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Stock Status of Coho Salmon in Upper Cook Inlet: Report to the Alaska Board of Fisheries, January 2005

by

Robert Lafferty,

Robert Massengill,

Dan Bosch,

and

James J. Hasbrouck

February 2007

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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STOCK STATUS OF COHO SALMON IN UPPER COOK INLET: REPORT TO THE ALASKA BOARD OF FISHERIES, JANUARY 2005

by
Robert Lafferty
Division of Sport Fish, Anchorage

Robert Massengill
Division of Sport Fish, Soldotna

and

Dan Bosch and James J. Hasbrouck
Division of Sport Fish, Anchorage

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

February 2007

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Robert Lafferty,
Alaska Department of Fish and Game, Division of Sport Fish
333 Raspberry Road, Anchorage, Alaska 99518-1599, USA

Robert Massengill,
Alaska Department of Fish and Game, Division of Sport Fish
43961 Kalifornsky Beach Road, Suite B, Soldotna, AK 99669-8367, USA

and

Dan Bosch and James J. Hasbrouck,
Alaska Department of Fish and Game, Division of Sport Fish
333 Raspberry Road, Anchorage, Alaska 99518-1599 USA

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ABSTRACT

This report was originally provided to the Alaska Board of Fisheries in January 2005. It examines status of coho salmon stocks in Upper Cook Inlet through 2003, including harvests and escapements, and sport, commercial, and personal use fisheries. Stocks addressed include Knik Arm drainages, Anchorage and Turnagain Arm, Susitna River, West Cook Inlet, the Kenai Peninsula, and the Kenai River. Available coded wire tagging information and a sport fish bag limit analysis are also provided.

Key words: Coho salmon, *Oncorhynchus kisutch*, Upper Cook Inlet, Knik Arm, Anchorage, Turnagain Arm, Susitna River, West Cook Inlet, Kenai Peninsula, Kenai River, coded wire tag, bag limit analysis, stock assessment, stock status, commercial fisheries, sport fisheries.

INTRODUCTION

This report examines status of coho salmon *Oncorhynchus kisutch* stocks in Upper Cook Inlet, Alaska. It includes information contained in two previously unpublished Alaska Department of Fish and Game (ADF&G) reports (Clark et al. *Unpublished*; Yanusz et al. *Unpublished*) with updates of harvests, escapements and assessments of coho salmon in Upper Cook Inlet through 2003. This report was originally provided to the Alaska Board of Fisheries in January 2005 to provide information necessary for deliberations of possible regulatory changes that were being considered because of (1) perceived poor runs in the late 1990s, (2) increasing sport harvests, (3) commercial harvests from the early 1980s through mid-1990s that were above historic levels, and (4) preliminary information from developing stock assessment programs. This version of the report reflects a subsequent peer review and revisions to clarify some of the text and figures; however, most aspects of the report remain unchanged from the original provided to the Alaska Board of Fisheries (BOF).

The Upper Cook Inlet (UCI) area encompasses Cook Inlet north of the latitude of Anchor Point (Figure 1). The combined watersheds of this area embody approximately 179,000 km^2, equivalent to the area of the state of Missouri. Within UCI, 1,222 anadromous rivers and streams have been documented, and coho salmon inhabit approximately 946 of these. Major runs of coho salmon return to the Susitna River drainage, Kenai River, Little Susitna River, Swanson River, and Kustatan River (Figure 2).

The commercial fisheries management area in UCI is divided into the Northern and Central Districts (Figure 1). The Northern District (ND) fishery is prosecuted solely with set gillnets and is further subdivided into the General (or Western) and Eastern subdistricts. The General subdistrict comprises the Westside, Fire Island, Point Mackenzie/Susitna Flats, and Knik Arm fisheries. The Eastern subdistrict contains only the Eastside fishery. Fishing in the Central District is prosecuted by both set and drift gillnets and further subdivided into (1) Upper Subdistrict (Eastside) set (ESSN); (2) Westside, Kustatan, Kalgin Island, and Chinitna Bay set (combined herein as WSS); and (3) drift (CDD) net fisheries (Figure 1). Management of the sport fishery in UCI is divided into the Northern Cook Inlet, Anchorage/Turnagain Arm, Northern Kenai Peninsula, and Lower Kenai Peninsula areas. These areas are further subdivided into the Knik Arm, Susitna East and West, West Cook Inlet, Anchorage/Turnagain Arm, Northern Kenai Peninsula, and Lower Kenai Peninsula management units.

For the purposes of describing coho salmon stock status in this report, harvests from commercial, sport, and personal use fisheries (Kenai River only) are included. When appropriate, effort is included for sport fisheries. Commercial harvests that occur in all subdistricts of UCI have been included. To eliminate the influence of hatchery production on determination of stock status, harvests of UCI hatchery fish were removed from CDD, ESSN and ND commercial harvests and

all sport fishery harvests. When possible harvest and escapement figures in this report are presented with average harvest or escapement in intervals to facilitate trend comparisons.

Harvests from commercial fisheries are available from the Commercial Fisheries Fish Ticket Database. Sport harvests are available from the Statewide Harvest Survey, an annual postal survey of anglers fishing in Alaska. At the time this report was submitted to the BOF, 2004 estimates were not yet available. Estimates of personal use harvest are available from permits issued to dipnet anglers, and returned with harvest information upon completion of the season.

Fishery regulations and participation have a significant impact on harvest and effort, and can cause harvest or harvest rate data to be misleading when used to infer trends in stock status. However, the programs listed above are the only consistently and comprehensively collected data for coho salmon on an inlet-wide basis. Trends inferred from effort and harvest data should be interpreted only as a general "indicator" of changes in abundance over time, and always in the context of regulation and participation changes. Additionally, sport fishing effort estimates are inclusive of all fish species and represent total angler-days expended within a body of water for the entire year, regardless of targeted species.

As noted above, this report was provided to the BOF in response to specific regulatory proposals under consideration. Therefore, an overview of Upper Cook Inlet is presented first, followed by stock status by management unit: Knik Arm, Anchorage/Turnagain Arm, Susitna River Drainage, West Cook Inlet, Kenai Peninsula north of Anchor Point (excluding the Kenai River), and the Kenai River (Figure 2). Available information from coded wire tagging studies and a sport fish bag limit analysis are presented, as these were important data considered by the BOF during deliberations of the proposals. Finally, several conclusions are provided. At the beginning of each report section, sources of information contained in the section are provided.

UPPER COOK INLET STOCK STATUS

Commercial and sport fishery harvests of wild fish are the primary means of determining overall stock status of UCI coho salmon. Coho salmon escapements have been assessed in relatively few systems, either counted at weirs, estimated by capture-recapture experiments, or indexed by foot or aerial surveys. Coded wire tag data are available for all hatchery stocks and some wild stocks, allowing estimation of the contributions of these stocks in mixed stock fisheries and reconstruction of annual runs.

Information about UCI coho salmon can be found in the following sources in addition to sources listed for individual management units:

Commercial fisheries reports: Fox and Shields 2001; Fox and Shields 2003; Fox and Shields 2004; Shields and Fox 2005;

Sport fish harvest reports: Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a, b;

Research reports: Vincent-Lang and McBride 1989; Vincent-Lang 1990;

Unpublished escapement goal and BOF reports: Meyer et al. *Unpublished*; Bue and Hasbrouck *Unpublished*; Clark et al. *Unpublished*; Hasbrouck and Edmundson *Unpublished*; Yanusz et al. *Unpublished*;

Information about stocking: ADF&G *Unpublished*;

Information about anadromous streams: Johnson and Weiss 2006.

WHAT IS THE OVERALL STATUS OF COHO SALMON IN UCI?

It is difficult to assess runs of coho salmon to UCI in 2004 without estimates of sport harvest; however, the 2004 commercial harvest was approximately 300,000 coho salmon. This was the largest commercial coho salmon harvest observed since 1995 (Figure 3), but still below the last 20-year average harvest of 380,000 coho salmon. Additionally, coho salmon escapements in 2004 were above average in Northern Cook Inlet (NCI) and Anchorage areas. Escapement in 2004 in 10 of 15 monitored systems exceeded the historical average, with six of these systems exceeding the historical average by 3-4 fold. Inseason reports from the 2004 sport fishery suggest an average harvest; average harvest from 2000-2003 was 175,000 coho salmon (Figure 4). If sport harvest was average, the total commercial and sport harvests in UCI approached 500,000 coho salmon during 2004.

Despite low commercial harvests, the high sport fishery harvests and moderate to high escapement counts suggest that total coho salmon runs to UCI were relatively good in 2002 and at least moderate in 2003.

The sport fishery harvest in 2002 was the highest observed and in 2003 ranked 8th of the last 27 years (Figure 4). Thirty-nine percent of UCI sport harvests between 1977 and 2003 has come from the Kenai River, 27% from the Susitna River drainage, 15% from Knik Arm and Little Susitna River, 11% from Kenai Peninsula drainages (excluding the Kenai River), 6% from West Cook Inlet drainages, and 2% from Anchorage and Turnagain Arm drainages (Figure 5).

Since 1997, only in 2000 and 2002 did commercial harvests of coho salmon in UCI attain the average harvest observed in the mid to late 1990s; all other years were below this average (Figure 3). The commercial fishery harvest in 2002 ranked 27th out of 50 years, and in 2003 it ranked 49th out of 50 years (Figure 3). During 1977-2003, 49% of the harvests in UCI commercial fisheries came from the CDD, 23% from the ND, 17% from the WSS, and 11% from the ESSN (Figure 6).

Total harvest (commercial and sport combined) in 2003 was low; consistent with harvests of 1977-1978, 1997-1999, and 2001; and ranked only 24th out of the last 27 years (Figure 7). Total harvest in 2002 ranked 17th out of the last 27 years. The proportion of harvest taken by the commercial fisheries remained lower than it was prior to 1998 (Figure 7).

Weir projects and escapement surveys had record or near-record highs during 2002 and average or slightly below average escapements in 2003. Coho salmon escapements appeared high again in 2004. For reasons discussed below, it appears that the number of coho salmon harvested in the commercial fisheries were not a good indicator of coho salmon abundance since at least 2000. For example, harvest in the commercial fisheries in 2003 was nearly the lowest since 1954 (Figure 3), but sport harvests were good and escapements were only slightly below average. Therefore, it appears distribution of the runs was shifted towards inriver components.

ARE THERE OTHER FACTORS BESIDES THE ABUNDANCE OF COHO SALMON THAT INFLUENCE HARVESTS IN SPORT AND COMMERCIAL FISHERIES?

First, commercial harvests of coho salmon are strongly influenced by management actions taken to target harvest of sockeye salmon *O. nerka*. The commercial fishery in UCI is managed primarily to achieve escapements of sockeye salmon thought to produce sustained yields and provide commercial fishermen with an economic yield. As a consequence, these fisheries are managed to accommodate annual and inseason fluctuations in the abundance and run timing of

sockeye salmon. Low runs of sockeye salmon in 2000 and 2001 resulted in less commercial fishing time for those years. Higher sockeye salmon runs in 2003 and 2004 resulted in increased commercial harvests of sockeye and, in 2004, coho salmon.

Secondly, both commercial and sport fisheries have undergone specific restrictions to reduce the harvest of coho salmon, especially since the mid-1990s. In 1996 the CDD fishery had one district-wide restriction in fishing time (loss of a regularly scheduled 12-hour fishing period) promulgated in regulation to reduce the harvest of Northern District coho salmon. Also, the season ending date was set to August 9 to reduce overall coho salmon harvests. Beginning in 1999 an additional late-July, district-wide restriction to the commercial fishery (loss of an additional regularly scheduled 12-hour fishing period) was implemented in regulation to reduce the harvest of Northern District coho salmon. Since 1992, ND fishing time has been restricted to regular periods after August 15. Additional fishing time at Kalgin Island has also been reduced or curtailed to reduce coho salmon harvests. The Knik Arm set net fishery was closed in regulation during 1999. Concerns for coho salmon in West Cook Inlet were also addressed by a spawning season closure of October 1 through December 31 in the sport fishery and by prohibiting coho salmon anglers from fishing after their bag or possession limit was retained.

The BOF, at its UCI meeting in 2000, passed several regulatory measures affecting UCI fisheries. The ESSN season was closed after August 7 with only one, emergency order opening (up to 24-h duration) allowed from August 1-7, to protect Kenai River coho salmon. An August 1-3 closure in the Kenai River sport fishery was also enacted. Allowable gear after the last regular opening in July was reduced in the ND fishery. Wasilla Creek and portions of upper Jim Creek were closed to sport fishing. In addition, the coho salmon bag and possession limit for wild-stock sport fisheries was reduced from three fish to two fish for all of UCI, except for freshwater sport fisheries in West Cook Inlet south of the West Foreland.

Thirdly, growth of the sport fishery during the late 1970s through the mid-1990s likely influenced harvest trends. Although sport fishing effort is not measured by species, angler-days of effort in UCI have more than doubled from 1977 to the present (Figure 8). Sport harvests of coho salmon incrementally increased as angler effort increased through the early 1990s, declined during the late 1990s and increased to higher levels during early 2000s (Figure 5).

Despite these somewhat independent factors that could differentially influence trends among commercial and sport fisheries, harvests in both fisheries during 1995-1999 decreased relative to levels observed during 1990-1994 (Figures 3 and 5). Commercial harvests of coho salmon decreased 49% (1990-1994 average of 444,000 vs. 1995-1999 average of 227,000 coho salmon), sport fishery harvests decreased 24% (1990-1994 average of 154,000 vs. 1995-1998 average of 117,000 coho salmon) and sport fishery effort declined 20% (1990-1994 average of 1,013,591 vs. 1995-1999 average of 818,580 angler-days).

Other data suggest the commercial harvest patterns may be unique to UCI. Commercial harvests of coho salmon in areas west of Yakutat declined during 1997-1999 and have rebounded in 2000-2003 to a steady level, slightly below 2 million (Figure 9). This rebounding in UCI was not as prevalent in the commercial harvests during the same period of the early 2000s (Figure 3), likely because of restrictions placed on UCI commercial fisheries since 1997.

DOES THE DEPARTMENT HAVE SUSTAINED YIELD OBJECTIVES FOR COHO SALMON IN UCI?

Not overall. Although there are several regulatory management plans that direct the Department to manage for coho salmon, there is no comprehensive sustained yield objective for UCI coho salmon. However, five sustainable escapement goals were established for specific UCI drainages in 2001: four in Knik Arm and one in the Anchorage/Turnagain Arm area.

KNIK ARM DRAINAGES

Important Knik Arm drainages include Fish, Cottonwood, Wasilla, and Jim creeks (Figure 10). Although the Little Susitna River does not drain into Knik Arm, it is included with Knik Arm stocks as a management unit because it flows into UCI just west of the mouth of Knik Arm. Status of these stocks has been monitored through inriver sport harvests and escapements indexed via foot survey or enumerated via weir.

In addition to the UCI-wide sources listed previously, information about Knik Arm drainage coho salmon can be found in the following sources:

Area management reports: Whitmore et al. 1994-1996; Whitmore and Sweet 1997-1999; Rutz and Sweet 2000; Sweet and Rutz 2001; Sweet et al. 2003, 2004.

Coded wire tagging studies: Bosch and Evans 2006; Cyr et al. 1997-1999, 2001; Hoffmann and Hasbrouck 1994; Stratton et al. 1996.

Research reports: Bentz 1984-1987; Bartlett and Conrad 1988; Bartlett and Vincent-Lang 1989; Bartlett and Sonnichsen 1990; Bartlett and Bingham 1991, 1993; Bartlett 1992, 1994, 1996 a,b; Namtvedt and Evans *In prep*; Namtvedt et al. *In prep a-b*.

WHAT IS THE RECENT STATUS OF COHO SALMON IN KNIK ARM, INCLUDING THE LITTLE SUSITNA RIVER?

Recent sport fishery harvests have varied greatly. The sport harvest of coho salmon for Knik Arm in 2002 was the highest in 27 years (Figure 11). Approximately 59% of this harvest since 1977 has come from the Little Susitna River (Figure 12). Sport harvest of coho salmon in 2002 at the Little Susitna River was the third largest in the 27 year history, slightly below the harvests of 2000 and 1993 (Figure 13). As for the smaller Knik Arm coho systems, the sport harvest of coho salmon at Jim Creek in 2002 was the highest in 23 years (Figure 14). In contrast, in 2003 sport harvest declined relative to 2002 in the Little Susitna River and Jim Creek, was the tenth lowest in 25 years at Cottonwood Creek (Figure 15), and was the lowest on record at Fish Creek (Figure 16). All four of these systems were subject to more restrictive regulations beginning in 2000 that reduced the daily bag limit from three fish to two fish. Wasilla Creek had a long-running sport fishery that was closed in 2000 and 2001, but reopened in 2002 (Figure 17).

In recent years, coho salmon escapements to each of the five monitored systems were the highest or among the highest observed. Escapements during 2001, 2002 and 2004 were the highest observed in 18 years at the Little Susitna River (Figure 18) and survey counts in 2002 and 2004 were the highest observed in 20 years at Jim Creek (Figure 19). Weir counts of coho salmon at Cottonwood Creek were the highest observed in 2001 and 2002, low in 2003, and intermediate in 2004 (Figure 20A). Peak foot survey index counts at Cottonwood Creek since 1997 show very close correlation to the weir counts (R^2 = 0.78; Figure 20B), suggesting that the escapements

observed since 1997 are higher than or similar to the escapements during 1981-1996. The coho salmon escapements into Fish Creek in 2001 and 2002 were the highest observed during the past seven years though the minimum of the sustainable escapement goal range was barely attained in 2003 (Figure 21). The weir count at Wasilla Creek in 2002 was nearly double the relatively high weir counts in 2000 and 2001 (Figure 22A). Similar to Cottonwood Creek, foot surveys were closely correlated to weir counts during 1998-2003 ($R^2 = 0.90$; Figure 22B). This suggests that, based on foot survey indices, the escapements observed since 1998 were higher than the escapements during 1985-1997 and that the escapement observed in 2004 was comparable to the record escapement observed in 2002 (Figure 22A).

DOES THE DEPARTMENT HAVE SUSTAINED YIELD OBJECTIVES FOR COHO SALMON IN KNIK ARM?

Five escapement goals were in place for Knik Arm coho systems in 2001. The goal in effect for the Little Susitna River from 1990 through 1998 (7,500 fish) was revised upward in 1999 to 9,600 - 19,200 fish. Goals for the other four systems were in effect from 1994 through 2001. In November 2001, as a result of ADF&G's comprehensive review of UCI salmon escapement goals, goals for the Little Susitna River, Jim Creek, Cottonwood Creek and Fish Creek were changed and the Wasilla Creek goal was eliminated, as shown below. Methodologies and historic data used in establishing these new goals are described in Bue and Hasbrouck (*Unpublished*). Escapements for each system have annually met or exceeded goals from 2001 through 2004, with the exception of Cottonwood Creek in 2003 (Figures 18-21).

System	Biological Escapement Goal (BEG) until 2001	Sustainable Escapement Goal (SEG) adopted 2001
Little Susitna River	9,600-19,200 via weir	10,100-17,700 via weir
Jim Creek	830 via foot survey	450-700 via foot survey in McRoberts Creek
Cottonwood Creek	300 via foot survey	800-2,200 via weir
Fish Creek	2,700 via weir	1,200-4,400 via weir
Wasilla Creek	300 via foot survey	none

ADF&G again reviewed the escapement goals in 2004, and recommended removing the Fish and Cottonwood creek goals because escapements in these creeks are no longer enumerated with weirs (Hasbrouck and Edmundson *Unpublished*).

HOW ACCURATE ARE THE FOOT SURVEYS FOR ESTIMATING ESCAPEMENTS?

A weir was operated at Cottonwood Creek during 1997-2004. During 1999-2004 between two to four foot surveys were conducted and the peak survey count used to index escapement. These data were examined to determine the quality of the relationship between the foot surveys and the full coho salmon escapements (i.e., the weir count). A weir was also operated at Wasilla Creek during 1997-2003, but only single, annual foot surveys were done. (Weir data from 1997 at Wasilla Creek were not used in examining this relationship because it was not "fish tight" throughout the run). At both Cottonwood and Wasilla creeks, foot surveys for coho salmon were

significantly correlated with the weir counts (Figures 20B and 22B), suggesting that trends in escapement can be evaluated by using the foot surveys. However, the relationships are not exact and there are too few data points to allow estimating a precise number of fish in the escapement.

TO WHAT EXTENT ARE ISSUES OUTSIDE OF FISHERY MANAGEMENT INFLUENCING PRODUCTION OF COHO SALMON IN KNIK ARM?

A program was started at Cottonwood Creek to estimate marine survival and freshwater production of coho salmon. Marine survival averaged 8% during adult runs of 2000-2003. Coho salmon smolt estimates in Cottonwood Creek have varied little during this five year period, even though escapement producing these smolt ranged from 500 to 2,000. It is possible that intensive urbanization in Palmer and Wasilla has affected production of coho salmon in Cottonwood and Wasilla creeks, and that these current values may not reflect the historical production.

ANCHORAGE/TURNAGAIN ARM

Sport fishery harvests are the primary means of determining stock status of coho salmon entering Anchorage/Turnagain drainages.

In addition to the UCI-wide sources listed previously, information about Anchorage/Turnagain Arm coho salmon can be found in the following sources:

Coded wire tagging studies: Bosch and Evans 2006; Cyr et al. 1997-1999, 2001; Hoffmann and Hasbrouck 1994; Stratton et al. 1996; Starkey et al. 1995; Starkey et al. 1996, 1997, 1999; Loopstra et al. 2000a, 2000b, 2002; Loopstra and Hansen 2005;

Area management reports: Stratton et al. 1994; Stratton and Cyr 1995, 1997; Miller and Bosch 2004.

WHAT IS THE RECENT STATUS OF COHO SALMON IN ANCHORAGE/TURNAGAIN ARM?

Overall sport harvest of wild coho salmon in Anchorage/Turnagain Arm increased by approximately 1,000 fish every five years from the mid-1980s to the early 2000s (Figure 23). The major producer of sport-caught wild coho salmon is the Twentymile River in the upper reach of Turnagain Arm (Figure 2). Like many of the UCI sport fisheries for coho salmon the five-year average harvests in Twentymile River have increased steadily since 1977 (Figure 24A). The highest harvest occurred in 2000 and the 3rd and 4th highest harvests occurred in 2001 and 2002, respectively. Aerial surveys have been flown over the Twentymile River since 1994, with an average index of 2,405 coho salmon for 2000-2004 (Figure 24B). The coho salmon index counts in the Twentymile River have ranged from a low of 282 in 2003 to a high of 5,858 in 2004. The nearby Placer River has had similar trends and magnitude of coho salmon escapement during aerial surveys, with an average index of 2,671 coho salmon for 2000-2004 and a record high index count of 5,790 coho salmon in 2004 (Figure 25). There are also major hatchery programs for coho salmon in Ship, Campbell, and Bird creeks, all within the Anchorage urban area, that contribute to UCI harvests.

DOES THE DEPARTMENT HAVE SUSTAINED YIELD OBJECTIVES FOR COHO SALMON IN ANCHORAGE/TURNAGAIN ARM?

The only escapement goal in the Anchorage area is an SEG of 100-500 wild coho salmon indexed via a single foot survey at Campbell Creek. There are no escapement goals or sustained

yield objectives for Turnagain Arm systems, where the majority of wild runs of coho salmon occur. Sustained yield is thought to be provided for by basic bag limits and time/area restrictions in the sport fishery and inseason management of the commercial fishery.

TO WHAT EXTENT ARE ISSUES OUTSIDE OF FISHERY MANAGEMENT INFLUENCING PRODUCTION OF COHO SALMON IN ANCHORAGE/TURNAGAIN ARM?

There are no substantial habitat issues for stocks in Turnagain Arm. Freshwater production and marine survival of wild stocks is not monitored, but the marine survival of hatchery-reared coho salmon is monitored and is discussed later in this report.

SUSITNA RIVER DRAINAGE

Major producers of sport-caught coho salmon include the Talkeetna River drainage, Willow Creek, and Montana Creek on the east side of the Susitna River and the Deshka River and Lake Creek on the west side of the Susitna River (Figure 26). Sport fishery harvests and escapement programs are the primary means of determining stock status of Susitna River drainage coho salmon.

In addition to the UCI-wide sources listed previously, information about Susitna River drainage coho salmon can be found in the following sources:

Area management reports: Whitmore et al. 1994-1996; Whitmore and Sweet 1997-1999; Rutz and Sweet 2000; Sweet and Rutz 2001; Sweet et al. 2003, 2004.

WHAT IS THE RECENT STATUS OF COHO SALMON IN THE SUSITNA RIVER DRAINAGE?

The estimated sport harvest in 2000 of approximately 60,000 coho salmon in the entire Susitna River drainage was highest in the last 27 years (Figure 27). Harvests have declined each year since 2000 to a harvest of 35,000 coho salmon in 2003, similar to the average harvest from 1995-1999. Both the east side and west side Susitna River coho salmon sport fisheries have had recent declines from the record harvests that occurred in 2000 (Figures 28 and 29).

Until the mid-1990s, there were no consistent escapement enumeration programs for coho salmon on the major Susitna River tributaries. The Deshka River weir has been operating through the coho migration for the last ten years (Figure 30A). Escapements in 2000-2002 were approximately 25,000 coho salmon each year, decreased to 17,000 fish in 2003, and increased to a record high of 63,000 coho salmon in 2004. All of these escapements were greater than weir counts during 1995-1999. The escapement count was incomplete in 1996 because of a high water event. Sonar indices of coho salmon passage have been obtained in the lower Yentna River since 1988 (Figure 30B). Indices in 2002 and 2004 were the highest observed and those in 2001 and 2003 ranked 4th and 5th , respectively.

Foot surveys have been performed on four small clearwater tributaries (Rabideux, Birch, Question, and Answer creeks) to the Susitna River since 1984 (Figure 31A-D). High index counts were observed annually since 2000 and record high counts occurred in each system during either 2000 or 2001.

HOW ACCURATE ARE THE FOOT SURVEYS FOR ESTIMATING ESCAPEMENTS?

It is not known how well foot survey counts in Susitna River tributaries correlate with actual escapements. We consider it likely, however, that the extremely high foot counts made during the 2000-2004 period indicate improved escapements in recent years.

DOES THE DEPARTMENT HAVE SUSTAINED YIELD OBJECTIVES FOR COHO SALMON IN THE SUSITNA RIVER DRAINAGE?

No. There are several regulatory management plans pertinent to the Susitna River that direct the Department to manage for coho salmon, but there are no escapement goals or comprehensive sustained yield objectives for Susitna River drainage coho salmon. Sustained yield is thought to be provided for by basic bag limits and seasons in the sport fishery and inseason management of the commercial fishery. There have been modest increases in sport harvests and escapements since 2000.

TO WHAT EXTENT ARE ISSUES OUTSIDE OF FISHERY MANAGEMENT INFLUENCING PRODUCTION OF COHO SALMON IN THE SUSITNA RIVER DRAINAGE?

Fishery managers are concerned that illegally introduced northern pike in the Susitna River drainage may negatively affect coho salmon production. West side Susitna River drainages, such as Alexander Creek and the Deshka River (Figure 26), may be particularly affected. However, it is unknown if affects on total juvenile coho salmon production is significant enough to cause a detectable decrease in adult returns. There are no substantial habitat issues in the Susitna River drainage, although residential development continues and some logging occurs. Freshwater production and marine survival are not assessed.

WEST COOK INLET DRAINAGES

Sport fishery harvests are the primary means of determining overall stock status of coho salmon entering West Cook Inlet drainages. Based on harvest levels, major producers of sport caught coho salmon include the Chuitna River, Kustatan River, and Silver Salmon Creek (Figure 2).

In addition to the UCI-wide sources listed previously, information about West Cook Inlet drainage coho salmon can be found in the following sources:

Area management reports: Whitmore et al. 1994-1996; Whitmore and Sweet 1997-1999; Rutz and Sweet 2000; Sweet and Rutz 2001; Sweet et al. 2003, 2004.

WHAT IS THE RECENT STATUS OF COHO SALMON IN WEST COOK INLET?

The total sport harvest from West Cook Inlet drainages in 2002 was the highest in 27 years, with harvests in 2001 and 2003 ranked 4th and 3rd, respectively (Figure 32). The highest and second highest sport harvest at Chuitna River (Figure 33) and Silver Salmon Creek (Figure 34) occurred in 2001-2003. Average annual sport harvests at the Kustatan River increased in the 2000s (Figure 35).

DOES THE DEPARTMENT HAVE SUSTAINED YIELD OBJECTIVES FOR COHO SALMON IN WEST COOK INLET?

No. There are several regulatory management plans pertinent to West Cook Inlet drainages that direct the Department to manage for coho salmon, but there are no escapement goals or comprehensive sustained yield objectives for coho salmon in West Cook Inlet. Sustained yield is thought to be provided for by basic bag limits and seasons in the sport fishery and inseason management of the commercial fishery. There are no long-term, negative trends in sport harvests; average sport harvests have generally increased since 1997 (Figure 32).

TO WHAT EXTENT ARE ISSUES OUTSIDE OF FISHERY MANAGEMENT INFLUENCING PRODUCTION OF COHO SALMON IN WEST COOK INLET?

While there are recent large-scale timber harvests and a long-standing oil exploration presence in West Cook Inlet, no impacts to coho salmon production from these development activities have been identified to date. Freshwater production or marine survival are not monitored.

KENAI PENINSULA (EXCLUDING THE KENAI RIVER)

Sport fishery harvests are the primary means of determining overall stock status of coho salmon entering Kenai Peninsula drainages. Major producers of sport-caught coho salmon include the southern Kenai Peninsula streams of Ninilchik and Anchor rivers and Deep and Stariski creeks, and the Kasilof and Swanson rivers (Figure 2).

In addition to the UCI-wide sources listed previously and the Kenai River sources listed in the next section, information about coho salmon of other Kenai Peninsula drainages can be found in the following sources:

Area management reports: Nelson 1994, 1995; Bethe et al. 2002; Gamblin et al. 2004; Pappas and Marsh 2004; Szarzi and Begich 2004a, b;

Research reports: Hammarstrom 1977, 1978; King and Breakfield 1998, 1999, 2002; Begich 2002, 2006; Begich and Evans 2005.

WHAT IS THE RECENT STATUS OF COHO SALMON IN THE KENAI PENINSULA?

The sport harvest of coho salmon on the Kenai Peninsula, excluding the Kenai River, in 2002 was the highest observed and in 2003 ranked 2nd out of 27 years (Figure 36). The coho harvests of 2002 and 2003 were slightly larger than the harvests of 1989, 1993 and 1994. The 2002 and 2003 sport harvests on the lower Kenai Peninsula were ranked 2nd and 1st, respectively, during the past 27 years (Figure 37). In salt water adjacent to the lower Kenai Peninsula streams, a record sport harvest occurred in 2002, the second largest occurred in 2001 (Figure 38). Marine sport harvest declined in 2003 to slightly below 3,000 fish, which still ranked 5th out of 27 years. Sport harvests at the Swanson River in 2003 ranked 4th over 21 years, with average harvests since 2000 greater than average harvests observed in the 1990s (Figure 39). An enhancement project for coho salmon in the Kasilof River was conducted from 1985-1994 and influenced sport and commercial fishery harvests from 1986-1995 to an unknown extent. Sport harvests at the Kasilof River in 2002 and 2003 ranked 2nd and 7th, respectively, out of 23 years (Figure 40).

Coho salmon escapements are monitored in Deep Creek and the Anchor River. A weir in Deep Creek operated during 1997-2002 with an average escapement of 2,600 coho salmon. As observed in other UCI systems, the highest coho salmon escapements in Deep Creek occurred in 2001 (3,747 fish) and 2002 (6,089 fish). Approximately 5,700 coho salmon were counted in the Anchor River in 2004, the first year escapement was monitored.

DOES THE DEPARTMENT HAVE SUSTAINED YIELD OBJECTIVES FOR COHO SALMON IN THE KENAI PENINSULA?

No. There are several regulatory management plans pertinent to Kenai Peninsula drainages that direct the Department to manage for coho salmon, but there are no escapement goals or comprehensive sustained yield objectives for coho salmon on the Kenai Peninsula. Sustained yield is thought to be provided for by basic bag limits and seasons in the sport fishery and inseason management of the commercial fishery. There are no negative, long-term trends in either sport harvests (Figure 36) or escapements.

TO WHAT EXTENT ARE ISSUES OUTSIDE OF FISHERY MANAGEMENT INFLUENCING PRODUCTION OF COHO SALMON IN THE KENAI PENINSULA?

Although there have been large scale timber harvests on the lower Kenai Peninsula and a long standing oil exploration and refining presence on the northern Kenai Peninsula, no impacts to coho salmon production from these development activities have been identified to date. Residential development is continuing in many areas. A coded wire tag project at Deep Creek provided estimates of coho salmon smolt abundance during 1995-1997 and again from 2001-2003; smolt abundance averaged 30,900 and 47,700, respectively. Smolt-to-adult (marine) survival was an estimated 8% for 1996-1997, 20% for 1997-1998, and 19% for 2001-2002.

KENAI RIVER

Concerns about the status of Kenai River coho salmon led to the adoption of the Kenai River Coho Salmon Conservation Plan (5 AAC 21.357) in 1997. Prior to fishery restrictions imposed by this precautionary plan, a long trend of increasing sport harvests had been documented, and the stock had contributed to marine commercial harvests in UCI. The plan was implemented in two increasingly restrictive stages. The first stage was implemented during the 1997-1999 fishing seasons in response to a decline in smolt abundance. The second stage was implemented beginning in 2000 in response to a decline in adult harvests throughout UCI. Fishery restrictions in the plan were developed to reduce harvest potential among all user groups during average and above average runs. Additionally, sustained yield levels are unknown because of limited stock production information.

In addition to the UCI-wide sources listed previously, information about Kenai River coho salmon can be found in the following sources:

Area management reports: Nelson 1994, 1995; Bethe et al. 2002; Gamblin et al. 2004; Pappas and Marsh 2004;

Research reports: Hammarstrom 1977, 1978; Carlon 1992, 2000, 2003; Carlon and Hasbrouck 1993-1994, 1996-1998; Massengill and Carlon 2004a, b; Massengill and Carlon *In prep a-b*; Massengill *In prep*; Carlon and Evans *In prep*; King 1993, 1994; Reimer and Sigurdsson 2004; Hammarstrom 1988-1992; King and Breakfield 1998, 1999, 2002; Vincent-Lang 1990;

Information about other similar stocks: Shaul et al. 2003;

Northern pike reports: Begich and McKinley 2005.

WHAT IS THE RECENT STATUS OF COHO SALMON IN THE KENAI RIVER?

The status of coho salmon of Kenai River origin is assessed from three sources of information: (1) the annual population-specific total harvest including commercial and inriver sport and personal use harvests, (2) the annual drainage-wide smolt production, and (3) the annual total run of adults. These sources of information are examined to evaluate current stock status.

Although these sources of information served to define the concerns leading to the precautionary plan, the record of information does not yet provide a basis for defining sustained yield. Annual total harvest and smolt production have been estimated only since 1993 and 1992, respectively, and total run has been estimated only since 1999. The record of annual sport harvests spans a longer time period (since 1977) and is therefore examined for historical perspective.

Harvest

Annual sport harvests of coho salmon from the Kenai River increased from 1977 to a record high of 91,000 in 1994 and have been lower since (Figure 41). The five-year averages during 1980-1994 increased steadily from 35,000 to 69,000 coho salmon. In 1997, emergency orders were issued inseason restricting fisheries to address concerns of a weak run. The resulting sport harvest was only about 21,000 fish. After 1999, sport harvests have averaged about 56,000 fish.

Commercial harvests of Kenai River coho salmon have been estimated annually since 1993 through a coded wire tag recovery program (Tables 1-3). A more in-depth discussion of the coded wire tagging program is found later in this report. Prior to the initial management plan in 1997, the annual commercial harvest of Kenai River-bound coho salmon in UCI averaged 17,500 fish. In 1997, inseason emergency orders restricted commercial fisheries in response to the weak coho salmon run to UCI that reduced commercial harvests of Kenai River coho salmon to about 3,000 fish. Since 1997, commercial harvests of Kenai River coho salmon have averaged 6,000 under the first stage (1997-1999) and 3,500 under the second stage (2000-2003) of the management plan.

Inriver personal use and subsistence harvests are estimated annually and have averaged 1,400 fish from 1993 through 2003. Adding annual sport, personal use/subsistence, and commercial harvest estimates together provides a record of total harvest for the stock from 1993 through 2003 (Figure 42). Total harvest prior to 1997 averaged 79,000 fish, from 1997-1999 averaged 36,000 fish, and from 2000-2003 averaged 61,000 fish. Total harvest has ranged from 25,000 fish during the restricted 1997 season to a record of 121,000 coho salmon in 1994. The second highest total harvest of 74,000 Kenai River coho salmon occurred in 2002.

The record high total harvest of 121,000 in 1994 demonstrates the harvest potential of users prior to the implementation of the management plan in 1997. Since 1993 the inriver sport harvests have on average accounted for 84% of the total annual harvest. The distribution of the total harvest has changed over the periods 1993-1996 (prior to the management plan), 1997-1999 (under the first stage of the plan), and 2000-2003 (under the second stage of the plan; Figure 43). During 1993-1996, the inriver fisheries took an average 78% of the total harvest, with 39% taken by unguided sport anglers in the mainstem. In 1997-1999, inriver harvest accounted for an average of 83% of the total harvest, with 55% of the total harvest taken by unguided sport anglers in the mainstem. During 2000-2003, inriver harvest accounted for an average of 94% of the total harvest, with unguided sport anglers taking 68% of the total harvest. Conversely, the percentage of total harvest of Kenai River coho salmon by the commercial fisheries has on average decreased from 22% to 6% over these time periods. Based on averages, approximately 16% of the total harvest of Kenai River coho salmon has shifted to the inriver fisheries since 1993.

Smolt Abundance

Kenai River coho salmon typically rear in freshwater for two winters and one at sea before returning to spawn as adults. River-wide smolt abundance has been estimated annually since 1992 through the same coded wire tag program applied to estimate commercial harvest. Abundance has ranged from a high of about 1,200,000 smolt emigrating to sea in 2003 to a low of 374,000 in 1997 (Figure 44A). Index projections indicate that as many as 850,000 smolt may have emigrated in 2004. However, the index method also suggests that the true smolt abundance likely falls within a range between 560,000 and 1.33 million. A final estimate of the 2004 smolt abundance will be available in the fall of 2005; however, it appears that the declining trend of

coho salmon smolt that initialized concerns and development of the management plan in 1997 has been reversed.

The relationship between parent year harvest and smolt production is being evaluated (Figure 44B). The data indicate that the lowest smolt production is associated with the highest parent year (1994) harvest of 121,000 (Figures 42, 44B). It is not possible at present to determine if the decrease in smolt production was harvest-induced, natural, or a combination of both; this assessment approach requires multiple harvest-smolt estimates within a wide harvest range to determine if a relationship exists. This will require estimating annual harvest and smolt abundance over a number of years.

Total Run

An inriver tagging and recovery program has been used since 1999 to estimate the number of adults reaching a study area at river mile 28. Total run is estimated by summing the number reaching the study area with estimates of harvest occurring downstream from the study area (including marine commercial harvest). Using this approach, total run was estimated for 1999-2003 and has ranged from 48,000 (1999) to 209,000 (2002) coho salmon (Table 4).

Estimates of total run provide information to estimate harvest exploitation and, with estimates of smolt abundance, marine survival (Table 4). The highest total exploitation rate of over 80% in 1999 indicates that at low levels of abundance (as was measured in 1999), exploitation rates of fisheries as configured at that time can attain levels that are probably not sustainable over consecutive years. In years of greater abundance, such as 2000-2003 when annual total run estimates of Kenai River coho salmon were at least 130,000 fish, exploitation averaged 41%. This level of exploitation is considered sustainable for a number of coho salmon stocks in Southeast Alaska; total exploitation of some of these stocks has averaged 60% from 1982-2002.

Marine survival estimates of Kenai River coho salmon have ranged between 6-33% during 1999-2003 (Table 4). Survival estimates during the last four years have been relatively stable between 22-33%. The relatively higher estimates of smolt abundance since 1998 coupled with good marine survival has resulted in good runs of Kenai River coho salmon in recent years; however, as observed for Kenai River and other coho salmon stocks marine survival can be highly variable from one year to the next (e.g., Deep Creek, Cottonwood Creek, hatchery-produced coho salmon returning to Anchorage streams).

DOES THE DEPARTMENT HAVE SUSTAINED YIELD OBJECTIVES FOR COHO SALMON IN THE KENAI RIVER?

No. The ongoing assessment program has provided good information on status of Kenai River coho salmon; however, it is too early to develop an escapement goal or sustained yield objective for this stock. In place of a sustained yield objective, the current management approach is to rely on the precautionary plan to provide for an "average" exploitation rate that will provide for sustainability. The actual exploitation realized under the management plan will vary annually but should approximate the "average" exploitation over the long-term. It is not feasible to manage for an absolute exploitation rate due to inter-annual variation in run strength, fishing conditions, and, specifically in the case of commercial fisheries, sockeye salmon management actions. In addition, the management plan provides specific guidelines to the Department with which to take additional restrictive measures on fisheries to respond to weak runs.

IS SUSTAINED YIELD FOR COHO SALMON IN THE KENAI RIVER LIKELY TO BE MET IN THE NEAR TERM?

Probably. Although there are no sustained yield objectives for managing Kenai River coho salmon, harvest during 1993-1996 likely exceeded sustainable levels relative to observed declines in smolt production. Restrictions enacted in 1997 may have reduced harvest in 1998, but it appears the overall exploitation rate on Kenai River coho salmon in 1998 was 65-75% assuming marine survival was 17-20%. The increased smolt abundance observed in 1998 was offset by low marine survival (6%), resulting in a weak run in 1999 and an exploitation rate estimated at nearly 85%.

Since 1999 these trends have reversed. Increased smolt production and higher marine survival rates have resulted in total runs of Kenai River coho salmon of 130,000 or more fish. Annual exploitation on these runs was 35-45%, levels that are sustainable for many coho salmon stocks. If marine survival remains at levels observed in the 2000s, with the relatively high smolt outmigration observed in 2003 and likely again in 2004, runs of Kenai River coho salmon for the next few years should provide adequate harvest without additional restrictions.

ARE THERE EARLY AND LATE RUNS OF COHO SALMON IN THE KENAI RIVER AND CAN THE DEPARTMENT MANAGE FOR THESE TWO STOCKS SEPARATELY?

There is anecdotal evidence to suggest that there are two, perhaps more, "runs" of coho salmon spawning in the Kenai River, but the Department cannot separately assess and manage for runs that overlap greatly in the timing of their return. First, creel surveys conducted during 1991-1993 and 1998 indicated that distinct runs were not discernable using harvest rate data. Second, catch rates of adult coho salmon in fish wheels during the inriver marking project from 1999-2004 showed no distinct decrease or lull during August and September. Distinct runs relative to differences in timing should have caused a cumulative catch rate curve that increased, leveled off, and then increased again, a pattern that was not observed (Figures 45A and B). Finally, estimates of smolt abundance apply to the annual smolt emigration as a whole and cannot be separated into smolt estimates of "early" and "late" run timing. Recoveries of these marked coho salmon during the adult return indicate that time of entry and time of spawning are independent of time of marking. Preliminary genetics work conducted by the U.S. Fish and Wildlife Service indicated that genetic differences may exist among spawning Kenai River coho salmon, but this study can provide no information on run timing relative to time of spawning. Based on results of these various studies, assessment information (smolt abundance, harvest, etc.) is used to manage Kenai River coho salmon as a single, discrete run.

Because the combined fishing effort on Kenai River coho salmon changes over the duration of the run, there is the possibility for differential exploitation between early-returning and late-returning fish. Fish returning in July and August are subject to exploitation in multiple fisheries (marine commercial, inriver personal use, inriver sport), while fish returning later are harvested only in the sport fishery.

TO WHAT EXTENT ARE ISSUES OUTSIDE OF FISHERY MANAGEMENT INFLUENCING PRODUCTION OF COHO SALMON IN THE KENAI RIVER?

Urbanization and stream bank development along the Kenai River have the potential to affect production of coho salmon. There have been no specific studies to address potential loss of coho salmon spawning and/or rearing habitat in the Kenai River, although loss of habitat due to the effects of bank angling and boat traffic are being studied.

Northern pike have also been introduced to the Kenai River drainage. Affects on salmon production in the Kenai River watershed is unknown. If they became established in coho salmon rearing habitat, production of juvenile coho salmon could be negatively affected in the Soldotna Creek and Moose River drainages, and other portions of the watershed. U.S. Fish and Wildlife Service surveys of lakes in the Moose River have not found pike although pike captures by ice-fishing anglers have been anecdotally reported. Several hundred pike have been captured and removed from lakes in the Soldotna Creek drainage. Anecdotal evidence suggests the presence of pike in other lakes that can potentially drain into the Kenai River.

ANALYSIS OF CODED WIRE TAGGING INFORMATION

Information about coded wire tagging projects can be found in the following sources:

General information: Bernard and Clark 1996; Bernard et al. 1998;

Kenai River projects: Carlon 1992, 2000, 2003; Carlon and Hasbrouck 1993-1994, 1996-1998; Massengill and Carlon 2004a, b; King and Breakfield 1998, 1999, 2002;

Northern Cook Inlet projects: Bosch and Evans 2006; Cyr et al. 1997-1999, 2001; Hoffmann and Hasbrouck 1994; Stratton et al. 1996.

CAN WE USE CODED WIRE TAGGING (CWT) INFORMATION TO INFER HARVEST TIMING AND EXPLOITATION RATE OF COHO SALMON IN CDD, ND, AND ESSN COMMERCIAL FISHERIES?

Yes, but only to a limited extent. A CWT marking and hatchery release program in the Anchorage area (Ship, Campbell, and Bird creeks; Figure 2) has been in operation since 1992, with a catch sampling program in UCI commercial fisheries since 1993. The harvest timing of coho salmon from these releases was similar to all other coho salmon harvested in the CDD fishery in nine of eleven years (Figure 46 and Table 1). However, the harvest timing of hatchery coho salmon was similar to all other coho salmon harvested in the ND fishery in only four of eleven years (Table 2). For the Westside setnet and the Eastside setnet fisheries of the ND (Figure 1) the agreement between harvest timing of marked stocks and total harvest was fair for the Westside but poor for the Eastside (Figures 47 and 48). The harvest timing of hatchery coho salmon was similar to all other coho salmon harvested in the ESSN fishery in eight out of the eleven years (all years except 1994, 1995, 2000; Table 3), but the harvests are fairly small and intermittent.

A wild stock of coho salmon in Knik Arm, Cottonwood Creek, has been marked with CWTs since the 2000 adult return. The harvest timing of this stock in the CDD and the entire ND were similar to the timing of total harvest in seven out of eight comparisons (Figure 46, Tables 1 and 2).

Similarities in harvest timing in the CDD fishery indicate that commercial fishery exploitation rates of hatchery coho salmon returning to the Anchorage area are likely similar to exploitation rates of all other coho salmon. The exploitation rate of hatchery coho salmon in the CDD fishery during 1993-2003 ranged from 3% (2001) to 44% (1994) and averaged 20% (Table 5). Harvest of hatchery coho salmon in the CDD peaks during late July (Table 1, Figure 46). Although exploitation rates of hatchery coho salmon are known in the ND fishery (Table 5), these rates may not apply to other particular stocks. The exploitation rate of Cottonwood Creek coho

salmon in the CDD fishery ranged from 4% (2001) to 17% (2000) and in the ND fishery ranged between 9% (2002) and 25% (2000) during 2000-2003 (Table 4).

CAN WE USE CWT INFORMATION TO INFER HARVEST TIMING AND EXPLOITATION RATE OF KENAI RIVER COHO SALMON IN THE ESSN FISHERY?

Yes. A CWT recovery program has been in operation on the Kenai River and in UCI commercial fisheries since 1993. Harvest of Kenai River coho salmon is estimated from Kenai-origin CWT recoveries and fish ticket information on the harvest of all coho salmon in the ESSN fishery. Kenai River coho salmon contributed between 8% (2001) and 45% (1998) and averaged 22% (1993-2003) of the total coho salmon harvest in this fishery (Table 3). The proportion of Kenai River coho salmon in the total harvest is generally higher in the two southern beaches and lower on the four northern beaches of the ESSN fishery. However, because the inverse is true for total harvest, the absolute harvest of Kenai River coho salmon is similar among all six beaches.

Harvests of Kenai River coho salmon also increase in the ESSN fishery during the course of the fishing season. Harvest of Kenai River coho salmon begins around mid-July and is lowest during this time (1993-2003 average 4% of total harvest), increasing to 21% the last week of July, 36% during the first week of August, and 43% in the second week of August. The maximum harvest of Kenai River coho salmon occurred in this fishery during the last week of July or first week of August in nine out of ten years (2001 excluded due to complete closure after July; Table 3). There is also a temporal decrease in the number of sockeye salmon harvested per coho salmon harvested (i.e., sockeye-to-coho salmon harvest ratio). After August 7 from two to five sockeye salmon are harvested for every coho salmon harvested, with Kenai River coho salmon comprising a greater proportion of the total harvest of coho salmon (Table 6).

WHAT IS THE HARVEST TIMING OF KNIK ARM COHO SALMON IN THE CDD AND ND COMMERCIAL FISHERIES?

Based on CWT data, the Cottonwood Creek wild stock of coho salmon followed the commercial harvest trend of hatchery-produced coho salmon stocked into NCI systems (i.e., Anchorage urban and Eklutna). The highest harvest of Cottonwood Creek coho salmon occurred prior to 25 July each year during 2000-2003 in the CDD (Table 1) and prior to July 31 in two of the last four years in the Northern District (Table 2).

Exploitation rate of Cottonwood Creek coho salmon in all fisheries combined averaged 45% during 2000-2003 (Table 4). Exploitation by commercial fisheries decreased in 2001-2003 relative to 2000. Few Cottonwood Creek coho salmon were harvested in the ESSN fishery. Exploitation by the sport fishery was around 10% each year except 2003 when it increased to 33%, although the sport harvest itself did not increase appreciably in 2003. The low escapement in 2003, given no real changes in smolt outmigration or overall exploitation, was likely caused by relatively low marine survival. As noted with Deep Creek and Kenai River coho salmon, there can be much variation in marine survival, even between consecutive years.

Hatchery coho salmon of Jim Creek origin were first released into Eklutna Tailrace in 1998 and returned as adults in 1999. Jim Creek is in Knik Arm as is Eklutna Tailrace (adjacent to Eklutna Hatchery), so that patterns of harvest of these fish should be indicative of harvest timing of Knik Arm stocks, such as Jim, Cottonwood, and Wasilla creeks (Figure 10). In the CDD fishery, harvests of hatchery coho salmon from Eklutna Tailrace were similar in timing to hatchery coho salmon from Anchorage and all other stocks of coho salmon in three out of four years

(Figure 46; Table 1). The harvest timing of coho salmon from Eklutna Tailrace in the western subdistricts of the ND fishery (statistical areas 247-10, 247-20, and 247-30) was similar to the timing for the Anchorage Urban streams in 1999-2001 (Figure 48). In 2002 and 2003 the pattern of commercial harvest of Eklutna Tailrace coho salmon differed from other groups, suggesting that the run timing was later or that these fish may be milling in the Northern District from mid July to mid August.

SPORT FISHING HARVEST DISTRIBUTIONS (BAG LIMIT ANALYSIS)

WHAT EFFECT DID THE BAG LIMIT REDUCTION FROM THREE TO TWO COHO SALMON HAVE IN UCI SPORT FISHERIES?

In 2000 the Board of Fisheries reduced the sport fishery daily bag limit of coho salmon from three to two fish throughout most of UCI. The harvest distributions of coho salmon from the Statewide Harvest Survey in years prior to the bag limit reduction were combined among all wild stocks within each of the management units in UCI. It is assumed that the distribution of harvest of coho salmon is equal during each angler-day of effort. Only data from 1996 and 1998 are summarized because these were the two years of what appeared to be average coho salmon runs to UCI prior to the reduction in the daily bag limit.

On average between 8% (Kenai Peninsula) and 38% (Twentymile River) of the total harvest of coho salmon in these management units was from anglers harvesting more than two and up to three coho salmon per angler-day (Table 7). Thus, reducing the bag limit to two coho salmon per day likely reduced the harvest potential of the sport fisheries in each of the management units. Recall that the coho salmon sport harvest in UCI has increased modestly since 2000 (Figure 4). It is possible that the increased sport harvest is the result of increased angler effort, either through more days fished per angler and/or an increased number of anglers. The human population has increased by approximately 25,000 people in UCI communities since 2000 (State of Alaska Community Database).

CONCLUSIONS

- Upper Cook Inlet - Coho salmon stocks appear in good condition and have rebounded from low runs and below average escapements that occurred in 1997 and 1999. The combination of record-high escapements, good sport catches, and very low commercial harvest suggests that the total runs of coho salmon since 2000 have been at least moderate, and that the adult returns were shifted from the marine harvest component to the inriver components. Assessment projects allow inseason detection of below vs. average/above average run-strength of coho salmon. Existing management strategies are conservative and should provide sustainable harvest for average to above average coho salmon runs.
- Knik Arm, Anchorage/Turnagain Arm, and Susitna River drainages - Coho salmon stocks are in good condition. The preponderance of coho salmon escapements since 2000 have met or exceeded the few escapement goals. During 2001, 2002 and 2004 the majority of coho salmon escapements were the highest or near highest observed. Improved runs since 1997 and 1999 and lower exploitation in commercial fisheries have allowed more coho salmon to enter their natal streams. Habitat inundation by northern pike may affect production on certain west side Susitna River drainages to an unknown extent.

- West Cook Inlet drainages - Based solely on sport fish harvests, major stocks appear in good condition. The Kustatan River coho salmon stock is providing a stable sport harvest near 5,000 fish. Lower commercial harvests have likely occurred for these stocks. Sport fisheries in West Cook Inlet are currently constrained by limited access.

- Kenai Peninsula drainages - Status of major stocks appears good, with recent sport harvests above average. Limited escapement information indicates high escapements in recent years. Due to their later run timing, southern Kenai Peninsula stocks of coho salmon are exploited at lower rates than earlier-returning stocks.

- Kenai River - The current Kenai River coho salmon management plan provides for sustainability when total run is at least 130,000 fish, through a reduction in harvest potential that affects all users. The reduction in exploitation realized under the current management plan should provide for sustainability of the stock in the long-term. At run sizes observed in the 2000s, harvest potential (opportunity) and exploitation can be increased some and likely still be sustainable; however, the plan's effectiveness in protecting weak runs, especially in conjunction with strong runs of sockeye salmon, has not been tested. Inseason run-strength indicators can be used to detect weak runs and implement emergency fishery restrictions to avoid excessive exploitation. As noted with the Susitna River, northern pike are present in the Kenai River watershed and may decrease coho salmon production to an unknown extent.

- CWT Analyses - Tag recoveries from hatchery coho salmon returning to Anchorage area streams can be used to estimate exploitation rate of all coho salmon in the CDD fishery. Exploitation rates of hatchery coho salmon in the CDD fishery varied from 3% (2001) to 44% (1994) and averaged 20% during 1993-2003. Overall exploitation rate of coho salmon in the ND fishery could not be estimated from the CWT recovery data, with earlier-returning coho salmon occurring in the western statistical areas and later-returning coho salmon occurring in eastern statistical areas. Exploitation rates of Cottonwood Creek coho salmon in commercial fisheries averaged 13% and 16% in the CDD and ND, respectively.

  Harvest of Kenai River coho salmon in the ESSN fishery has declined since 1998. Exploitation rate of Kenai River coho salmon in this fishery averaged 2% during 2000-2003. Stock exploitation rates in this fishery varied from 0.3% in 2001 (because of reduced fishing time) to 6% in 1999. Harvest of Kenai River coho salmon in the ESSN increases beginning in late July or the first week of August. In addition, in early August the ratio of coho salmon to sockeye salmon increases in the harvest. CWT information indicates as well that additional commercial fishing time in August can increase harvest of Kenai River coho salmon, particularly in the ESSN fishery.

  Finally, CWT data and estimates of total run of returning adults have provided estimates of marine survival for some UCI coho salmon stocks. Marine survival has varied greatly among stocks and among years, even between consecutive years, within each stock.

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TABLES

Table 1.-Commercial harvest of coho salmon by the Upper Cook Inlet Central District drift gillnet fishery during four time intervals of July-September, 1993-2003.

	Time	Total	Kenai River		Anchorage Urb[b]		Ship Creek[c]		Little Susitna[d]		Cottonwood		Other CWTs[e]		Non-CWT Stocks	
Year	Interval	Harvest	Harvest	%[a]	Harvest	%[a]	Harvest	%[a]	Harvest	%[a]	Harvest	%[a]	Harvest	%[a]	Harvest	%[a]
1993	< 25 July	**53,114**	106	0.2	1,043	2.0	0	0.0	1,623	3.1			172	0.3	**50,170**	95
	25-31 July	49,691	**575**	1.2	**1,660**	3.3	0	0.0	**2,945**	5.9			**355**	0.7	44,156	89
	1-7 August	13,224	250	1.9	378	2.9	0	0.0	628	4.7			60	0.5	11,908	90
	> 7 August	5,756	0	0.0	107	1.9	0	0.0	89	1.5			40	0.7	5,520	96
1994	< 25 July	102,418	263	0.3	2,841	2.8	5	0.0	2,850	2.8			134	0.1	96,325	94
	25-31 July	**144,678**	4,299	3.0	**6,517**	4.5	291	0.2	**7,785**	5.4			**1,473**	1.0	**124,313**	86
	1-7 August	29,624	**4,511**	15.2	1,227	4.1	326	1.1	1,489	5.0			754	2.5	21,317	72
	> 7 August	27,215	2,659	9.8	472	1.7	**702**	2.6	592	2.2			486	1.8	22,304	82
1995	< 25 July	**162,242**	411	0.3	**3,616**	2.2	53	0.0	**2,278**	1.4			267	0.2	**155,620**	96
	25-31 July	43,169	**2,603**	6.0	2,052	4.8	298	0.7	1,449	3.4			**495**	1.1	36,271	84
	1-7 August	20,020	2,567	12.8	668	3.3	**528**	2.6	293	1.5			342	1.7	15,622	78
	> 7 August	8,695	1,351	15.5	18	0.2	295	3.4	18	0.2			91	1.0	6,923	80
1996	< 25 July	**146,530**	763	0.5	**8,641**	5.9			**2,544**	1.7			6	0.0	**134,575**	92
	25-31 July	18,054	**1,401**	7.8	2,136	11.8			581	3.2			0	0.0	13,937	77
	1-7 August	5,597	277	4.9	472	8.4			235	4.2			**22**	0.4	4,592	82
	> 7 August	1,180	241	20.4	0	0.0			0	0.0			0	0.0	939	80
1997	< 25 July	20,824	13	0.1	1,757	8.4							366	1.8	18,686	90
	25-31 July	**36,948**	359	1.0	**3,251**	8.8							**848**	2.3	**32,492**	88
	1-7 August	21,322	881	4.1	2,573	12.1							762	3.6	17,107	80
	> 7 August															
1998	< 25 July	**65,094**	146	0.2	**3,861**	5.9							**12**	0.0	**61,078**	94
	25-31 July															
	1-7 August	18,243	**1,822**	10.0	773	4.2							0	0.0	15,648	86
	> 7 August															
1999	< 25 July	17,005	17	0.1	314	1.8							146	0.9	16,528	97
	25-31 July	22,315	115	0.5	**933**	4.2							216	1.0	**21,051**	94
	1-7 August	**22,338**	**462**	2.1	795	3.6							**248**	1.1	20,833	93
	> 7 August	2,871	225	7.8	108	3.8							12	0.4	2,526	89

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Table 1.-Page 2 of 2.

Year	Time Interval	Total Harvest	Kenai River Harvest	Kenai River %[a]	Anchorage Urb[b] Harvest	Anchorage Urb[b] %[a]	Ship Creek[c] Harvest	Ship Creek[c] %[a]	Little Susitna[d] Harvest	Little Susitna[d] %[a]	Cottonwood Harvest	Cottonwood %[a]	Other CWTs[e] Harvest	Other CWTs[e] %[a]	Non-CWT Stocks Harvest	Non-CWT Stocks %[a]
2000	< 25 July	**117,965**	215	0.2	**4,134**	3.5					**633**	0.5	**1,455**	1.2	**111,528**	95
	25-31 July	7,706	26	0.3	51	0.7					16	0.2	29	0.4	7,584	98
	1-7 August	5,529	**290**	5.2	12	0.2					0	0.0	0	0.0	5,227	95
	> 7 August															
2001	< 25 July	**25,429**	15	0.1	**642**	2.5					**125**	0.5	**286**	1.1	**24,361**	96
	25-31 July	2,455	0	0.0	85	3.5					19	0.8	14	0.6	2,337	95
	1-7 August	9,418	**267**	2.8	495	5.3					33	0.4	12	0.1	8,611	91
	> 7 August	2,116	0	0.0	7	0.3					2	0.1	0	0.0	2,107	100
2002	< 25 July	**69,823**	95	0.1	1,428	2.0					**419**	0.6	**885**	1.3	**66,996**	96
	25-31 July	33,579	**953**	2.8	**2,986**	8.9					386	1.1	482	1.4	28,772	86
	1-7 August	20,193	238	1.2	98	0.5					106	0.5	11	0.1	19,740	98
	> 7 August	2,236	84	3.8	8	0.4					6	0.3	0	0.0	2,138	96
2003	< 25 July	**35,975**	33	0.1	**973**	2.7					**263**	0.7	**528**	1.5	**34,178**	95
	25-31 July	11,585	123	1.1	272	2.3					33	0.3	97	0.8	11,061	95
	1-7 August	4,861	**174**	3.6	49	1.0					0	0.0	15	0.3	4,623	95
	> 7 August															

Notes: Bold entries indicate peaks.

[a] Percentage of total harvest.

[b] Anchorage urban; includes Bird and Campbell creeks (1993-2001), and Ship Creek (1996-2001).

[c] Stocked with smolt of Ship Creek origin from 1992-1994. Run timing about two weeks later than Little Susitna River brood stock.

[d] Stocked with smolt of Little Susitna River origin from 1992-1995.

[e] Eklutna stocked in 1999-2003.

Table 2.-Commercial harvest of coho salmon by the Upper Cook Inlet Northern District setnet fishery during four time intervals of July-September, 1993-2003.

Year	Time Interval	Total Harvest	Kenai River Harvest	Kenai River %[a]	Anchorage Urb[b] Harvest	Anchorage Urb[b] %[a]	Ship Creek[c] Harvest	Ship Creek[c] %[a]	Little Susitna[d] Harvest	Little Susitna[d] %[a]	Cottonwood Harvest	Cottonwood %[a]	Other CWTs[e] Harvest	Other CWTs[e] %[a]	Non-CWT Stocks Harvest	Non-CWT Stocks %[a]
1993	< 25 July	14,466	0	0	27	0.2	0	0	146	1.0			0	0	14,293	99
	25-31 July	**36,045**	0	0	599	1.7	0	0	1,564	4.3			66	0.2	**33,816**	94
	1-7 August	26,445	25	0.1	910	3.4	4	0	**1,670**	6.3			**460**	1.7	23,376	88
	> 7 August	28,471	**32**	0.1	**953**	3.3	**182**	0.6	1,025	3.6			263	0.9	26,016	91
1994	< 25 July	2,539	0	0	61	2.4	0	0	0	0			0	0	2,478	98
	25-31 July	**62,923**	120	0.2	1,366	2.2	53	0.1	1,542	2.5			159	0.3	**59,683**	95
	1-7 August	45,738	131	0.3	**2,339**	5.1	320	0.7	**2,646**	5.8			482	1.1	39,820	87
	> 7 August	38,088	**226**	0.6	798	2.1	**1,332**	3.5	925	2.4			**538**	1.4	34,269	90
1995	< 25 July	**41,596**	0	0	**637**	1.5	0	0	424	1.0			27	0.1	**40,508**	97
	25-31 July	17,784	65	0.4	541	3.0	10	0.1	**453**	2.5			187	1.1	16,526	93
	1-7 August	10,463	167	1.6	516	4.9	95	0.9	332	3.2			208	2.0	9,160	88
	> 7 August	17,425	**336**	1.9	186	1.1	**1,246**	7.2	122	0.7			**309**	1.8	15,231	87
1996	< 25 July	**33,991**	0	0	1,253	3.7			400	1.2			0	0	**32,338**	95
	25-31 July	23,280	0	0	**4,080**	17.5			**685**	2.9			0	0	18,513	80
	1-7 August	4,552	0	0	473	10.4			42	0.9			0	0	4,038	89
	> 7 August	14,472	**29**	0.2	765	5.3			53	0.4			**4**	0	13,620	94
1997	< 25 July	2,887	0	0	63	2.2							62	2.1	2,763	96
	25-31 July	**18,473**	5	0	1,143	6.2							314	1.7	**17,010**	92
	1-7 August	15,892	**30**	0.2	**2,145**	13.5							**670**	4.2	13,047	82
	> 7 August															
1998	< 25 July	**17,667**	8	0	1,581	8.9							0	0	**16,078**	91
	25-31 July															
	1-7 August	5,896	34	0.6	**1,610**	27.3							0	0	4,251	72
	> 7 August	10,248	**133**	1.3	564	5.5							**4**	0	9,547	93
1999	< 25 July	4,380	0	0	57	1.3							42	1.0	4,281	98
	25-31 July	5,632	0	0	129	2.3							66	1.2	5,437	97
	1-7 August	**10,936**	0	0	**777**	7.1							**153**	1.4	**10,006**	92
	> 7 August	10,488	**171**	1.6	382	3.6							116	1.1	9,819	94

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Table 2.-Page 2 of 2.

Year	Time Interval	Total Harvest	Kenai River Harvest	Kenai River %[a]	Anchorage Urb[b] Harvest	Anchorage Urb[b] %[a]	Ship Creek[c] Harvest	Ship Creek[c] %[a]	Little Susitna[d] Harvest	Little Susitna[d] %[a]	Cottonwood Harvest	Cottonwood %[a]	Other CWTs[e] Harvest	Other CWTs[e] %[a]	Non-CWT Stocks Harvest	Non-CWT Stocks %[a]
2000	< 25 July	**39,140**	0	0.0	**1,454**	3.7					**361**	0.9	**776**	2.0	**36,549**	93
	25-31 July	11,348	**52**	0.5	788	6.9					196	1.7	234	2.1	10,079	89
	1-7 August	5,563	5	0.1	269	4.8					67	1.2	37	0.7	5,185	93
	> 7 August	15,197	26	0.2	232	1.5					130	0.9	20	0.1	14,789	97
2001	< 25 July	9,795	0	0.0	132	1.3					34	0.3	**135**	1.4	9,494	97
	25-31 July	7,274	60	0.8	823	11.3					147	2.0	131	1.8	6,113	84
	1-7 August	12,423	158	1.3	**1,632**	13.1					**212**	1.7	126	1.0	10,295	83
	> 7 August	**16,436**	**1,085**	6.6	1,507	9.2					186	1.1	110	0.7	**13,548**	82
2002	< 25 July	18,322	5	0.0	348	1.9					135	0.7	144	0.8	**17,690**	97
	25-31 July															
	1-7 August	12,604	**44**	0.3	1,450	11.5					201	1.6	**161**	1.3	10,748	85
	> 7 August	**19,366**	8	0.0	**1,709**	8.8					**232**	1.2	73	0.4	17,344	90
2003	< 25 July	**8,374**	0	0.0	**360**	4.3					**120**	1.4	**184**	2.2	**7,710**	92
	25-31 July	3,777	0	0.0	303	8.0					111	2.9	83	2.2	3,279	87
	1-7 August	3,925	13	0.3	344	8.8					50	1.3	90	2.3	3,428	87
	> 7 August	7,939	**113**	1.4	155	1.9					72	0.9	45	0.6	7,555	95

Notes: Bold entries indicate peaks.

[a] Percentage of total harvest.

[b] Anchorage urban includes Bird and Campbell creeks (1993-2001), and Ship Creek (1996-2001).

[c] Stocked with smolt of Ship Creek origin from 1992-1994. Run timing about two weeks later than Little Susitna River brood stock.

[d] Stocked with smolt of Little Susitna River origin from 1992-1995.

[e] Eklutna stocking in 1999-2003.

Table 3.-Commercial harvest of coho salmon by the Upper Cook Inlet Central District Upper Subdistrict (Eastside) setnet fishery during four time intervals of July-September, 1993-2003.

	Time	Total	Kenai River		Anchorage Urb[b]		Ship Creek[c]		Little Susitna[d]		Cottonwood		Other CWTs[e]		Non-CWT Stocks	
Year	Interval	Harvest	Harvest	%[a]	Harvest	%[a]	Harvest	%[a]	Harvest	%[a]	Harvest	%[a]	Harvest	%[a]	Harvest	%[a]
1993	< 25 July	5,975	153	2.6	0	0	0	0	0	0			0	0	5,822	97
	25-31 July	**18,756**	1,501	0.8	**411**	2.2	0	0	458	2.4			78	0.4	**16,308**	87
	1-7 August	12,813	**3,004**	23.4	275	2.1	**12**	0.1	**588**	4.6			**94**	0.7	8,840	70
	> 7 August	5,531	2,162	39.1	10	0.2	0	0	84	1.5			0	0	3,275	60
1994	< 25 July	12,560	521	4.1	148	1.2	0	0	445	3.5			34	0.3	11,412	91
	25-31 July	15,670	1,700	10.8	**407**	2.6	21	0.1	**819**	5.2			215	1.4	12,508	80
	1-7 August	**25,180**	**7,364**	29.2	289	1.1	**28**	0.1	746	3.0			**1,030**	4.1	**15,723**	62
	> 7 August	15,871	5,088	32.1	0	0	24	0.2	47	0.3			346	2.2	10,366	65
1995	< 25 July	**14,710**	586	4.0	180	1.2	18	0.1	**177**	1.2			41	0.3	**13,706**	93
	25-31 July	13,122	3,512	26.8	**183**	1.4	**51**	0.4	130	1.0			**106**	0.8	9,140	70
	1-7 August	9,333	**4,956**	53.1	72	0.8	6	0.1	32	0.3			12	0.1	4,254	46
	> 7 August	7,585	4,044	53.3	24	0.3	38	0.5	0	0			15	0.2	3,464	46
1996	< 25 July	11,970	926	7.7	495	4.1			283	2.4			**21**	0.2	10,243	86
	25-31 July	**17,031**	**5,641**	33.1	**573**	3.4			**306**	1.8			0	0	**10,511**	62
	1-7 August	7,311	3,619	49.5	65	0.9			0	0			0	0	3,627	50
	> 7 August	4,236	1,667	39.4	36	0.8			0	0			0	0	2,533	60
1997	< 25 July	5,811	58	1.0	517	8.9							65	1.1	5,171	89
	25-31 July	**9,767**	958	9.8	**601**	6.2							**281**	2.9	**7,929**	81
	1-7 August	4,090	**1,077**	26.3	471	11.5							120	2.9	2,424	59
	> 7 August															
1998	< 25 July	2,704	120	4.4	126	4.7							0	0	2,458	91
	25-31 July															
	1-7 August	**12,301**	**6,515**	53.0	**177**	1.4							**136**	1.1	**5,474**	45
	> 7 August	3,657	1,467	40.1	35	1.0							28	0.8	2,126	58
1999	< 25 July	958	0	0	6	0.6							3	0.3	949	99
	25-31 July	2,106	146	6.9	49	2.3							6	0.3	1,905	91
	1-7 August	**5,781**	1,172	20.3	**139**	2.4							**15**	0.3	**4,455**	77
	> 7 August	2,834	**1,586**	56.0	0	0							12	0.4	1,236	44

-continued-

Table 3.-Page 2 of 2.

Year	Time Interval	Total Harvest	Kenai River Harvest	Kenai River %[a]	Anchorage Urb[b] Harvest	Anchorage Urb[b] %[a]	Ship Creek[c] Harvest	Ship Creek[c] %[a]	Little Susitna[d] Harvest	Little Susitna[d] %[a]	Cottonwood Harvest	Cottonwood %[a]	Other CWTs[e] Harvest	Other CWTs[e] %[a]	Non-CWT Stocks Harvest	Non-CWT Stocks %[a]
2000	< 25 July	**6,842**	193	2.8	13	0.2					**18**	0.3	**6**	0.1	**6,612**	97
	25-31 July	1,314	576	43.8	0	0.0					3	0.3	0	0.0	735	56
	1-7 August	2,684	**1,582**	58.9	**22**	0.8					0	0.0	0	0.0	1,080	40
	> 7 August															
2001	< 25 July	**2,987**	0	0.0	**43**	1.4					12	0.4	**24**	0.8	**2,908**	97
	25-31 July	1,259	**349**	27.7	13	1.0					**27**	2.1	11	0.9	859	68
	1-7 August															
	> 7 August															
2002	< 25 July	6,230	36	0.6	102	1.6					20	0.3	24	0.4	6,048	97
	25-31 July	**17,795**	**2,638**	14.8	**792**	4.5					**151**	0.9	**35**	0.2	**14,179**	80
	1-7 August	11,128	2,014	18.1	0	0.0					8	0.1	0	0.0	9,106	82
	> 7 August															
2003	< 25 July	**4,251**	227	5.3	**57**	1.3					**23**	0.5	**31**	0.7	**3,913**	92
	25-31 July	3,410	**1,311**	38.4	26	0.8					0	0.0	0	0.0	2,073	61
	1-7 August	2,510	584	23.3	10	0.4					0	0.0	0	0.0	1,916	76
	> 7 August															

Notes: Bold entries indicate peaks.

[a] Percentage of total harvest.

[b] Anchorage urban includes Bird and Campbell creeks (1993-2001), and Ship Creek (1996-2001).

[c] Stocked with smolt of Ship Creek origin from 1992-1994. Run timing about two weeks later than Little Susitna River brood stock.

[d] Stocked with smolt of Little Susitna River origin from 1992-1995.

[e] Eklutna stocking in 1999-2003.

Table 4.-Components of the Kenai River coho salmon runs in 1999-2003, and Cottonwood Creek coho salmon runs in 2000-2003.

	Year									
	1999		2000		2001		2002		2003	
Statistic	Est.[a]	%[b]	Est.[a]	%[b]	Est.[a]	%[b]	Est.[a]	%[b]	Est.[a]	%[b]
Kenai River										
Total Run	48,014		131,302		134,155		209,196		136,115	
Harvests										
Central Drift	818	2	531	0	282	0	1,370	1	330	0
Eastside Setnet	2,905	6	2,351	2	349	0	4,688	2	2,122	2
Northern District	171	0	83	0	1,303	1	57	0	126	0
Total Commercial	3,894	8	2,965	2	1,934	1	6,115	3	2,578	2
Personal Use	1,009	2	1,449	1	1,555	1	1,721	1	1,332	1
Inriver Sport	35,554	74	52,489	40	55,004	41	66,104	32	51,944	38
Total Harvest	40,457	84	56,903	43	58,493	44	73,940	35	55,854	41
Escapement										
Inriver Run	44,120		128,337		132,221		203,081		133,537	
Inriver Harvest	36,563		53,938		56,559		67,825		53,276	
Project mortality	193		555		540		968		209	
Escapement	7,364		73,844		75,122		134,288		80,052	
Marine Survival										
Smolt Abundance[c]	799,687		578,355		601,236		641,693		626,335	
Marine Survival (%)	6		23		22		33		22	
Cottonwood Creek										
Total Run			3,804		5,091		6,309		2,027	
Harvests										
Central Drift			650	17	190	4	917	15	302	15
Eastside Setnet			30	1	51	1	180	3	18	1
Northern District			946	25	678	13	564	9	336	17
Total Commercial			1,626	43	919	18	1,661	26	656	32
Inriver Sport			282	7	647	13	561	9	665	33
Total Harvest			1,908	50	1,566	31	2,222	35	1,321	65
Escapement										
Inriver Run			2,178		4,172		4,648		1,371	
Escapement			1,896		3,525		4,087		706	
Marine Survival										
Smolt Abundance[c]			53,651		51,254		53,865		46,739	
Marine Survival (%)			7		10		12		4	

[a] Estimate.

[b] For harvests, the percent is an estimate of exploitation. Percents = 0 are less that 0.5 and are rounded to 0.

[c] Year i - 1.

Table 5.-Harvests, escapement, and marine survival of 1-ocean Little Susitna River coho salmon brood stocked into Anchorage urban systems that returned during 1993-2003.

Statistic		1993 Est.[a]	1993 %[b]	1994 Est.[a]	1994 %[b]	1995 Est.[a]	1995 %[b]	1996 Est.[a]	1996 %[b]	1997 Est.[a]	1997 %[b]	1998 Est.[a]	1998 %[b]	1999 Est.[a]	1999 %[b]
Smolt Released[c]		192,453		281,179		172,329		470,975		450,475		598,150		480,293	
Commercial Harvest[d]															
CDD	< 25 July	1,043	6.0	2,841	11.2	**3,616**	23.7	**8,641**	25.3	1,757	5.2	**3,861**	7.3	314	2.0
	25-31 July	**1,660**	9.5	**6,517**	25.8	2,052	13.4	2,136	6.2	**3,251**	9.7	0	0.0	**933**	5.9
	1-7 August	378	2.2	1,227	4.9	668	4.4	472	1.4	2,573	7.7	773	1.5	795	5.1
	> 7 August	107	0.6	472	1.9	18	0.1	0	0.0	0	0.0	0	0.0	108	0.7
	Total	3,188	18.2	11,057	43.8	6,354	41.6	11,249	32.9	7,581	22.6	4,634	8.8	2,150	13.7
ESSN	< 25 July	0	0.0	148	0.6	180	1.2	495	1.4	517	1.5	126	0.2	6	0.0
	25-31 July	**411**	2.3	**407**	1.6	**183**	1.2	**573**	1.7	**601**	1.8	0	0.0	49	0.3
	1-7 August	275	1.6	289	1.1	72	0.5	65	0.2	471	1.4	**177**	0.3	**139**	0.9
	> 7 August	10	0.1	0	0.0	24	0.2	36	0.1	0	0.0	35	0.1	0	0.0
	Total	696	4.0	844	3.3	459	3.0	1,169	3.4	1,589	4.7	338	0.6	194	1.2
ND General	< 25 July	23	0.1	61	0.2	342	2.2	1,253	3.7	47	0.1	**1,404**	2.7	57	0.4
	25-31 July	487	2.8	**1,366**	5.4	425	2.8	**3,886**	11.4	1,040	3.1	0	0.0	98	0.6
	1-7 August	**691**	3.9	1,313	5.2	**477**	3.1	391	1.1	**1,907**	5.7	1,312	2.5	**605**	3.9
	> 7 August	628	3.6	654	2.6	158	1.0	558	1.6	0	0.0	447	0.8	314	2.0
	Total	1,829	10.4	3,394	13.4	1,402	9.2	6,088	17.8	2,994	8.9	3,163	6.0	1,074	6.8
ND East	< 25 July	4	0.0	0	0.0	**295**	1.9	0	0.0	16	0.0	177	0.3	0	0.0
	25-31 July	112	0.6	0	0.0	116	0.8	**194**	0.6	103	0.3	0	0.0	32	0.2
	1-7 August	219	1.2	**1,026**	4.1	39	0.3	82	0.2	**238**	0.7	**298**	0.6	**176**	1.1
	> 7 August	**325**	1.9	144	0.6	28	0.2	207	0.6	0	0.0	117	0.2	67	0.4
	Total	660	3.8	1,170	4.6	478	3.1	483	1.4	357	1.1	592	1.1	275	1.8
Total Commercial Harvest		6,373	36.4	16,465	65.2	8,693	56.9	18,989	55.5	12,521	37.3	8,727	16.6	3,693	23.5
Sport Harvest		8,876	50.7	6,287	24.9	5,469	35.8	12,934	37.8	18,468	55.0	39,153	74.3	10,700	68.1
Escapement		2,273	13.0	2,504	9.9	1,124	7.4	2,265	6.6	2,597	7.7	4,833	9.2	1,309	8.3
Total Run		17,522		25,256		15,286		34,188		33,586		52,713		15,702	
Marine Survival (%)		9.1		9.0		8.9		7.3		7.5		8.8		3.3	

-continued-

Table 5.-Page 2 of 2.

Statistic		2000 Est.[a]	2000 %[b]	2001 Est.[a]	2001 %[b]	2002 Est.[a]	2002 %[b]	2003 Est.[a]	2003 %[b]
Smolt Released[c]		318,864		421,207		303,399		273,962	
Commercial Harvest[d]									
CDD	< 25 July	**4,134**	11.8	**642**	1.4	1,428	4.0	**973**	7.4
	25-31	51	0.1	85	0.2	**2,986**	8.4	272	2.1
	1-7	12	0.0	495	1.1	98	0.3	49	0.4
	> 7	0	0.0	7	0.0	8	0.0		
	Total	4,197	11.9	1,229	2.7	4,520	12.7	1,293	9.8
ESSN	< 25 July	13	0.0	**43**	0.1	102	0.3	**57**	0.4
	25-31	0	0.0	13	0.0	**792**	2.2	26	0.2
	1-7	**22**	0.1	0	0.0	0	0.0	10	0.1
	> 7	0	0.0	0	0.0	0	0.0	0	0.0
	Total	35	0.1	56	0.1	894	2.5	93	0.7
ND General	< 25 July	**1,303**	3.7	116	0.3	282	0.8	298	2.3
	25-31	730	2.1	786	1.7	0	0.0	260	2.0
	1-7	269	0.8	**1,595**	3.5	1,434	4.0	**329**	2.5
	> 7	228	0.6	1,445	3.2	**1,683**	4.7	103	0.8
	Total	2,530	7.2	3,942	8.6	3,399	9.6	991	7.5
ND East	< 25 July	**151**	0.4	16	0.0	**66**	0.2	**62**	0.5
	25-31	58	0.2	37	0.1	0	0.0	43	0.3
	1-7	0	0.0	37	0.1	16	0.0	15	0.1
	> 7	4	0.0	**62**	0.1	26	0.1	52	0.4
	Total	213	0.6	152	0.3	108	0.3	172	1.3
Total Commercial Harvest		6,975	19.8	5,379	11.8	8,921	25.1	2,548	19.3
Sport		23,463	66.7	35,681	78.0	18,948	53.3	8,327	62.9
Escapement		4,714	13.4	4,691	10.3	7,649	21.5	2,358	17.8
Total Run		35,152		45,751		35,518		13,233	
Marine Survival (%)		11.0		10.9		11.7		4.8	

Notes: Bold entries indicate peaks.

[a] Estimate.

[b] For harvests, the percent is an estimate of exploitation. Percents = 0.0 are less than 0.1 and are rounded to 0.0.

[c] Smolt released in year i - 1.

[d] CDD=Central District drift gillnet; ESSN=Eastside setnet; ND = Northern District.

Table 6.-Sockeye salmon harvests, escapement in the Kenai and Kasilof rivers, and exploitation rate, with estimates of Kenai River coho salmon harvests, total coho salmon harvest, and sockeye/coho ratio in the Eastside setnet fishery during 1993-2003.

		Sockeye Salmon			Coho		Sockeye:
					Kenai	Total	Coho
Year	Date	Harvest	Escapement	Exploitation	Harvest	Harvest	Ratio
1993	Before	1,382,640	587,615	70%	153	5,975	231
	7/25-7/31	418,326	166,892	71%	1,501	18,756	22
	8/1-8/7	128,598	95,761	57%	3,004	12,813	10
	After 8/7	12,142	59,718	17%	2,162	5,531	2
1994	Before	962,184	461,521	68%	521	12,560	77
	7/25-7/31	175,199	147,572	54%	1,700	15,670	11
	8/1-8/7	286,258	288,954	50%	7,364	25,180	11
	After 8/7	34,521	207,302	14%	5,088	15,871	2
1995	Before	572,670	481,526	54%	586	14,710	39
	7/25-7/31	174,471	180,841	49%	3,512	13,122	13
	8/1-8/7	56,250	87,833	39%	4,956	9,333	6
	After 8/7	27,377	45,107	38%	4,044	7,585	4
1996	Before	1,186,330	634,748	65%	926	11,970	99
	7/25-7/31	243,126	149,555	62%	5,641	17,031	14
	8/1-8/7	46,113	122,234	27%	3,619	7,311	6
	After 8/7	7,429	51,364	13%	1,667	4,236	2
1997	Before	1,394,315	782,835	64%	58	5,811	240
	7/25-7/31	308,296	65,092	83%	958	9,767	32
	8/1-8/7	130,205	70,443	65%	1,077	4,090	32
	After 8/7	Closed	307,742	Closed	Closed	Closed	NA
1998	Before	365,798	450,004	45%	120	2,704	135
	7/25-7/31	Closed	276,894	Closed	Closed	Closed	NA
	8/1-8/7	137,590	196,297	41%	6,515	12,301	11
	After 8/7	8,645	55,045	14%	1,467	3,657	2
1999	Before	617,280	450,317	58%	0	958	644
	7/25-7/31	291,781	350,506	45%	146	2,106	139
	8/1-8/7	157,247	132,216	54%	1,172	5,781	27
	After 8/7	12,660	108,138	10%	1,586	2,834	4
2000	Before	524,629	656,387	44%	193	6,842	77
	7/25-7/31	2,664	137,392	2%	576	1,314	2
	8/1-8/7	2,454	67,604	4%	1,582	2,684	1
	After 8/7	Closed	19,867	Closed	Closed	Closed	N/A
2001	Before	775,033	585,809	57%	0	2,987	259
	7/25-7/31	94,986	256,638	27%	349	1,259	75
	8/1-8/7	0	86,953	Closed	Closed	Closed	N/A
	After 8/7	0	28,168	Closed	Closed	Closed	N/A
2002	Before	1,042,411	817,912	56%	36	6,230	167
	7/25-7/31	229,472	143,764	61%	2,638	17,795	13
	8/1-8/7	31,275	126,450	20%	2,014	11,128	3
	After 8/7	0	96,480	Closed	Closed	Closed	N/A
2003	Before	1,557,270	1,143,057	58%	227	4,251	366
	7/25-7/31	140,903	228,251	38%	1,311	3,410	41
	8/1-8/7	48,668	147,292	25%	584	2,510	19
	After 8/7	0	22,342	Closed	Closed	Closed	N/A

Table 7.-Number of households that responded (n) to the Statewide Harvest Survey and percentage of the total harvest of coho salmon in Upper Cook Inlet in 1996 and 1998 categorized by daily bag limit.

Survey Area	Coho harvest per angler per day	1996 n	1996 %	1998 n	1998 %	Average %
Knik Arm	0 - 1	346	25%	326	28%	26%
	1 - 2		31%		28%	29%
	2 - 3		23%		19%	21%
	other[a]		21%		26%	23%
Twentymile River	0 - 1	40	17%	36	16%	17%
	1 - 2		32%		21%	26%
	2 - 3		40%		37%	38%
	other[a]		11%		26%	19%
East Susitna	0 - 1	423	43%	399	44%	43%
	1 - 2		31%		26%	28%
	2 - 3		19%		14%	16%
	other[a]		7%		17%	12%
West Susitna & West Cook Inlet	0 - 1	364	22%	292	27%	24%
	1 - 2		27%		29%	28%
	2 - 3		23%		24%	24%
	other[a]		28%		19%	24%
Kenai Peninsula	0 - 1	987	56%	1,070	62%	59%
	1 - 2		22%		26%	24%
	2 - 3		11%		5%	8%
	other[a]		11%		6%	9%

[a] Other is defined as a combination of proxy and small coho salmon less than 16 inches in length.

FIGURES

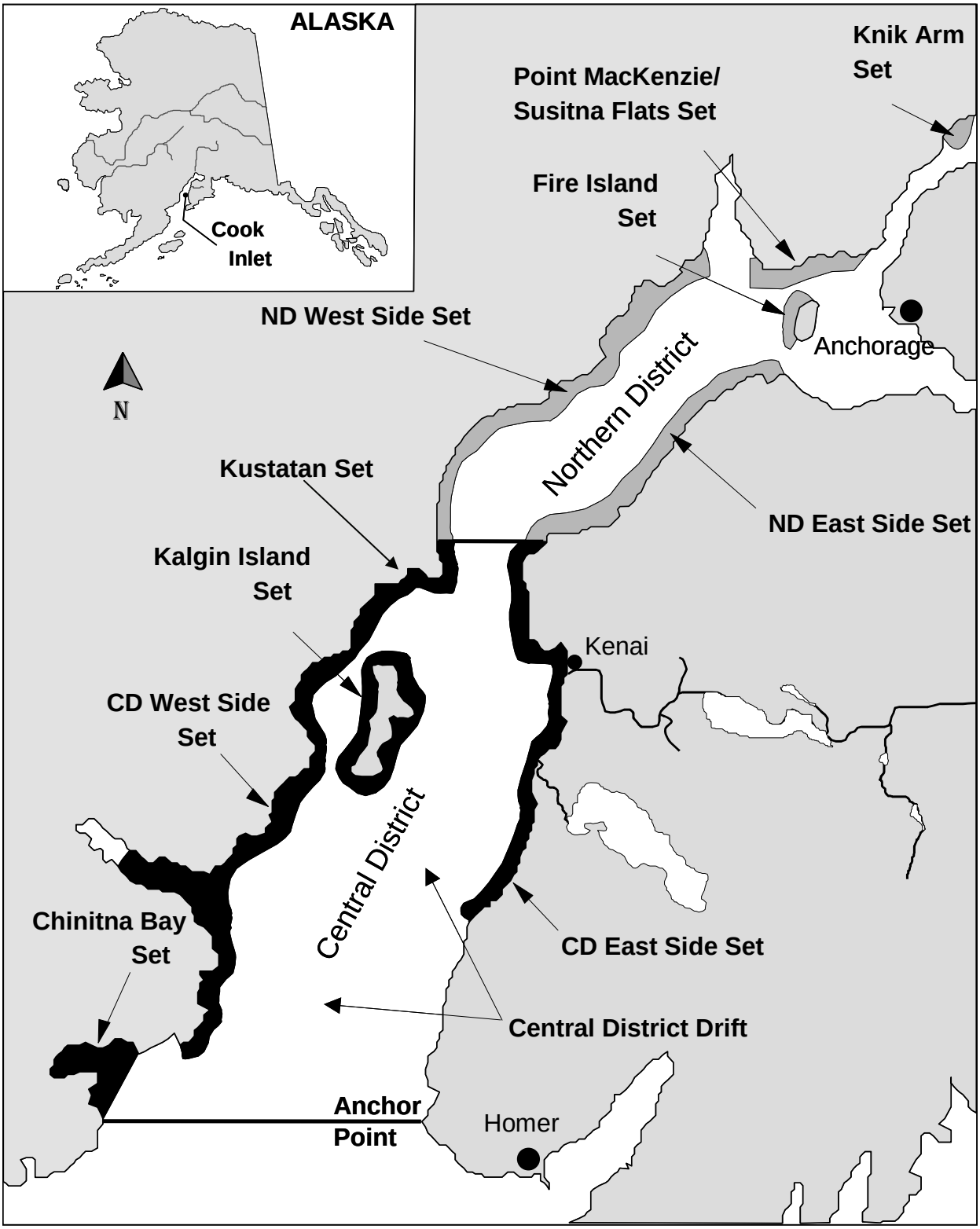


Figure 1.-Upper Cook Inlet with commercial fishing districts and individual set and drift net fisheries.

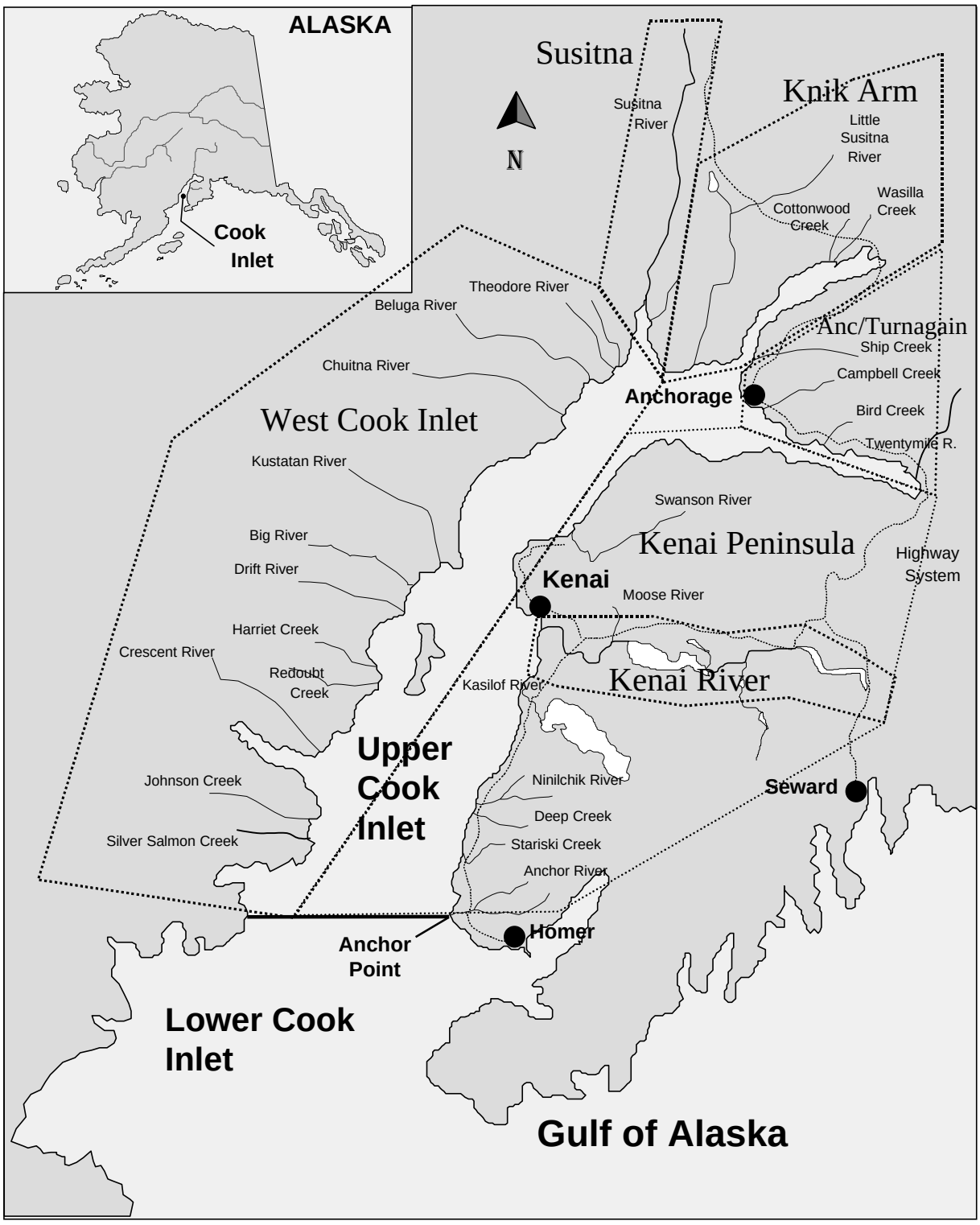


Figure 2.-Upper Cook Inlet with important coho salmon tributaries and management units.

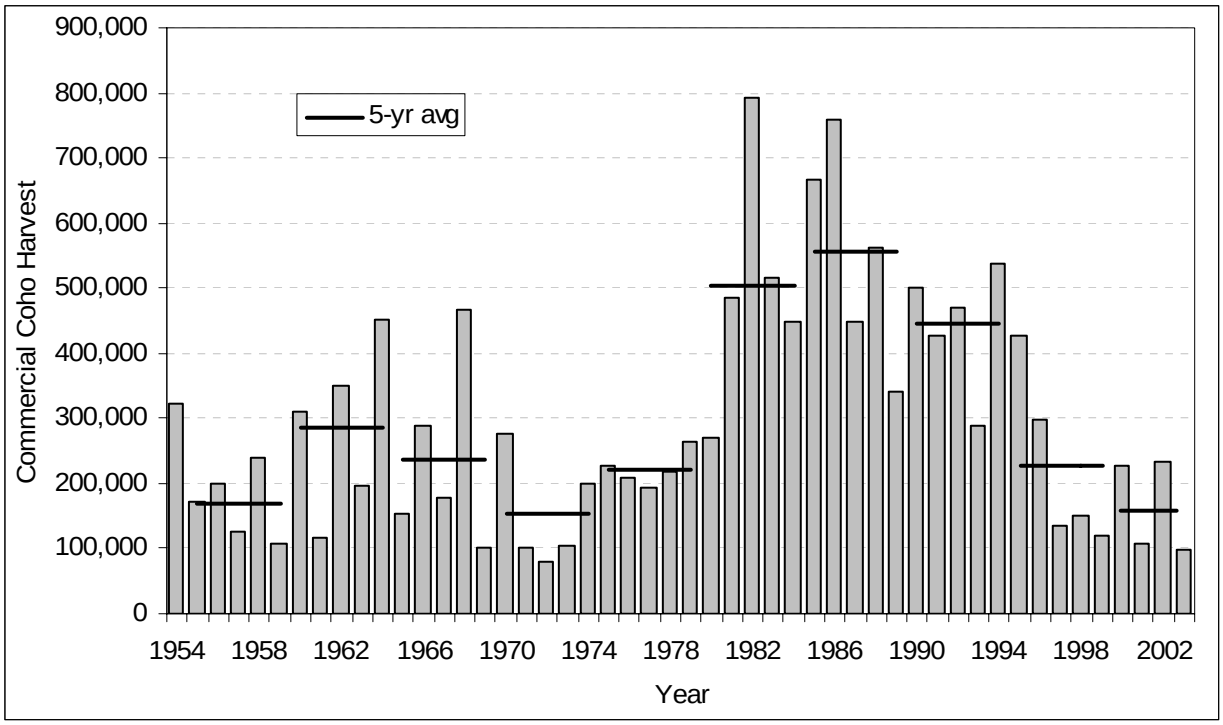


Figure 3.-Commercial harvest of wild coho salmon in Upper Cook Inlet, 1954-2003.

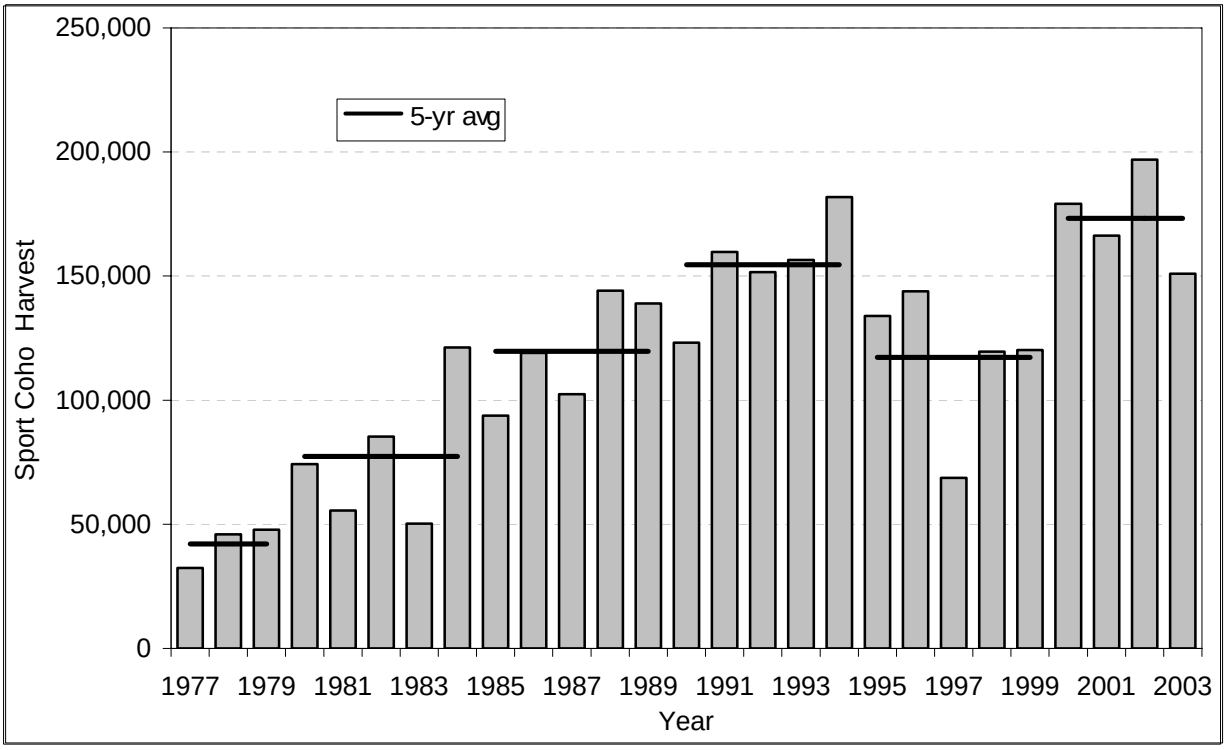


Figure 4.-Sport harvests of wild coho salmon in Upper Cook Inlet, 1977-2003.

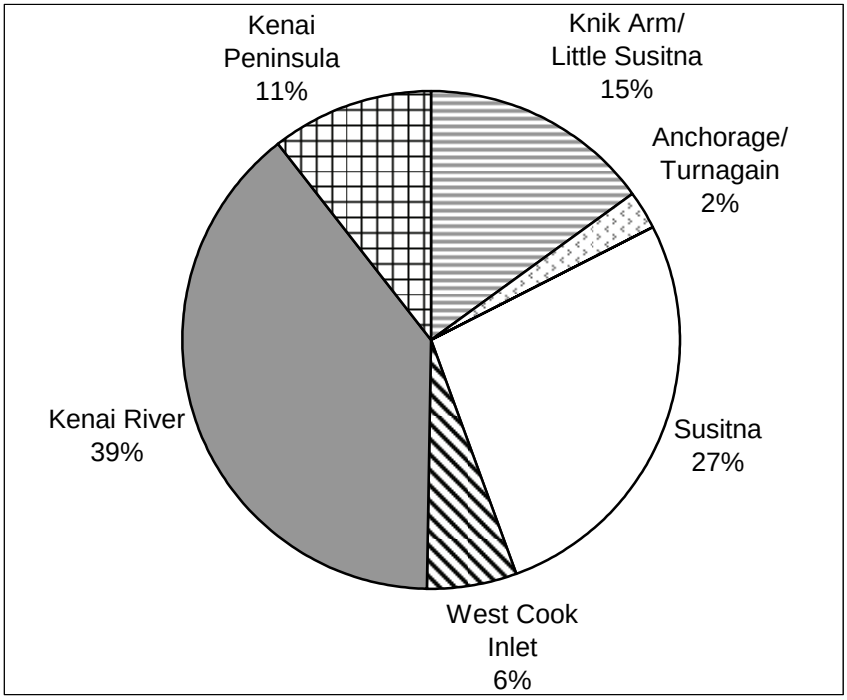


Figure 5.-Distribution of sport harvests of wild coho salmon in Upper Cook Inlet, 1977-2003.

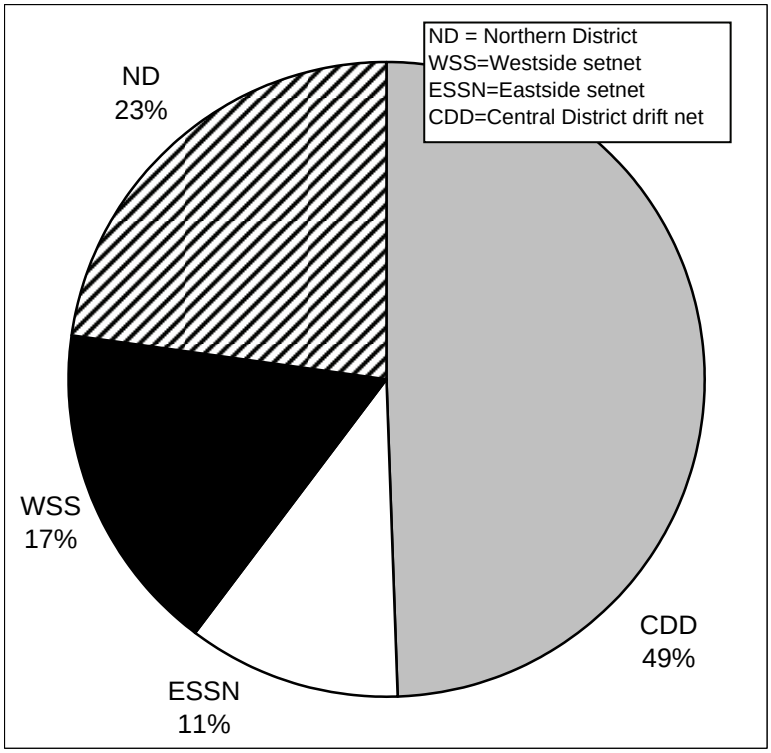


Figure 6.-Distribution of commercial harvests of wild coho salmon in Upper Cook Inlet, 1977-2003.

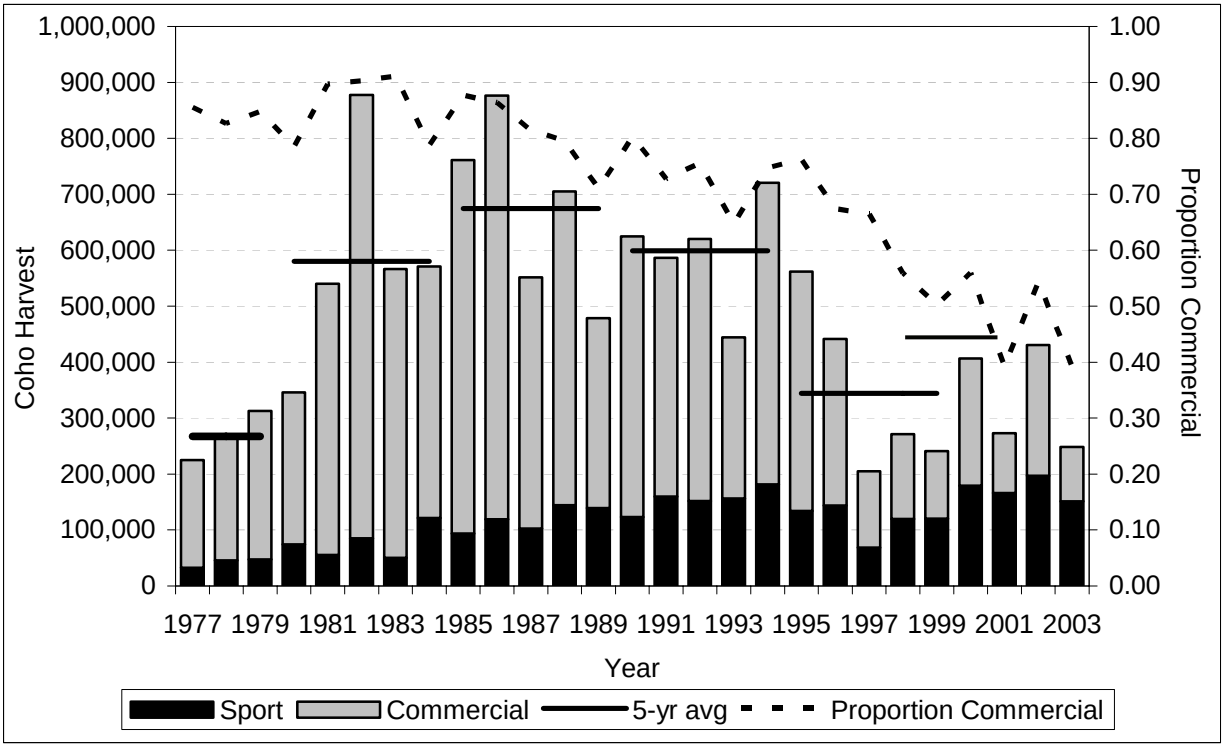


Figure 7.-Commercial and sport harvests of wild coho salmon in Upper Cook Inlet, 1977-2003.

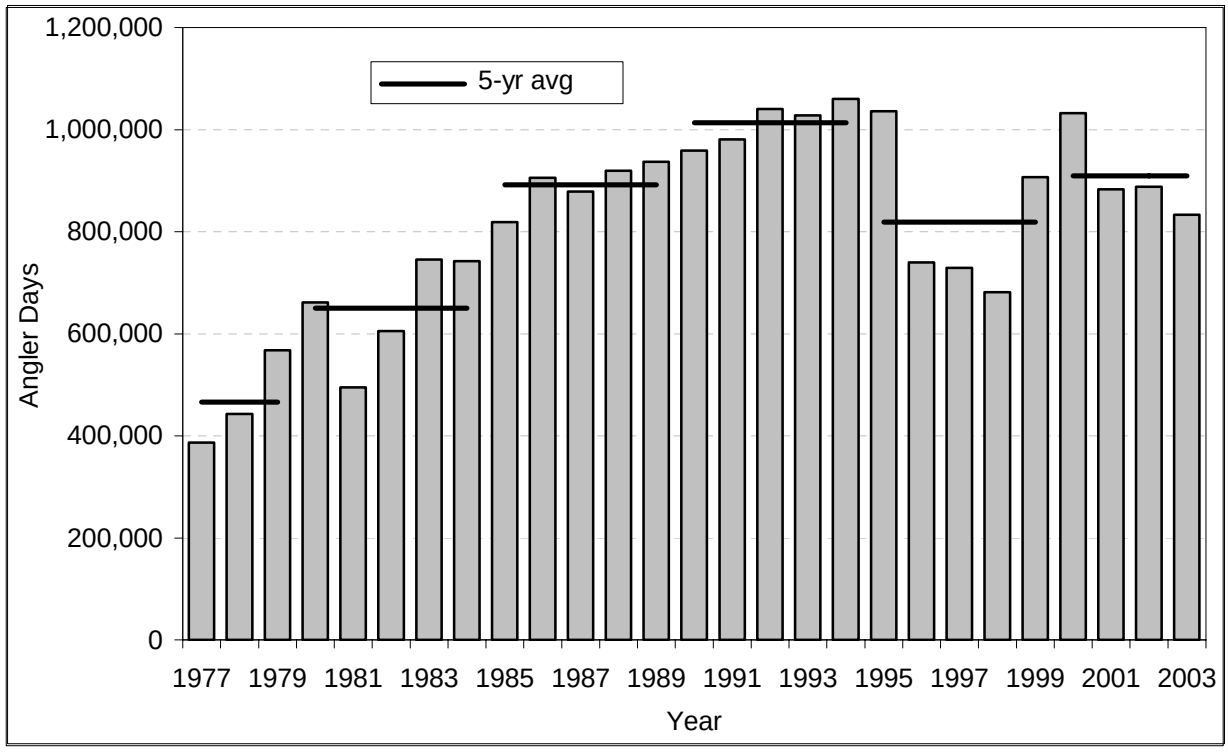


Figure 8.-Sport fishing effort (angler-days) for all species in Upper Cook Inlet, 1977-2003.

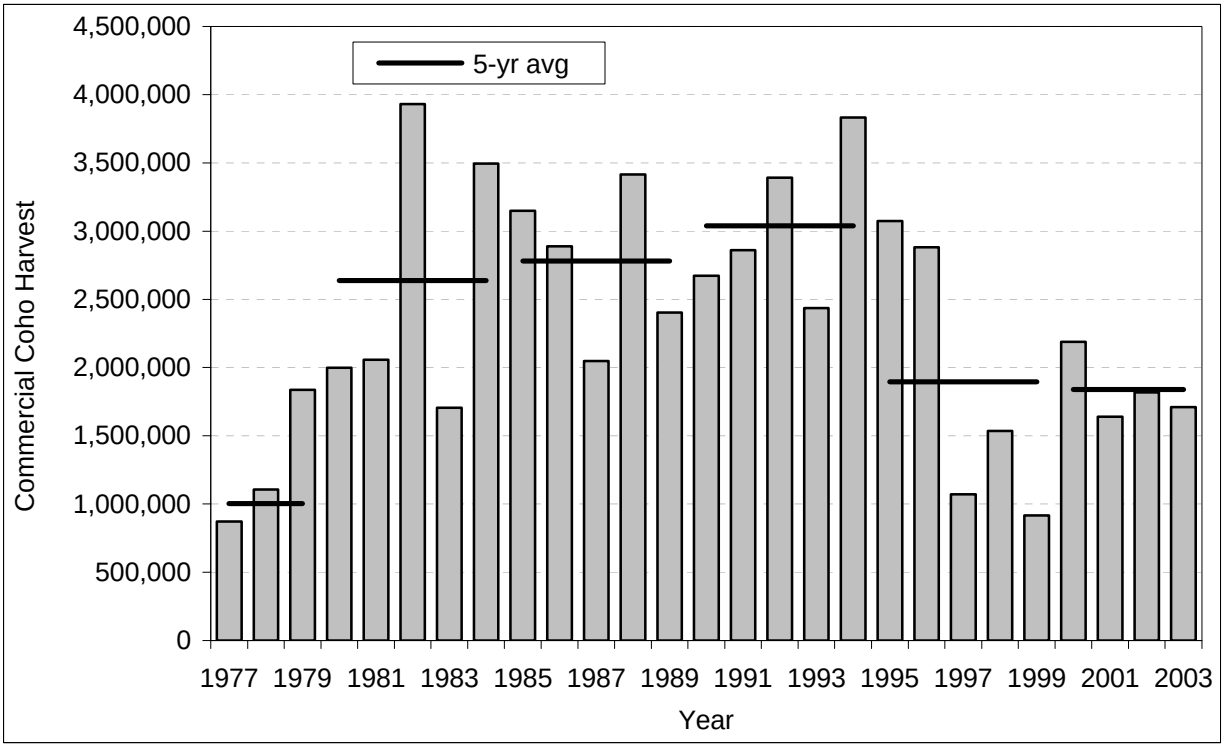


Figure 9.-Commercial harvests of wild coho salmon from areas of Alaska west of Yakutat, 1977-2003.

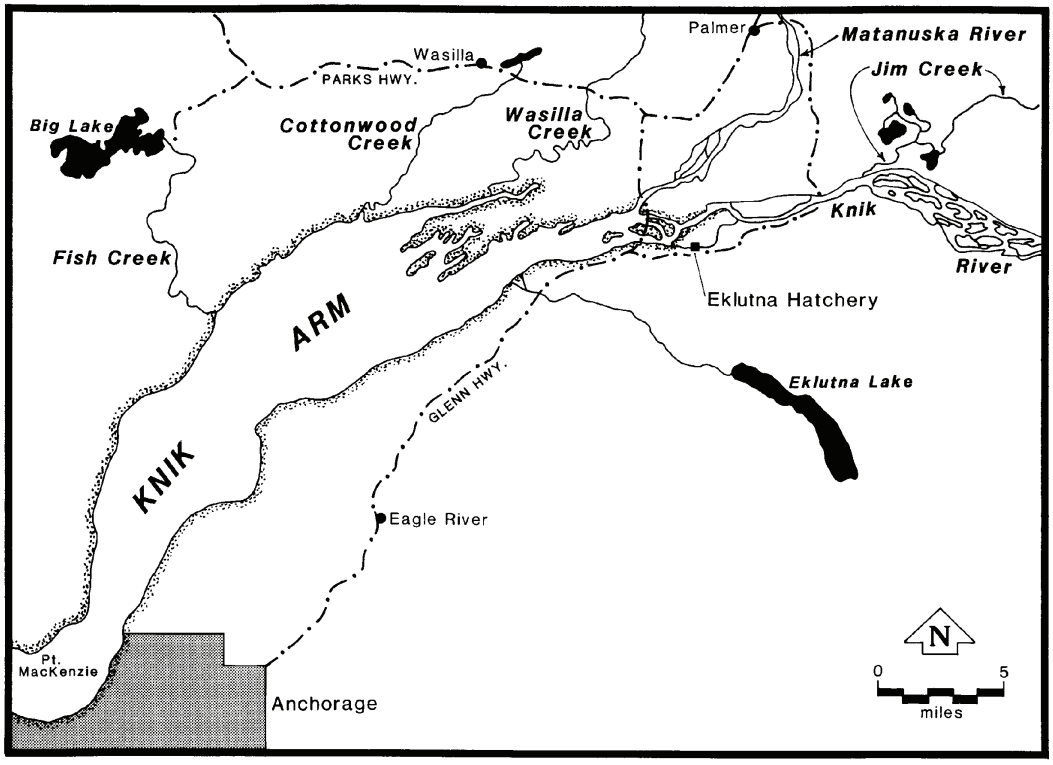


Figure 10.-Map of the Knik Arm drainage.

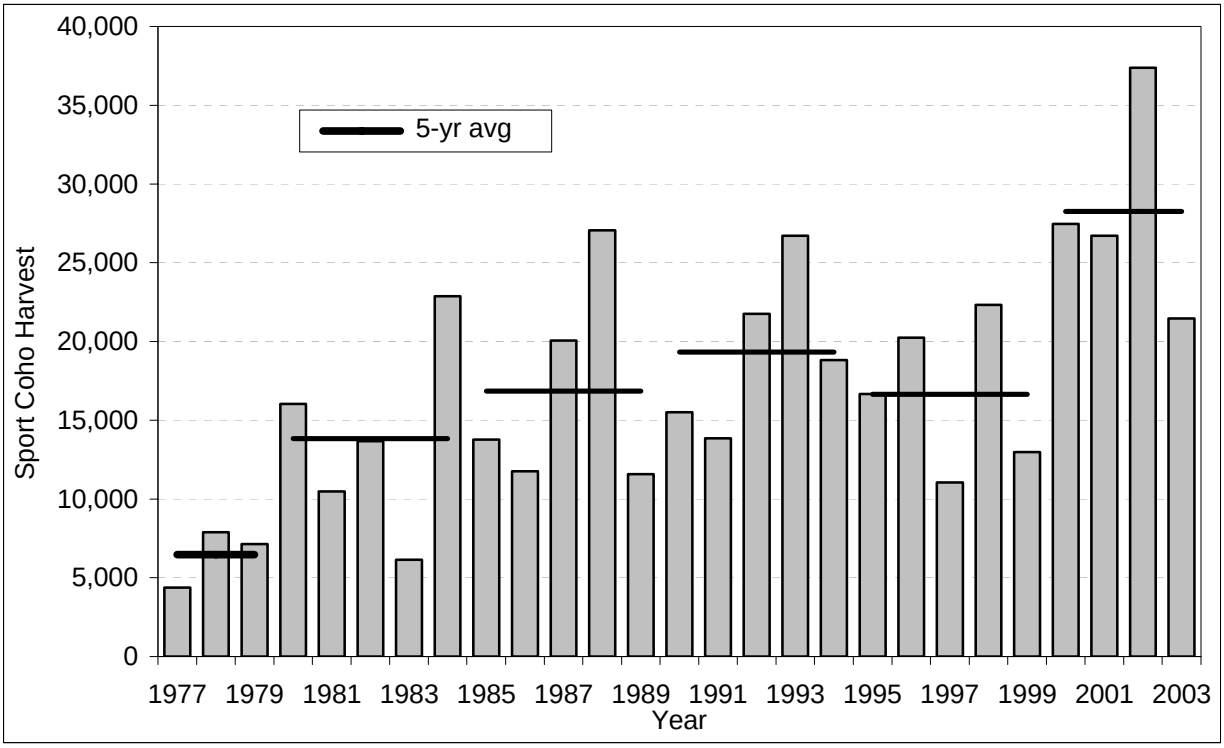


Figure 11.-Sport harvests of wild coho salmon in Knik Arm streams, including the Little Susitna River, 1977-2003.

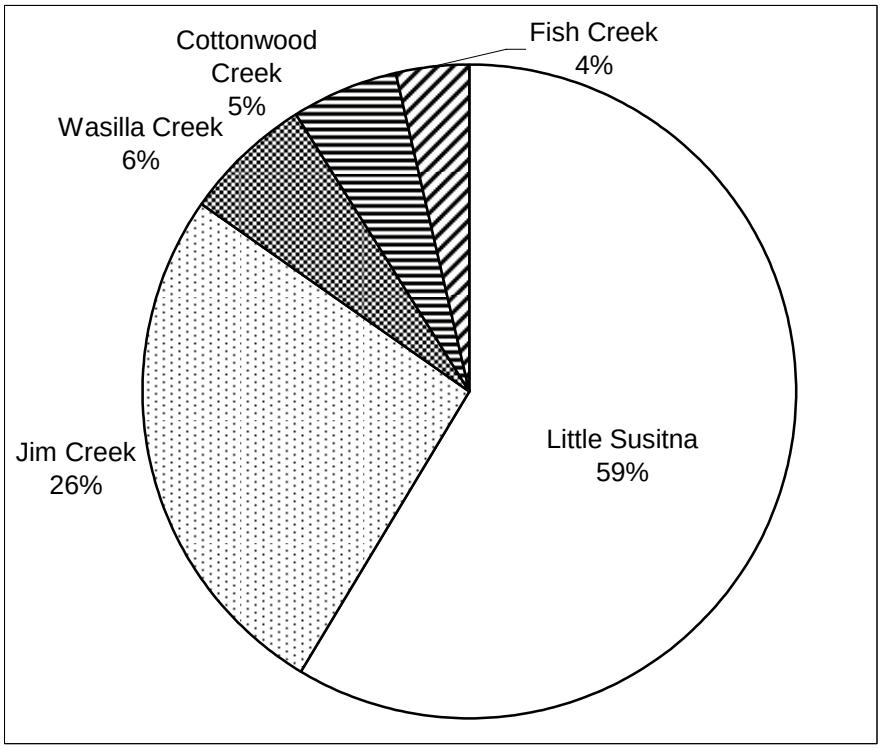


Figure 12.-Distribution of sport harvests of wild coho salmon in Knik Arm streams, 1977-2003.

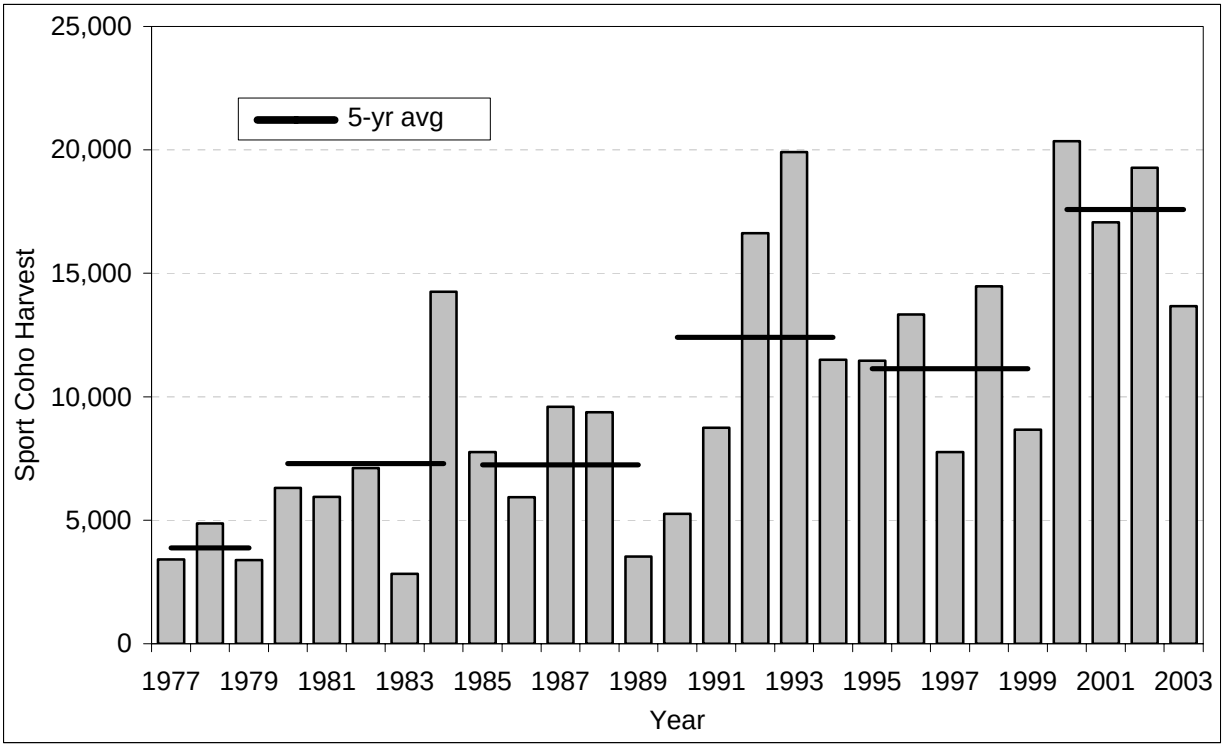


Figure 13.-Sport harvests of wild coho salmon in the Little Susitna River, 1977-2003.

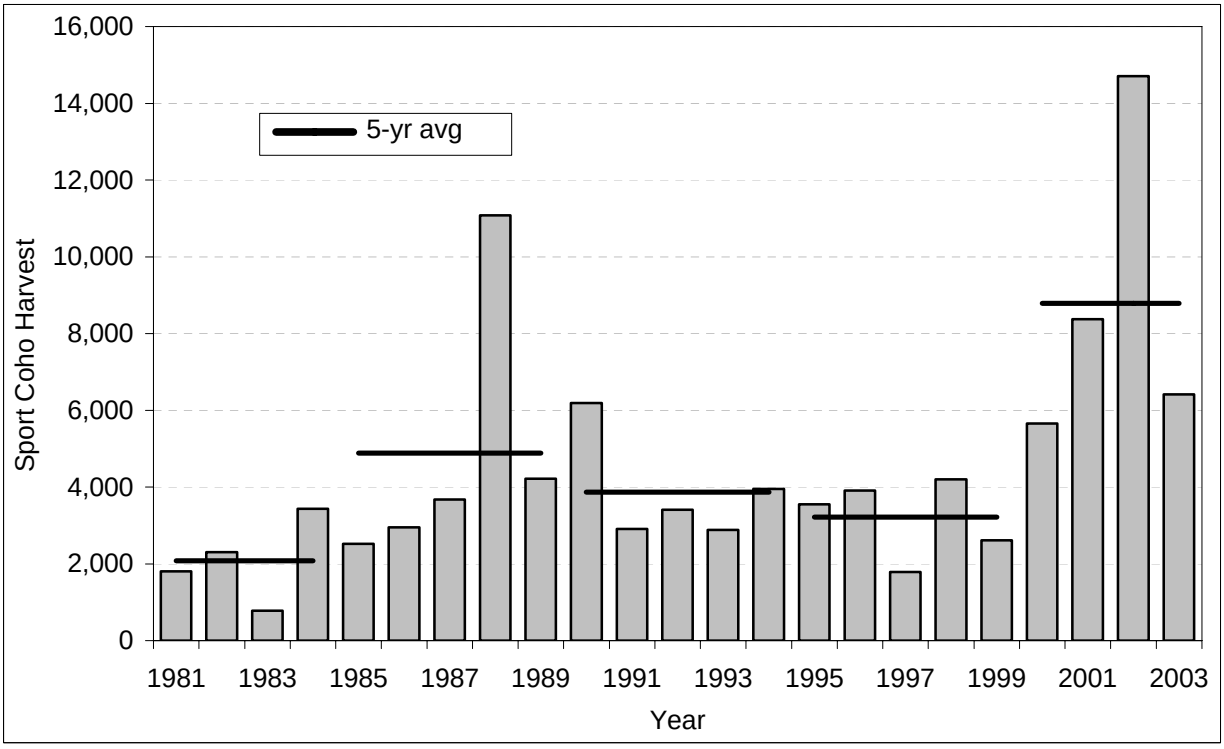


Figure 14.-Sport harvests of coho salmon in Jim Creek, 1981-2003.

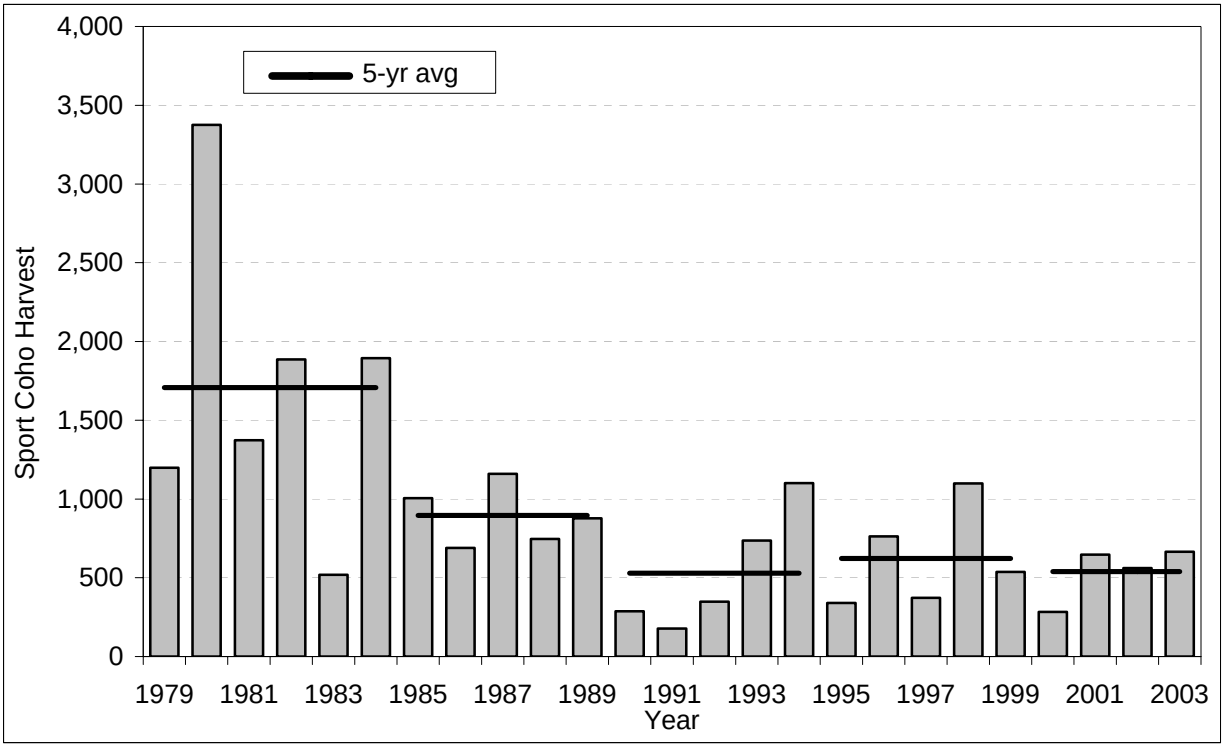


Figure 15.-Sport harvests of coho salmon in Cottonwood Creek, 1979-2003.

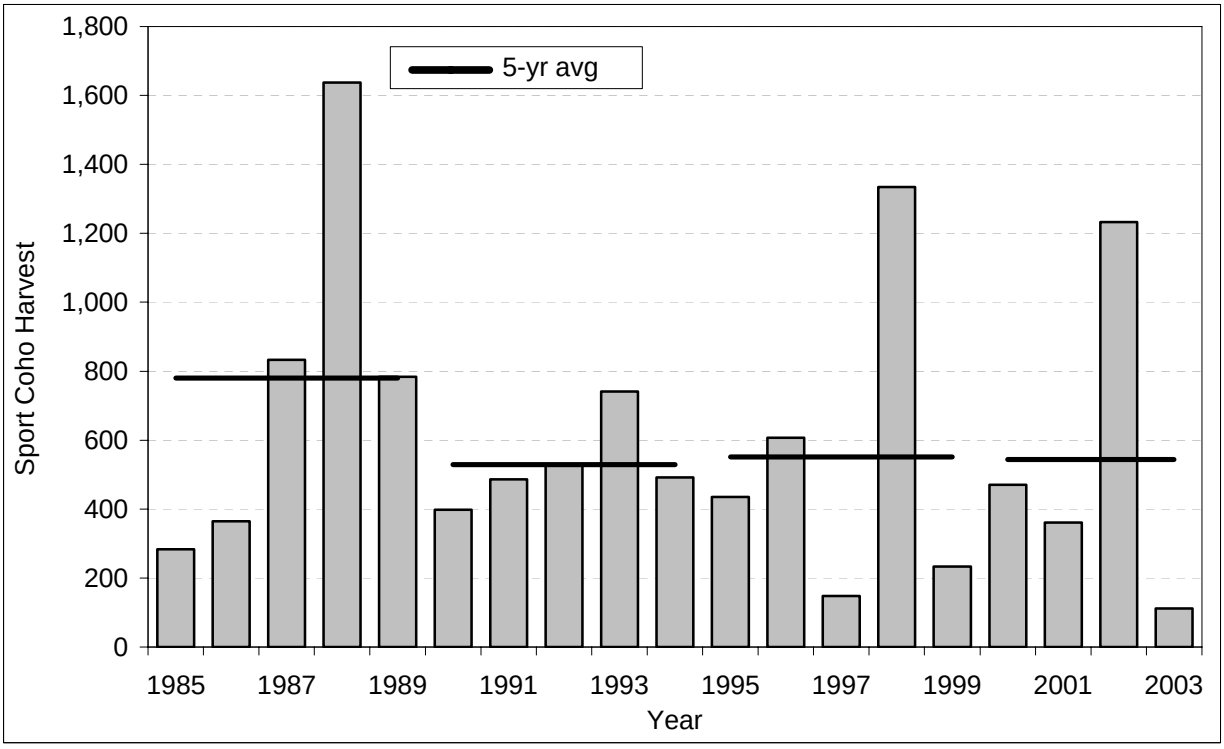


Figure 16.-Sport harvests of coho salmon in Fish Creek, 1985-2003.

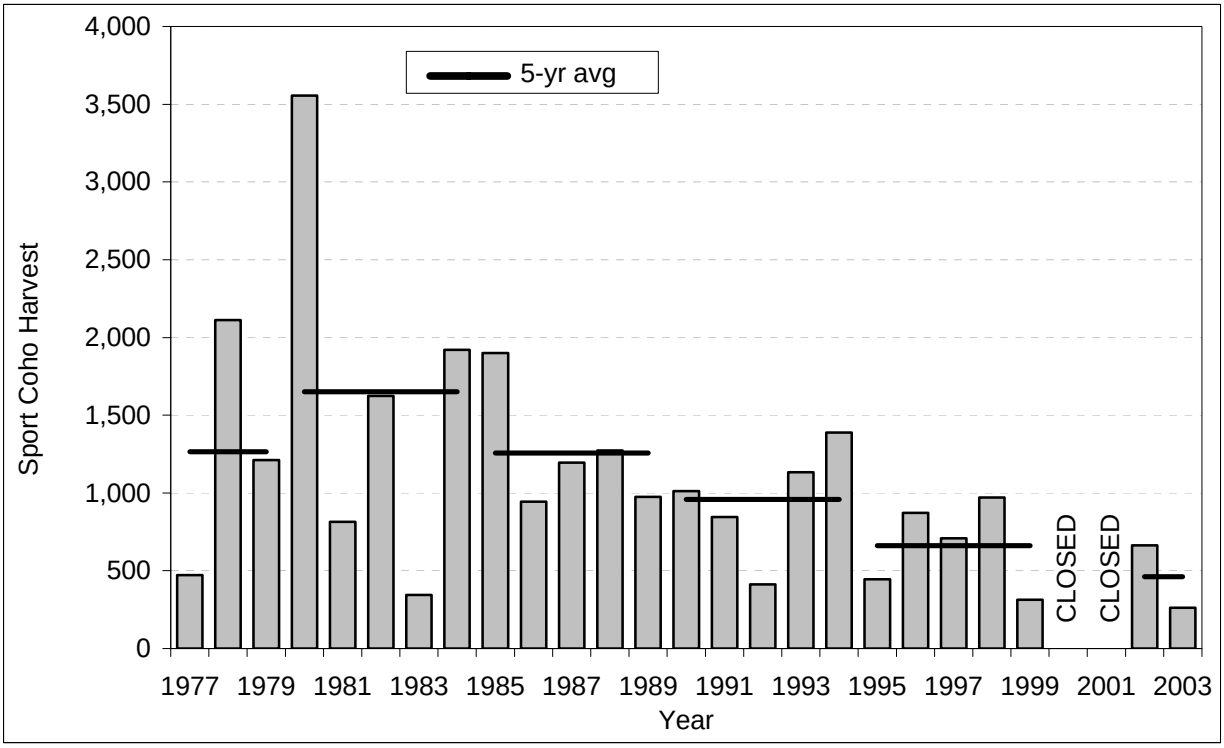


Figure 17.-Sport harvests of coho salmon in Wasilla Creek, 1977-2003.

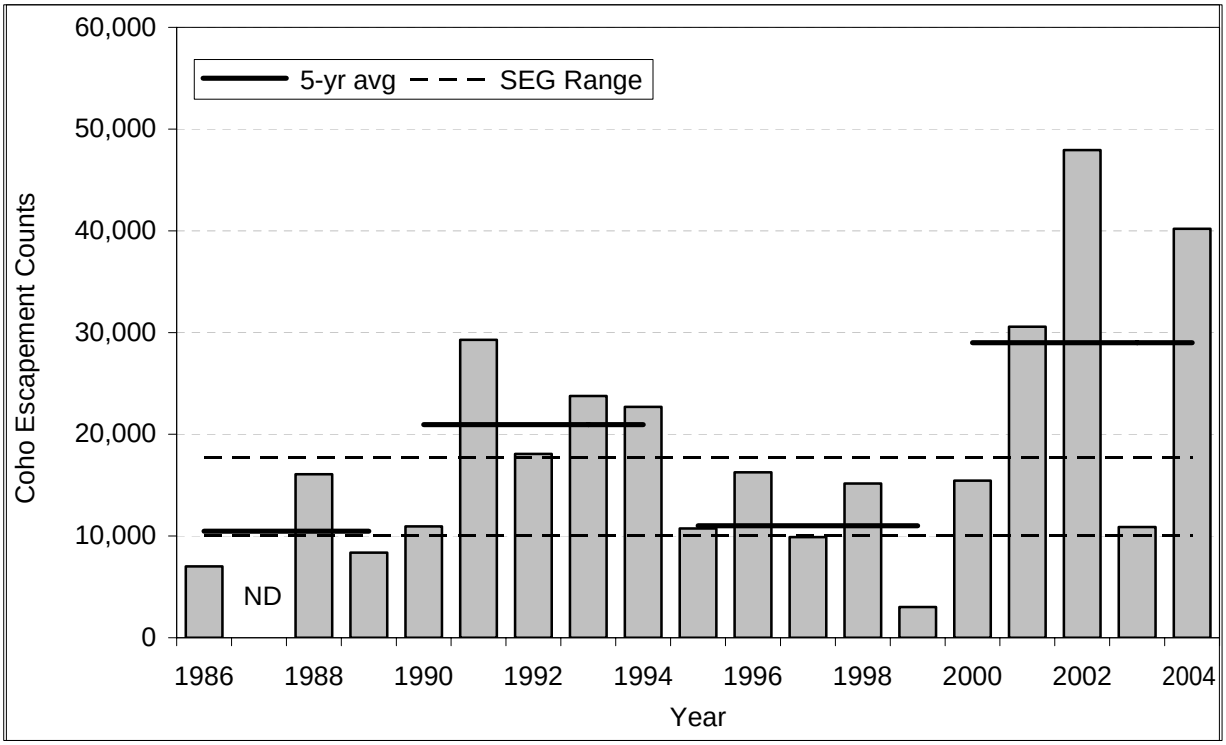


Figure 18.-Escapement of wild coho salmon in the Little Susitna River, 1986-2004.

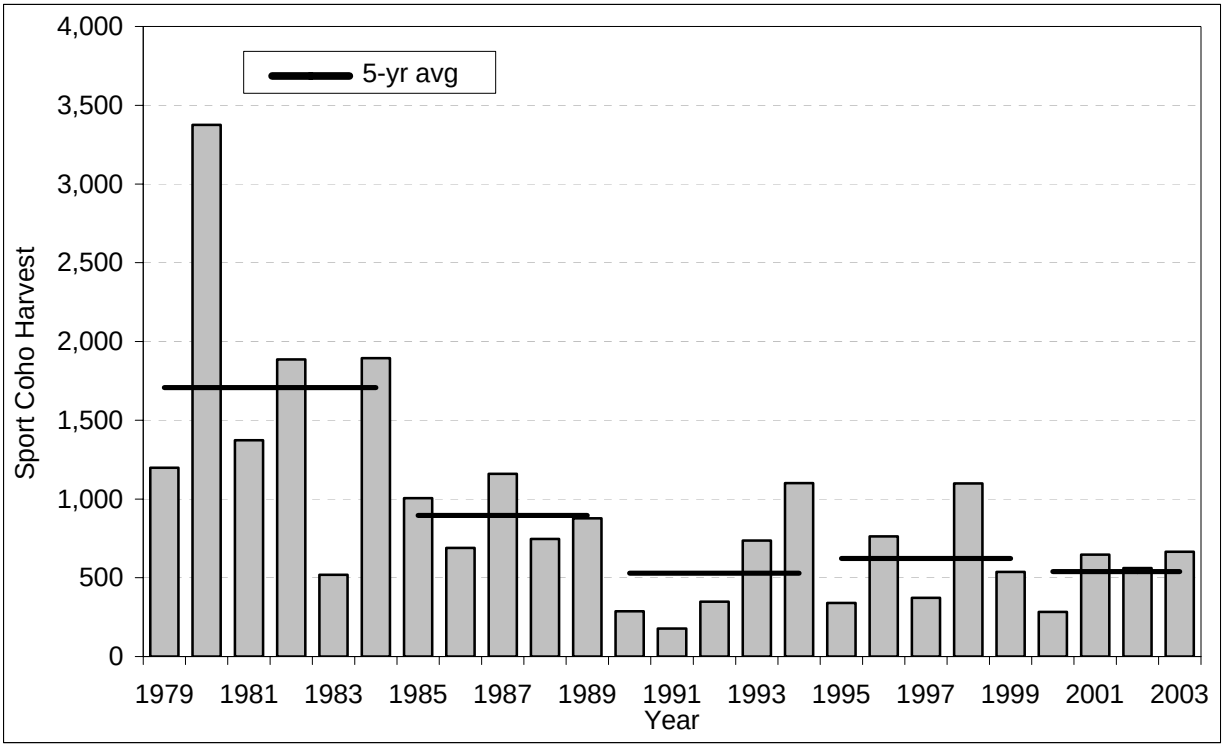


Figure 15.-Sport harvests of coho salmon in Cottonwood Creek, 1979-2003.

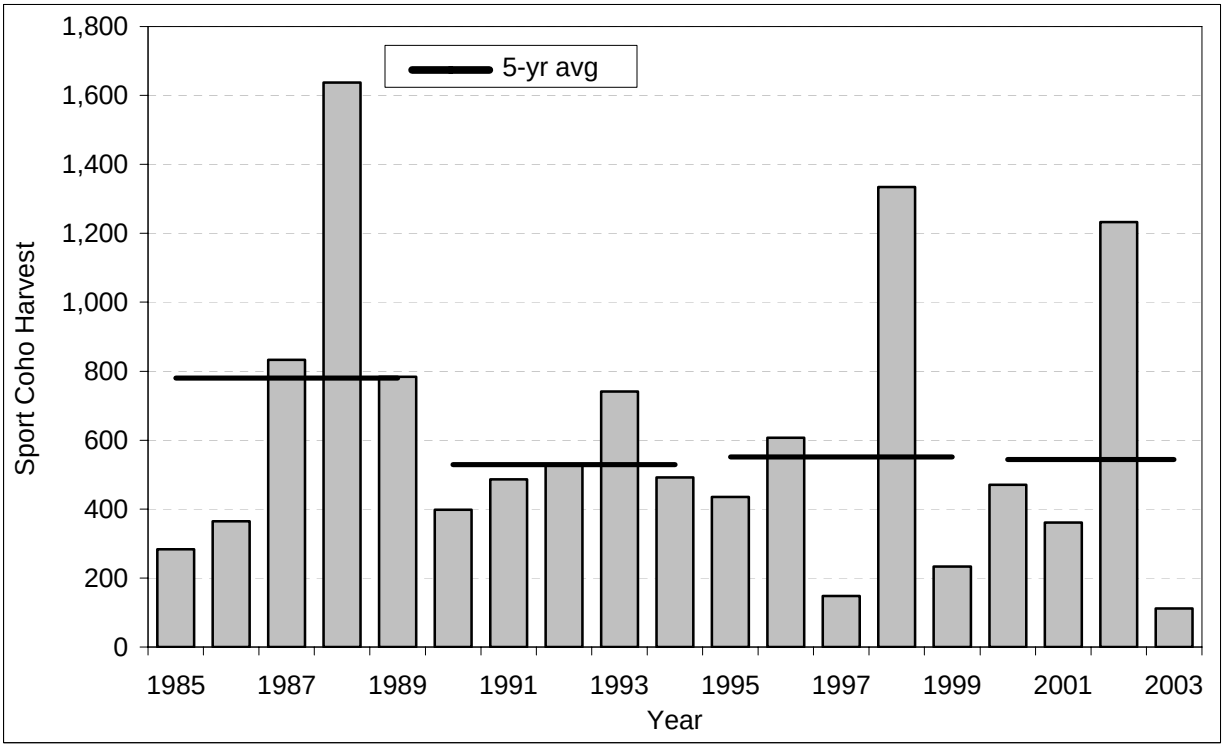
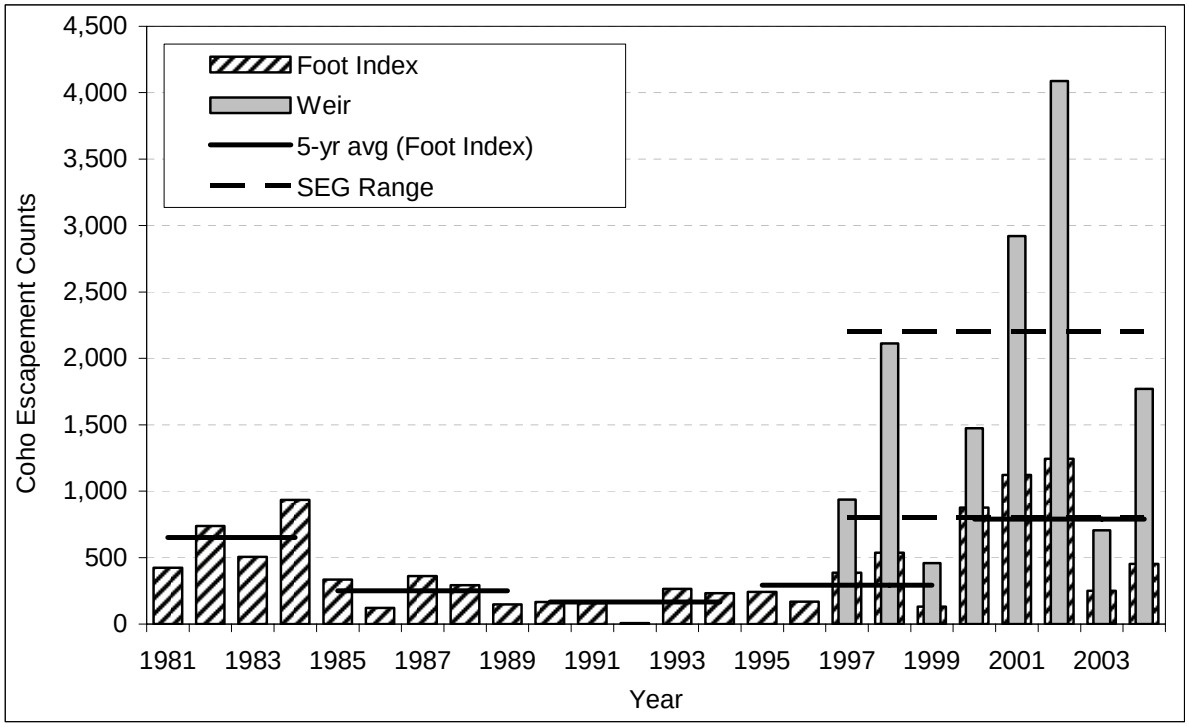


Figure 16.-Sport harvests of coho salmon in Fish Creek, 1985-2003.

A



B

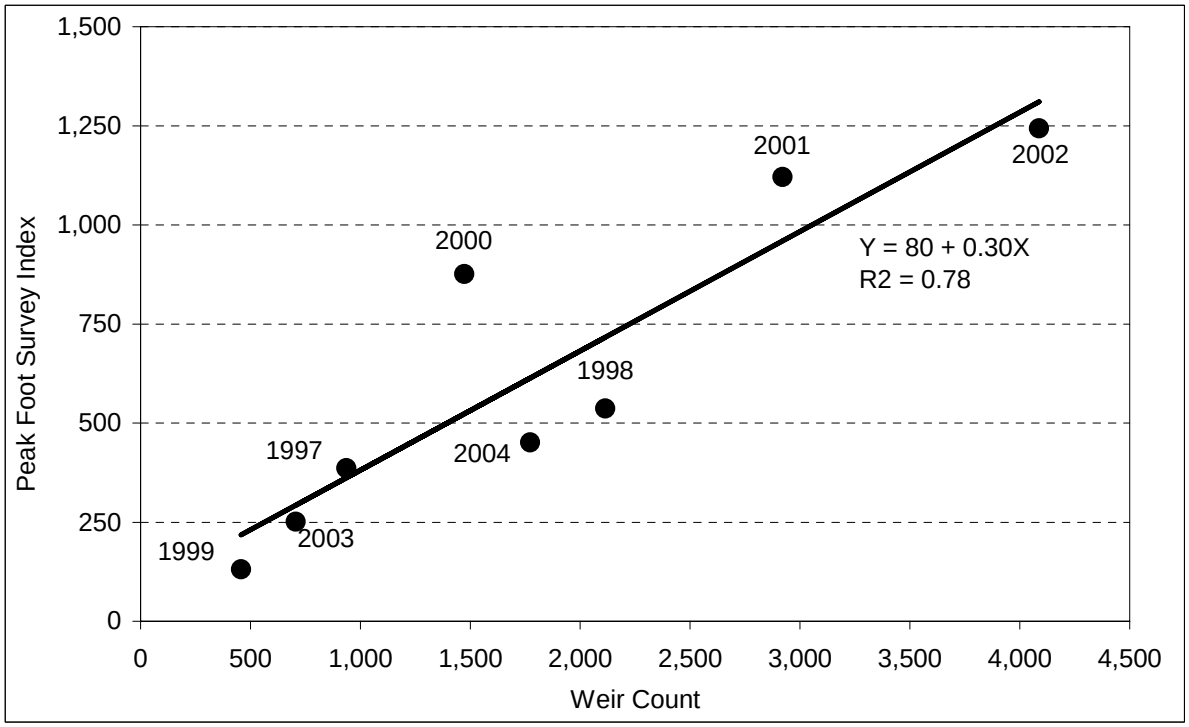


Figure 20.-(A) Escapement of coho salmon in Cottonwood Creek, 1981-2004, and (B) relationship between weir counts and peak survey index counts of coho salmon at Cottonwood Creek during 1997-2004.

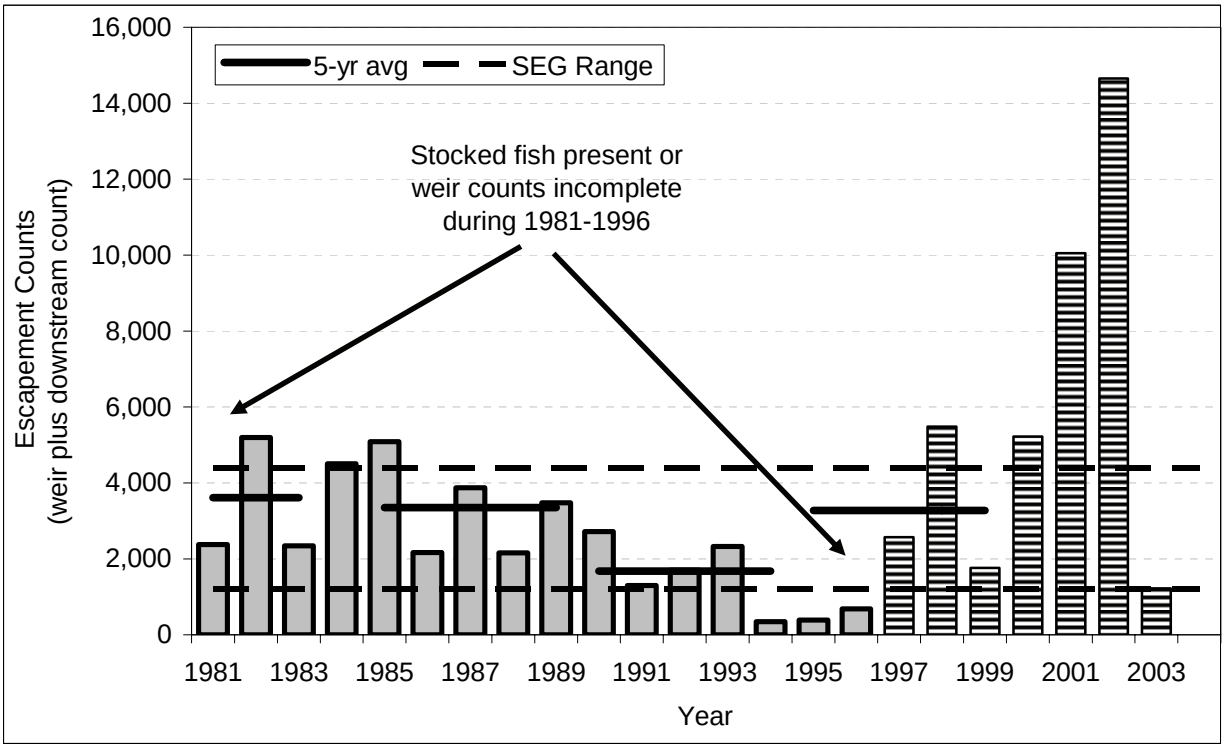
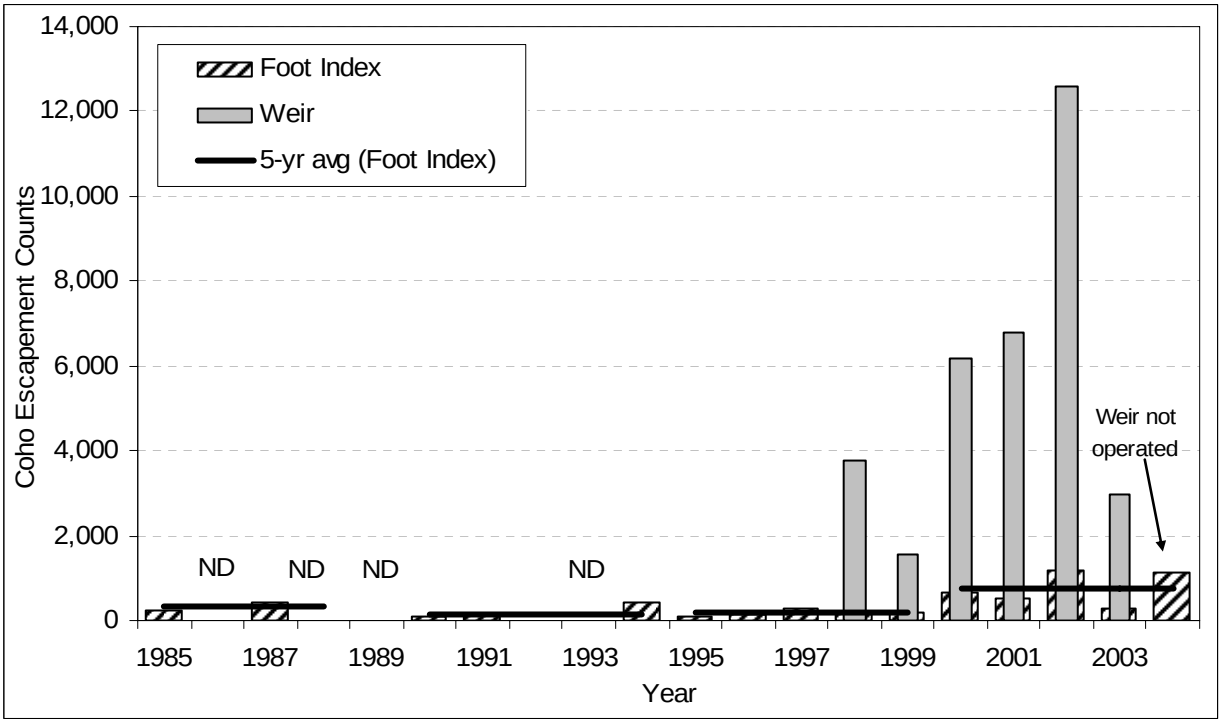


Figure 21.-Escapement of coho salmon in Fish Creek, 1981-2003.

A



B

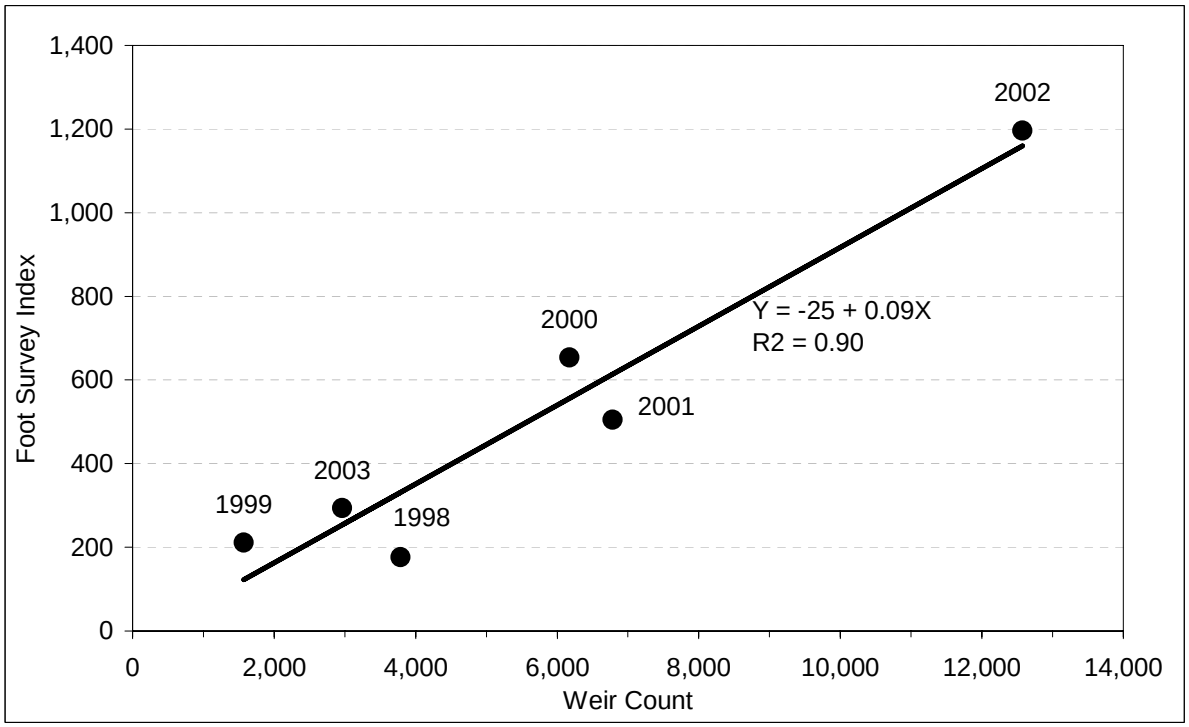


Figure 22.-(A) Escapement of coho salmon in Wasilla Creek, 1985-2004, and (B) relationship between weir counts and foot survey index counts of coho salmon at Wasilla Creek drainage during 1998-2003.

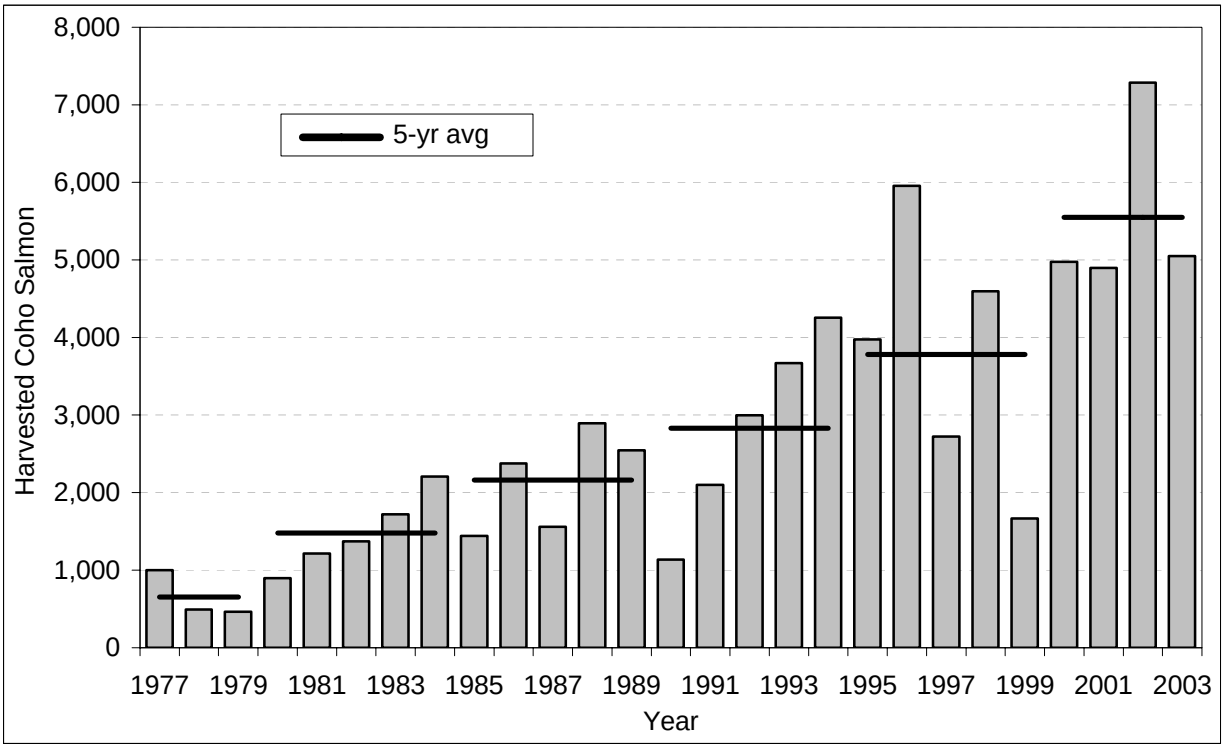
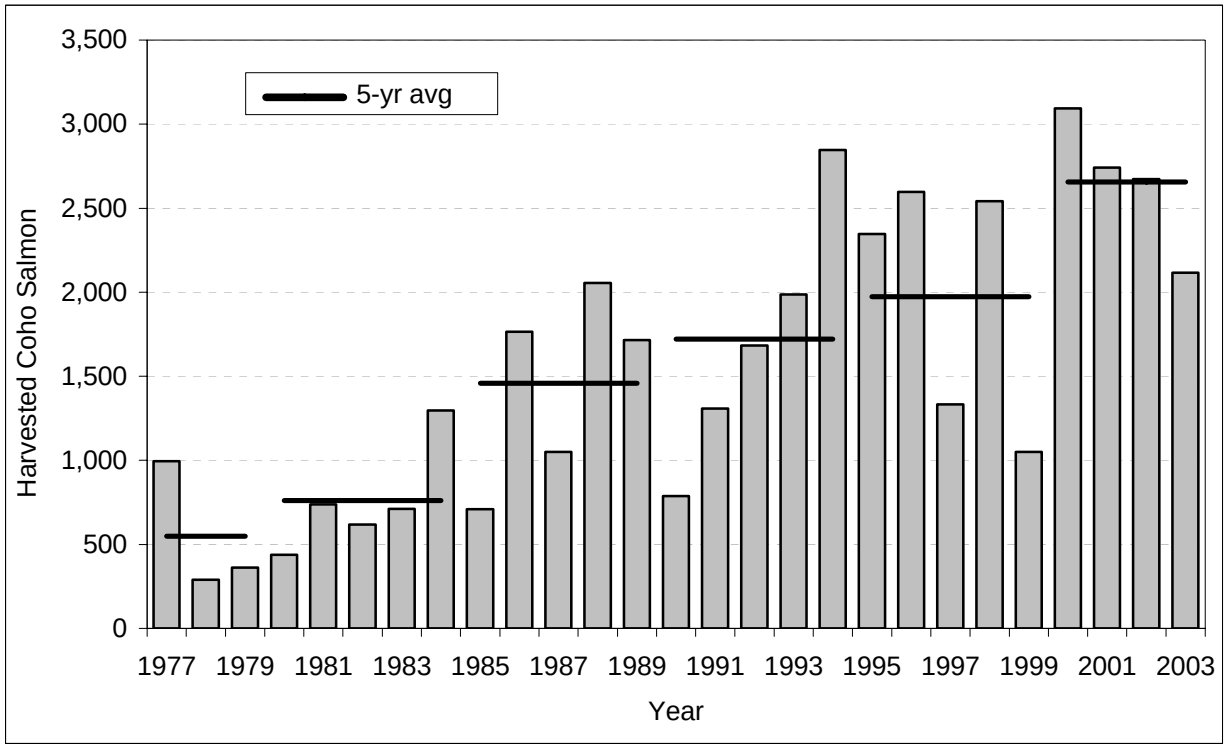


Figure 23.-Sport harvests of wild coho salmon in Anchorage/Turnagain Arm, 1977-2003.

A



B

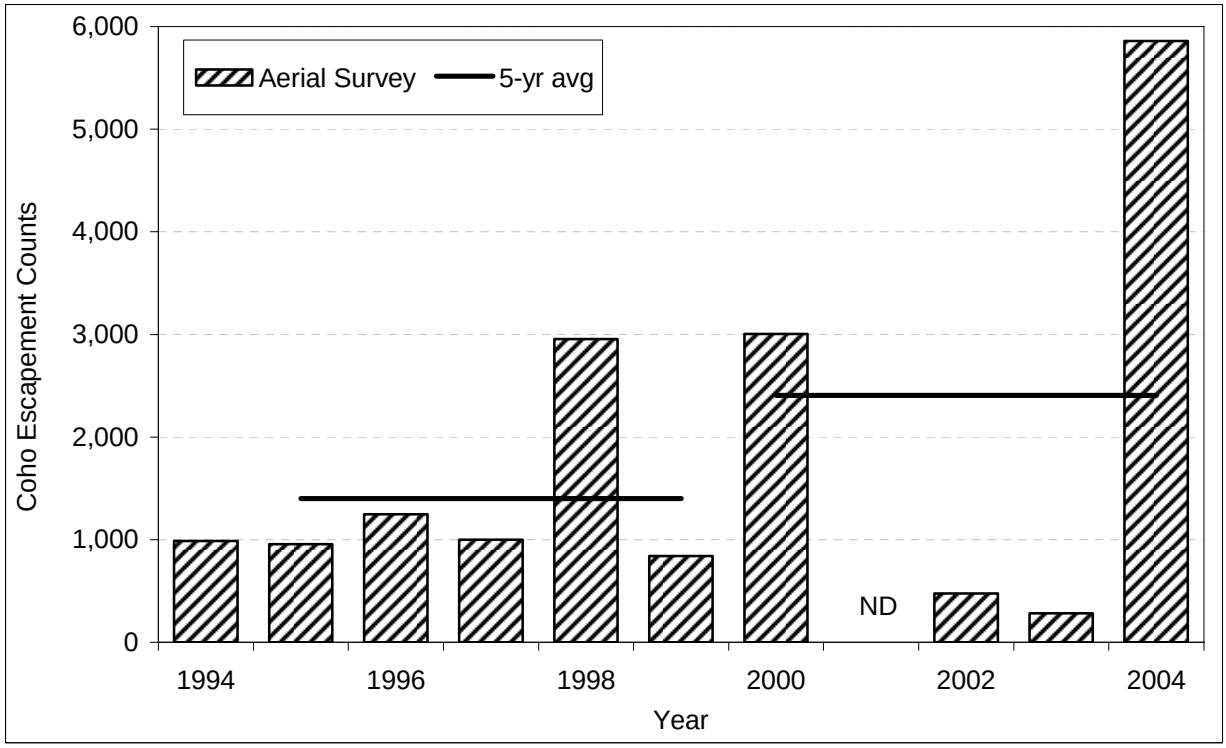


Figure 24.-(A) Sport harvests of coho salmon, 1977-2003, and (B) aerial index counts of coho salmon, 1994-2004, in the Twentymile River.

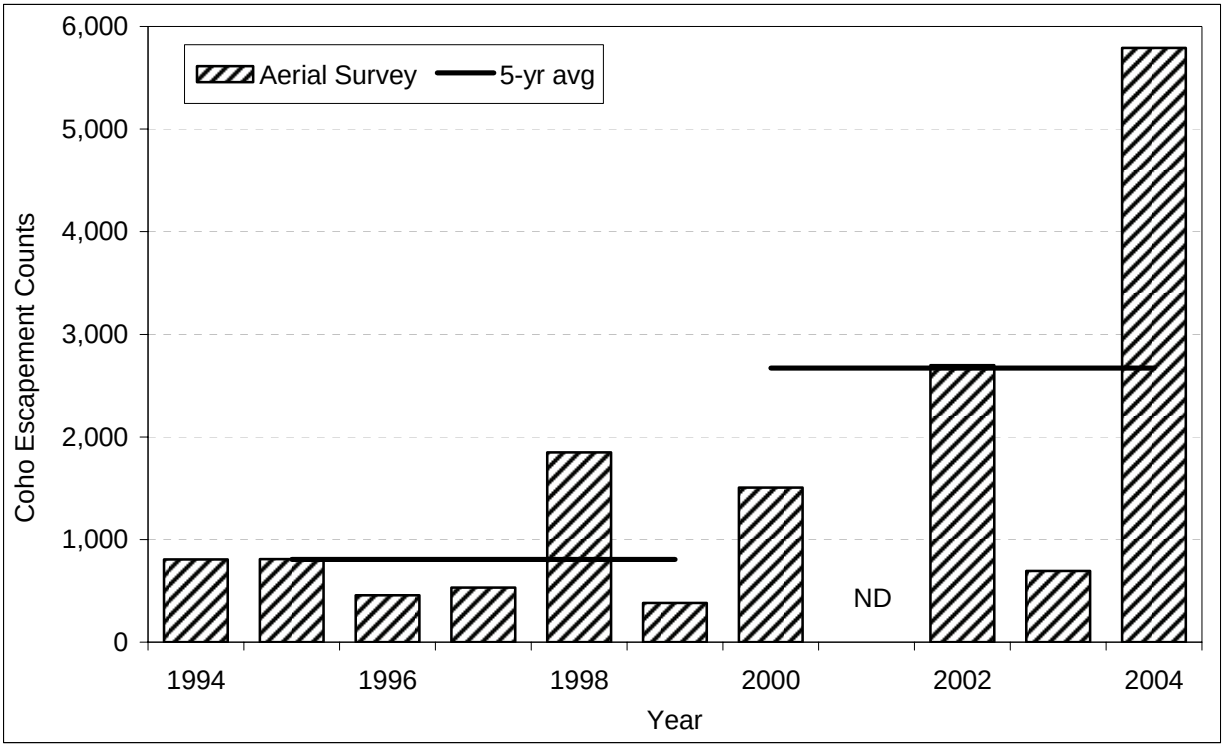


Figure 25.-Aerial index counts of coho salmon, 1994-2004, in the Placer River.

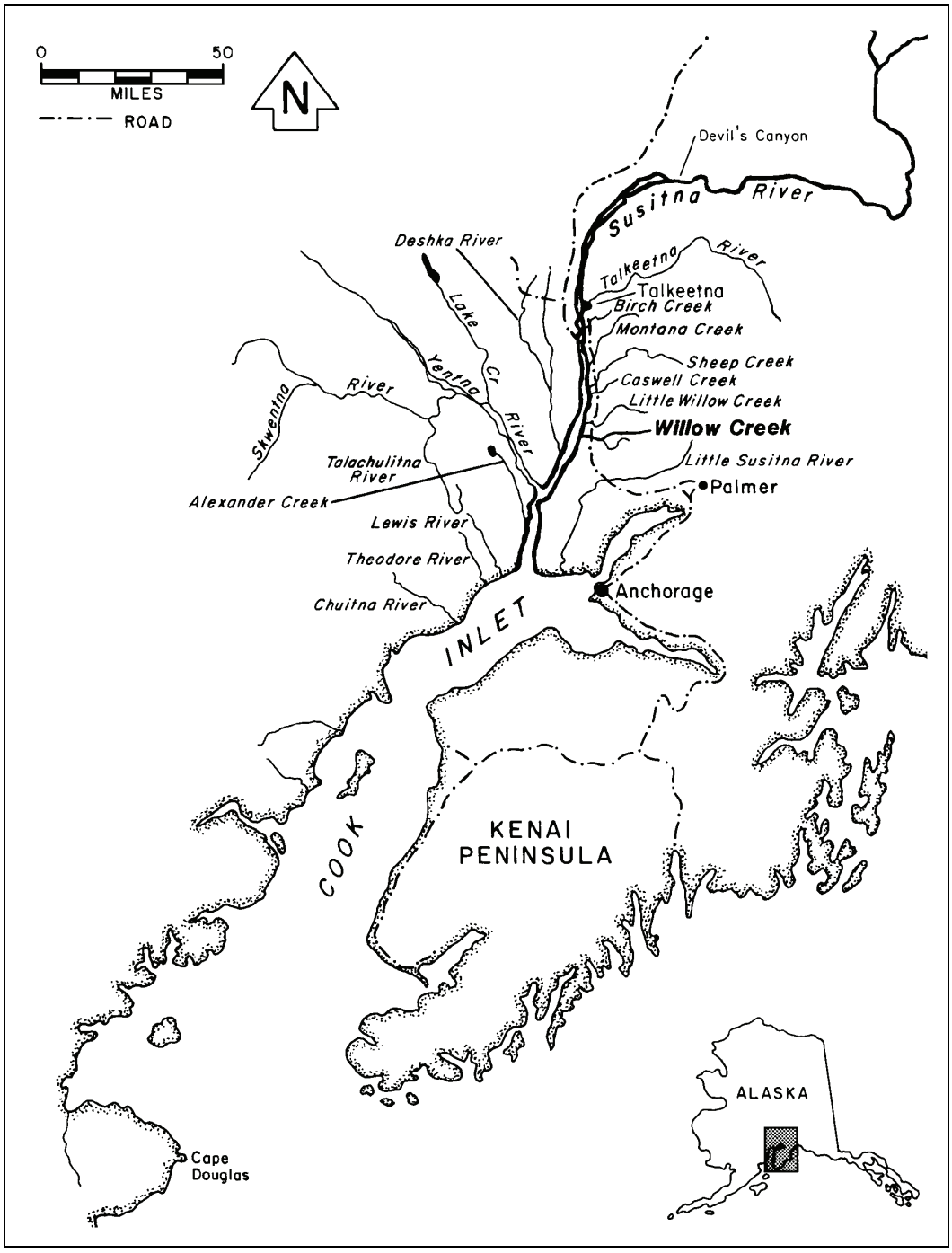


Figure 26.-Map of the Susitna River drainage.

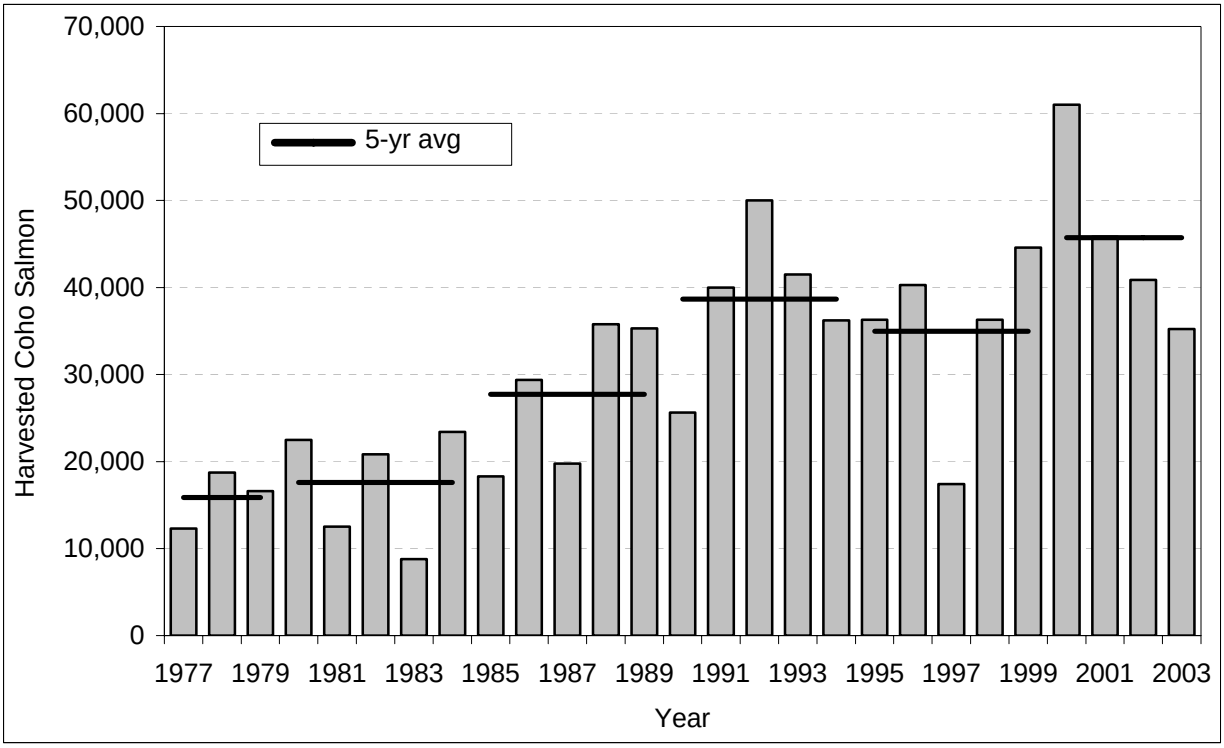


Figure 27.-Sport harvests of wild coho salmon in the Susitna River drainage, 1977-2003.

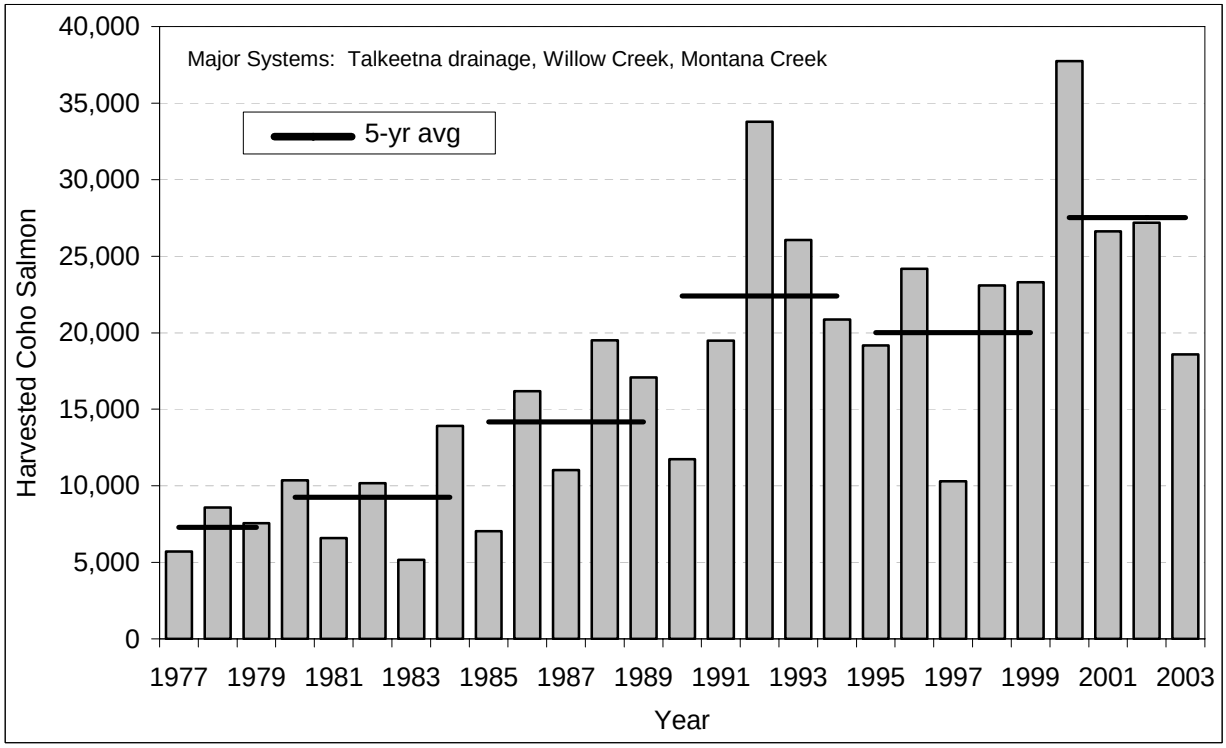


Figure 28.-Sport harvests of coho salmon in east side Susitna River drainages, 1977-2003.

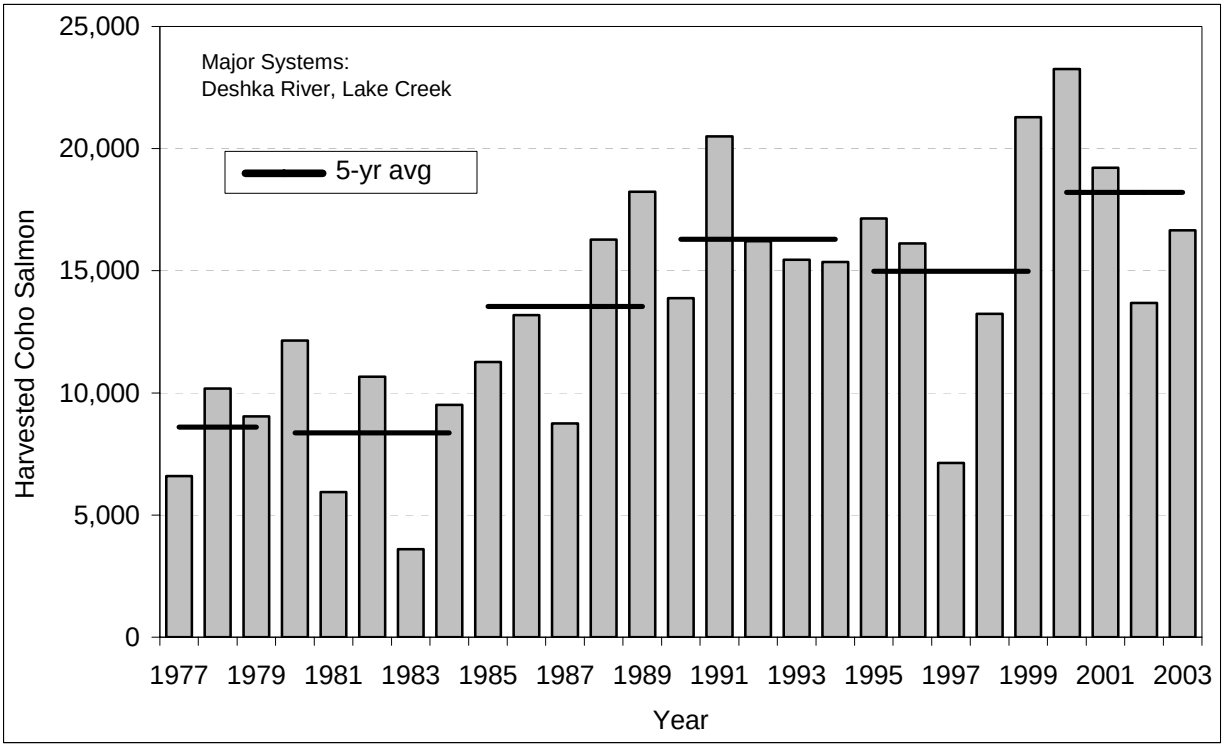
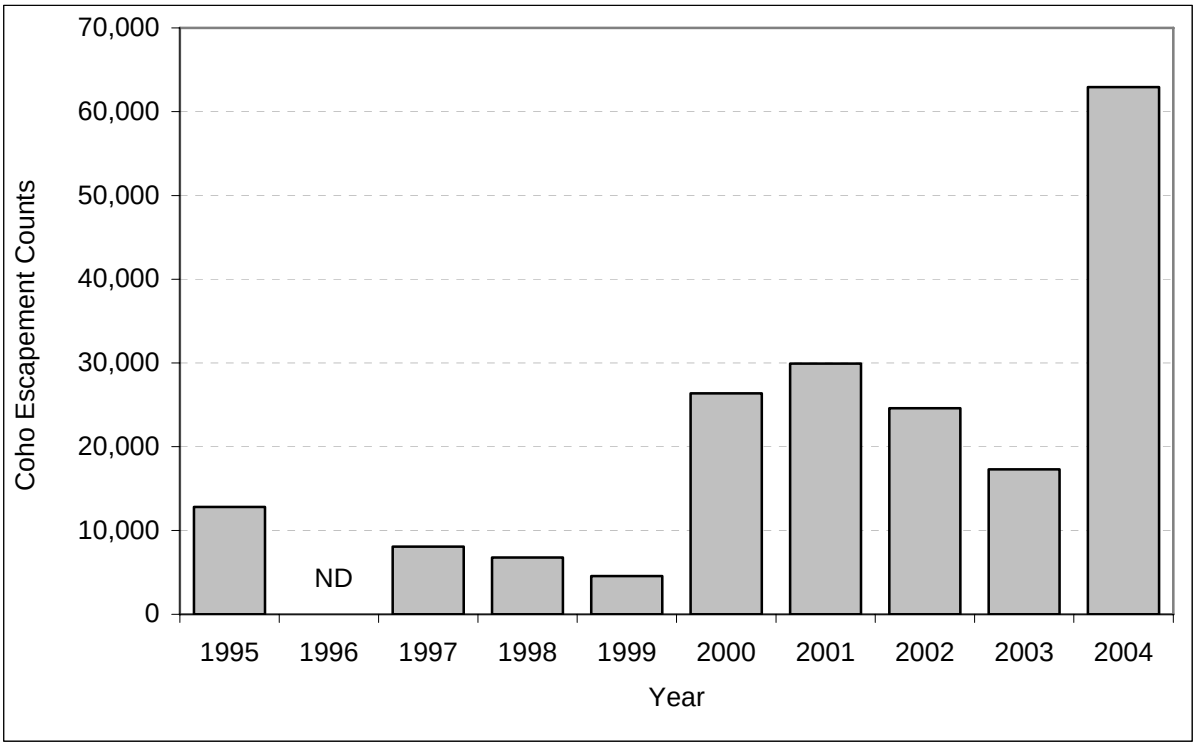


Figure 29.-Sport harvests of coho salmon in west side Susitna River drainages, 1977-2003.

A



B

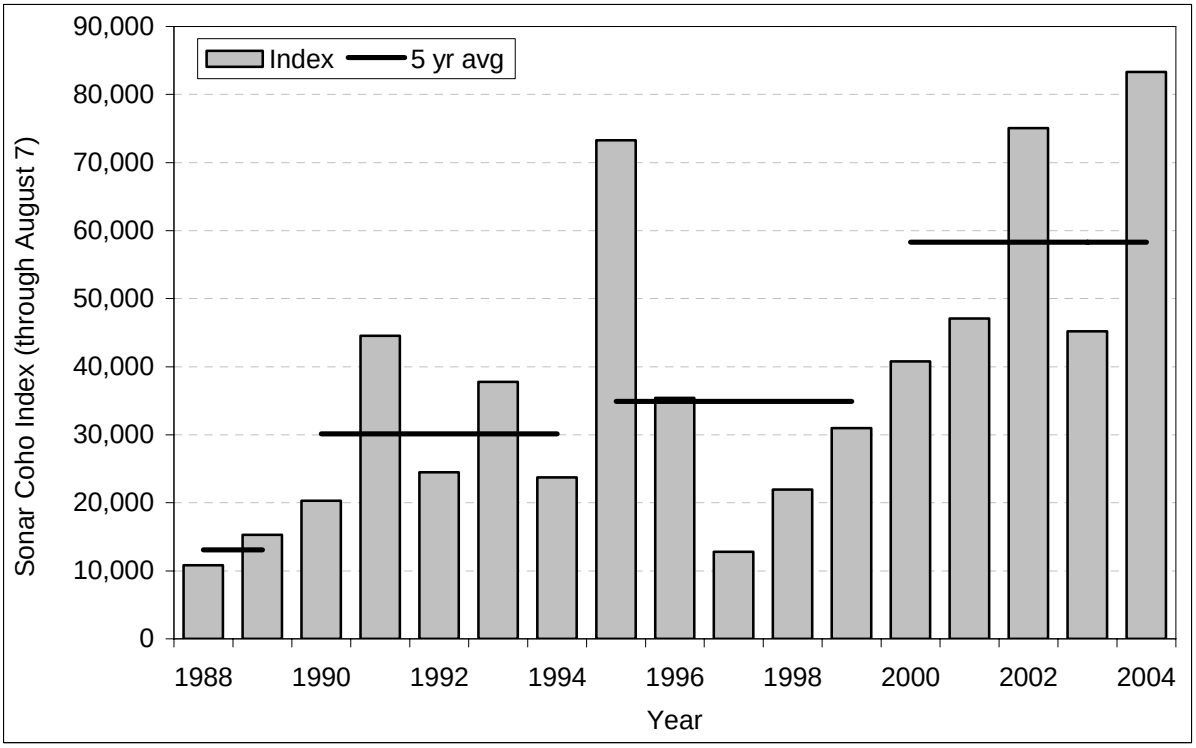
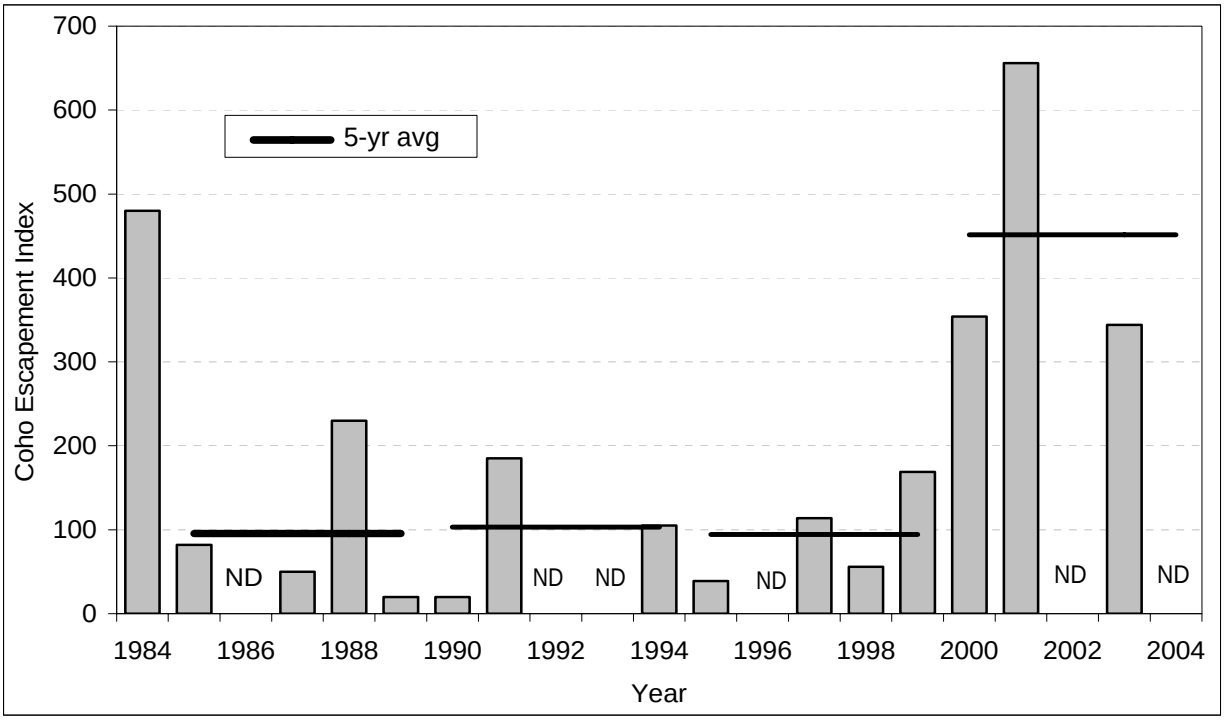


Figure 30.-Escapement of coho salmon (A) enumerated through a weir at the Deshka River, 1995-2004, and (B) indexed in the Yentna River drainage through August 7, 1988-2004.

A) Rabideux Creek



B) Birch Creek

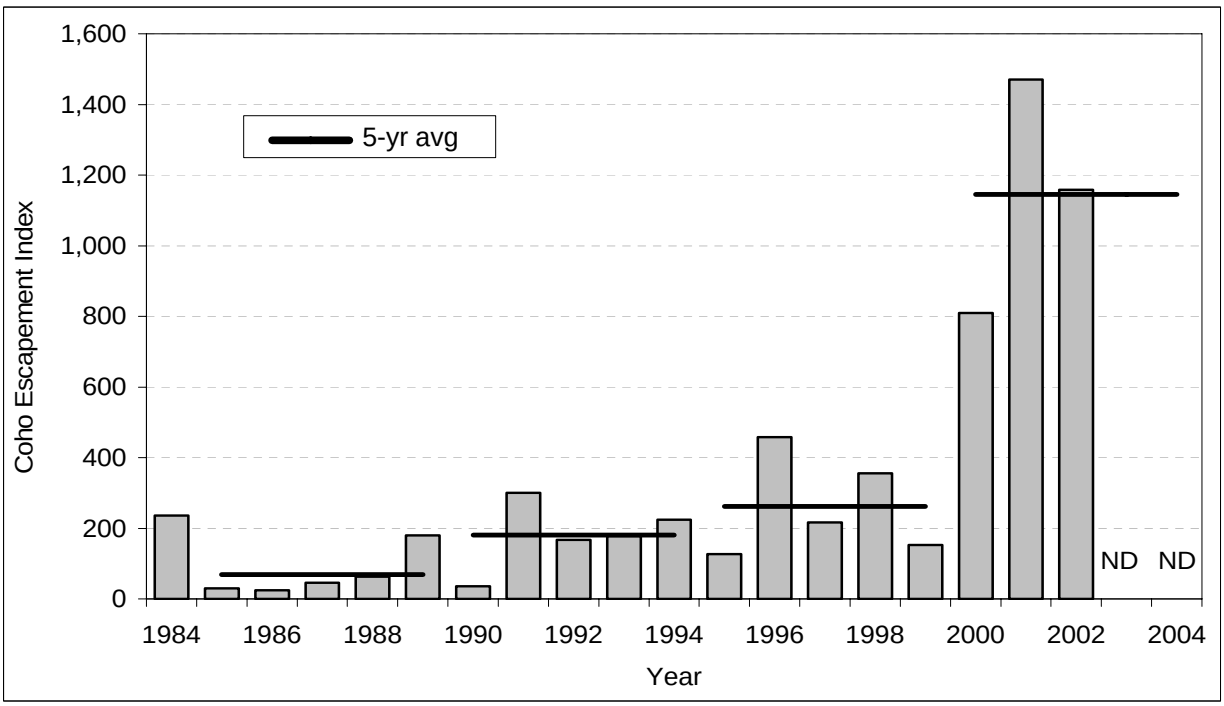
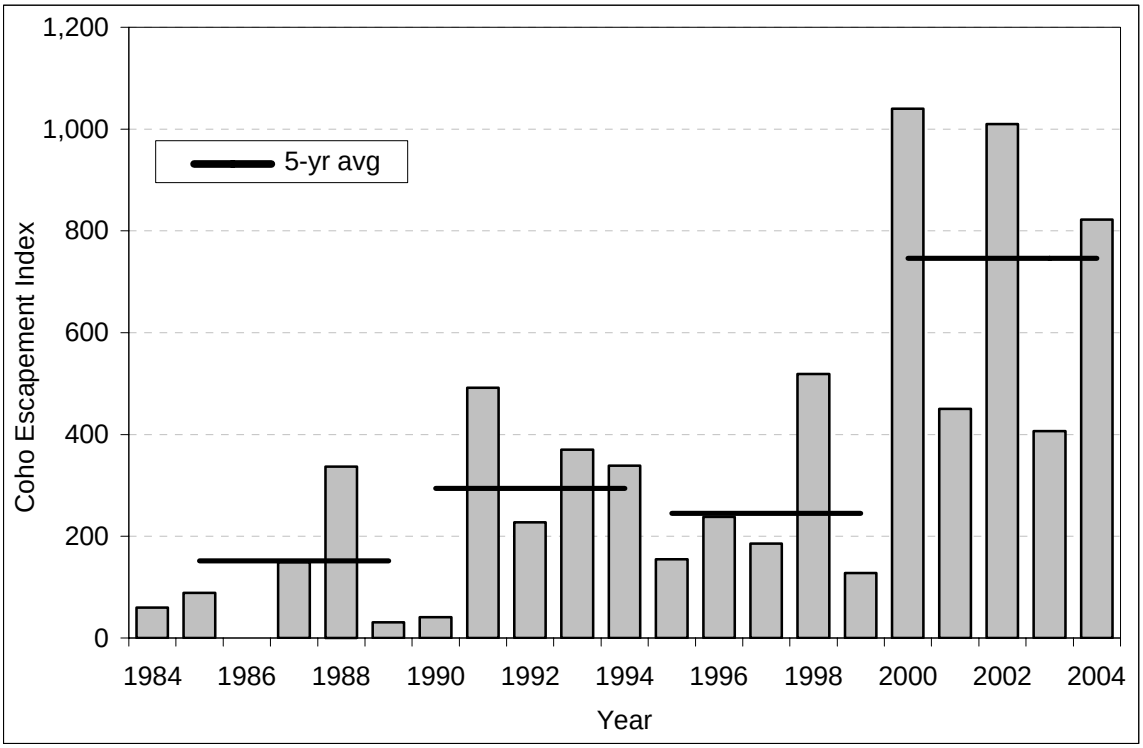


Figure 31.-Escapement of coho salmon in (A) Rabideux Creek, (B) Birch Creek, (C) Question Creek, and (D) Answer Creek, Susitna River drainage, 1984-2004.

-continued-

C) Question Creek



D) Answer Creek

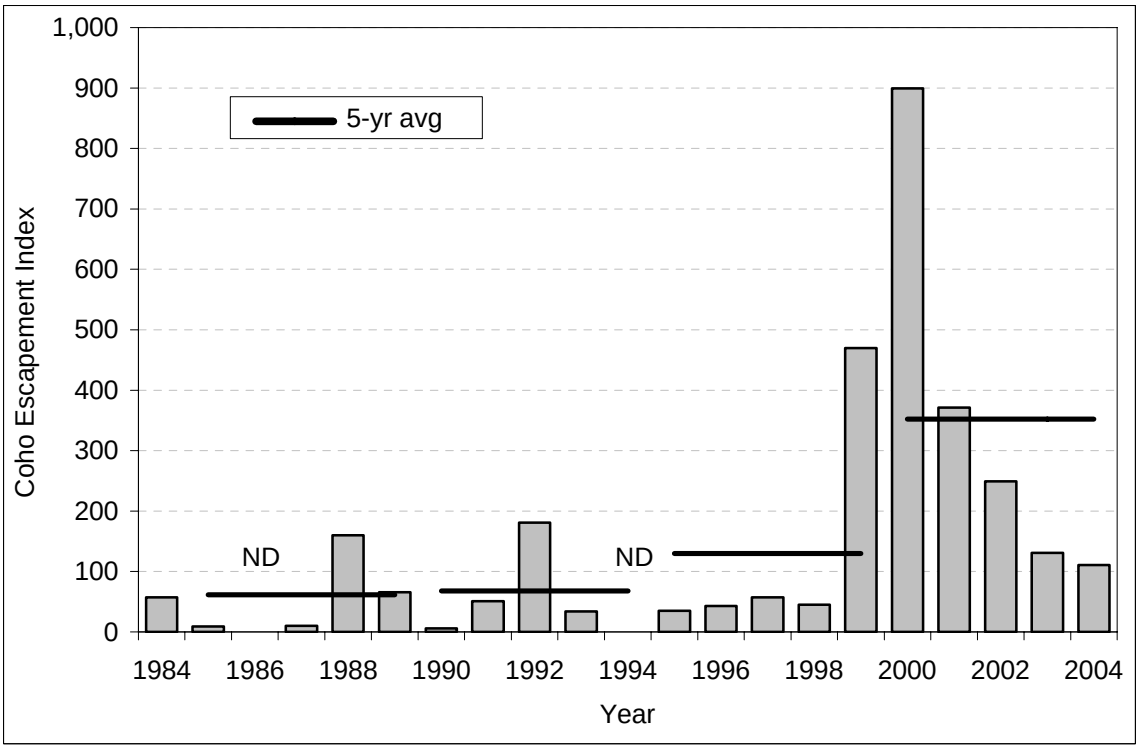


Figure 31.-Page 2 of 2.

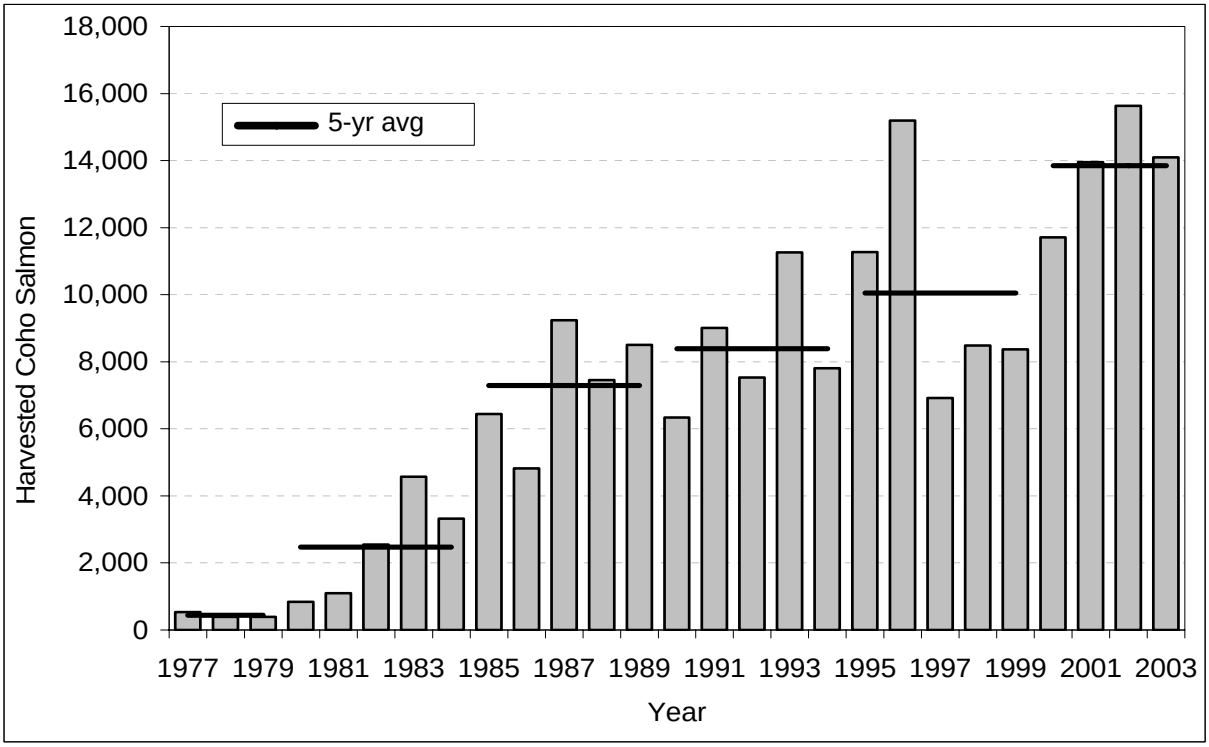


Figure 32.-Sport harvest of wild coho salmon in West Cook Inlet drainages, 1977-2003.

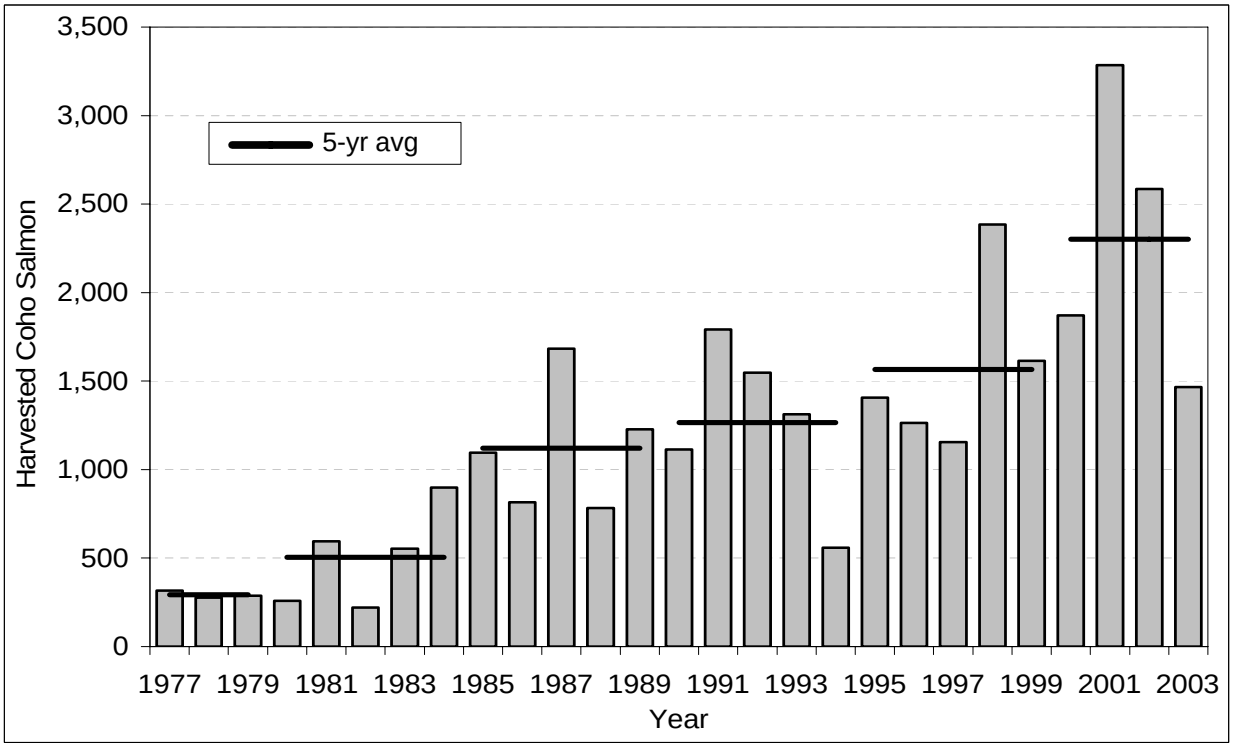


Figure 33.-Sport harvest of coho salmon in the Chuitna River, 1977-2003.

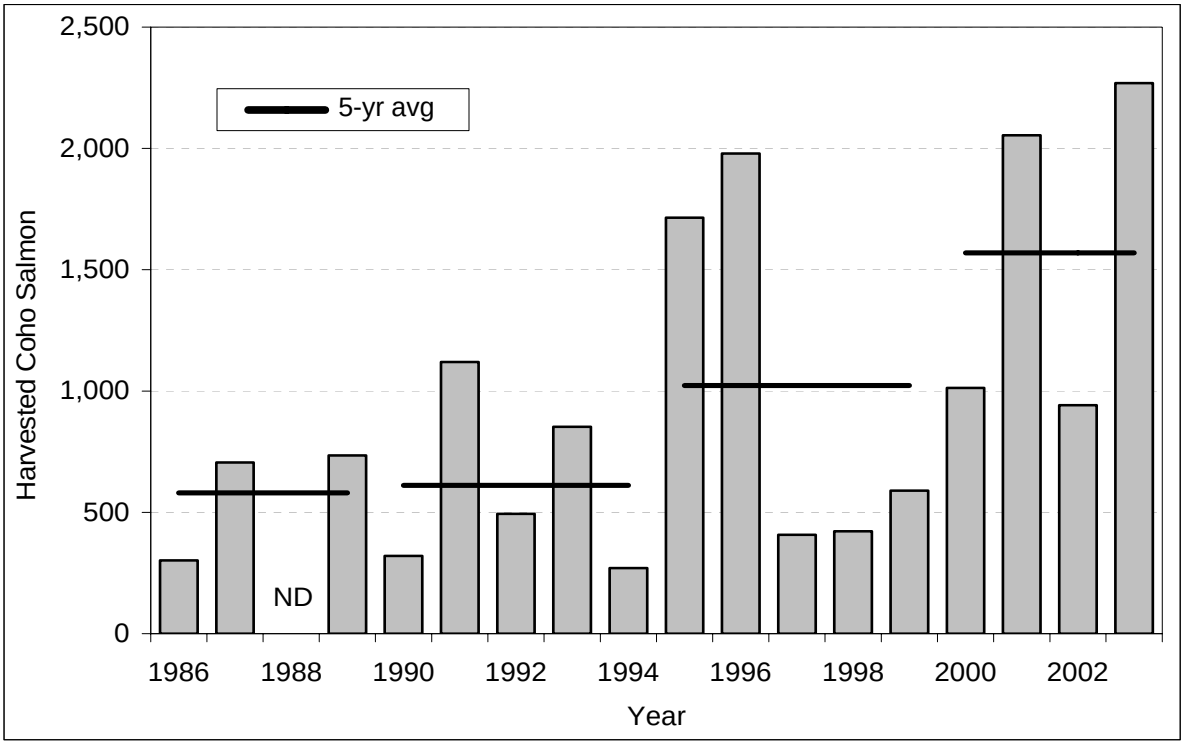


Figure 34.-Sport harvest of coho salmon in Silver Salmon Creek, 1986-2003.

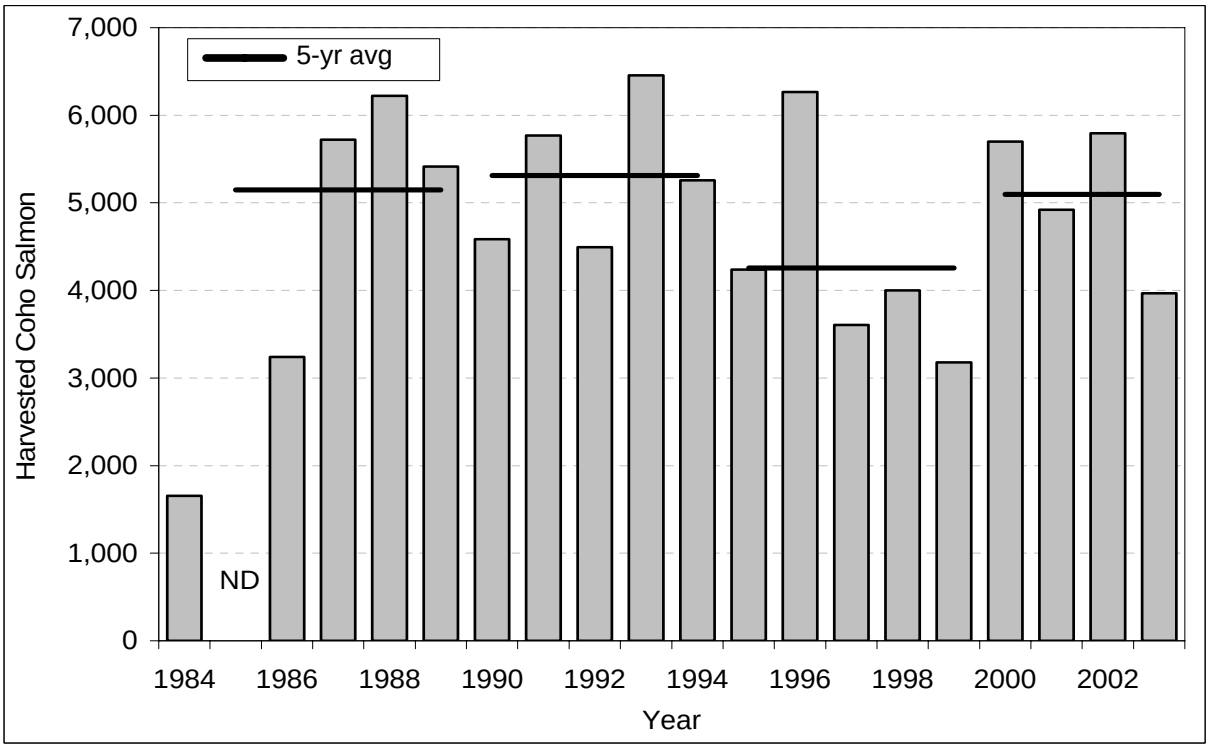


Figure 35.-Sport harvest of coho salmon in the Kustatan River, 1984-2003.

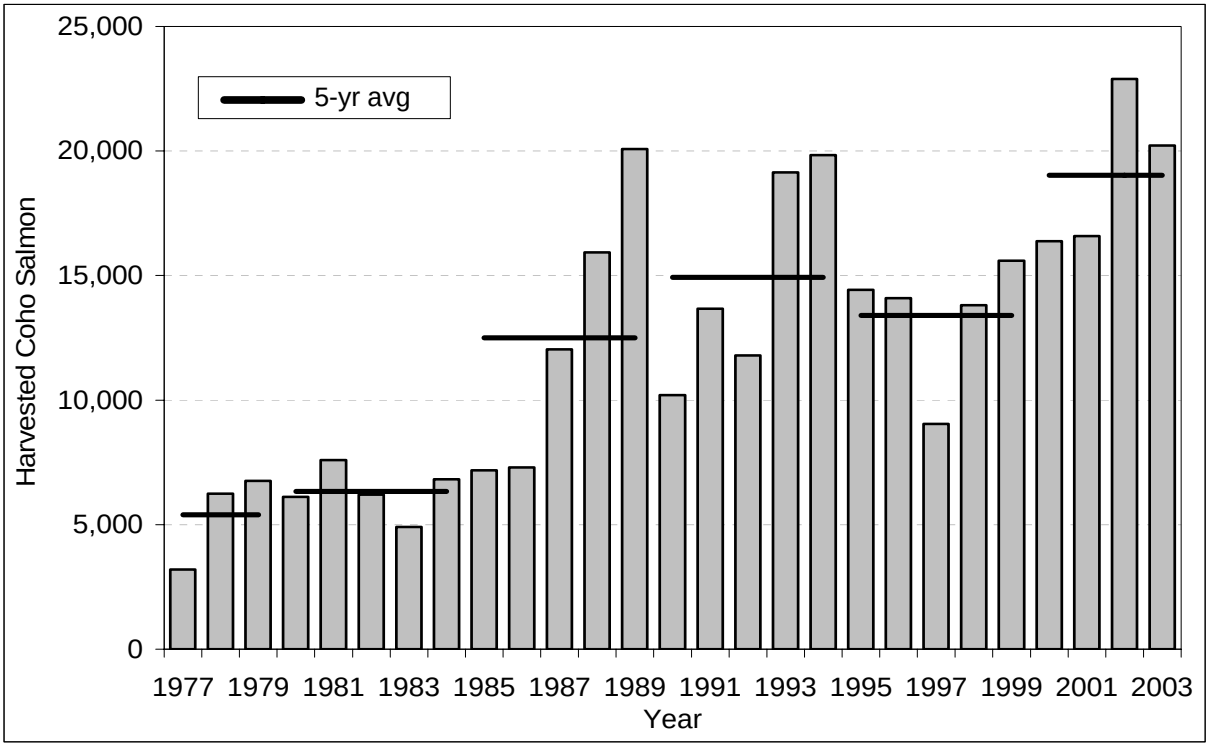


Figure 36.-Sport harvests of coho salmon in the Kenai Peninsula, excluding the Kenai River, 1977-2003.

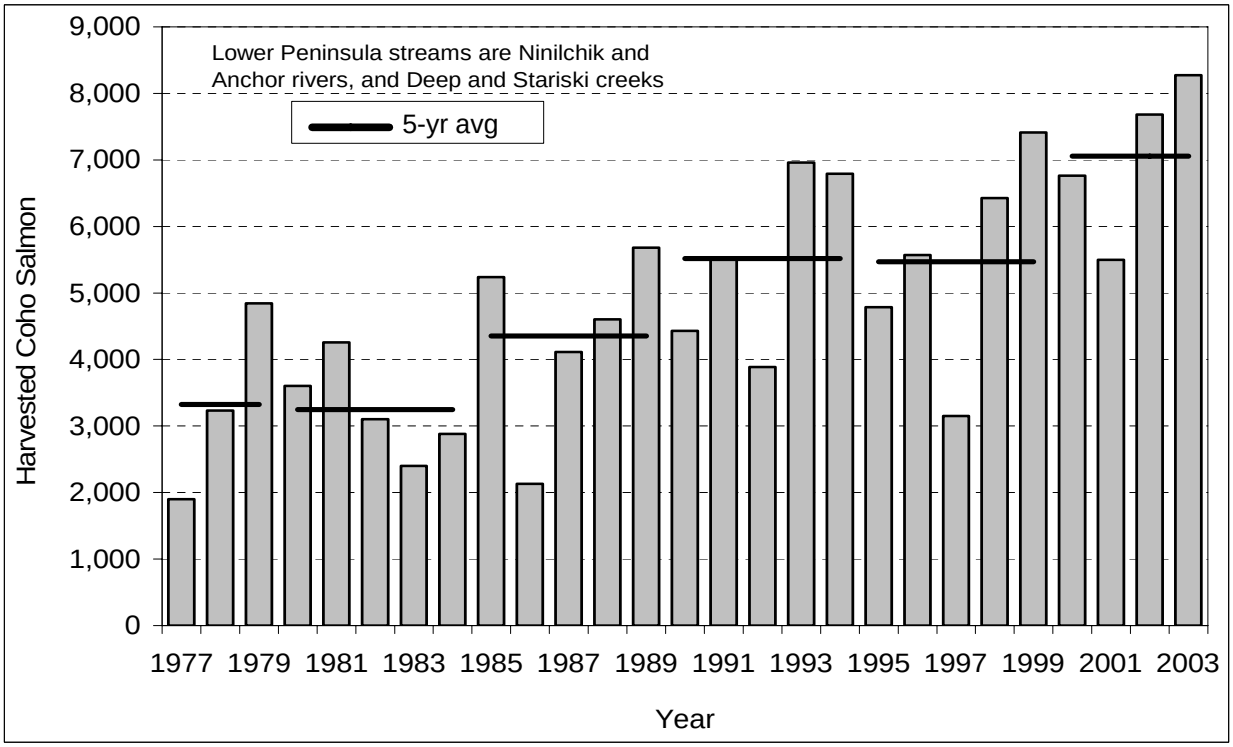


Figure 37.-Sport harvests of coho salmon in lower Kenai Peninsula streams, 1977-2003.

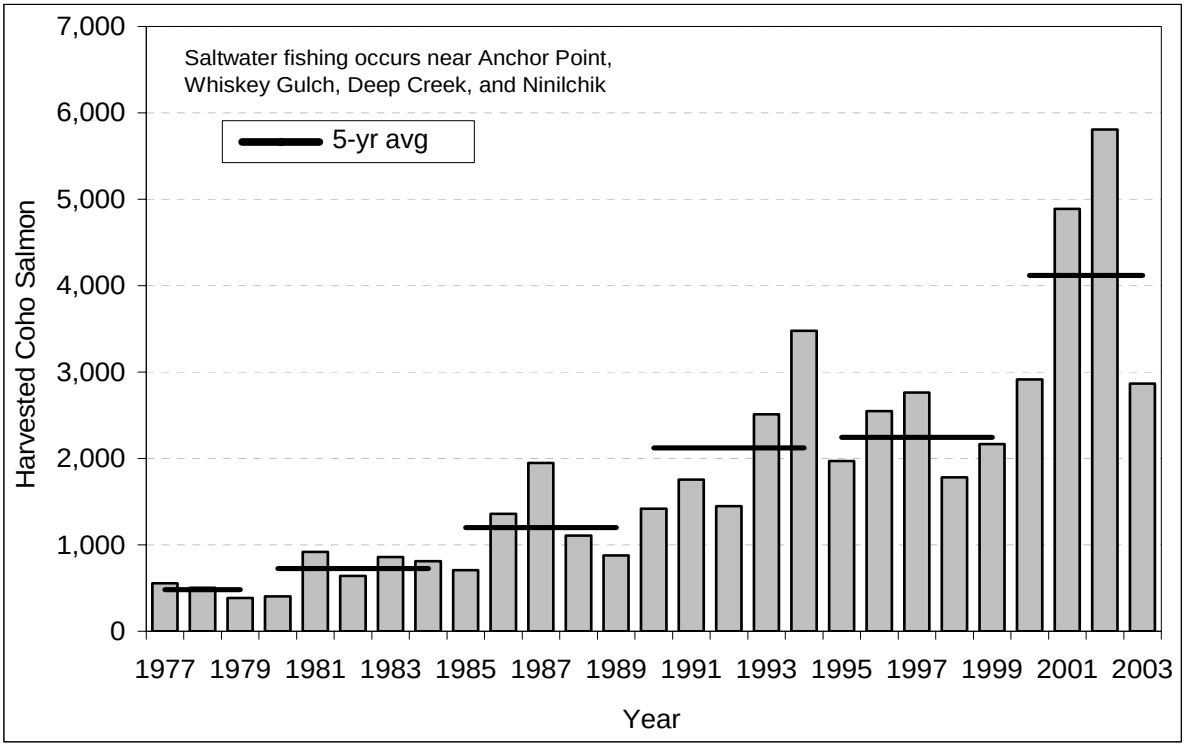


Figure 38.-Sport harvests of coho salmon in saltwater adjacent to lower Kenai Peninsula streams, 1977-2003.

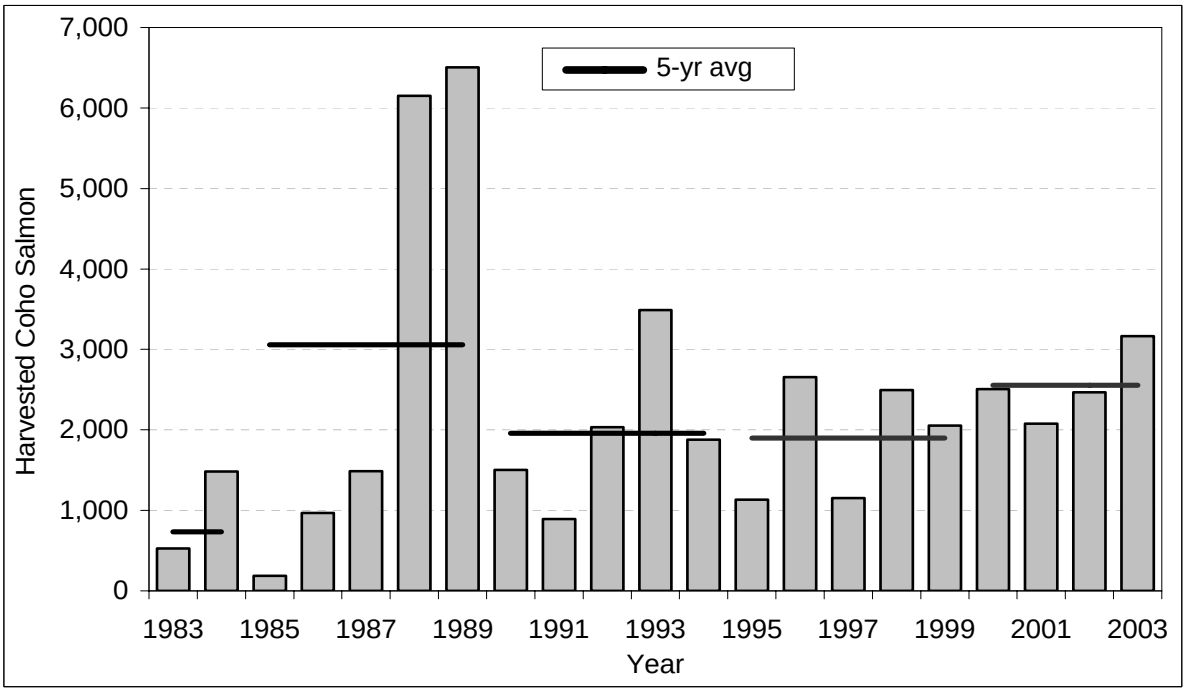


Figure 39.-Sport harvests of coho salmon in the Swanson River, 1983-2003.

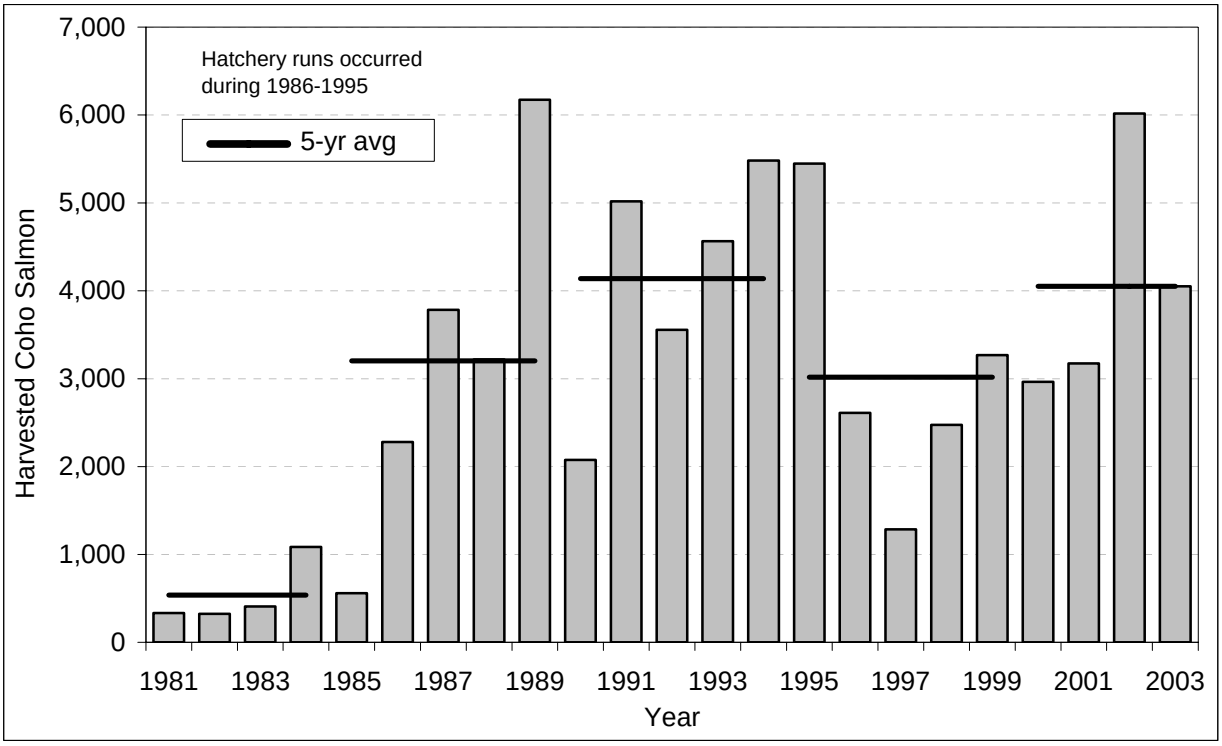


Figure 40.-Sport harvests of wild and hatchery coho salmon in the Kasilof River, 1981-2003. Harvests include an unknown proportion of hatchery fish during 1986-1995.

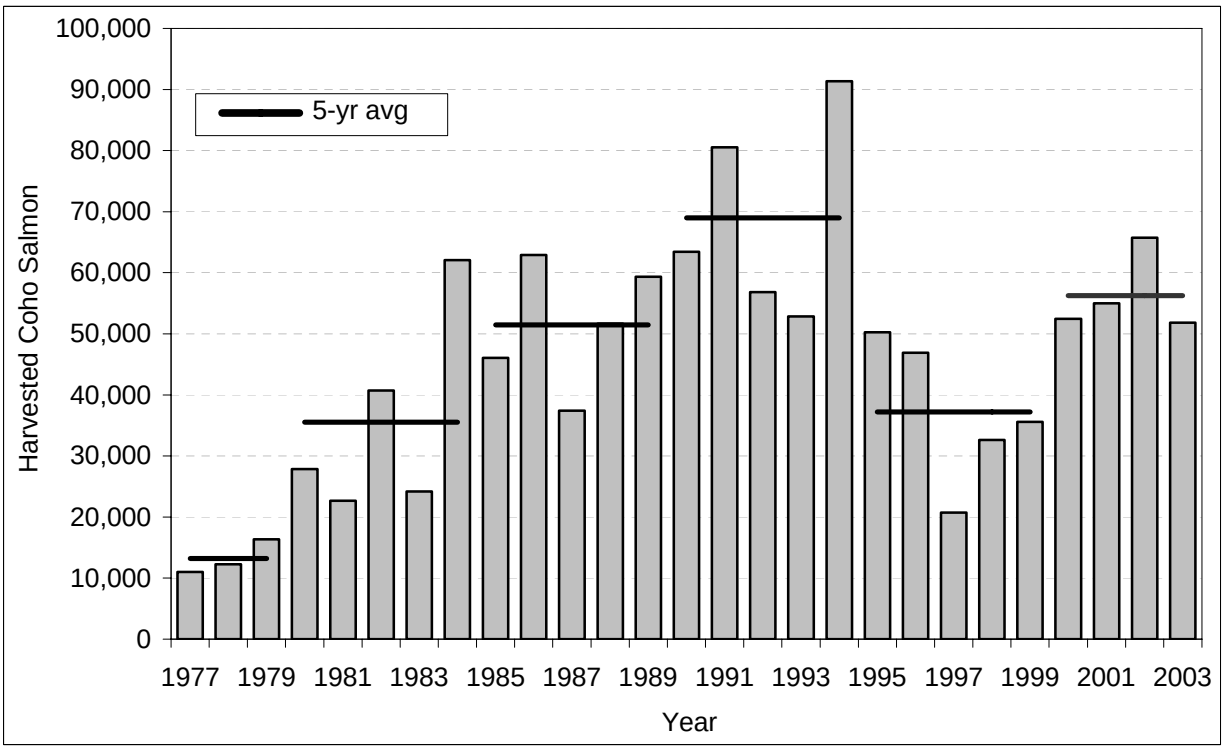


Figure 41.-Sport harvest of coho salmon in the Kenai River, 1977-2003.

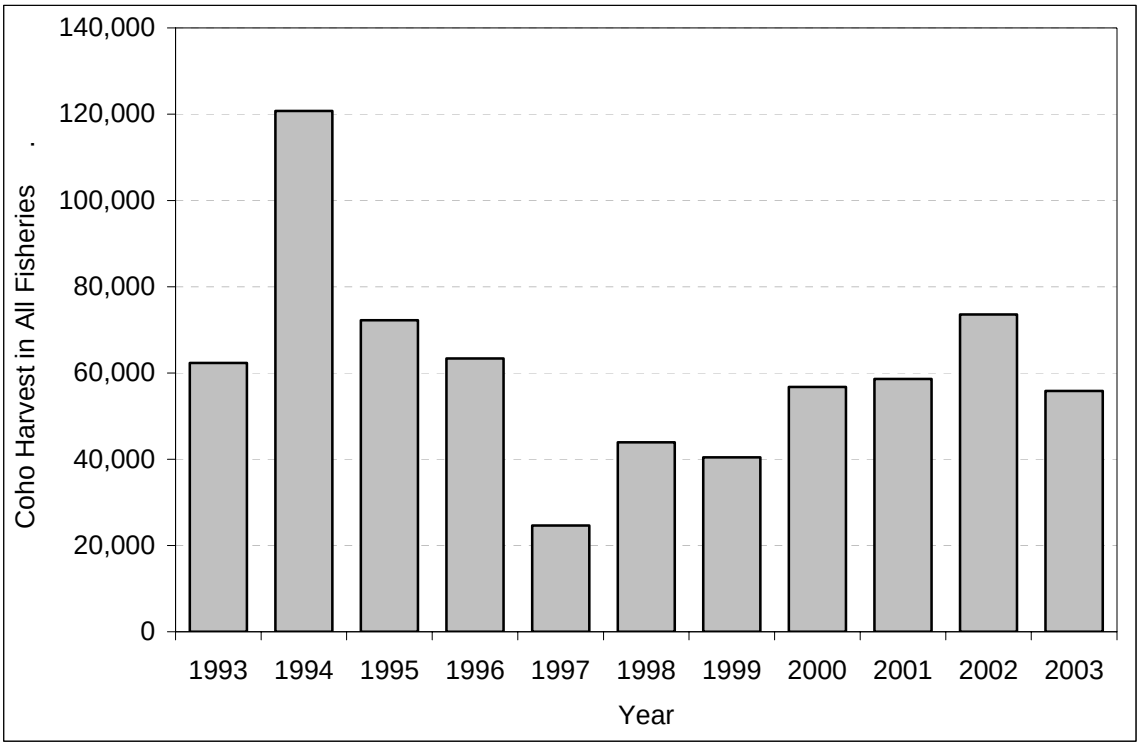


Figure 42.-Total harvest of Kenai River coho salmon in Upper Cook Inlet, 1993-2003.

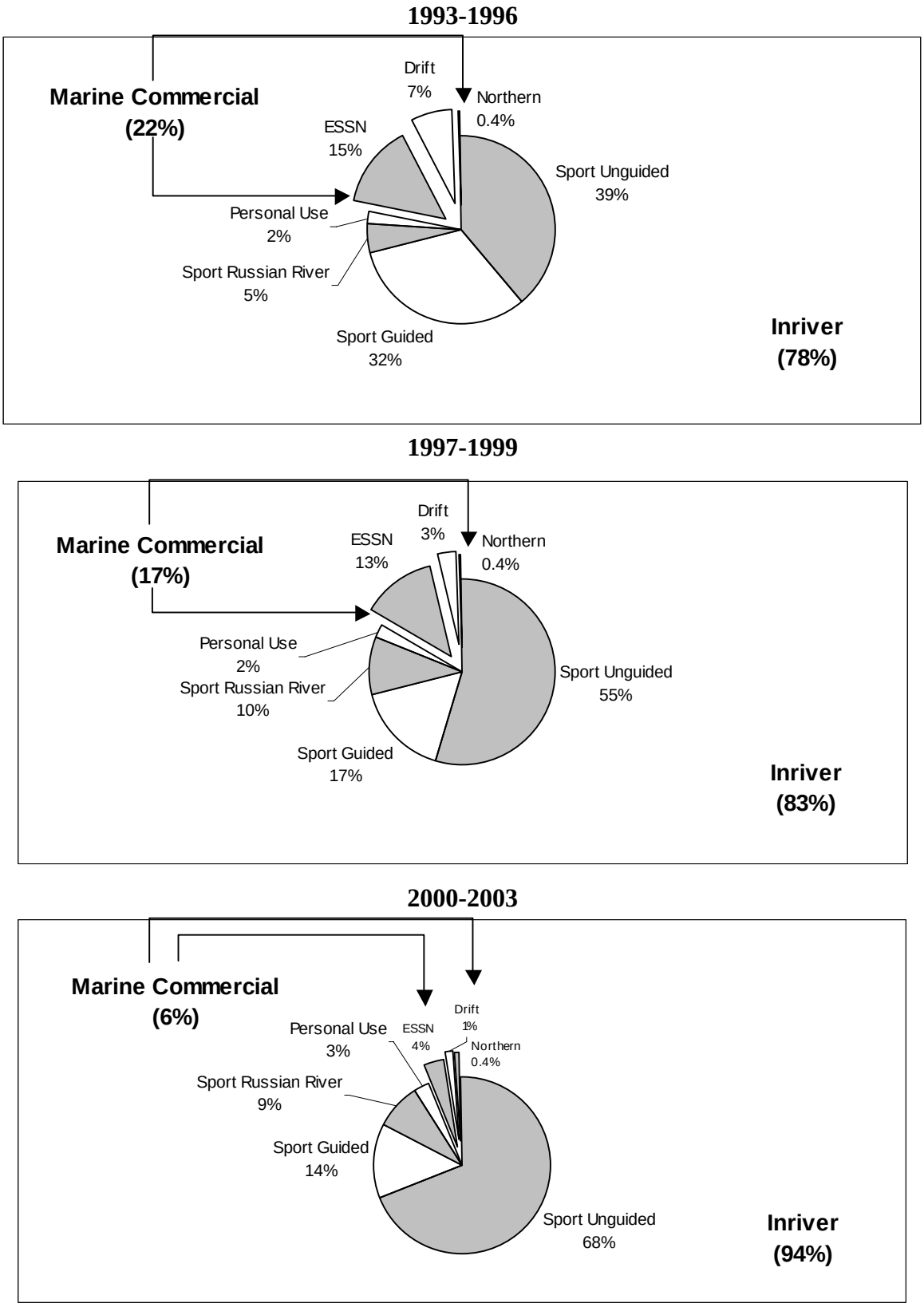
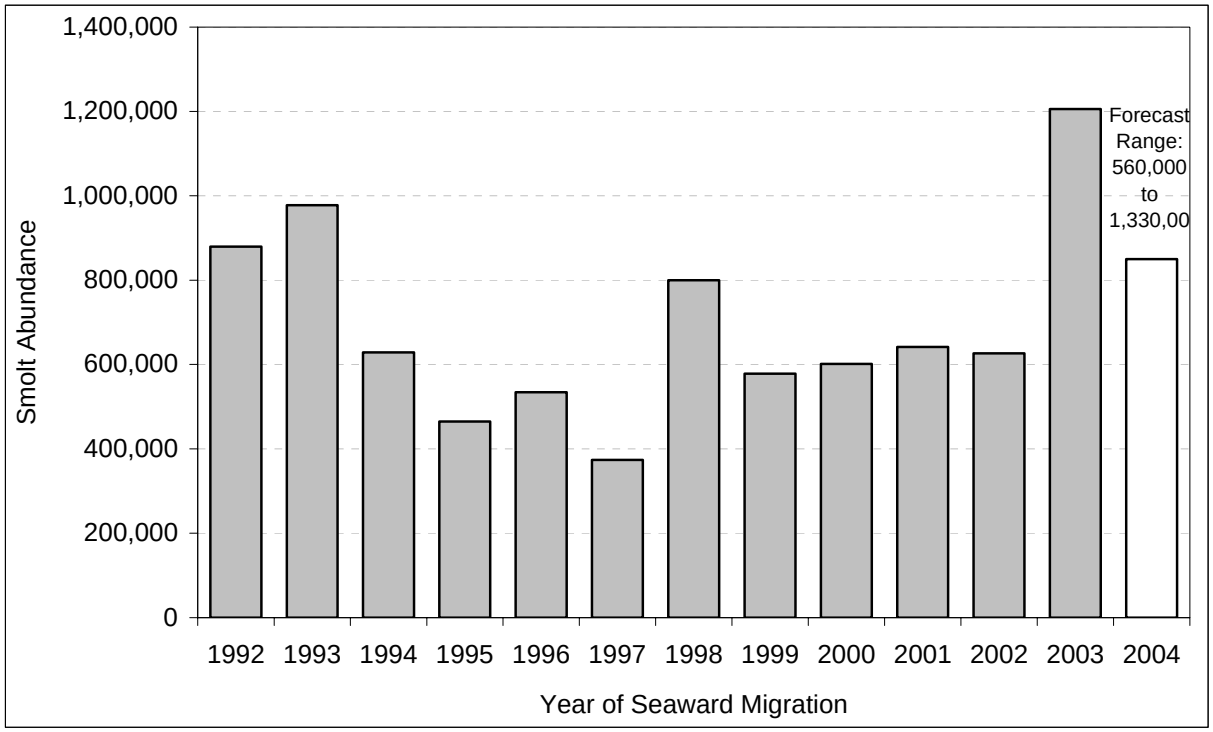


Figure 43.-Distribution of total harvest of Kenai River coho salmon in Upper Cook Inlet, 1993-2003.

A



B

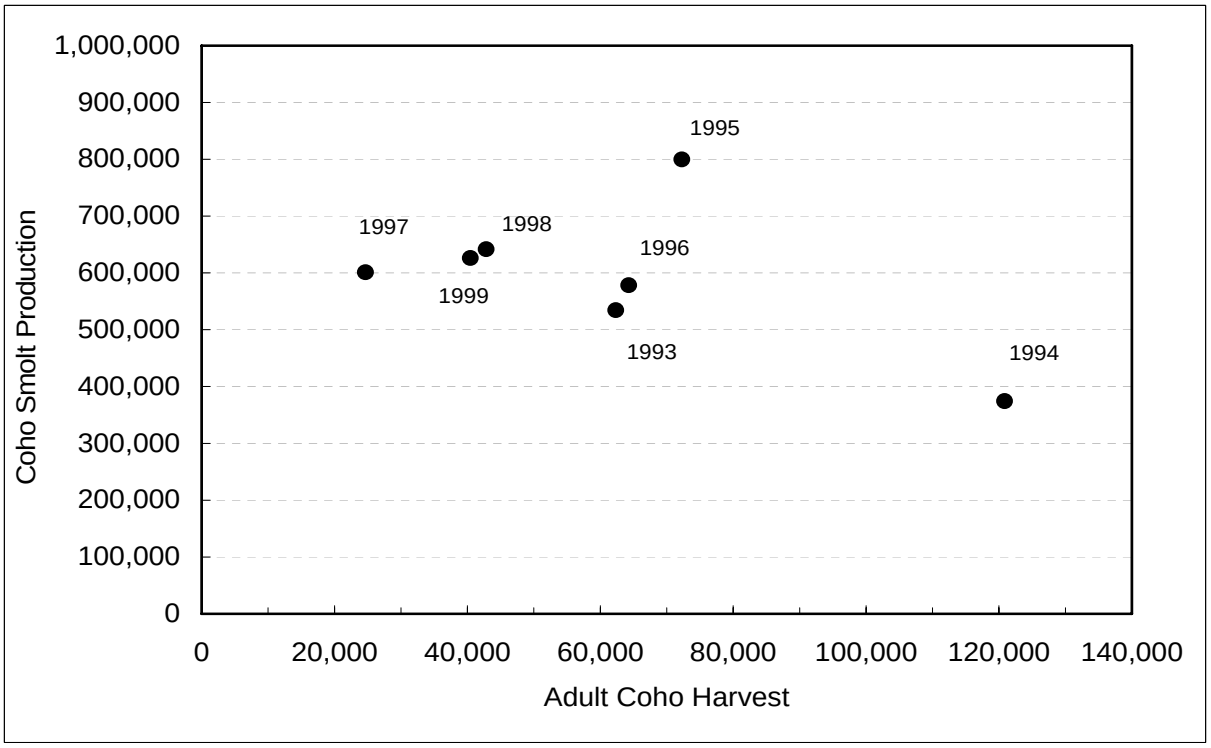
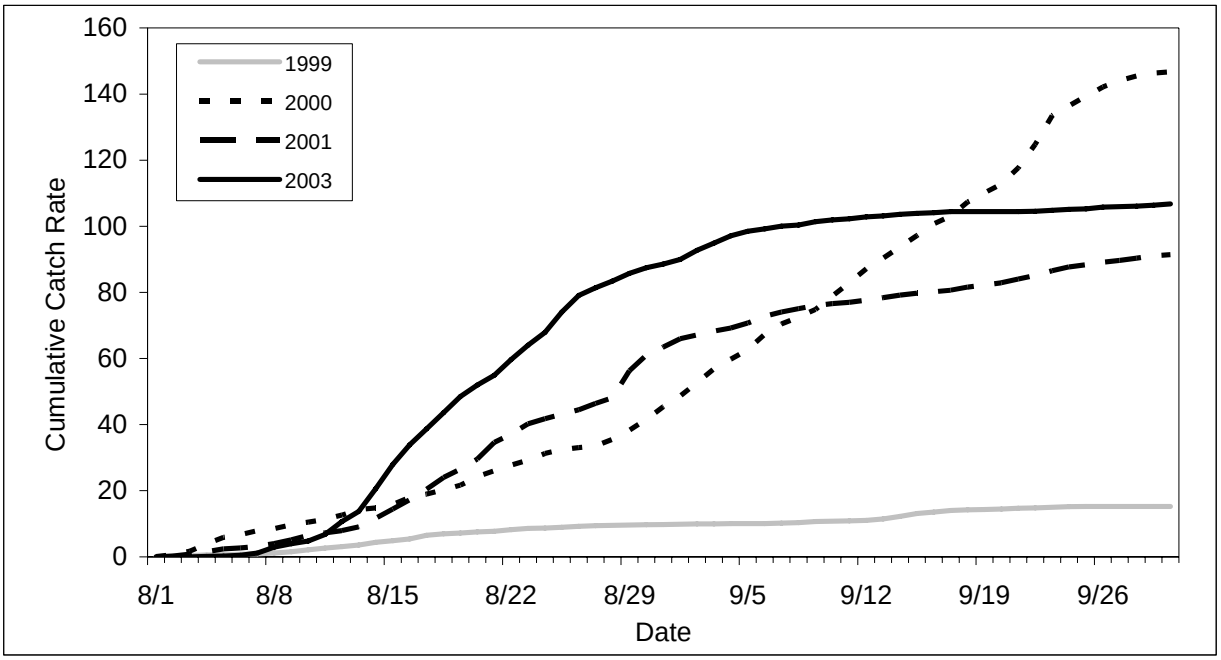


Figure 44.-(A) Estimates of smolt abundance in the Kenai River, 1992-2003 and forecast for 2004, and (B) the relationship between smolt production and total harvest of coho salmon in the Kenai River, with data labels showing year of parent year harvest.

A



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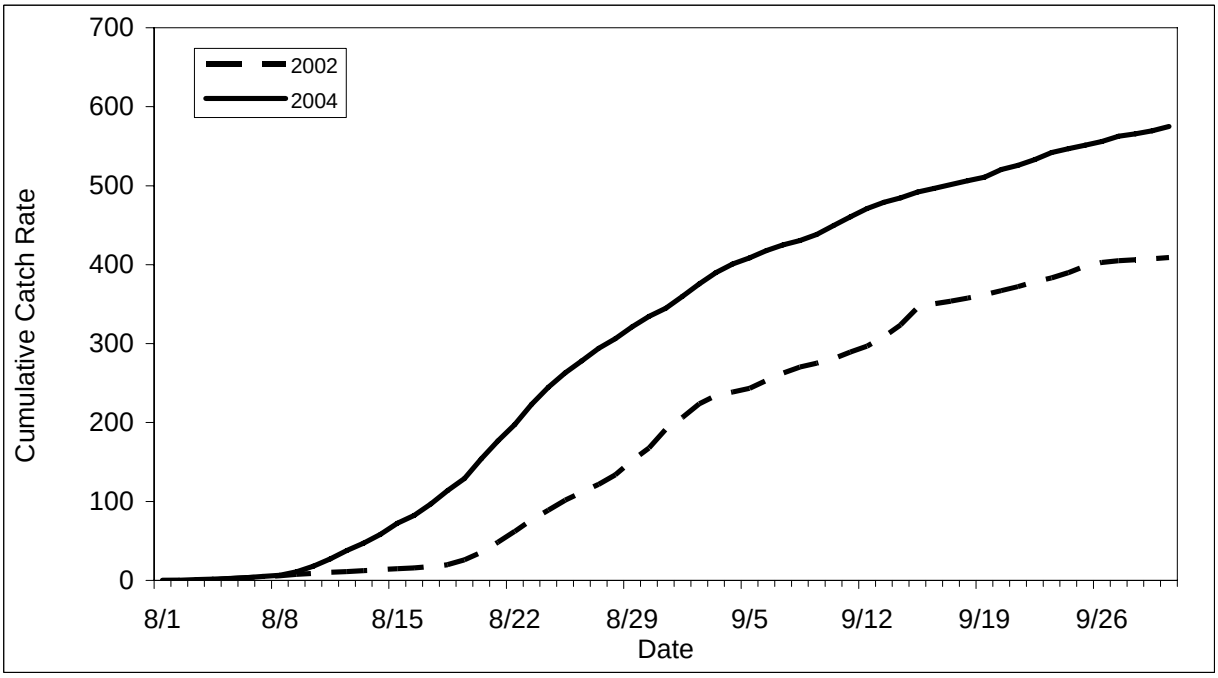

Figure 45.-Daily cumulative catch rate of coho salmon by fish wheels in the Kenai River (A) during 1999-2001 and 2003, and (B) during 2002 and 2004 when catch rate was much greater than the other years.

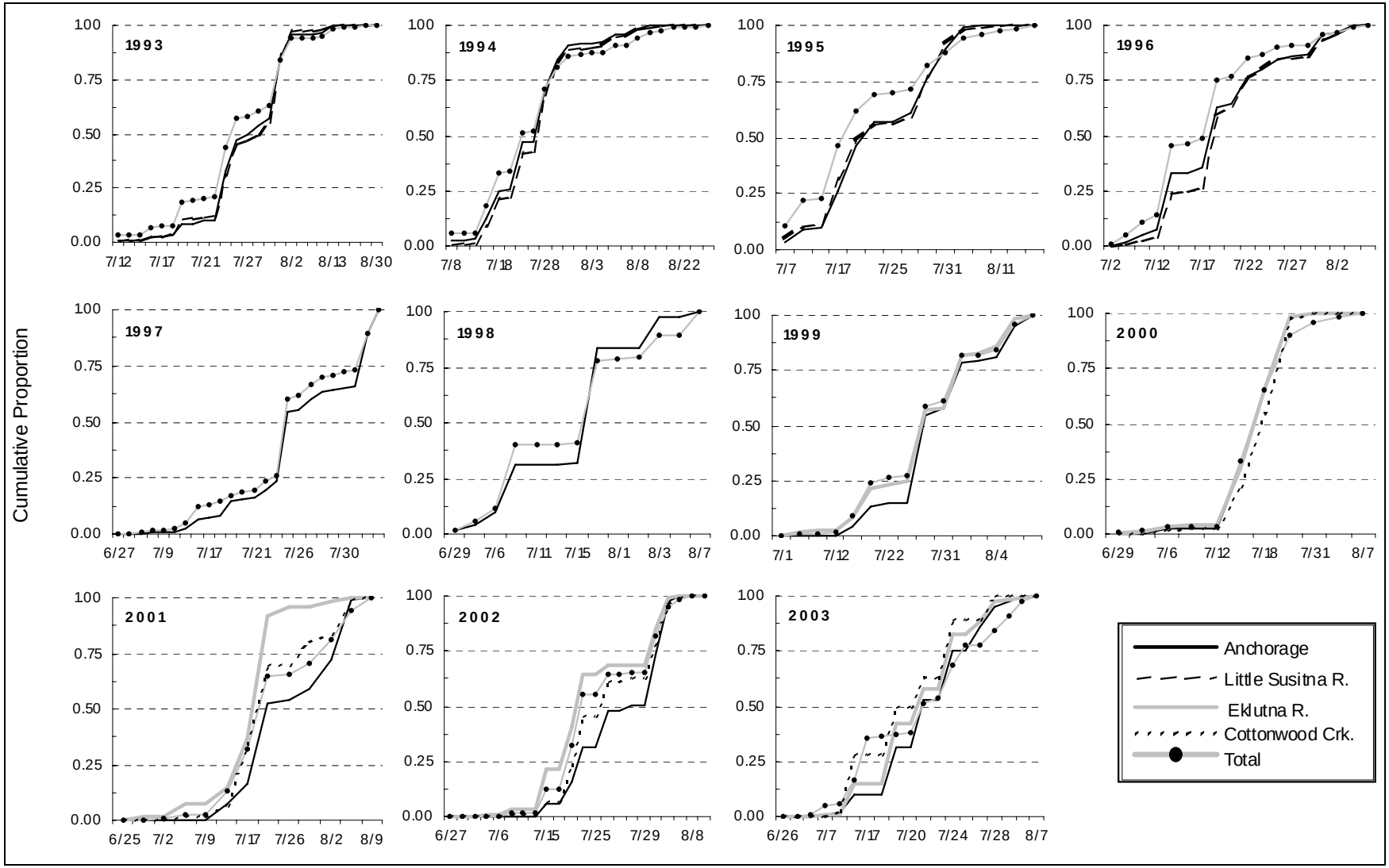

Figure 46.-Cumulative proportions of the harvest of all (Total), Anchorage hatchery-produced, Little Susitna River hatchery-produced, Eklutna River hatchery-produced, and Cottonwood Creek wild coho salmon by date in the Central District drift gillnet fishery, 1993-2003.

Notes: The panel for 2000 includes Anchorage, Eklutna, Cottonwood, and Total, but lines are obscured because they lie close together.

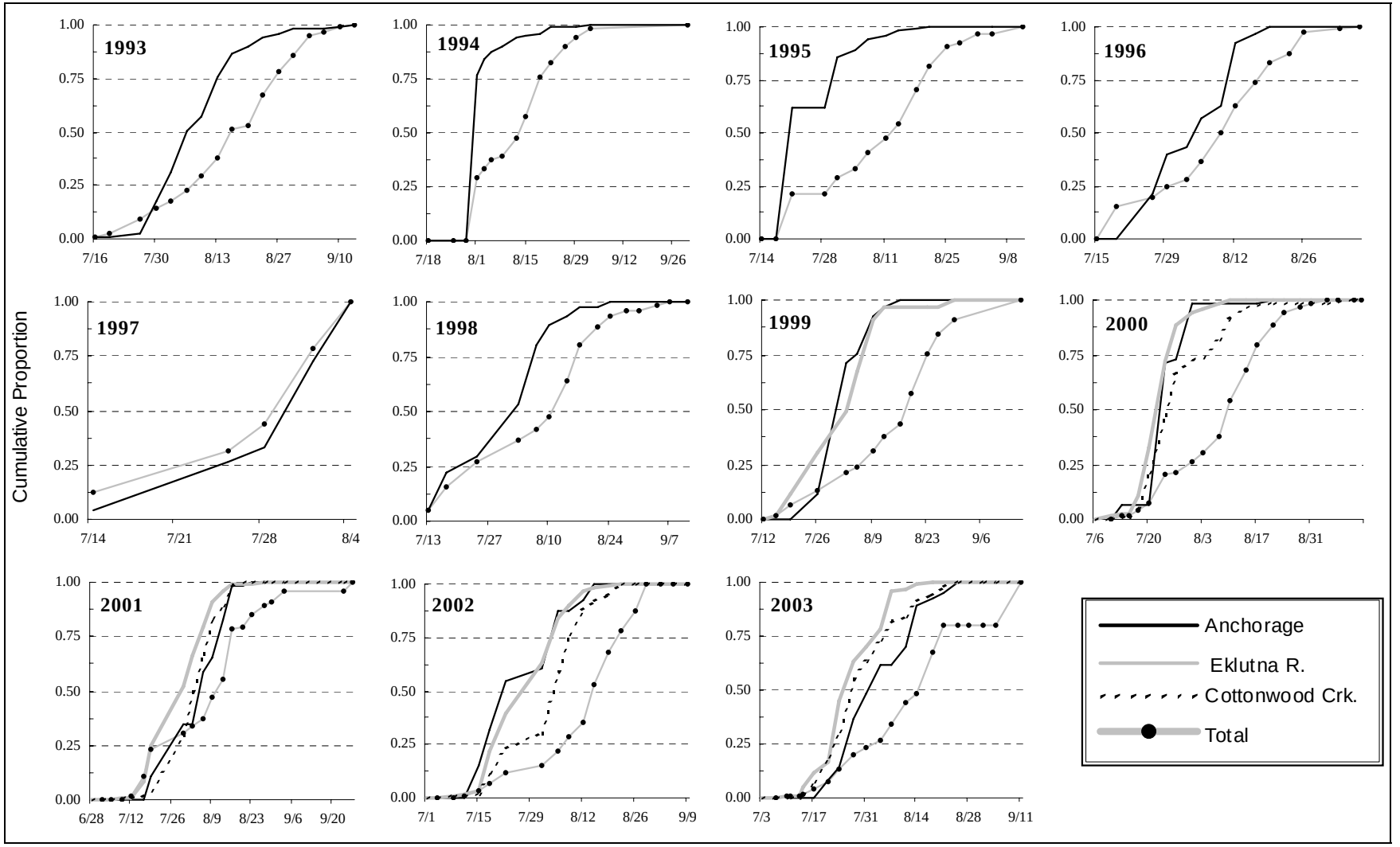

Figure 47.-Cumulative proportions of the harvest of all (Total), Anchorage hatchery-produced, Eklutna River hatchery-produced, and Cottonwood Creek wild coho salmon in eastern statistical areas (247-70, 247-80, and 247-90) of the Northern District setnet fishery, 1993-2003.

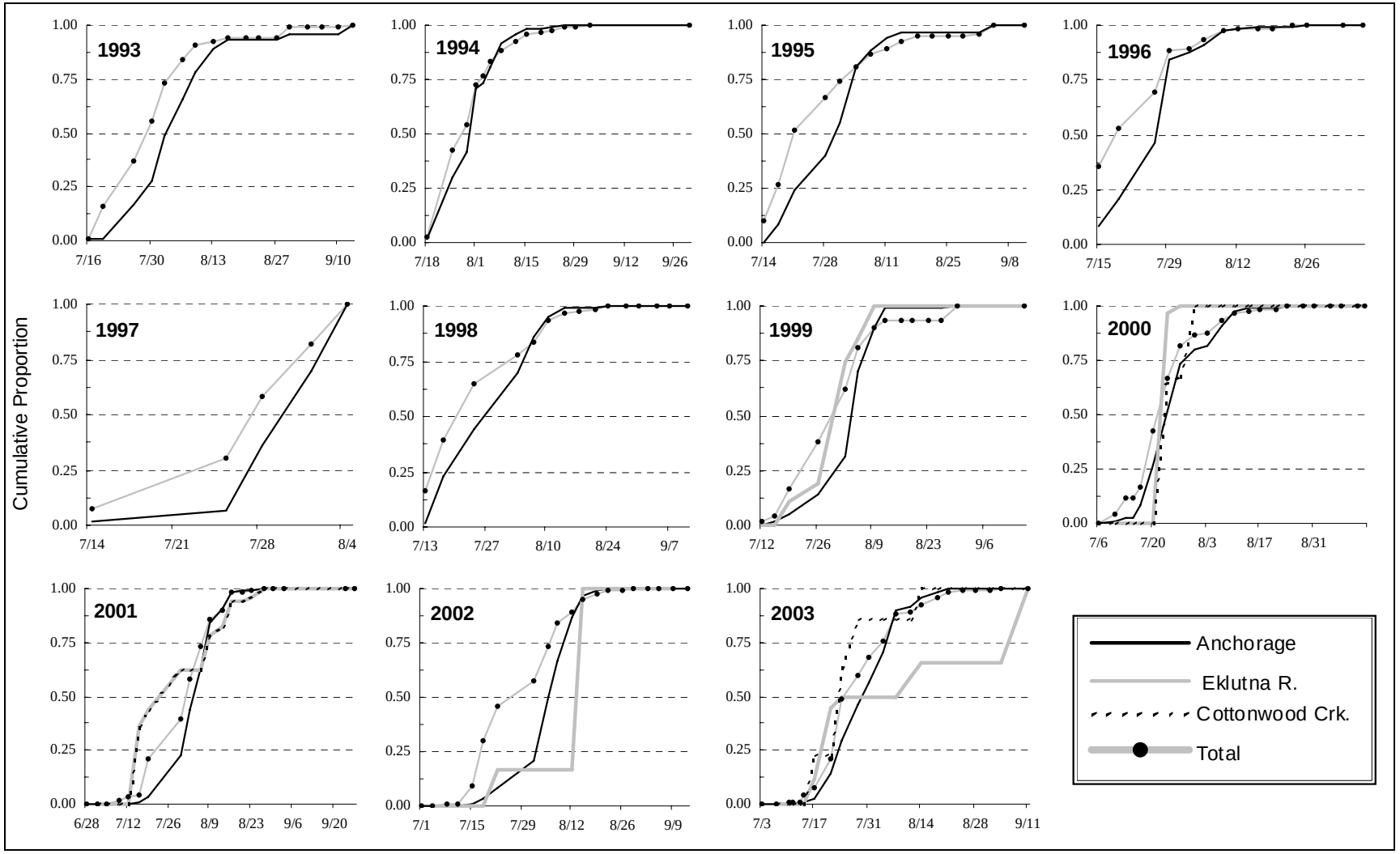

Figure 48.-Cumulative proportions of the harvest of all (Total), Anchorage hatchery-produced, Eklutna River hatchery-produced, and Cottonwood Creek wild coho salmon in western statistical areas (247-10, 247-20, 247-30, 247-41, 247-42, and 247-43) of the Northern District setnet fishery, 1993-2003.