	
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1993	1994	Daily	Cum.
08/12	20,312	1,629	5,235	8,459	2,009	179	11,984	13,365	8,011	1,078	696	1,922	6.25	67.06
08/13	13,541	1,215	5,050	4,289	1,179	193	3,359	5,738	21,355	949	811	920	4.54	71.59
08/14	20,000	944	1,881	8,554	2,106	238	3,278	2,300	13,331	1,327	846	884	3.90	75.49
08/15	27,082	982	426	4,098	728	387	2,107	1,568	5,943	1,409	1,480	706	2.51	78.00
08/16	8,180	855	6,995	605	362	387	1,928	704	2,382	322	1,687	590	1.84	79.85
08/17	7,873	552	6,616	1,286	391	302	2,852	339	6,794	141	1,049	584	2.04	81.89
08/18	2,653		8,938	960			1,701	350	7,238	230	813	446	2.06	83.95
08/19			6,872	963			1,421	795	3,450	110	9,074	1,065	4.08	88.03
08/20			4,880	698			799	470	2,063	124	4,151	1,012	2.23	90.26
08/21			5,463	156			911	352	1,301	37	1,129	1,422	1.29	91.55
08/22			26,267				1,016	291	1,078		693	1,492	3.90	95.45
08/23			15,314				291	195	864		415	708	2.24	97.69
08/24			5,782					1,275	694		342	582	1.49	99.17
08/25			4,435					282	557		119	84	0.83	100.00
08/26								78	808					
08/27									2,801					
08/28									2,130					
08/29									1,662					
08/30									1,458					
08/31									848					
09/01									722					
09/02									484					
09/03									602					
09/04									1,011					
09/05									831					
09/06									1,064					
09/07									1,283					
09/08									984					
09/09									1,289					
09/10									1,373					
09/11									1,512					
09/12									287					
Total	263,832	33,804	142,841	82,822	42,771	20,219	131,101	84,706	162,853	39,599	42,742	82,019		

[1] Average proportions for 1984–85 and 1988–94, June 29 through August 25.

Table 3. Nushagak River coho salmon spawners and returns by brood year, 1980–94.

Brood Year	Spawners	Returns By Age Class 1.1	2.1	3.1	1.2	2.2	Total Return	Returns/ Spawner
1980	93,811	12,982	387,195	0	1,455	2,445	404,077	4.31
1981	139,731	12,666	75,796	471	1,630	471	91,034	0.65
1982	292,025	26,894	111,958	1,600	0	0	140,452	0.48
1983	34,747	8,915	28,778	9,383	0	0	47,076	1.35
1984	138,156	9,593	147,938	4,694	0	0	162,225	1.17
1985	80,854	30,202	146,998	8,574	0	59	185,833	2.30
1986	43,588	14,899	135,576	0	0	0	150,475	3.45
1987	20,369	7,783	46,832		0	0	54,615	2.68
1988	129,298	6,568		1,378		0		
1989	79,420	7,500 [1]	59,981	9,148	0		76,629	0.96
1990	138,350	0	80,395	3,600 [1]			83,995	0.61
1991	37,779	3,695						
1992	[2]							
1993	42,173							
1994	79,861							
80–90 Avg.	108,214	12,546	122,145	3,885	309	331	139,641	1.80
83–90 Avg.	83,098	10,683	92,357	5,254	0	10	108,693	1.79

[1] Runs of age–1.1 and age–3.1 coho for 1992 were estimated from the relationship of spawners to returns and sibling to returns and sibling to returns. The total coho run in 1992 is unknown because the escapement was not counted, therefore, age –1.1 for brood year 1989 and age –3.1 for brood year 1987 had to be estimated. We did not estimate the age –2.1 return for brood year 1988 because we felt thay made up too large a portion of the total return to estimate.

[2] The number of spawners in 1992 are unknown, because escapement was not counted.

Table 4. Summary of commercial harvests of sockeye, pink and coho salmon in the Nushagak District for selected years.[1]

	Sockeye Salmon			Pink Salmon			Coho Salmon		
Date	Average Cumulative Catch(%)	Average Daily Catch	Maximum Daily Catch	Average Cumulative Catch(%)	Average Daily Catch	Maximum Daily Catch	Average Cumulative Catch(%)	Average Daily Catch	Maximum Daily Catch
7/10	73.40	156,993	488,452	0.02	422	2,934	0.07	1	21
11	78.03	160,041	470,560	0.04	603	5,508	0.07	2	13
12	82.53	133,197	300,471	0.47	787	5,593	0.07	7	60
13	85.66	98,775	338,476	0.94	1,271	5,880	0.08	15	93
14	88.70	81,112	159,725	1.46	1,850	8,261	0.09	83	1,076
15	90.10	50,416	121,347	1.99	4,058	17,818	0.10	55	283
16	93.33	44,730	167,705	2.59	9,138	37,168	0.16	157	1,890
17	95.22	36,799	124,531	3.80	13,061	65,321	0.25	272	2,618
18	96.67	28,106	70,182	5.41	23,063	104,760	0.43	311	1,960
19	97.82	19,470	51,512	8.40	31,200	103,446	0.83	645	5,620
20	98.51	15,292	41,035	12.29	37,462	119,059	1.24	768	5,803
21	98.97	9,481	28,927	15.24	35,399	128,715	2.10	899	6,487
22	99.23	6,462	22,431	17.95	33,381	100,575	3.71	1,128	11,125
23	99.41	4,044	13,796	22.15	47,585	136,504	5.44	1,603	11,579
24	99.54	3,901	15,341	31.74	85,852	316,776	6.00	2,054	12,767
25	99.67	3,283	8,937	38.30	134,877	515,407	11.87	3,390	15,541
26	99.73	1,592	6,339	44.89	67,456	277,447	15.07	2,770	27,107
27	99.79	1,432	5,672	52.32	71,326	312,936	18.65	3,506	26,644
28	99.84	1,388	6,049	60.16	83,650	492,760	21.26	3,153	18,691
29	99.88	1,055	3,405	67.01	80,591	351,364	24.09	5,260	40,610
30	99.91	582	2,658	74.02	96,766	311,585	27.54	5,393	26,932
31	99.92	419	2,167	79.71	66,717	313,791	30.75	3,645	26,070
8/01	99.94	340	1,272	83.88	67,461	278,917	33.84	3,508	17,145
02	99.95	344	1,218	88.05	59,706	222,176	37.08	2,421	12,887
03	99.96	216	819	92.24	78,356	265,428	40.77	3,475	21,836
04	99.97	327	1,571	95.06	62,669	267,995	49.54	2,717	8,749
05	99.98	257	814	96.21	27,429	172,336	55.18	3,270	7,503
06	99.98	67	322	97.60	24,287	98,890	58.42	5,183	22,097
07	99.98	57	109	98.57	30,474	151,540	61.25	4,500	25,646
08	99.99	56	113	98.96	16,491	56,169	63.22	1,587	5,948
09	99.99	42	59	99.29	11,522	33,219	67.03	5,067	49,926
10	99.99	23	104	99.59	5,759	28,572	73.33	9,697	65,525
11	99.99	19	132	99.87	3,830	20,721	77.28	4,348	18,462
12	99.99	17	74	99.88	4,511	16,789	81.14	4,470	10,566
13	99.99	9	67	99.89	1,634	7,852	82.82	2,929	10,367
14	99.99	17	46	99.91	1,633	7,550	83.68	3,862	27,164
15	99.99	25	172	99.93	1,800	4,403	84.23	1,796	8,826
16	99.99	8	32	99.94	1,427	4,487	85.44	915	4,293
17	99.99	18	31	99.96	550	2,619	87.80	1,488	8,131
18	99.99	4	26	99.98	538	2,629	89.07	888	4,307
19	99.99	15	39	99.98	297	852	90.62	1,059	6,832
20	99.99	2	8	99.98	56	191	91.63	703	4,373
21	100.00	9	87	99.98	42	610	94.19	2,040	5,182
22				99.99	42	610	95.24	836	3,567
23				99.99	57	610	96.07	656	4,676
24				100.00	56	610	96.54	372	3,729
25				100.00	45	610	96.74	166	1,201
26				100.00	3	138	97.26	407	2,386
27				100.00	7	138	97.43	135	716
28				100.00	0	138	97.47	39	555
29				100.00	0	138	98.73	1,001	5,983
30				100.00	0	1	99.51	619	3,792

[1] Average cumulative catch(%) includes only those years in which fishing took place on a constant or continuous basis; selected years for coho salmon include 1973, 77, 78, 81, 82 and 83; selected years for pink salmon include 1970, 78, 82, and 84 (only even-numbered years); selected years for sockeye salmon include 1969-73, 76-83, and 1986. Maximum daily catch is the maximum number of fish caught by date, 1969-1994.

Table 5. Price and ex-vessel value to commercial fishermen for sockeye, pink and coho salmon in the Nushagak District, 1975-94.

	Sockeye Salmon			Pink Salmon			Coho Salmon		
Year	Price/lb.	Value/fish	Ex-vessel Value	Price/lb.	Value/fish	Ex-vessel Value	Price/lb.	Value/fish	Ex-vessel Value
1975									
1976									
1977									
1978	0.68	4.01	18,509,279	0.33	1.06	4,591,843	0.62	4.65	208,041
1979	1.03	6.08	19,631,341	0.33			1.05	8.19	1,061,481
1980	0.57	3.19	25,187,607	0.25	0.85	1,872,163	0.57	3.99	589,427
1981	0.76	4.71	46,457,177	0.29			0.73	4.67	1,029,195
1982	0.70	4.48	37,863,597	0.22	0.77	1,031,239	0.71	5.18	1,812,334
1983	0.61	3.48	29,182,541	0.16			0.40	2.64	214,732
1984	0.69	3.86	11,159,014	0.22	0.70	2,201,516	0.71	5.33	1,386,151
1985	0.85	4.93	7,585,756	0.20			0.71	5.68	114,906
1986	1.42	8.52	16,315,878	0.15	0.53	140,236	0.68	4.56	312,396
1987	1.35	8.10	19,528,320				0.69	4.83	64,060
1988	1.93	11.97	10,581,639	0.34	1.22	298,521	1.14	8.89	468,591
1989	1.07	5.99	15,613,836	0.17			0.67	4.96	382,148
1990	1.04	5.93	20,135,495	0.27	1.03	55,534	0.74	5.55	42,918
1991	0.70	3.99	28,806,917	0.11			0.58	4.23	22,859
1992	1.04	5.93	16,535,592	0.12	0.44	84,213	0.58	4.06	344,686
1993	0.62	3.72	31,964,610	0.11			0.52	3.54	50,367
1994	0.70	3.85	18,881,544	0.04	0.15	1,332	0.45	3.69	25,092
Min	0.57	3.19	7,585,756	0.04	0.15	1,332	0.40	2.64	22,859
Mean	**0.93**	**5.46**	**21,996,479**	**0.21**	**0.75**	**1,141,844**	**0.68**	**4.98**	**478,199**
Max	1.93	11.97	46,457,177	0.34	1.22	4,591,843	1.14	8.89	1,812,334

Table 6. Commercial harvests of coho salmon, Nushagak District, Bristol Bay, 1893-1994.

Year	No.	Year	No.	Year	No.	Year	No.
1893	74,000						
1894	47,000						
1895	28,050						
1896	117,530						
1897	150,000						
1898	55,744						
1899	100,396						
1900	0	1930	34,150	1960	13,457	1990	7,733
1901	2,893	1931	920	1961	16,653	1991	5,574
1902	193,838	1932	4,630	1962	28,418	1992	84,077
1903	60,073	1933	15,800	1963	29,648	1993	14,345
1904	123,661	1934	12,190	1964	26,416	1994	6,814 [a]
1905	65,568	1935	2,230	1965	2,851		
1906	207,257	1936	19,107	1966	11,517		
1907	129,065	1937	1,380	1967	31,517		
1908	103,013	1938	4,485	1968	48,867		
1909	80,513	1939	26	1969	37,799		
1910	139,200	1940	11,131	1970	3,688		
1911	129,971	1941	30,958	1971	8,036		
1912	195,083	1942	28,733	1972	3,654		
1913	66,640	1943	1,360	1973	28,709		
1914	81,434	1944	23,660	1974	12,569		
1915	117,172	1945	8,954	1975	7,342		
1916	293,210	1946	31,126	1976	6,778		
1917	62,260	1947	1,015	1977	52,562		
1918	108,576	1948	2,269	1978	44,740		
1919	46,687	1949	21,014	1979	129,607		
1920	145,510	1950	21,788	1980	147,726		
1921	84,564	1951	2,856	1981	220,290		
1922	159,783	1952	2,067	1982	349,669		
1923	9,274	1953	2,195	1983	81,338		
1924	39,787	1954	20,423	1984	260,310		
1925	16,591	1955	13,920	1985	20,230		
1926	12,947	1956	53,999	1986	68,568		
1927	137	1957	61,454	1987	13,263		
1928	4,825	1958	127,088	1988	52,698		
1929	58,444	1959	12,779	1989	77,077		

[a] Preliminary.

Table 7. Coho Harvest and Use Patterns in Nushagak Watershed Communities. [1]

Community	Survey Year	Households Used (%)	Households Harvested (%)	Households Received (%)	Households Gave (%)	Mean Household Harvest (pounds)	Coho as Percent of Total Subsistence Harvest (%)
Aleknagik	1989	76	60	42	39	53	4
Clarks Point	1989	77	53	47	47	93	8
Dillingham	1984	61	46	26	17	60	8
Ekwok	1987/88	76	48	31	28	179	7
Koliganek	1987/88	74	57	34	19	234	7
Manokotak	1985	80	56	33	37	82	4
New Stuyahok	1987/88	53	38	26	8	85	3

[1] Represents cohos harvested for home use by all methods, including subsistence nets, rod and reel, and removal from commercial catch.

Table 8. Coho Harvest by Gear Type in Nushagak Watershed Communities.

Community	Survey Year	Total Coho Harvest (fish)	Commercial Gear (#)	Commercial Gear (%)	Subsistence Nets (#)	Subsistence Nets (%)	Rod and Reel (#)	Rod and Reel (%)
Aleknagik	1989	472	94	19.9	248	52.5	130	27.5
Clarks Point	1989	337	59	17.5	278	82.4	0	0.0
Dillingham	1984	8,698	1,116	12.8	6,775	77.8	808	9.2
Ekwok	1987/88	1,246	0	0.0	1,108	88.9	138	11.0
Koliganek	1987/88	2,436	6	0.2	1,926	79.0	505	20.7
Manokotak	1985	874	191	21.9	634	72.5	49	5.6
New Stuyahok	1987/88	1,373	0	0.0	1,269	92.4	104	7.5

Sources: Seitz 1992; Fall et al 1986; Schichnes and Chythlook 1988 and 1990; on file, ADF&G, Dillingham.

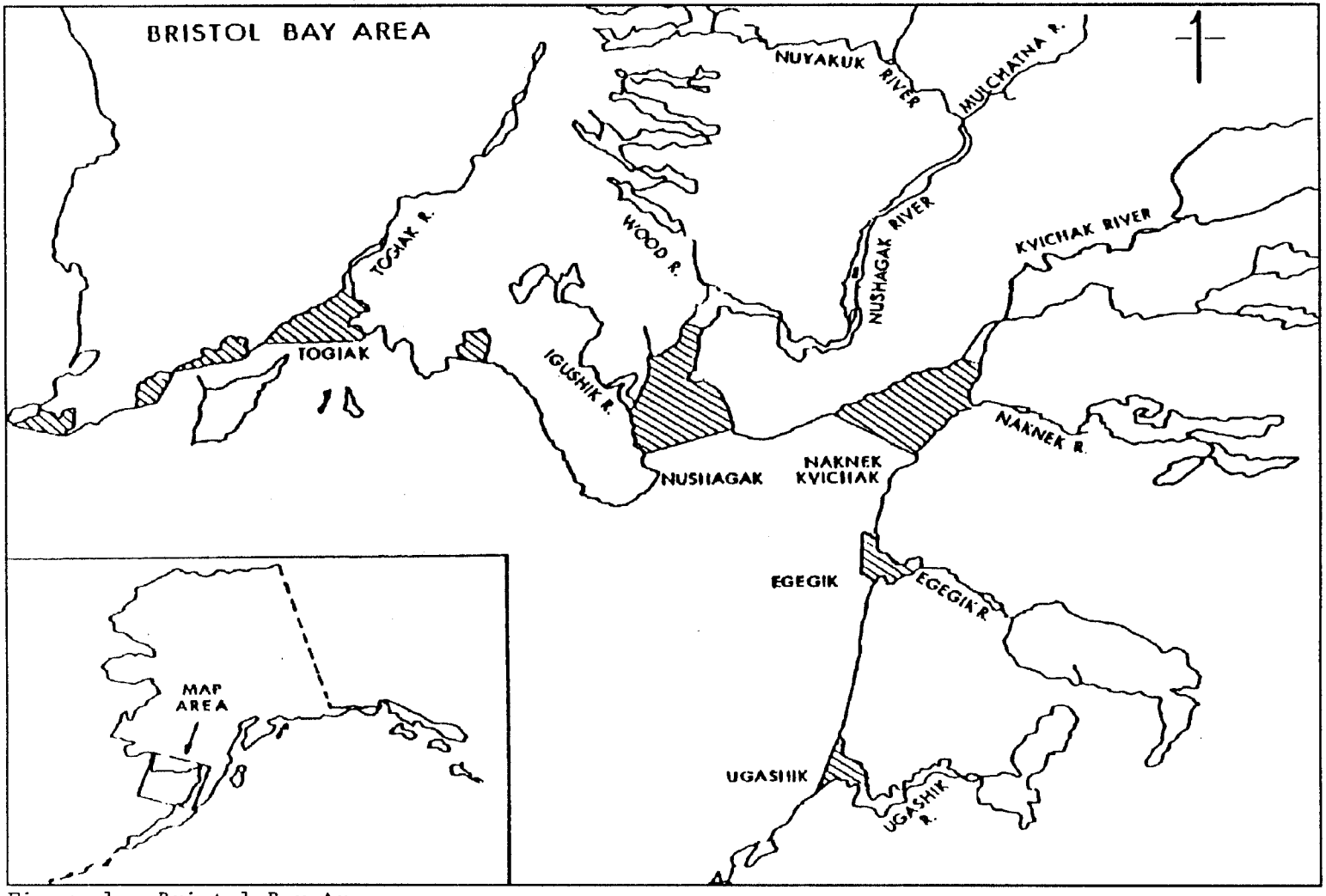


Figure 1. Bristol Bay Area.

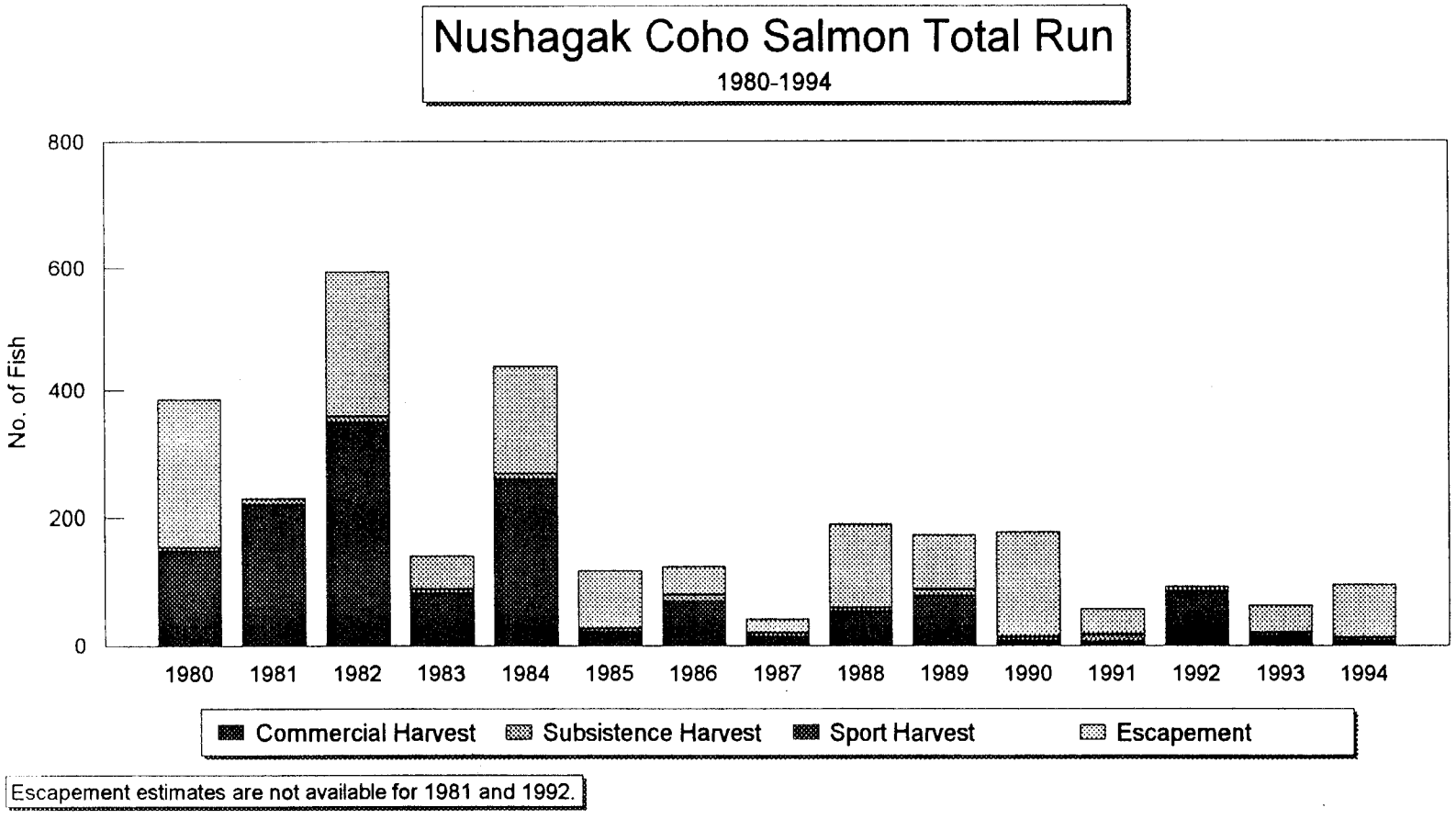
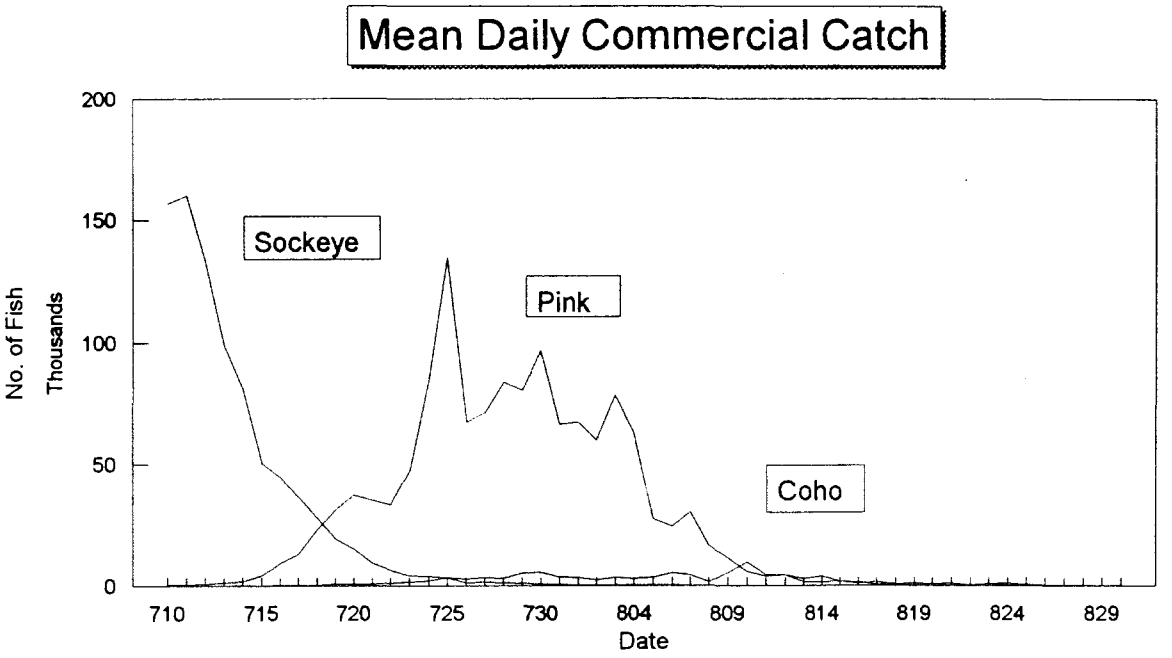


Figure 2. Inshore run size of coho salmon, 1980-94.



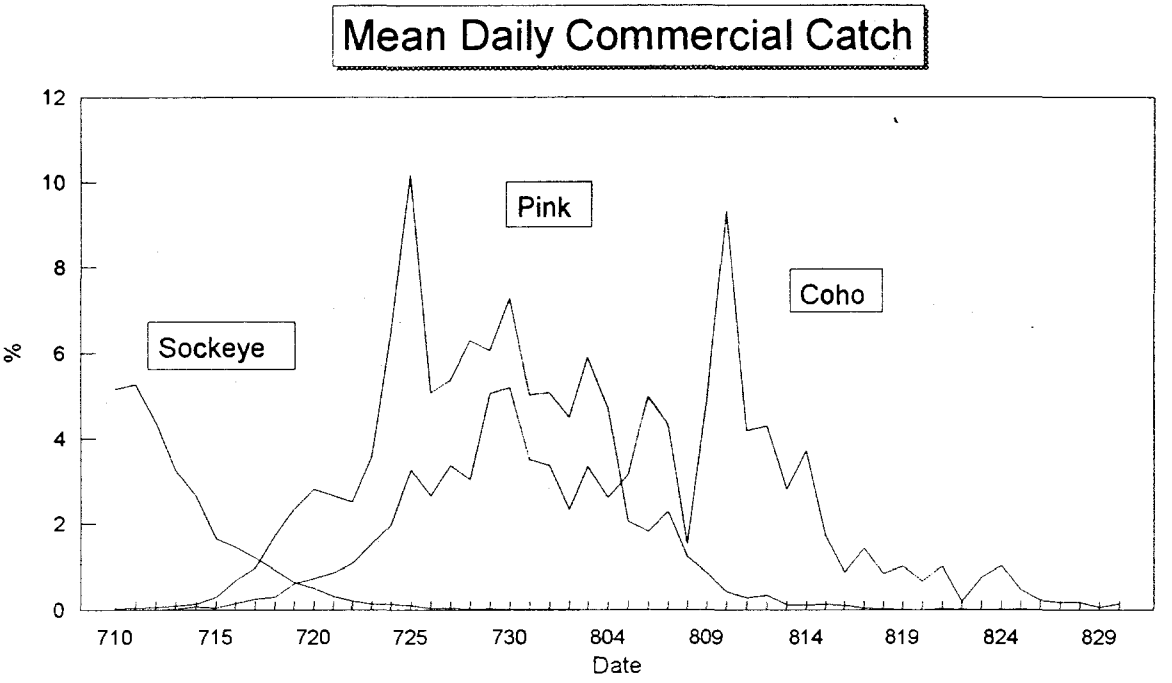


Figure 3. Mean daily commercial harvests of sockeye, pink and coho salmon in the Nushagak District.

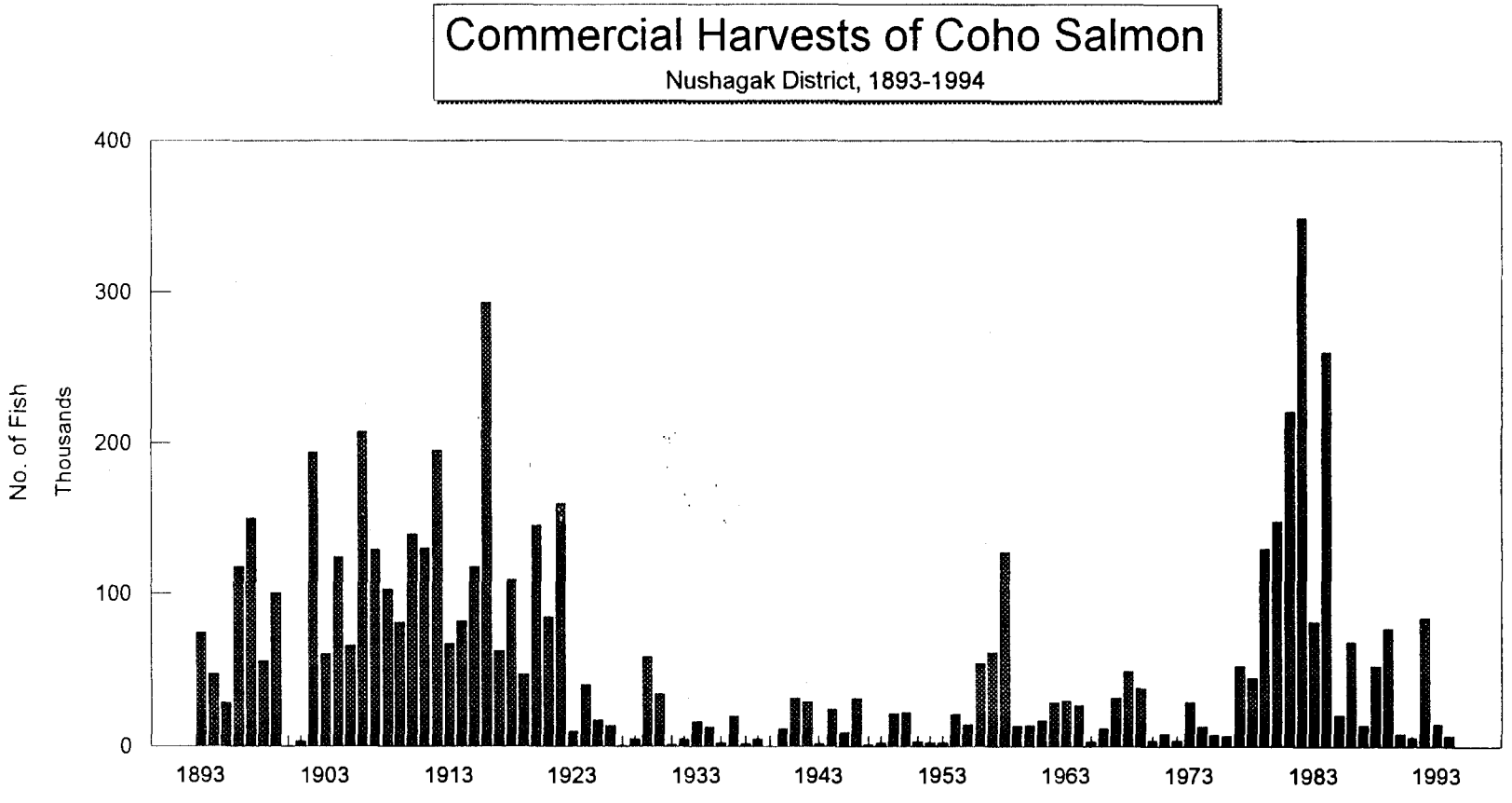


Figure 4. Commercial harvests of coho salmon, Nushagak District, 1893-94.