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Escapement Goals for Salmon Stocks in Upper Cook Inlet, Alaska: Report to the Alaska Board of Fisheries, January 2005

by

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and

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May 2007

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

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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	$\geq$
harvest per unit effort	HPUE
less than	$<$
less than or equal to	$\leq$
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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by

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ABSTRACT

In February 2004, a salmon escapement goal review committee, composed of staff from the Division of Commercial Fisheries and Division of Sport Fish, was formed to review Pacific salmon *Oncorhynchus* spp. escapement goals in Upper Cook Inlet, Alaska. These goals were last reviewed in 2001. The committee recommended changing three of 23 Chinook salmon goals, two of five coho salmon goals, and five of eight sockeye salmon goals. This report was originally provided to the Alaska Board of Fisheries in January 2005.

Based on results of a spawner-recruit analysis constructed in a Bayesian framework, the committee recommended lowering the biological escapement goal (BEG) of early-run Kenai River Chinook salmon from the current range of 7,200-14,400 to a new range of 4,000-9,000. The committee recommended not changing the BEG of 17,800-35,700 for late-run Kenai River Chinook salmon because this range was consistent with the estimated range of escapements that would produce 90-100% of maximum sustained yield. The committee recommended removing the sustainable escapement goal (SEG) for Deception Creek Chinook salmon since the escapement data were not collected in a consistent manner and Deception Creek is a tributary of Willow Creek, so the Alaska Department of Fish and Game does not manage these stocks independently. In addition, removing the SEG for Campbell Creek Chinook salmon was recommended because there is currently no fishery on this stock.

For coho salmon stocks, the committee recommended removing the SEG for Fish Creek (Knik Arm) and Cottonwood Creek stocks because the coho salmon escapement to each system will no longer be monitored with a weir. Because escapements of coho salmon past the Little Susitna River weir were highly correlated with escapements and total inriver run to these Knik Arm systems, future coho salmon escapements to the Little Susitna River will be used to gauge inriver stock status of coho salmon to other Knik Arm systems.

For sockeye salmon stocks, the committee recommended changing the goal type of Kenai River and early-run Russian River stocks from a BEG to an SEG because the spawner-recruit data of each stock lacks sufficient information to estimate maximum sustained yield. The committee recommended not changing the goal range of either stock: 500,000-800,000 for the Kenai River and 14,000-37,000 for early-run Russian River. Based on updated brood table information and spawner-recruit analysis, the committee recommended increasing the BEG range of Crescent River sockeye salmon from 25,000-50,000 to 30,000-70,000. A minor change to the late-run Russian River sockeye salmon SEG of 33,000-121,000 fish to a new goal of 30,000-110,000 fish was recommended. The current goal includes, incorrectly, sockeye salmon that spawn in the Russian River downstream of the weir that are already part of the Kenai River sockeye salmon escapement goal. The committee recommended removing the SEG for Packers Lake sockeye salmon because the escapement is no longer monitored.

Key words: Upper Cook Inlet, escapement goal, biological escapement goal, BEG, sustainable escapement goal, SEG, sockeye salmon, *Oncorhynchus nerka*, Chinook salmon, *O. tshawytscha*, coho salmon, *O. kisutch*, chum salmon, *O. keta*, Alaska Board of Fisheries.

INTRODUCTION

In this report, we review and evaluate the escapement goals of salmon stocks of Upper Cook Inlet (UCI). This report is the fourth in a series of reviews examining escapement goals for UCI salmon stocks (Fried 1995, 1999; Bue and Hasbrouck *Unpublished*). This report was originally provided to the Alaska Board of Fisheries in January 2005 to provide information necessary for deliberations of possible regulatory changes. 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).

Understanding salmon population dynamics and achieving salmon sustainability requires knowledge of the size of the spawning stock (Hilborn and Walters 1992). Escapement usually means the number of salmon that reach the spawning grounds. Escapement is affected by a variety of factors including exploitation, predation, diseases, and physical and biological changes in the environment.

Estimates or indices of salmon escapement are obtained with a variety of methods such as foot and aerial surveys, capture-recapture experiments, weir counts, counting towers, and hydroacoustics (sonar). Differences in methods among years can affect the comparability and reliability of data. In the practical arena of salmon management, fishery biologists try to determine the amount of harvestable surplus and the number of spawners necessary to perpetuate the stock or run, known as the escapement goal. Escapement goals for salmon have typically been based on spawner-recruit relations (e.g., Ricker 1954; Beverton and Holt 1957), which represent the productivity of the stock and estimated carrying capacity. However, specific methods to determine escapement goals vary in their technical complexity. Thus, escapement goals should be evaluated and revised over time as improved methods of assessment and goal setting are developed, and when new and better data become available.

REVIEW PROCESS

Following the adoption of the Alaska Department of Fish and Game (ADF&G) Salmon Escapement Goal Policy in 1992 (Fried 1994), escapement goals were categorized as biological escapement goals, optimal escapement goals, or inriver goals. During 2000-2001, the BOF adopted the Policy for the Management of Sustainable Salmon Fisheries (SSFP, 5 ACC 39.222) and the Policy for Statewide Salmon Escapement Goals (EGP, 5 AAC 39.223). Under sections (b) (2) and (3) of the escapement goal policy, ADF&G is to:

> (2) establish biological escapement goals (BEG) for salmon stocks for which the department can reliably enumerate salmon escapement levels, as well as total annual returns; and
>
> (3) establish sustainable escapement goals (SEG) for salmon stocks for which the department can reliably estimate escapement levels when there is not sufficient information to enumerate total annual returns and the range of escapements that are used to develop a BEG.

Section (f) of the sustainable fisheries policy provides definitions that are more detailed:

> (3) “biological escapement goal” or “(BEG)” means the escapement that provides the greatest potential for maximum sustained yield; BEG will be the primary management objective for the escapement unless an optimal escapement or inriver run goal has been adopted; BEG will be developed from the best available biological information and should be scientifically defensible on the basis of available biological information; BEG will be determined by the department and will be expressed as a range based on factors such as salmon stock productivity and data uncertainty; the department will seek to maintain evenly distributed salmon escapements within the bounds of a BEG; and
>
> (36) “sustainable escapement goal” or “(SEG)” means a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated due to the absence of stock specific catch estimate; the SEG is the primary management objective for the escapement, unless an optimal escapement or inriver run goal has been adopted by the board, and will be developed from the best available biological information; the SEG will be determined by the department and will be stated as a range that takes into account data uncertainty; the department will seek to maintain escapements within the bounds of the SEG.

A committee composed of ADF&G staff from both the Divisions of Sport Fish and Commercial Fisheries was organized to review escapement goals. Committee members from Sport Fish Division were Dave Bernard, Rich Yanusz, Tim McKinley, Robert Begich, Tom Vania, George Pappas, and Jim Hasbrouck; those from Commercial Fisheries Division were John H. Clark, Mark Willette, Nancy Gove, Jim Browning, Jeff Fox, and Jim Edmundson. The committee reviewed the escapement goal for each of the 23 Chinook *Oncorhynchus tshawytscha*, eight sockeye *O. nerka*, five coho *O. kisutch* and one chum *O. keta* salmon stocks in UCI. There are no pink salmon *O. gorbuscha* stocks with an escapement goal in UCI. The purpose of the team was to 1) determine the appropriate goal type (biological or sustainable escapement goal) for stocks being reviewed, 2) determine the most appropriate methods to evaluate the escapement goal, 3) estimate the escapement goal for each stock and compare these estimates with the current goal, 4) determine if a goal could be developed for any stocks or stock-aggregates that currently have no goal, and 5) develop recommendations and present these recommendations to the Directors of the two divisions for approval. The committee met to discuss and develop recommendations on 9 February, 8 August, 15 September (this meeting involved only part of the committee), and 12 October 2004. The committee also communicated by telephone and email.

METHODS

STUDY AREA

The UCI management unit consists of that portion of Cook Inlet north of Anchor Point and is divided into the Central and Northern districts (Figure 1). The Central District is approximately 120 km (75 miles) long, averages 50 km (32 miles) in width, and is further subdivided into six subdistricts. The Northern District is 80 km (50 miles) long, averages 32 km (20 miles) in width, and is divided into two subdistricts. Commercial salmon fisheries target mainly sockeye salmon with secondary catches of Chinook, coho, chum and pink salmon. Sport fish management is divided into the Northern Kenai Peninsula, Northern Cook Inlet, and the Anchorage management areas. These areas offer diverse personal use and recreational fishing opportunities for all five salmon species.

ESCAPEMENT AND HARVEST DATA COLLECTION

Escapements of most Chinook salmon stocks in UCI have been monitored by single foot and aerial surveys. Such surveys provide only an index of escapement because we lack supporting data (e.g., accurate estimates of stream life and observer variability) to estimate number of fish in the escapement. The indices are a measurement on a numeric scale that provides information only about the relative level of the escapement. These measurements provide a ranking of escapement magnitude across years, but alone these measurements provide no information on the total number of fish in the escapement.

Hydroacoustics (sonar) have been used to assess early- and late-run Chinook salmon inriver runs to the Kenai River (Miller et al. 2003). A gillnetting program has been used to sample Chinook salmon to estimate age composition. Since 1995, the Deshka River Chinook salmon escapement has been counted and sampled at a weir, but in prior years escapement was indexed annually by single aerial surveys (Yanusz *In prep* a). Chinook salmon escapement into the Deshka River prior to 1995 was estimated by expanding the aerial surveys in those years using the relationship between weir counts and survey indices observed since 1995. A weir project has also been in place to count and sample Chinook salmon in Crooked Creek (Gamblin et al. 2004). Sonar and weir data provides a count or an estimate of the total number of fish in the escapement.

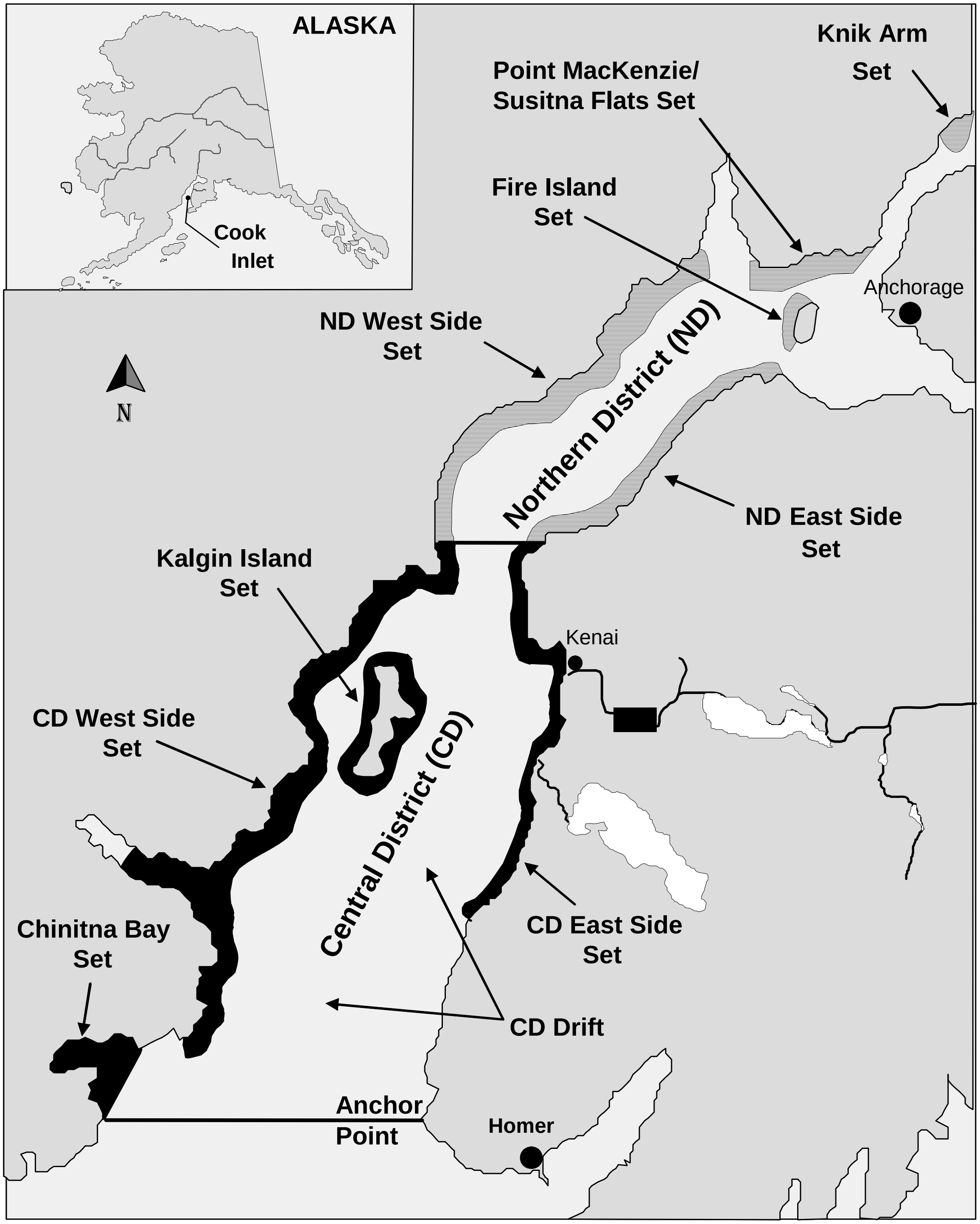

Figure 1.-Map of Upper Cook Inlet with commercial fishing districts and individual set and drift gillnet fisheries.

For coho salmon stocks, escapements have been monitored with a combination of single foot surveys and weir counts (Bue and Hasbrouck *Unpublished*). Peak aerial surveys have been used to index escapement of chum salmon in Clearwater Creek, the only chum salmon stock in UCI that is monitored by the department (Tobias and Willette 2004).

Sonar has been deployed to index sockeye salmon passing the counting location in the Kenai, Kasilof, Crescent and Yentna rivers and fish wheel catches were used to apportion sonar counts to species in these systems (Westerman and Willette 2003). Weirs have been installed to count adult sockeye salmon escapements in the Russian River (Gamblin et al. 2004), Fish Creek (Sweet et al. 2003), and Packers Creek (Fandrei 1996).

Commercial catch statistics were compiled from ADF&G fish ticket information. Estimates of sport harvest were derived from the postal survey (Statewide Harvest Survey) conducted annually by the Division of Sport Fish (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003).

ESCAPEMENT GOAL SETTING

Available escapement, harvest, and age data associated with each stock or combination of stocks to be examined were compiled from research reports, management reports, and unpublished historical databases. Limnological and spawning habitat data were compiled for each system when available. The committee evaluated the type, quality, and amount of data for each stock according to criteria described in Bue and Hasbrouck (*Unpublished*). If a sufficient time series of escapement and total return estimates were available, if spawning contrast was sufficiently large, and if the estimates were sufficiently accurate and precise, then the data were considered sufficient to attempt to estimate the escapement level with the greatest potential to provide maximum sustained yield (MSY) and develop a BEG for the stock. This level of spawning escapement is identified as S_{msy} (Hilborn and Walters 1992; CTC 1999; Quinn and Deriso 1999). If return estimates were not available because harvest and/or age were not consistently measured, or if the data did not provide a scientifically defensible estimate of S_{msy}, other methods were applied to establish an SEG.

In keeping with the SSFP, only data from naturally produced ("wild") fish were used in estimating escapement goals. The Kenai River sockeye salmon goal does not include hatchery-stocked fish returning to Hidden Lake. For Kasilof River sockeye salmon, the number of fish taken for brood stock was removed from the escapement but hatchery fish were not removed from the total return. The average hatchery return to the Kasilof River in the last several brood years has averaged approximately 32,000 fish or 3-6% of the total return (Kyle 1992; Todd and Kyle 1994, 1995; USFWS and CIAA 1997). Only data collected from years prior to stocking were used to estimate the escapement goal for sockeye salmon at Fish and Packers creeks. Estimates of "wild only" fish in the escapement were used to estimate the goal range for Crooked Creek, Deception Creek and Willow Creek Chinook salmon, and Campbell, Fish, and Jim creeks and Little Susitna River coho salmon.

Biological Escapement Goals

Seven stocks from Upper Cook Inlet currently have a BEG: Chinook salmon from Deshka River and early- and late-run Kenai River; and sockeye salmon from the Kenai, Kasilof, Crescent, and the early-run component of the Russian River. Traditionally and per policy, a BEG is based on maximum sustained yield, often estimated from spawner-recruit data. Spawner-recruit data were analyzed using Ricker (1954) type stock-recruitment models to estimate MSY, S_{msy}, and the BEG range, which is often estimated from the escapements that produce 90% of MSY (Figure 2). Hilborn and Walters (1992), Quinn and Deriso (1999), and the CTC (1999) provide good descriptions of the Ricker model, as well as other traditional stock-recruit curves, and diagnostics to assess the model fits. All stock-recruitment models were tested and corrected for autocorrelation among model residuals when necessary. Additionally, the Ricker alpha parameter was corrected for the natural logarithm (ln) transformation bias induced into the model as described in Hilborn and Walters (1992) from fitting a regression line to ln (recruits/spawners) versus spawners.

Additional analyses were conducted to examine stock productivity and the escapement goal for Kenai River sockeye salmon. Details about the various methods are provided in ADF&G (*Unpublished*). These analyses included:

(1) examination of a hierarchy of mathematical models that related number of spawners and adult recruitment of Kenai River sockeye salmon;

(2) simulations using brood-interaction model parameters (Carlson et al. 1999) using the 1969-1999 spawner-recruit data and for the recent brood years 1979-1999 because the latter data set was obtained using more consistent methods for stock composition;

(3) analyzing the brood-interaction model to simulate the effects of alternating spawner abundances on yields; and

(4) Markov yield probability matrices (Hilborn and Walters 1992).

Sustainable Escapement Goals

Most salmon stocks in UCI with an escapement goal have an SEG. In 2001, the SEG of these stocks was developed using percentiles of observed escapements, whether estimates or indices, that incorporated contrast in the escapement data and exploitation of the stock (Bue and Hasbrouck *Unpublished*). Percentile ranking is the percent of all escapement values that fall below a particular value. To calculate percentiles, escapement data are ranked from smallest to the largest value, with the smallest value the 0^{th} percentile (i.e., none of the escapement values are less than the smallest). The percentile of all remaining escapement values is a cumulative, or summation, of 1/(n-1), where n is the number of escapement values. Contrast in the escapement data is simply the maximum value divided by the minimum value. As contrast increased, the percentiles used to estimate the SEG were narrowed, primarily from the upper range, to allow the SEG to include a wide range of escapements. For exploited stocks with high contrast, the lower end of the SEG range was increased to the 25^{th} percentile as a precautionary measure for stock protection. The percentiles used at different levels of contrast were as follows (Bue and Hasbrouck *Unpublished*):

Escapement Contrast and Exploitation	SEG Range
Low Contrast (<4)	15^{th} Percentile to maximum observation
Medium Contrast (4 to 8)	15^{th} to 85^{th} Percentile
High Contrast (>8); Low Exploitation	15^{th} to 75^{th} Percentile
High Contrast (>8); Exploited Population	25^{th} to 75^{th} Percentile

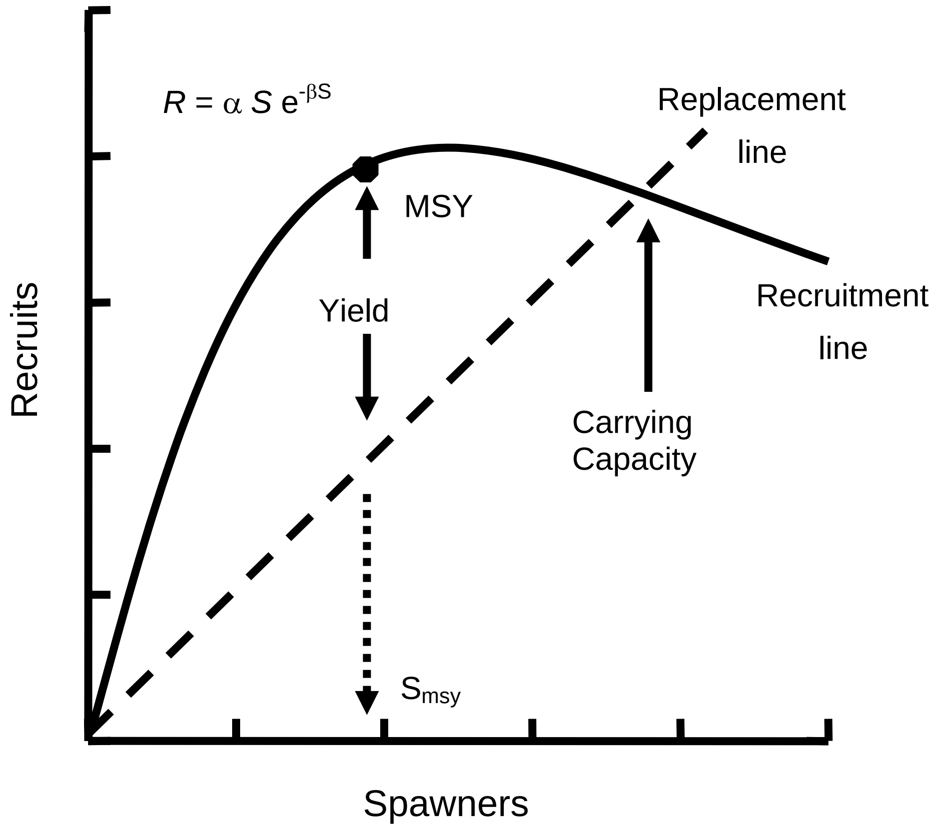

Figure 2.-Typical Ricker spawner-recruit relationship relating escapement (number of spawners, S) to adult recruitment (R).

Notes: α is the productivity parameter and β is the density dependent parameter. Also indicated are the estimates of the number of recruits at maximum sustained yield (MSY), number of spawners producing maximum sustained yield (S_{MSY}), carrying capacity of the system, and the replacement line (i.e., number of recruits = number of spawners).

For this review, the SEG ranges of all stocks were reevaluated using the SEG algorithm with updated or revised escapement data. If the estimated SEG range was consistent with the current goal (i.e., a high degree of overlap), the committee recommended no change to the goal.

RESULTS AND DISCUSSION

The committee recommended that most escapement goals for UCI salmon stocks not change (Table 1). The committee recommended changes to one BEG and two SEGs of the total 23 goals for Chinook salmon, two of the five SEGs for coho salmon, and three BEGs and two SEGs of the total eight sockeye salmon goals. Details on the recommendations are provided below.

Historical escapement through 2000 and, when possible harvest or total return data, of each stock appear in Appendices A–D. Data in the appendices were used in the review of escapement goals and development of SEGs of UCI salmon stocks in 2001 (Bue and Hasbrouck *Unpublished*). For stocks with spawner-recruit data, brood tables in the appendices have been updated with additional returns since 2002. Escapement values of some Chinook and coho salmon stocks were corrected because errors were discovered in the data.

BIOLOGICAL ESCAPEMENT GOALS

Chinook Salmon

Kenai River

Escapements of early- and late-run Kenai River Chinook salmon since 2001 have mostly met or exceeded the BEG of each stock (Table 1). Only the early run in 2002 did not meet the BEG.

The committee recommended lowering the BEG of early-run Kenai River Chinook salmon from the current goal of 7,200-14,400 to a new goal of 4,000-9,000. A standard Ricker model fit to spawner-recruit data for the 1986-1997 brood years estimated the spawning escapement that produces maximum sustained yield (S_{msy}) is approximately 5,100 fish. Because the low contrast in observed escapements (= 3.5) and ignoring measurement error in estimating escapement may make the estimate of S_{msy} biased, a Ricker model was also constructed in a Bayesian framework which allowed incorporation of measurement error (Tim McKinley, Alaska Department of Fish and Game, Division of Sport Fish, Soldotna, personal communication). This analysis estimated S_{msy} is approximately 5,800 fish (Appendix A11) with an escapement range of 4,000-9,000 fish producing ~90-100% of MSY. This goal range is based on a scientifically defensible assessment of the best biological information on the stock (Tim McKinley, Alaska Department of Fish and Game, Division of Sport Fish, Soldotna, personal communication). The analysis hinged in part on the return of the 1996 brood year, which was completed in 2003. Modeling these data in a Bayesian framework is a recent development. Although these results are preliminary, the completed analyses (Tim McKinley, Alaska Department of Fish and Game, Division of Sport Fish, Soldotna, personal communication) will likely not alter this recommendation.

The committee recommended no change to the late-run Kenai River Chinook salmon BEG of 17,800-35,700 fish. The same analyses conducted on the early-run data were conducted on spawner-recruit data of the late-run (Appendix A12). Results of these analyses indicated this range is very similar to the estimated range of escapements that would produce 90-100% of MSY (Tim McKinley, Alaska Department of Fish and Game, Division of Sport Fish, Soldotna, personal communication).

Table 1.-Current escapement goals, escapements observed from 2001-2004, and escapement goal recommendations in 2004 for Chinook, chum, coho, and sockeye salmon stocks of Upper Cook Inlet, Alaska.

System	Escapement Data[a]	Current Escapement Goal Type (BEG, SEG)	Current Escapement Goal Range	Escapements[b] 2001	2002	2003	2004	Recommendation[c]
Chinook Salmon								
Alexander Creek	SAS	SEG	2,100-6,000	2,282	1,936	2,012	2,215	NC
Campbell Creek	SFS	SEG	50-700	717	744	747	964	NC
Chuitna River	SAS	SEG	1,200-2,900	1,501	1,394	2,339	2,938	NC
Chulitna River	SAS	SEG	1,800-5,100	2,353 [d]	9,002	NS	2,162	NC
Clear (Chunilna) Creek	SAS	SEG	950-3,400	2,096	3,496	NS	3,417	NC
Crooked Creek[e]	Weir	SEG	650-1,700	1,381	958	2,554	2,196	NC
Deception Creek[e]	SAS	SEG	350-700	943	123	288	NA	Remove
Deshka River	Weir	BEG	13,000-28,000	27,966	28,535	39,257	57,934 [f]	NC
Eagle River-S. Fork	SFS	SEG	50-350	77 [d]	27 [d]	89	47 [d]	NC
Goose Creek	SAS	SEG	250-650	NS	565	175	417	NC
Kenai River - Early Run	Sonar	BEG	7,200-14,400	14,075	6,185	10,097	15,498 [g]	BEG = 4,000 - 9,000
Kenai River - Late Run	Sonar	BEG	17,800-35,700	17,947	30,464	22,663	56,205 [g]	NC
Lake Creek	SAS	SEG	2,500-7,100	4,661	4,852	8,153	7,598	NC
Lewis River	SAS	SEG	250-800	502	439	878	1,000	NC
Little Susitna River	SAS	SEG	900-1,800	1,238	1,660	1,114	1,694	NC
Little Willow Creek	SAS	SEG	450-1,800	2,084	1,680	879	2,227	NC
Montana Creek	SAS	SEG	1,100-3,100	1,930	2,357	2,576	2,117	NC
Peters Creek	SAS	SEG	1,000-2,600	4,226	2,959	3,998	3,757	NC
Prairie Creek	SAS	SEG	3,100-9,200	5,191	7,914	4,095	5,570	NC
Sheep Creek	SAS	SEG	600-1,200	NS	854	NS	285	NC
Talachulitna River	SAS	SEG	2,200-5,000	3,309	7,824	9,573	8,352	NC
Theodore River	SAS	SEG	500-1,700	1,237	934	1,059	491	NC
Willow Creek[e]	SAS	SEG	1,600-2,800	3,132	2,533	3,855	NA	NC
Chum Salmon								
Clearwater Creek	PAS	SEG	3,800-8,400	14,570	8,864	7,200	NA	NC

-continued-

Table 1.-Page 2 of 2.

System	Escapement Data[a]	Current Escapement Goal: Type (BEG, SEG)	Current Escapement Goal: Range	Escapements[b]: 2001	2002	2003	2004	Recommendation[c]
Coho Salmon								
Campbell Creek[e]	SFS	SEG	100-500	452 [d]	1,561	91	NA	NC
Cottonwood Creek	Weir	SEG	800-2,200	2,921	4,081	706	1,772	Remove
Fish Creek (Knik)	Weir	SEG	1,200-4,400	9,247	14,651	1,231	No weir	Remove
Jim Creek[h]	SFS	SEG	450-700	1,019	2,473	1,421	4,652	NC
Little Susitna River	Weir	SEG	10,100-17,700	30,587	47,938	10,877	40,199	NC
Pink Salmon								
No stocks with an escapement goal								
Sockeye Salmon								
Crescent River	Sonar	BEG	25,000-50,000	78,081	62,833	122,457	103,201	BEG = 30,000 - 70,000
Fish Creek (Knik)[i]	Weir	SEG	20,000-70,000	43,486	90,483	91,952	22,157	NC
Kasilof River	Sonar	BEG	250,000	297,000	216,000	347,000	577,581	NC
Kenai River	Sonar	BEG	800,000	457,000	728,000	966,000	1,385,981 [g]	SEG
Packers Creek	Weir	SEG	15,000-30,000	No weir	No weir	No weir	No weir	Remove
Russian River - Early Run	Weir	BEG	14,000-37,000	78,255	85,943	23,650	56,582	SEG
Russian River - Late Run	Weir	SEG	33,000-121,000	74,964	62,115	157,469	110,244	SEG = 30,000-110,000
Yentna River	Sonar	SEG	90,000-160,000	83,532	78,591	180,813	71,281	NC

[a] SAS = Single Aerial Survey, PAS = Peak Aerial Survey, SFS = Single Foot Survey.

[b] NS = No Survey and NA = Not Available. Fish required to meet broodstock needs, in addition to meeting escapement goal, include 250 Chinook salmon at Crooked Creek and Deception Creek; 500 Chinook salmon at Ship Creek; 150 coho salmon at Jim Creek; 1,000 coho salmon at Ship Creek; 10,000 sockeye salmon at the Kasilof River; and 5,000 sockeye salmon at Fish Creek.

[c] NC = No Change.

[d] Poor survey count due to timing, weather, or poor visibility.

[e] Escapement of naturally produced fish only.

[f] Weir count. Historic harvest upstream of weir = 1,005 Chinook salmon during 2000-2003.

[g] Sonar estimates of inriver return. Actual estimates of escapement not available at time of 2005 Alaska Board of Fisheries meeting, pending results from the 2005 Statewide Harvest Survey (Jennings et al. *In prep*).

[h] Foot survey of McRoberts Creek only, upon which the SEG is based.

[i] Total escapement of hatchery-stocked and naturally produced fish. SEG based on naturally produced fish only.

Deshka River

Deshka River Chinook salmon escapements since 2001 have been at the upper range or exceeded the BEG of 13,000-28,000 fish (Table 1). The 2004 escapement was the largest observed through the weir. Based on analyses of the updated spawner-recruit data, the committee recommended no change to the BEG (Appendix A8). The spawner-recruit data were updated since this goal was last reviewed in 2001 to include two additional completed brood years (Yanusz *In prep* a). This stock has fairly high contrast (= 9.9) in escapements and some large escapements with a return-per-spawner ratio less than one, providing good information to fit a Ricker model (CTC 1999).

Sockeye Salmon

Kenai River

The BEG of 500,000-800,000 spawners for Kenai River sockeye salmon was adopted in 1999. The goal was met or exceeded three of the past four years, only in 2001 was the goal not met (Table 1).

The committee recommended no change to the escapement goal range of 500,000-800,000 fish; however, the committee recommended changing the goal type from a BEG to an SEG. The goal type recommendation was based on several factors. There were no observational data available at high levels of escapement, thus making it difficult to scientifically determine the true stock-recruit relationship. Alternative Ricker models fit to the spawner-recruit data provided very different answers. One model indicated MSY could be achieved by an alternating biannual pattern of very low and very high escapements. A different model indicated that S_{msy} was about 1.3 million fish. There was uncertainty in the set of stock and recruit estimates available over the past 30 years. It was considered inappropriate for the escapement goal of 500,000-800,000 Kenai River sockeye salmon to be a BEG because that escapement range is not scientifically defensible as an MSY-based goal, but it was fully appropriate for this range to be an SEG. ADF&G (*Unpublished*) provides a comprehensive review of the escapement goal for this stock.

Kasilof River

The BEG for Kasilof River sockeye salmon is 150,000-250,000 fish. Escapements have exceeded the goal in three of the last four years. Over the last three decades, the 2004 sockeye salmon escapement estimate of 577,581 was the largest observed for this system (Table 1; Appendix C3).

The committee recommended no change to the BEG of Kasilof River sockeye salmon. A hierarchy of standard stock-recruit models, including linear regression, simple Ricker, and autoregressive Ricker were fit to the available stock-recruit data (1975-1998 brood years; Table 2). The simple Ricker model had a significant fit to the data (Figure 3A) and density dependence is evident by the likelihood profile of the sampling distribution for escapements that produce maximum sustained yield (Figure 3B). However, analysis of the residuals indicated a significant lag-1 autocorrelation. An autoregressive Ricker model fit to the data resulted in a significant improvement in fit and corrected for autocorrelation (Figure 4A). The autoregressive Ricker model was therefore the best model based on fit (Table 2), and the escapement that provided for maximum sustained yield was 181,000 (Figure 4B). The range of escapements that produced 90% of MSY was 113,000-263,000, consistent with the current BEG for this stock (Table 1). However, productivity response to the recent higher escapements over the next few years should

Table 2.-Parameters, negative log-likelihoods, escapements to produce maximum sustained yield (MSY), and 90% MSY escapement range, for four models of stock-recruitment fit to the Kasilof and Crescent River sockeye salmon data (brood years 1975-1998).

Stock	Model	Structure		Parameters			Negative log-	Likelihood	*P* -value	MSY Escapement		
			n	ln α	β	ϕ	likelihood	ratio		Estimate	Lower	Upper
Kasilof	Constant	$R_i = \beta S_i$	24	NA[a]	3.807	NA	13.0		<0.001			
	Linear	$R_i = \alpha + \beta S_i$	24	NA	NA	NA	16.4		NS[b]			
	Standard Ricker	$\ln R_i/S_i = \alpha - \beta S_i$	24	2.3858	-0.00000454	NA	4.2	17.65	<0.001	177,000	110,000	258,000
	Autoregressive Ricker	$\ln R_i/S_i = \ln \alpha - \beta S_i + \phi e_{i-1}$	23	2.368	0.00000443	0.505	1.1	6.247	0.012	181,000	113,000	263,000
Crescent	Constant	$R_i = \beta S_i$	24	NA	1.556	NA	19.9		<0.001			
	Linear	$R_i = \alpha + \beta S_i$	24	NA	NA	NA	24.6		NS			
	Standard Ricker	$\ln R_i/S_i = \alpha - \beta S_i$	24	1.431	-0.0000134	NA	19.1	1.6	0.206	46,000	30,000	65,000
	Autoregressive Ricker	$\ln R_i/S_i = \ln \alpha - \beta S_i + \phi e_{i-1}$	23	1.373	-0.0000129	0.517	13.6	10.8	0.001	48,000	31,000	68,000

[a] NA = not applicable.

[b] NS = not significant.

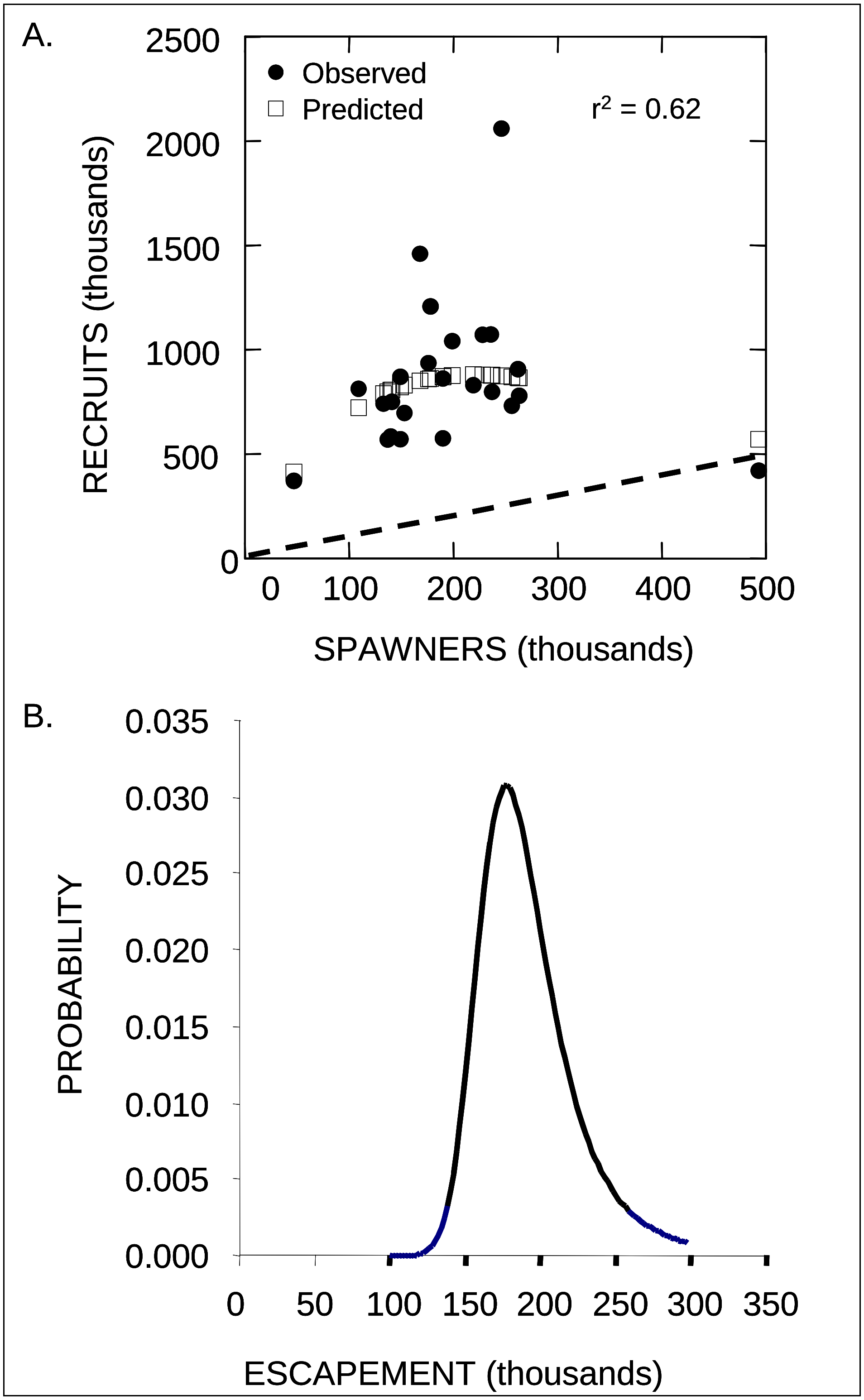

Figure 3.-(A) Standard Ricker model fit to Kasilof River sockeye spawner-recruit data (brood years 1975-1998; dashed line indicates replacement); and (B) the likelihood profile for the escapement that produces maximum sustained yield**.**

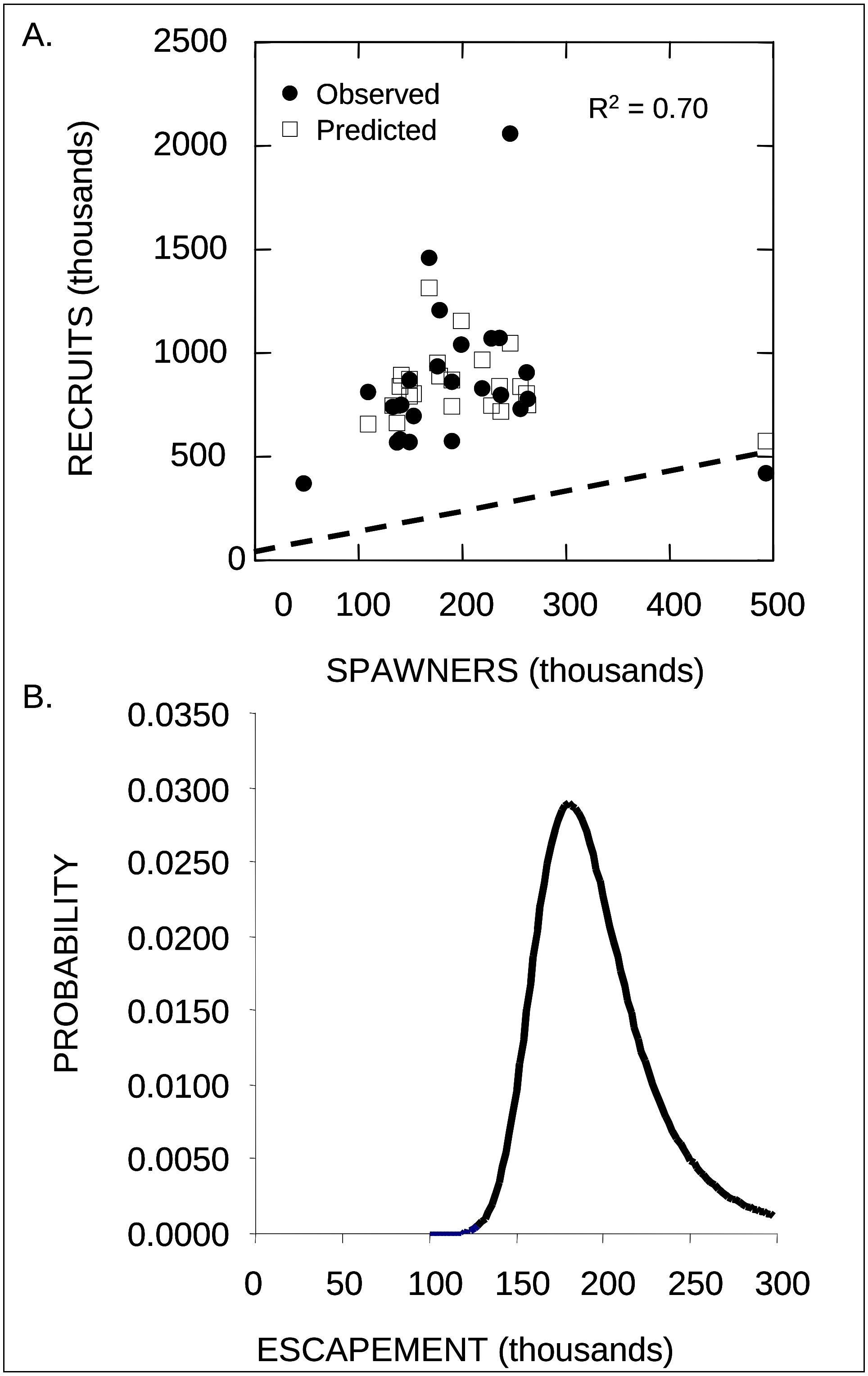

Figure 4.-(A) Autoregressive Ricker model fit to Kasilof River sockeye spawner-recruit data (brood years 1975-1998; dashed line indicates replacement); and (B) the likelihood profile for the escapement that produces maximum sustained yield.

provide additional and critical knowledge about the relationship between spawners and recruits and about the upper end of the BEG range.

Crescent River

In 1999, the BEG of Crescent River sockeye salmon was reduced from 50,000-100,000 fish to the current range of 25,000-50,000 fish. This recommendation was based on increased glacial turbidity, decreased light penetration (euphotic zone depth), and very low density of cyclopoid copepods (*Cyclops*), the primary food resource (crustacean zooplankton) for rearing sockeye juveniles in Crescent Lake (Fried 1999; Edmundson and Edmundson 2002). However, recent (2001-2004) escapement estimates for Crescent River sockeye salmon have exceeded the upper end of the BEG, particularly in 2003 (122,457) and 2004 (103,201) when escapement levels were more than twice the upper end of the goal range (Table 1). Although it is possible that the productivity of this stock has increased recently in response to a lessening of turbidity in Crescent Lake (Edmundson and Edmundson 2002), the escapement levels observed over the last few years are probably more related to lower commercial fishing effort on this stock (Fox and Shields 2005).

The committee recommended increasing the BEG of Crescent River sockeye salmon to a range of 30,000-70,000 spawners (Table 1). A hierarchy of standard stock-recruit models, including constant escapement, linear regression, simple Ricker, and autoregressive Ricker were fit to the available stock-recruit data (1975-1998 brood years; Table 2). The simple Ricker model did not result in a significant improvement in fit over the constant recruitment model. Despite the relatively poor fit (Figure 5A), there was significant density dependence in the data as evidenced by the tight likelihood profile for estimated MSY escapement level (Figure 5B). Moreover, analysis of the residuals indicated significant lag-1 autocorrelation. An autoregressive Ricker model produced a significant improvement in fit (Figure 6A) and the level of escapement that provided for maximum sustained yield was 48,000 (Figure 6B). The BEG based on the range of escapement that produced 90% of maximum sustained yield was 31,000-68,000, higher than the current goal range.

Early-run Russian River

The BEG of early-run Russian River sockeye salmon is 14,000-37,000 fish. Escapements have exceeded the goal in three of the past four years (Table 1). Escapements in 2001 and 2002 were the largest observed over the four decades that the escapement has been monitored (Appendix C6).

As with Kenai River sockeye salmon, the committee recommended no change to the escapement goal range of 14,000-37,000 fish; however, the committee recommended changing the goal type from a BEG to an SEG. A Ricker model did not fit the data (P-value = 0.55 for the beta parameter estimate) and no observed escapements have produced density-dependent effects. Other summaries of the data provided no clear indication of MSY for the stock. The current goal range is sustainable, but it was developed using the percentile approach so it is not scientifically defensible. Returns in coming years from the large escapements in 2001 and 2002 may provide better information to estimate MSY and develop a BEG for this stock.

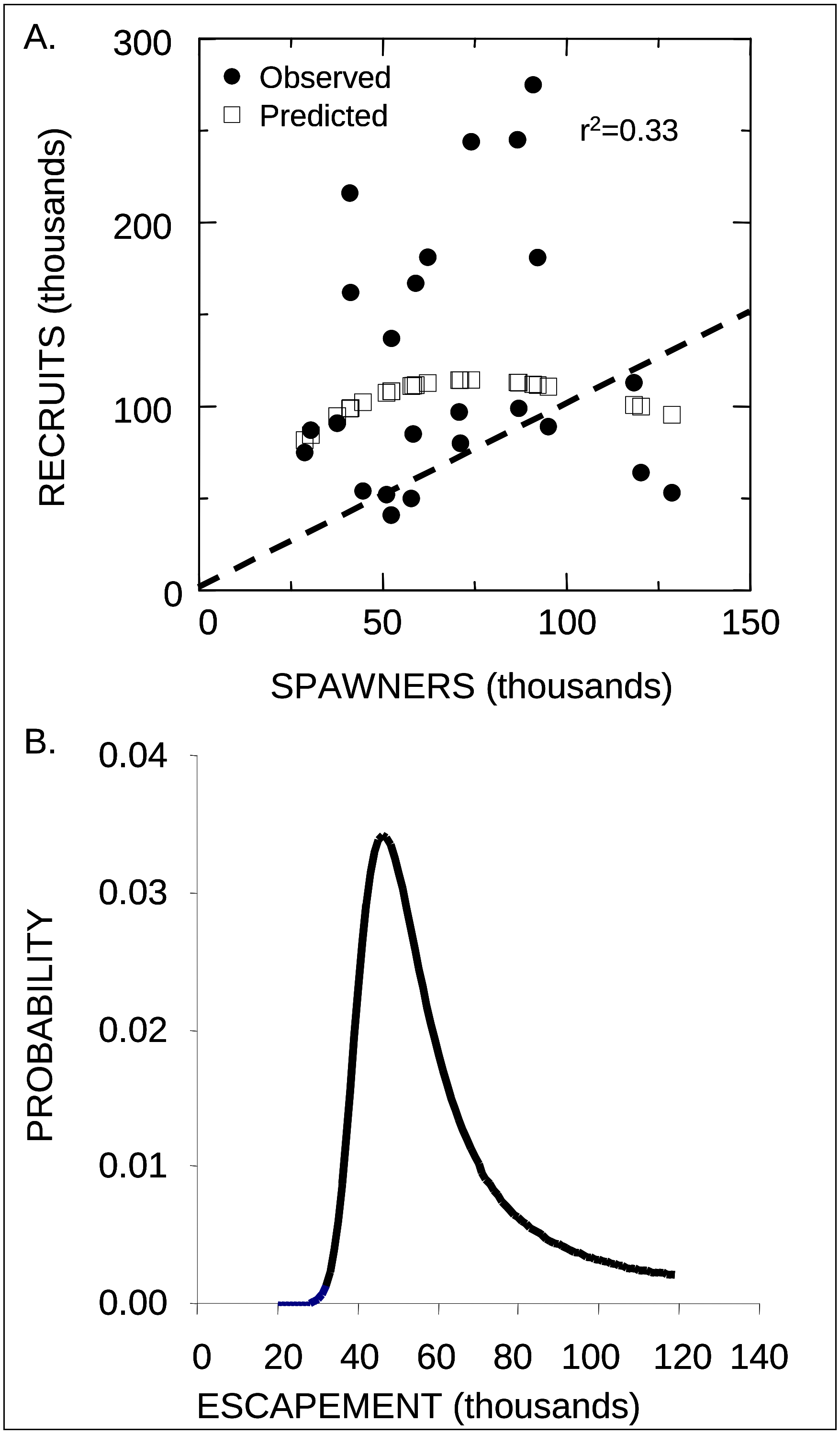

Figure 5.-(A) Standard Ricker model fit to Crescent River sockeye spawner-recruit data (brood years 1975-1998; dashed line indicates replacement); and (B) the likelihood profile for the escapement that produces maximum sustained yield.

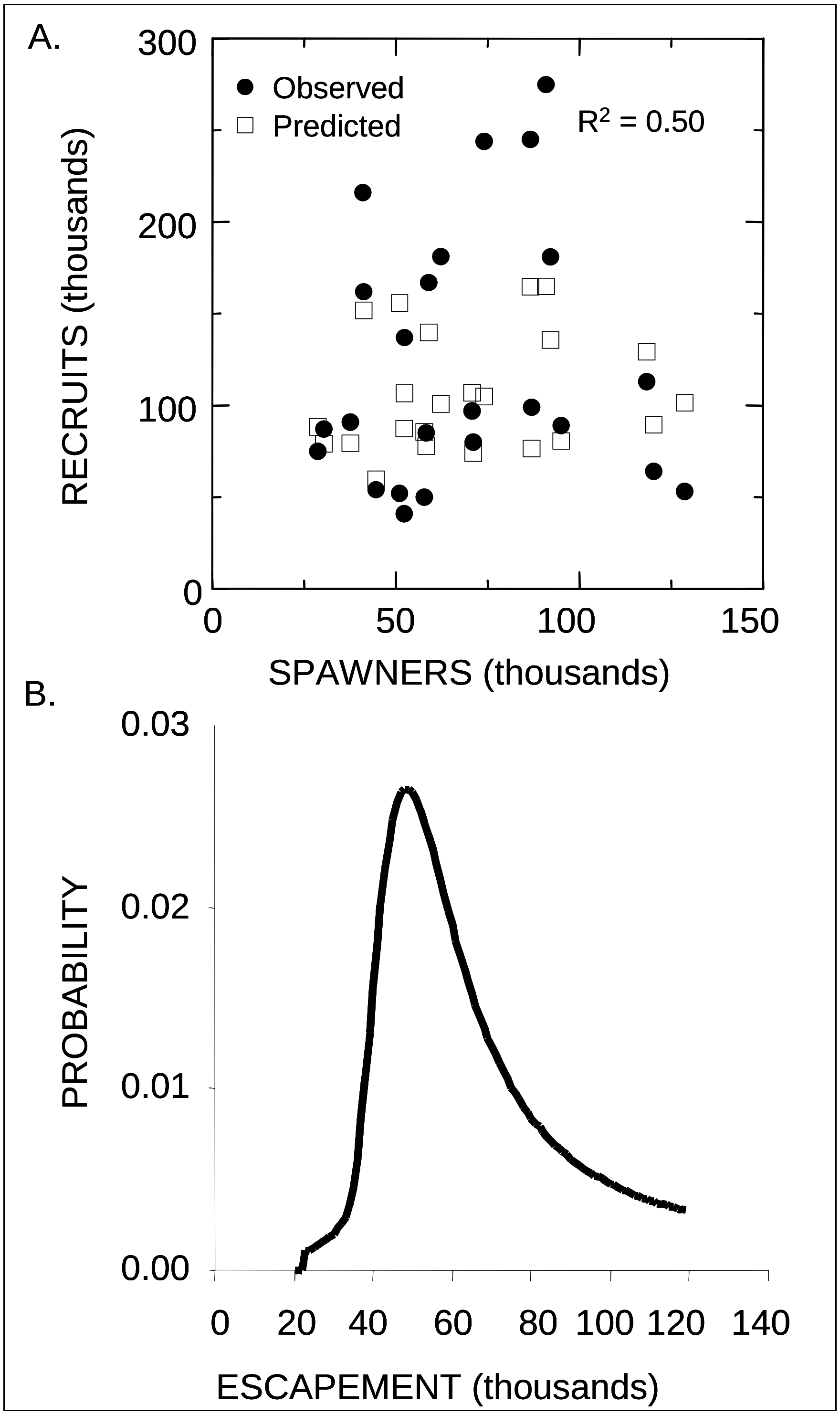

Figure 6.-(A) Autoregressive Ricker model fit to Crescent River sockeye spawner-recruit data (brood years 1975-1998; dashed line indicates replacement); and (B) the likelihood profile for the escapement that produces maximum sustained yield.

SUSTAINABLE ESCAPEMENT GOALS

Chinook Salmon

For the 20 Chinook salmon stocks with an SEG, the goal was met or exceeded in all but nine of 73 (12%) surveys conducted from 2001-2004 (Table 1). This result is not surprising given that the lower SEG value for most stocks was based on the 15th percentile of escapements observed before 2001; based on the percentile approach we would expect these stocks to not attain the lower SEG value 15% of the time. No stock consistently failed to meet the lower end of its respective SEG.

The committee recommended removing the SEG for Deception Creek Chinook salmon because the escapement was assessed by a variety of methods (e.g., aerial surveys and weirs located at different sites) and these fish were subjected to harvest by, and managed as part of, the Willow Creek Chinook salmon fishery. The committee also recommended removing the SEG for Campbell Creek Chinook salmon because there is currently no fishery on this stock. If a fishery develops, then the goal should remain as is. The committee recommended no change in the goal of the other 18 Chinook salmon stocks with an SEG.

Although the committee recommended no changes to SEGs for Chinook salmon stocks in the Susitna River drainage, the committee did review these goals. Escapement, harvest, and age data of all Susitna River Chinook salmon monitored downstream of Devils Canyon were combined to develop a brood table for this aggregation of stocks (Yanusz *In prep* b). A Ricker model was then fit to these spawner-recruit data to determine if a BEG for this aggregation could be developed. As with Kenai River Chinook salmon, there was low contrast in observed escapements (= 3.6) and measurement error in estimating escapement; however, there was more uncertainty in both the data and quantifying measurement error for the aggregate Susitna River Chinook salmon analyses. The committee determined an estimate of S_{msy} and a BEG based on these analyses were not scientifically defensible, and that changes to the current SEGs of the individual streams were not warranted.

Coho Salmon

The SEG of the five coho salmon stocks with an escapement goal was met or exceeded in all but two of the 18 (11%) surveys or weir counts conducted from 2001-2004 (Table 1). Record high escapements were observed in 2002 in Campbell, Cottonwood, and Fish (Knik Arm) creeks, and the Little Susitna River. A record high escapement was observed in Jim Creek in 2004. The previous record high escapement in Jim Creek occurred in 2002.

The committee recommended changing two of the five coho salmon goals (Table 1), removing the SEGs for both Fish Creek (Knik Arm) and Cottonwood Creek coho salmon because escapement in these systems will no longer be monitored with a weir. However, 1995-2004 weir count data suggested that escapements of coho salmon at the Little Susitna River weir were highly correlated with escapements and total run to these Knik Arm systems (Namtvedt and Evans *In prep*). This does not mean coho salmon weir counts obtained at the Little Susitna River will be used to estimate escapement or total run of coho salmon to these other streams, but rather trends in the Little Susitna River coho salmon weir counts follow the trends of coho salmon in Knik Arm systems. Thus, monitoring coho salmon only at the Little Susitna River should provide sufficient information to evaluate coho runs to these Knik Arm streams. In addition, an increased number of foot surveys conducted at Cottonwood Creek annually and a wider range of measured escapements indicated that these surveys provide a reliable index of coho salmon escapement (Namtvedt and Evans *In prep*). At Wasilla Creek single foot surveys are still conducted, but recent large escapements expanded the range of observed escapements there, too. Peak foot surveys at Cottonwood Creek and single foot surveys at Wasilla Creek conducted since the mid 1990s were highly correlated with the weir counts of each respective system, indicating trends in the survey indices provide a reliable measure of trends in the escapement (Namtvedt and Evans *In prep*).

Chum Salmon

The SEG for Clearwater Creek chum salmon is 3,800-8,400 fish (Table 1). In two of the last three years for which escapements are available, the escapement index (peak aerial survey counts) has exceeded the escapement goal, by as much as four times in 2000 (Table 1).

The committee recommended no change to the SEG for Clearwater Creek chum salmon. Given the latest escapement data (Table 1, Appendix D1), high contrast in the escapement indices, and low exploitation, applying the SEG algorithm (Bue and Hasbrouck *Unpublished*) provided an escapement range of 3,100-8,700, which is consistent with the current range.

Sockeye Salmon

Yentna River

The SEG for Yentna River sockeye salmon is 90,000-160,000 fish (Table 1). In three of the last four years (2001, 2002 and 2004), the sonar estimates of sockeye salmon into the Yentna River fell below the lower end of the SEG, whereas the 2003 estimate exceeded the upper end of the SEG (Table 1). The level of escapement in 2003 was the highest observed over the available time series of data (Appendix C8).

The committee recommended no change to the SEG for Yentna River sockeye salmon. Considering the updated escapement information and low contrast in the escapement data, applying the SEG algorithm (Bue and Hasbrouck *Unpublished*) provided an escapement range of 75,000-181,000, which is consistent with the current range.

Fish Creek

In 2001, Fish Creek sockeye salmon was designated as a stock of concern, specifically a yield concern, by the BOF. Escapement counts on this system date back to 1938 (Appendix C2). Due to declining returns in the late 1960s and continuing through the early 1970s, a hatchery program was instituted to rebuild this stock. This decline may have resulted from installation (1969) of a cofferdam at the lake outlet, which hampered the migration of emergent fry from the main spawning grounds in Fish Creek to the nursery lake (Big Lake). The first hatchery returns began in 1979. The hatchery manager set the first escapement goal for this system at 50,000 in 1982. The methods for this goal were not documented. In 1992, the first formal BEG policy implementation documented that the escapement goal of 50,000 should remain in place because of a lack of consistent hatchery production information. In addition, the policy required that a change in a goal only be made if it would increase production. Because of the lack of credible and consistent data and the fact that changing the goal had to result in raised production, the escapement goal remained at 50,000 fish.

Consistent with the new policies adopted by the BOF in 2001, a new goal range was developed using the 1938 to 1978 (pre-hatchery) data. The SEG for this system was set at 20,000-70,000 sockeye salmon with an additional 5,000 fish for brood stock for the hatchery program (Bue and Hasbrouck *Unpublished*). In the past 5 years, sockeye salmon escapements (1) exceeded the upper end of the SEG twice (2002, 2003), (2) were within the SEG in two years (2001, 2004), and (3) fell just below the lower end of the SEG once (2000; Table 1, Appendix C2).

ADF&G concluded that no yield concern continues to exist for this system because recent (2001-2004) escapements have met or exceeded the SEG. The department recommended that Fish Creek sockeye no longer be considered a stock of (yield) concern. The escapement goal review committee recommended no change to the SEG. Although total escapements to Fish Creek have declined in recent years relative to historical weir counts, an examination of the available limnological data for Big Lake suggested the decline in sockeye salmon production was probably not tied to changes in dissolved oxygen concentration, nutrient status or plankton abundance (Litchfield and Willette 2002). In addition, the cofferdam was removed from Fish Creek in 2004 to improve the passage of fry into the lake.

Packers Creek

The SEG for Packers Creek sockeye salmon is 15,000-30,000 fish (Table 1). The committee recommended removing the SEG for Packers Lake sockeye salmon because, since 2001, escapements have not been monitored on this system and assessment of this stock in the future is not likely.

Late-run Russian River

The SEG of late-run Russian River sockeye is 33,000-121,000 fish. Escapements have been within the SEG range three times and exceeded it once in the last four years (Table 1). Upon review of the available data used to calculate the SEG of late-run Russian River sockeye (Appendix C7), it was discovered that the current goal incorrectly includes sockeye salmon that spawn in the Russian River downstream of the weir that are already part of the Kenai River sockeye salmon escapement goal. Based on a recalculation of the SEG range without the downstream component, the committee recommended that the SEG range for late-run Russian River sockeye be revised from 33,000-121,000 fish to a new goal of 30,000-110,000 fish.

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APPENDIX A.
SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR CHINOOK SALMON OF UPPER COOK INLET

Appendix A1.-Data available for analysis of escapement goals, Alexander Creek Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1974	2,193	
1975	1,878	
1976	5,412	
1977	9,246	
1978	5,854	
1979	6,215	712
1980		1,438
1981		1,121
1982	2,546	2,506
1983	3,755	1,711
1984	4,620	2,107
1985	6,241	2,761
1986	5,225	2,937
1987	2,152	2,224
1988	6,273	4,687
1989	3,497	4,882
1990	2,596	5,119
1991	2,727	6,548
1992	3,710	4,124
1993	2,763	5,154
1994	1,514	3,070
1995	2,090	1,217
1996	2,319	1,005
1997	5,598	1,470
1998	2,807	1,275
1999	3,974	2,241
2000	2,331	2,721

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003). Years with no harvest estimate occur because the escapement time series precedes the survey (begun in 1977) or harvest could not be estimated from survey data.

Appendix A2.-Data available for analysis of escapement goals, Campbell Creek Chinook salmon.

Year	Escapement [a]
1961	70
1962	40
1963	187
1964	116
1965	119
1966	15
1967	300
1968	125
1969	
1970	63
1971	102
1972	37
1973	201
1974	79
1975	
1976	210
1977	349
1978	
1979	
1980	
1981	
1982	68
1983	
1984	423
1985	
1986	733
1987	571
1988	
1989	218
1990	458
1991	590
1992	931
1993	937
1994	1,076
1995	734
1996	369
1997	1,119
1998	761
1999	1,035
2000	591

[a] Escapement not surveyed or monitored during years with no escapement value.

Appendix A3.-Data available for analysis of escapement goals, Chuitna River Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1977		227
1978		408
1979	1,246	78
1980		17
1981	1,362	115
1982	3,438	105
1983	4,043	1,185
1984	2,845	723
1985	1,600	734
1986	3,946	960
1987		146
1988	3,024	312
1989	990	581
1990	480	1,064
1991	537	377
1992	1,337	516
1993	2,085	893
1994	1,012	530
1995	1,162	201
1996	1,343	844
1997	2,232	728
1998	1,869	551
1999	3,721	561
2000	1,456	512

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003).

Appendix A4.-Data available for analysis of escapement goals, Chulitna River Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1982	863	
1983	4,058	
1984	4,191	
1985	783	
1986		
1987	5,252	
1988		
1989		
1990	2,681	
1991	4,410	
1992	2,527	
1993	2,075	
1994	1,806	
1995	3,460	
1996	4,172	43
1997	5,618	0
1998	2,586	41
1999	5,455	76
2000	4,218	10

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey for North Fork Chulitna River only (Mills 1983-1994, Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003). Years with no harvest estimate occur because harvest could not be estimated from survey data.

Appendix A5.-Data available for analysis of escapement goals, Clear Creek Chinook salmon.

Year	Escapement [a]
1979	864
1980	
1981	
1982	982
1983	938
1984	1,520
1985	2,430
1986	
1987	
1988	4,850
1989	
1990	2,380
1991	1,974
1992	1,530
1993	886
1994	1,204
1995	1,928
1996	2,091
1997	5,100
1998	3,894
1999	2,216
2000	2,142

[a] Escapement not surveyed or monitored during years with no escapement value.

Appendix A6.-Data available for analysis of escapement goals, Crooked Creek Chinook salmon.

Brood	Count at the Weir[a]			Actual Escapement[b]			Sport Harvest[c]	
							Early Run	
Year	Wild	Hatchery	Total	Total	Wild	Year	(thru 6/30)	Total
1976	1,682 [d]		1,682	1,537	1,537			
1977	3,069 [d]		3,069	2,390	2,390			
1978	4,535	180	4,715	4,388	4,220	1978		251
1979	2,774	770	3,544	3,177	2,487	1979		283
1980	1,764	518	2,282	2,115	1,635	1980		310
1981	1,871	1,033	2,904	2,919	1,881	1981		1,242
1982	1,449	2,054	3,503	4,107	1,699	1982		2,316
1983	1,543	2,762	4,305	3,842	1,377	1983		2,853
1984	1,372	2,278	3,650	3,409	1,281	1984		3,964
1985	1,175	1,637	2,812	2,491	1,041	1985		2,986
1986	1,539	2,335	3,874	4,055	1,611	1986		7,071
1987	1,444	2,280	3,724	3,344	1,297	1987		4,461
1988	1,174	2,622	3,796	700	216	1988		4,953
1989	1,081	1,930	3,011	750	269	1989		3,767
1990	1,066	1,581	2,647	1,663	670	1990		2,852
1991			2,281	893		1991		5,055
1992			3,533	843		1992		6,049
1993			2,291	657		1993		8,695
1994			1,790	640		1994		7,217
1995			2,206	750		1995		6,681
1996			2,224	764		1996	5,295	6,128
1997						1997	5,627	6,728
1998						1998	4,201	4,839
1999	602	1,189	1,791	1,503	505	1999	7,597	8,255
2000	662	752	1,414	1,100	515	2000	8,815	9,901

[a] Excludes age 0.1 fish. No weir count in 1997 and 1998.

[b] Number of fish estimated to have actually spawned. Includes fish counted during foot surveys below the weir. During all years fish were removed at the weir for brood stock and from 1988-1996 fish were also sacrificed for disease concerns.

[c] From Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003) (large fish >20" only) for the Kasilof River sport fishery. Includes both wild and hatchery fish and an unknown number of late-run fish prior to 1996.

[d] Assumed wild.

Appendix A7.-Data available for analysis of escapement goals, Deception Creek Chinook salmon.

	Escapement		
Year	All Fish[a]	Hatchery[b]	Wild
1979	239	0	239
1980			
1981	366	0	366
1982	229	0	229
1983	121	0	121
1984	675	0	675
1985	1,044	0	1,044
1986	521	157	364
1987	692	174	518
1988	790	253	537
1989	800	177	623
1990	700	280	420
1991	747	232	515
1992	983	560	423
1993	1,221	720	501
1994	766	378	388
1995	834	389	445
1996	1,211	557	654
1997	1,340	670	670
1998	1,273	574	699
1999	1,000	199	801
2000	1,563	735	828

[a] Includes wild and hatchery fish. Escapement not surveyed in 1980. Since 1994 escapement indexed by a single aerial survey, but prior years were monitored by aerial survey or a weir, with weir located at different locations over the entire time series.

[b] Chinook salmon have been stocked into Deception Creek since 1985. The contribution of enhanced fish to the escapements has been sampled annually since 1986.

Appendix A8.-Table of data available for analysis of escapement goals; and graph showing fitted Ricker curve, line of replacement, and actual data for Deshka River Chinook salmon.

Table of data available for analysis of escapement goals, Deshka River Chinook salmon.

Brood Year	Aerial Survey [a]	Spawning Escapement [b]	Weir Escapement	Total Return [b]	Yield	Return/ Spawner	Year	Sport Harvest [c]
1974	5,279	13,195		57,508	44,313	4.36	1974	
1975	4,737	12,135		30,902	18,767	2.55	1975	
1976	21,693	45,283		34,781	-10,502	0.77	1976	
1977	39,642	80,373		35,833	-44,540	0.45	1977	
1978	24,639	51,043		41,815	-9,228	0.82	1978	
1979	27,385	56,411		48,932	-7,479	0.87	1979	2,811
1980		32,130 [d]		42,131	10,001	1.31	1980	3,685
1981		20,772 [d]		42,120	21,348	2.03	1981	2,769
1982	16,000	34,154		70,519	36,365	2.06	1982	4,307
1983	19,237	40,482		33,875	-6,607	0.84	1983	4,889
1984	16,892	35,898		33,144	-2,754	0.92	1984	5,699
1985	18,151	38,359		43,859	5,500	1.14	1985	6,407
1986	21,080	44,085		28,514	-15,571	0.65	1986	6,490
1987	15,028	32,253		20,041	-12,212	0.62	1987	5,632
1988	19,200	40,410		18,606	-21,804	0.46	1988	5,474
1989		20,852 [d]		14,211	-6,641	0.68	1989	8,062
1990	18,166	38,388		6,579	-31,809	0.17	1990	6,161
1991	8,112	18,733		15,912	-2,821	0.85	1991	9,306
1992	7,736	17,998		42,229	24,231	2.35	1992	7,256
1993	5,769	14,152		30,460	16,308	2.15	1993	5,682
1994	2,665	8,084		29,467	21,383	3.65	1994	624
1995	5,150		10,048	53,063	43,015	5.28	1995	0
1996	6,343		14,349	25,539	11,190	1.78	1996	11
1997	19,047		35,587	33,654	-1,933	0.95	1997	42
1998 [e]	15,556	33,286					1998	3,384
1999 [e]	12,904		29,088				1999	3,496
2000 [e]			33,965				2000	7,075

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] Data used for spawner-recruit analysis. Aerial surveys were expanded, based on the relationship of aerial surveys to weir counts observed for 1995-2004, to obtain estimates of spawning escapement (Yanusz *In prep* a).

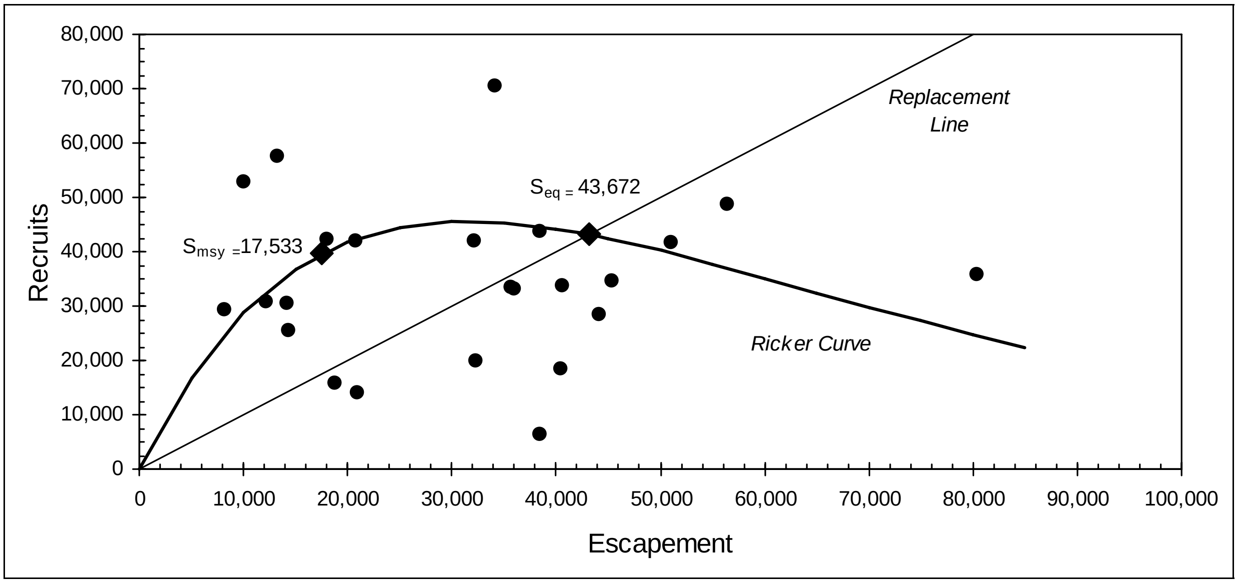
[c] From Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003). Years with no harvest estimate occur because the escapement time series precedes the survey (begun in 1977) or harvest could not be estimated from survey data.

[d] Based on average survey indices from nearby years for 1980 and an expectation-maximization (E-M) algorithm for 1981 and 1989 (Yanusz *In prep* a), and regression expansion noted in footnote b.

[e] Complete return data not yet available.

-continued-

Graph showing fitted Ricker curve, line of replacement, and actual data for Deshka River Chinook salmon.



S_{msy} = Estimated escapement which will result in maximum sustained yield (maximum distance between Ricker Curve and Replacement Line).

S_{eq} = Estimated carrying capacity of the system, where escapement and estimated recruits are equal.

Appendix A9.-Data available for analysis of escapement goals, Eagle River-South Fork Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1963	135	
1964	123	
1965	159	
1966	49	
1967	50	
1968	28	
1969		
1970	81	
1971		
1972		
1973	61	
1974		
1975		
1976	81	
1977	313	
1978		
1979		
1980		
1981		
1982		
1983		
1984		25
1985		
1986	222	
1987		
1988		
1989	37	28
1990	326	
1991	513	6
1992	336	48
1993	378	47
1994	440	59
1995	447	194
1996	141	309
1997	412	140
1998	163	19
1999	224	22
2000		109

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1979, 1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003) for entire Eagle River. Years with no harvest estimate occur because the escapement time series precedes the survey (begun in 1977) or harvest could not be estimated from survey data.

Appendix A10.-Data available for analysis of escapement goals, Goose Creek Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1981	262	
1982	140	
1983	477	
1984	258	
1985	401	
1986	630	145
1987	416	334
1988	1,076	218
1989	835	385
1990	552	504
1991	968	288
1992	369	1,033
1993	347	633
1994	375	361
1995	374	226
1996	305	437
1997	308	298
1998	415	348
1999	268	371
2000	348	258

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1983-1994; Howe et al. 1995, 1996, 2001a-d); Walker et al. 2003). Years with no harvest estimate occur because harvest could not be estimated from survey data.

Appendix A11.-Table of data available for analysis of escapement goals; and graph of return plotted against escapement, and line of replacement, Kenai River early-run Chinook salmon.

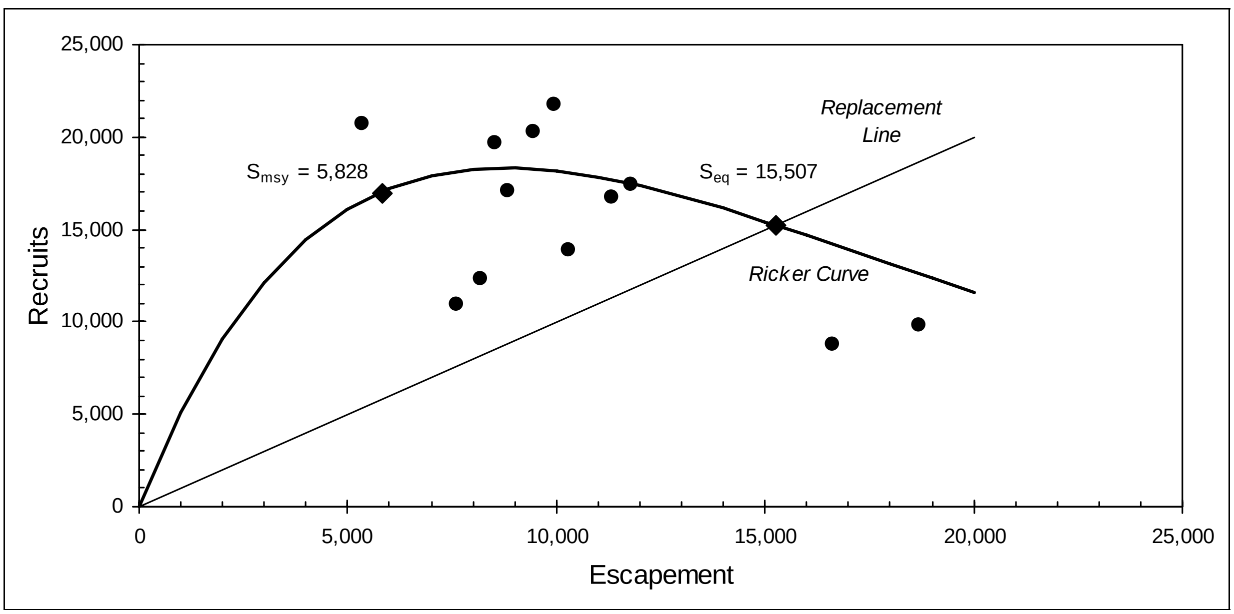
Table of data available for analysis of escapement goals, Kenai River early-run Chinook salmon.

Year	Escapement	Total Return	Yield [a]	Return/ Spawner
1986	18,682	9,863	-8,819	0.53
1987	11,780	17,438	5,658	1.48
1988	5,331	20,736	15,405	3.89
1989	9,449	20,326	10,877	2.15
1990	8,494	19,716	11,222	2.32
1991	8,834	17,162	8,328	1.94
1992	7,610	11,008	3,398	1.45
1993	10,293	13,926	3,633	1.35
1994	9,947	21,814	11,867	2.19
1995	11,310	16,782	5,472	1.48
1996	16,595	8,854	-7,741	0.53
1997	8,185	12,399	4,214	1.51
1998 [b]	7,760			
1999 [b]	17,276			
2000 [b]	10,476			

[a] Yield is total return minus escapement.

[b] Complete return data not yet available.

Return plotted against escapement, and line of replacement for early-run Kenai River Chinook salmon.



S_{msy} = Estimated escapement which will result in maximum sustained yield (maximum distance between Ricker Curve and Replacement Line).

S_{eq} = Estimated carrying capacity of the system, where escapement and estimated recruits are equal.

Appendix A12.-Table of data available for analysis of escapement goals; and graph of return plotted against escapement, and line of replacement, Kenai River late-run Chinook salmon.

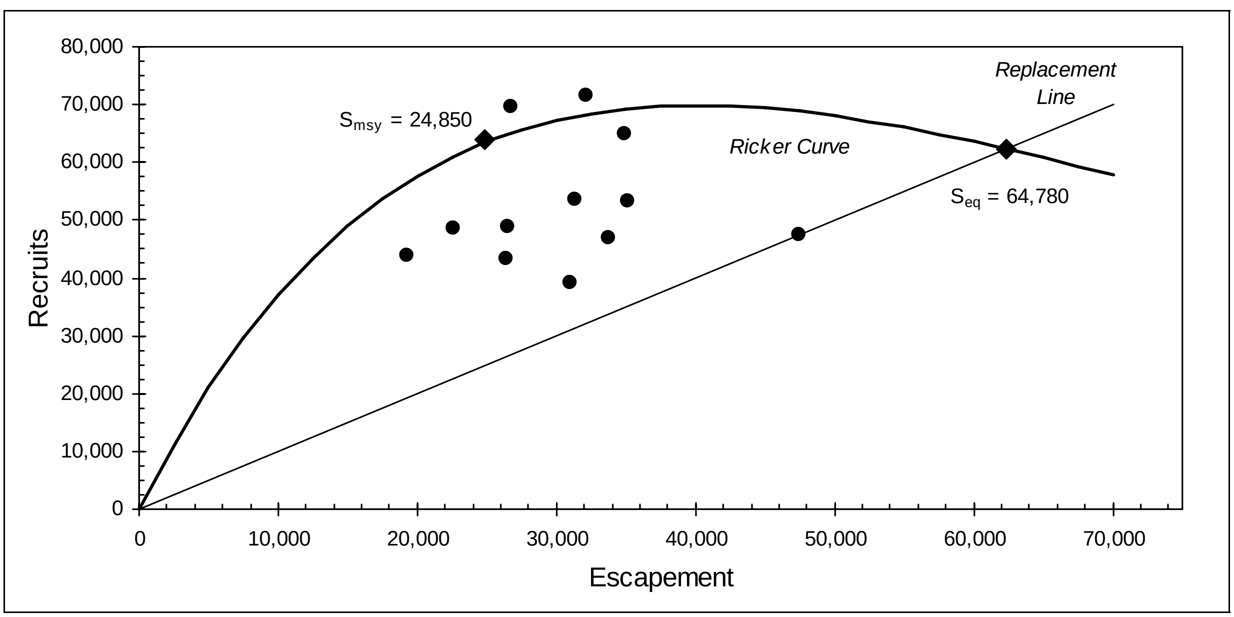
Table of data available for analysis of escapement goals, Kenai River late-run Chinook salmon.

Year	Escapement	Total Return	Yield [a]	Return/ Spawner
1986	47,375	47,475	100	1.00
1987	34,900	65,177	30,277	1.87
1988	32,137	71,743	39,606	2.23
1989	19,256	44,111	24,855	2.29
1990	26,508	49,078	22,570	1.85
1991	26,695	69,694	42,999	2.61
1992	22,524	48,784	26,260	2.17
1993	33,738	47,132	13,394	1.40
1994	35,065	53,482	18,417	1.53
1995	31,255	53,697	22,442	1.72
1996	30,907	39,270	8,363	1.27
1997	26,297	43,586	17,289	1.66
1998 [b]	26,768			
1999 [b]	34,962			
2000 [b]	29,627			

[a] Yield is total return minus escapement.

[b] Complete return data not yet available.

Return plotted against escapement, and line of replacement for late-run Kenai River Chinook salmon.



S_{msy} = Estimated escapement which will result in maximum sustained yield (maximum distance between Ricker Curve and Replacement Line).

S_{eq} = Estimated carrying capacity of the system, where escapement and estimated recruits are equal.

Appendix A13.-Data available for analysis of escapement goals, Lake Creek Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1979	4,196	1,796
1980		775
1981		795
1982	3,577	1,645
1983	7,075	2,423
1984		2,881
1985	5,803	2,575
1986		2,134
1987	4,898	3,282
1988	6,633	2,784
1989		3,554
1990	2,075	3,423
1991	3,011	2,712
1992	2,322	3,668
1993	2,869	6,425
1994	1,898	3,548
1995	3,017	2,838
1996	3,514	2,587
1997	3,841	3,777
1998	5,056	2,511
1999	2,877	3,037
2000	4,035	4,610

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003).

Appendix A14.-Data available for analysis of escapement goals, Lewis River Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1977		9
1978		12
1979	546	
1980		
1981	560	
1982	606	
1983		
1984	947	
1985	861	100
1986	722	
1987	875	185
1988	616	246
1989	452	190
1990	207	285
1991	303	16
1992	445	
1993	531	27
1994	164	
1995	146	
1996	257	
1997	777	
1998	626	
1999	675	
2000	480	

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994, Howe et al. 1995, 1996, 2001 a-d, Walker et al. 2003). Years with no harvest estimate occur because harvest could not be estimated from survey data.

Appendix A15.-Data available for analysis of escapement goals, Little Susitna River Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1977		191
1978		93
1979		800
1980		646
1981		1,418
1982		1,467
1983	929	1,187
1984	558	1,883
1985	1,005	1,845
1986		1,457
1987	1,386	2,282
1988	3,197	2,822
1989	2,184	4,204
1990	922	1,965
1991	892	2,102
1992	1,441	3,920
1993		3,441
1994	1,221	4,204
1995	1,714	1,698
1996	1,079	1,484
1997		2,938
1998	1,091	2,031
1999		2,713
2000	1,094	2,803

[a] Escapement not surveyed or monitored during years with no escapement value. No aerial survey conducted in 1989; however, in 1988, 1989, 1994, and 1995 a weir was operated on the Little Susitna River. Based on the relationship of weir counts to aerial surveys in 1988, 1994, and 1995, 50% of the 1989 weir count of 4,367 Chinook salmon was used for an index of escapement.

[b] From Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003).

Appendix A16.-Data available for analysis of escapement goals, Little Willow Creek Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1979	327	0
1980		32
1981	459	0
1982	316	0
1983	1,042	0
1984		37
1985	1,305	25
1986	2,133	872
1987	1,320	711
1988	1,515	937
1989	1,325	507
1990	1,115	387
1991	498	684
1992	673	1,023
1993	705	1,200
1994	712	745
1995	1,210	436
1996	1,077	896
1997	2,390	699
1998	1,782	546
1999	1,837	1,344
2000	1,121	577

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003).

Appendix A17.-Data available for analysis of escapement goals, Montana Creek Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1981	814	661
1982		241
1983		504
1984		1,522
1985		979
1986		2,796
1987	1,320	1,726
1988	2,016	1,070
1989		1,708
1990	1,269	478
1991	1,215	575
1992	1,560	3,078
1993	1,281	4,054
1994	1,143	3,111
1995	2,110	1,004
1996	1,841	1,612
1997	3,073	2,181
1998	2,936	1,471
1999	2,088	3,279
2000	1,271	1,728

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003).

Appendix A18.-Data available for analysis of escapement goals, Peters Creek Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1983	2,272	
1984	324	112
1985	2,901	
1986	1,915	
1987	1,302	
1988	3,927	549
1989	959	339
1990	2,027	385
1991	2,458	495
1992	996	655
1993	1,668	283
1994	573	202
1995	1,041	252
1996	749	74
1997	2,637	34
1998	4,367	74
1999	3,298	197
2000	1,648	236

[a] In 1983 only a tributary was surveyed, not the mainstem of Peters Creek.

[b] From Statewide Harvest Survey (Mills 1984-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003). Years with no harvest estimate occur because harvest could not be estimated from survey data.

Appendix A19.-Data available for analysis of escapement goals, Prairie Creek Chinook salmon.

Year	Escapement
1981	1,875
1982	3,844
1983	3,200
1984	9,000
1985	6,500
1986	8,500
1987	9,138
1988	9,280
1989	9,463
1990	9,113
1991	6,770
1992	4,453
1993	3,023
1994	2,254
1995	3,884
1996	5,037
1997	7,710
1998	4,465
1999	5,871
2000	3,790

Appendix A20.-Data available for analysis of escapement goals, Sheep Creek Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1979	778	10
1980		45
1981	1,013	0
1982	527	0
1983	975	0
1984	1,028	0
1985	1,634	0
1986	1,285	1,778
1987	895	1,610
1988	1,215	1,847
1989	610	1,116
1990	634	1,537
1991	154	1,519
1992		2,663
1993		2,300
1994	542	1,349
1995	1,049	746
1996	1,028	1,397
1997		550
1998	1,160	700
1999		2,558
2000	1,162	852

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003).

Appendix A21.-Data available for analysis of escapement goals, Talachulitna River Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1979	1,648	293
1980		121
1981	2,025	57
1982	3,101	0
1983	10,014	336
1984	6,138	424
1985	5,145	224
1986	3,686	201
1987		116
1988	4,112	909
1989		403
1990	2,694	709
1991	2,457	848
1992	3,648	445
1993	3,269	875
1994	1,575	927
1995	2,521	509
1996	2,748	697
1997	4,494	778
1998	2,759	563
1999	4,890	977
2000	2,414	694

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003).

Appendix A22.-Data available for analysis of escapement goals, Theodore River Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1977		237
1978		58
1979	512	20
1980		17
1981	535	77
1982	1,368	42
1983	1,519	0
1984	1,251	1,110
1985	1,458	1,195
1986	1,281	1,418
1987	1,548	1,146
1988	1,906	1,137
1989	1,026	1,317
1990	642	748
1991	508	369
1992	1,053	522
1993	1,110	527
1994	577	581
1995	694	360
1996	368	183
1997	1,607	0
1998	1,807	0
1999	2,221	0
2000	1,271	0

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003).

Appendix A23.-Data available for analysis of escapement goals, Willow Creek Chinook salmon.

Year	Escapement [a]	Sport Harvest [b]
1979	848	459
1980		289
1981	991	585
1982	592	629
1983	1,291	534
1984	2,789	774
1985	1,856	1,063
1986	2,059	1,017
1987	2,768	1,987
1988	2,496	2,349
1989	4,908	2,846
1990	2,315	3,237
1991	2,006	3,208
1992	1,457	8,884
1993	1,935	8,626
1994	1,430	5,980
1995	2,965	2,742
1996	1,577	2,690
1997	3,945	3,135
1998	3,033	2,793
1999	1,955	4,988
2000	2,272	3,782

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003) which includes harvest for the entire drainage, including wild and hatchery produced fish of Deception Creek origin (Appendix A7).

APPENDIX B.
SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR COHO SALMON OF UPPER COOK INLET

Appendix B1.-Data available for analysis of escapement goals, Campbell Creek coho salmon.

	Escapement			Sport
Year	Total [a]	Wild [b]	Hatchery [b]	Harvest [c]
1986	99	99	0	
1987	132	132	0	
1988				
1989				28
1990	126	126	0	
1991	282	282	0	25
1992	157	157	0	8
1993	2,312	462	1,850	3,942
1994	3,054	611	2,443	1,256
1995	1,423	285	1,138	1,947
1996	1,612	322	1,290	1,458
1997	1,007	208	799	1,651
1998	2,968	388	2,580	1,167
1999	537	100	437	1,341
2000	3,196	639	2,557	555

[a] Single foot survey except 1993 and 1994 that were weir counts. Escapement not surveyed or monitored during years with no escapement value.

[b] Based on sampling and coded wire tag data collected at the weir in 1993 and 1994 and by beach seining in 1995-2000.

[c] From Statewide Harvest Survey (Mills 1987-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al 2003). Years with no harvest estimate occur because harvest could not be estimated from survey data.

Appendix B2.-Data available for analysis of escapement goals, Cottonwood Creek coho salmon.

Year	Escapement: Foot Survey	Escapement: Weir [a]	Sport Harvest [b]
1975	236		
1976	204		
1977	115		
1978	264		
1979	64		1,198
1980	870		3,375
1981	423	2,436	1,373
1982	821	764	1,886
1983	506		518
1984	935		1,895
1985	334		1,005
1986	121		690
1987	360		1,159
1988	293		746
1989	147		876
1990	167		286
1991	158		176
1992	6		348
1993	265		736
1994	209		1,100
1995	168		340
1996	189		762
1997	386	936	372
1998	537	2,114	1,098
1999	131	458	537
2000	876	1,482	282

[a] Weir operated in 1981-1982 and 1997-2000 only. Some spawning may have occurred downstream of the weir in 1981 and 1982.

[b] From Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003). Years with no harvest estimate occur because the escapement time series precedes the survey (begun in 1977) or harvest could not be estimated from survey data.

Appendix B3.-Data available for analysis of escapement goals, Fish Creek coho salmon.

Year	Escapement [a]	Sport Harvest [b]
1969	5,671	
1970		
1971		
1972	955	
1973	280	
1974	1,539	
1975	2,135	
1976	1,020	
1977	970	
1978	3,184	
1979	2,511	
1980	8,924	
1981	2,330	
1982	5,201	
1983	2,342	
1984	4,510	
1985	5,089	284
1986	2,166	364
1987	3,871	833
1988	2,162	1,637
1989	3,479	784
1990	2,673	398
1991	1,297	486
1992	1,705	526
1993	2,078	741
1994	350	492
1995	390	435
1996	682	607
1997	2,578	148
1998	5,463	1,334
1999	1,766	233
2000	5,218	470

[a] Escapement in 1969, 1972-1976, and 1997 were expanded by 25% to account for removal of weir between 9/1-9/17. In 1977 and 1979-1996, the weir was not operated after 9/1. Escapements in 1977 and 1979-1996 were not expanded and were excluded from the analysis because the weir was removed in August in 1977 and escapement included wild and hatchery produced fish in 1989-1996.

[b] From Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003). Years with no harvest estimate occur because the escapement time series precedes the survey (begun in 1977) or harvest could not be estimated from survey data.

Appendix B4.-Data available for analysis of escapement goals, Jim Creek coho salmon.

Year	Escapement [a]	Sport Harvest [b]
1981		1,801
1982		2,306
1983		774
1984		3,429
1985	662	2,523
1986	439	2,948
1987	667	3,676
1988	1,911	11,078
1989	597	4,220
1990	599	6,184
1991	484	2,920
1992	11	3,409
1993	503	2,878
1994	506	3,946
1995	702	3,549
1996	72	3,911
1997	701	1,786
1998	922	4,197
1999	12	2,612
2000	657	5,653

[a] Escapement for McRoberts Creek only, a tributary to Jim Creek. Escapement not surveyed or monitored during years with no escapement value.

[b] From Statewide Harvest Survey (Mills 1982-1994, Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003) for Knik River and tributaries including Jim Creek.

Appendix B5.-Data available for analysis of escapement goals, Little Susitna River coho salmon.

Year	Total Escapement [a]	% Hatchery Contribution to Escapement [b]	Escapement Hatchery	Escapement Wild	Sport Harvest [c]
1977					3,415
1978					4,865
1979					3,382
1980					6,302
1981					5,940
1982					7,116
1983					2,835
1984					14,253
1985					7,764
1986	6,999			6,999	6,039
1987					13,003
1988	20,491	22	4,428	16,063	19,009
1989	15,232	45	6,862	8,370	14,129
1990	14,310	24	3,370	10,940	7,497
1991	37,601	22	8,322	29,279	16,450
1992	20,393	11	2,324	18,069	20,033
1993	33,378	29	9,615	23,763	27,610
1994	27,820	18	5,124	22,696	17,665
1995	11,817	9	1,069	10,748	14,451
1996	16,699	3	444	16,255	16,753
1997	9,894			9,894	7,756
1998	15,159			15,159	14,469
1999	3,017			3,017	8,864
2000	15,436			15,436	20,357

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] Based on sampling and coded wire tag data collected at the weir in 1988-1996. Hatchery stocking program ended in 1995, thus no hatchery produced fish in the coho salmon run since 1997.

[c] From Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003).

APPENDIX C.
SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR SOCKEYE SALMON OF UPPER COOK INLET

Appendix C1.-Data available for analysis of escapement goals, Crescent River sockeye salmon.

Year	Escapement [a]	Total Return	Yield [a]	Return/ Spawner
1975	41,000	216,000	175,000	5.27
1976	51,000	52,000	1,000	1.02
1977	87,000	99,000	12,000	1.14
1978	74,000	244,000	170,000	3.30
1979	86,654	245,000	158,346	2.83
1980	90,863	275,000	184,137	3.03
1981	41,213	162,000	120,787	3.93
1982	58,957	167,000	108,043	2.83
1983	92,122	181,000	88,878	1.96
1984	118,345	113,000	-5,345	0.95
1985	128,628	53,000	-75,628	0.41
1986 [b]	95,000	89,000	-6,000	0.94
1987	120,219	64,000	-56,219	0.53
1988	57,716	50,000	-7,716	0.87
1989	71,064	80,000	8,936	1.13
1990	52,238	41,000	-11,238	0.78
1991	44,578	54,000	9,422	1.21
1992	58,229	85,000	26,771	1.46
1993	37,556	91,000	53,444	2.42
1994	30,355	87,000	56,645	2.87
1995	52,311	137,000	84,689	2.62
1996	28,729	75,000	46,271	2.61
1997	70,768	97,000	26,232	1.37
1998	62,257	181,133	118,876	2.91
1999 [c]	66,519			
2000 [c]	56,599			

[a] Escapement was estimated by sonar beginning in 1975.

[b] In 1986, the sonar operation was terminated earlier than usual on July 16. A total of 20,385 sockeye salmon had been counted through that date. To account for the missing period, total sockeye salmon escapement in 1986 was estimated using the exploitation rate through July 13 and total Western Subdistrict catch.

[c] Complete return data not yet available.

Appendix C2.-Data available for analysis of escapement goals, Fish Creek sockeye salmon.

Brood Year	Escapement [a]	Brood Year	Escapement [a]
1938	182,463	1970	25,000 [e]
1939	116,588	1971	31,900 [f]
1940	306,982	1972	6,981
1941	55,077	1973	2,705
1942		1974	16,225
1943		1975	29,882
1944		1976	14,032
1945		1977	5,183
1946	57,000 [b]	1978	3,555
1947	150,000 [b]	1979	68,739 [g]
1948	150,000 [b]	1980	62,828 [g]
1949	68,240	1981	50,479 [g]
1950	29,659	1982	28,164 [g]
1951	34,704	1983	118,797 [g]
1952	92,724	1984	192,352 [g]
1953	54,343	1985	68,577 [g]
1954	20,904	1986	29,800 [g]
1955	32,724	1987	91,215 [g]
1956	32,663 [c]	1988	71,603 [g]
1957	15,630	1989	67,224 [g]
1958	17,573	1990	50,000 [g]
1959	77,416 [cd]	1991	50,500 [g]
1960	80,000 [cd]	1992	71,385 [g]
1961	40,000 [cd]	1993	117,619 [g]
1962	60,000 [cd]	1994	95,107 [g]
1963	119,024 [cd]	1995	115,000 [g]
1964	65,000 [cd]	1996	63,160 [g]
1965	16,544 [cd]	1997	54,656 [g]
1966	41,312 [cd]	1998	22,853 [g]
1967	22,624 [cd]	1999	26,746 [g]
1968	19,616 [cd]	2000	19,533 [g]
1969	12,456		

[a] Data for 1979-2000 were excluded from analyses because hatchery stocks were present.

[b] Escapement enumerated by ground surveys.

[c] Escapement enumerated using a counting screen.

[d] Includes 3,500 sockeye salmon behind weir when it washed out on 8/8/70.

[e] Includes 500 sockeye salmon behind weir when it was removed on 8/7/71.

[f] Counting occurred downstream of Knik Road prior to 1983, at South Big Lake Road. From 1983-1991, and at Lewis Road from 1992-present.

[g] Partial counts due to termination of counting before the end of the run.

Appendix C3.-Data available for analysis of escapement goals, Kasilof River sockeye salmon.

Year	Escapement [a]	Total Return	Yield [a]	Return/ Spawner	Hatchery Release (milliions) [b]
1975	47,000	371,000	324,000	7.89	1.14
1976	133,000	741,000	608,000	5.57	0.00
1977	153,000	697,000	544,000	4.56	0.40
1978	109,000	812,000	703,000	7.45	7.76
1979	149,000	870,000	721,000	5.84	5.21
1980	178,000	1,208,000	1,030,000	6.79	8.78
1981	246,000	2,059,000	1,813,000	8.37	15.95
1982	168,000	1,460,000	1,292,000	8.69	16.94
1983	199,000	1,041,000	842,000	5.23	17.05
1984	219,000	830,000	611,000	3.79	16.39
1985	493,000	420,000	-73,000	0.85	13.56
1986	263,000	779,000	516,000	2.96	15.53
1987	236,000	1,073,000	837,000	4.55	6.27
1988	141,000	750,000	609,000	5.32	6.01
1989	149,000	571,000	422,000	3.83	6.01
1990	137,000	569,000	432,000	4.15	6.00
1991	228,000	1,071,000	843,000	4.70	6.06
1992	176,000	936,000	760,000	5.32	6.00
1993	140,000	584,000	444,000	4.17	0.00
1994	190,000	862,000	672,000	4.54	6.00
1995	190,000	576,000	386,000	3.03	6.14
1996	237,000	798,000	561,000	3.37	5.98
1997	256,000	732,000	476,000	2.86	4.56
1998	262,000	906,000	644,000	3.46	5.95
1999 [c]	301,000				5.43
2000 [c]	245,000				0.00

[a] The hatchery component of the escapement was removed.

[b] Hatchery release arranged by brood year.

[c] Complete return data not yet available.

Appendix C4.-Data available for analysis of escapement goals, Kenai River sockeye salmon (excludes late-run Russian River escapement through the weir and Hidden Lake enhanced).

Year	Escapement	Total Return	Yield	Return/ Spawner
1968	82,180	916,445	834,265	11.15
1969	51,850	409,481	357,631	7.90
1970	72,400	519,828	447,428	7.18
1971	289,270	862,669	573,399	2.98
1972	301,950	2,185,543	1,883,593	7.24
1973	358,070	1,995,399	1,637,329	5.57
1974	144,470	665,130	520,660	4.60
1975	128,500	895,207	766,707	6.97
1976	353,161	1,186,922	833,761	3.36
1977	663,627	2,810,690	2,147,063	4.24
1978	349,828	3,450,735	3,100,907	9.86
1979	245,850	1,110,592	864,742	4.52
1980	397,557	2,345,553	1,947,996	5.90
1981	359,344	2,267,624	1,908,280	6.31
1982	566,034	8,929,594	8,363,560	15.78
1983	556,652	8,697,304	8,140,652	15.62
1984	309,514	3,251,505	2,941,991	10.51
1985	396,032	2,245,906	1,849,874	5.67
1986	400,302	1,740,938	1,340,636	4.35
1987	1,333,136	9,530,501	8,197,365	7.15
1988	838,851	2,119,694	1,280,843	2.53
1989	1,333,687	3,898,327	2,564,640	2.92
1990	439,052	1,333,864	894,812	3.04
1991	376,149	3,926,048	3,549,899	10.44
1992	752,239	3,468,728	2,716,489	4.61
1993	669,758	1,287,000	617,242	1.92
1994	894,646	2,549,000	1,654,354	2.85
1995	520,778	1,490,000	969,222	2.86
1996	578,927	1,887,000	1,308,073	3.26
1997	872,041	3,136,000	2,263,959	3.60
1998	551,891	3,878,000	3,326,109	7.03
1999 [a]	582,907			0.00
2000 [a]	393,154			0.00

[a] Complete return data not yet available.

Appendix C5.-Data available for analysis of escapement goals, Packers Lake sockeye salmon.

Year	Escapement [a]
1974	2,123
1975	4,522
1976	13,292
1977	16,934
1978	23,651
1979	37,755
1980	28,520
1981	12,934
1982	15,687
1983	18,403
1984	30,403
1985	36,864
1986	29,604
1987	35,401
1988	18,607
1989	22,304
1990	31,868
1991	41,275
1992	30,143
1993	40,869
1994	30,776
1995	29,473
1996	16,971
1997	31,439
1998	17,728
1999	25,648
2000	20,150

[a] Only weir data from 1974-1989 were used in calculating the goal.

Appendix C6.-Table of data available for analysis of escapement goals; and graph of return plotted against escapement, and line of replacement, early-run Russian River sockeye salmon.

Table of data available for analysis of escapement goals, early-run Russian River sockeye salmon.

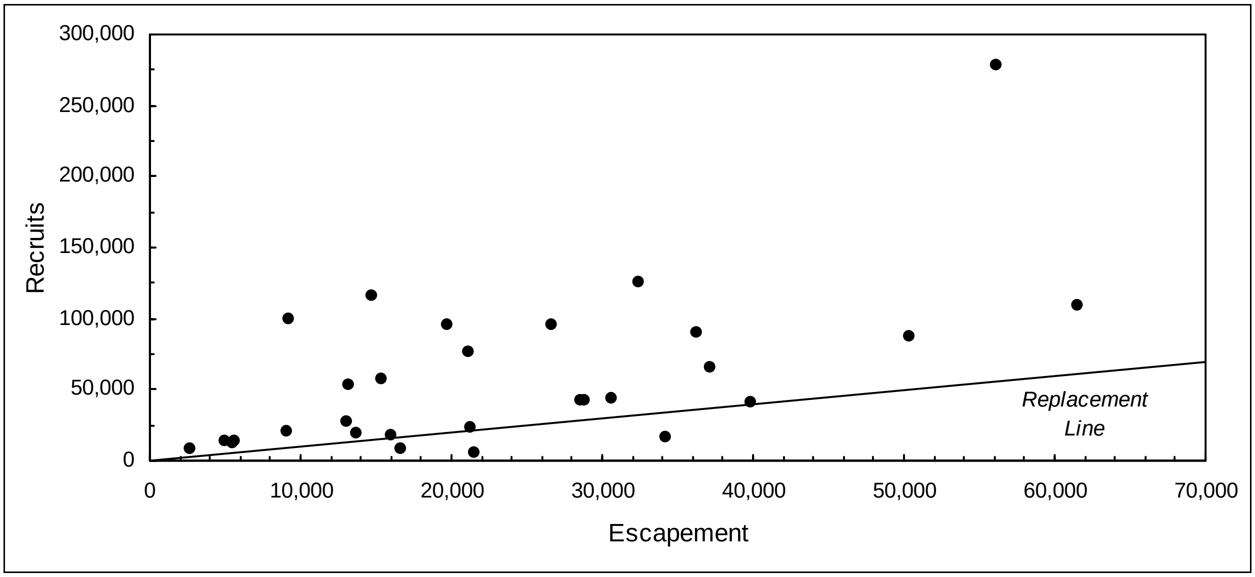
Brood Year	Escapement [a]	Total Return	Yield	Return/ Spawner	Year	Harvest [b]
1965	21,510	5,970	-15,540	0.28	1965	10,030
1966	16,660	7,822	-8,838	0.47	1966	14,950
1967	13,710	18,662	4,952	1.36	1967	7,240
1968	9,120	19,800	10,680	2.17	1968	6,920
1969	5,000	13,169	8,169	2.63	1969	5,870
1970	5,450	12,642	7,192	2.32	1970	5,750
1971	2,650	8,728	6,078	3.29	1971	2,810
1972	9,270	98,980	89,710	10.68	1972	5,040
1973	13,120	26,788	13,668	2.04	1973	6,740
1974	13,160	52,849	39,689	4.02	1974	6,440
1975	5,650	14,130	8,480	2.50	1975	1,400
1976	14,735	115,408	100,673	7.83	1976	3,380
1977	16,060	17,515	1,455	1.09	1977	20,400
1978	34,240	17,001	-17,239	0.50	1978	37,720
1979	19,750	94,836	75,086	4.80	1979	8,400
1980	28,620	42,401	13,781	1.48	1980	27,220
1981	21,140	76,040	54,900	3.60	1981	10,720
1982	56,110	278,179	222,069	4.96	1982	34,500
1983	21,270	23,549	2,279	1.11	1983	8,360
1984	28,900	42,857	13,957	1.48	1984	35,880
1985	30,610	43,776	13,166	1.43	1985	12,300
1986	36,340	90,637	54,297	2.49	1986	35,100
1987	61,510	109,215	47,705	1.78	1987	154,200
1988	50,410	87,848	37,438	1.74	1988	54,780
1989	15,340	57,055	41,715	3.72	1989	11,290
1990	26,720	94,893	68,173	3.55	1990	30,215
1991	32,389	126,044	93,655	3.89	1991	65,390
1992	37,117	64,978	27,861	1.75	1992	30,512
1993	39,857	41,584	1,727	1.04	1993	37,261
1994	44,872	114,720	69,848	2.56	1994	48,923
1995	28,603	24,238	-4,365	0.85	1995	23,572
1996	52,905	191,509	138,604	3.62	1996	39,075
1997	36,280	66,662	30,382	1.84	1997	36,788
1998 [c]	34,143				1998	42,711
1999 [c]	36,607				1999	34,283
2000 [c]	32,736				2000	40,732

[a] Escapements of brood years 1965-1968 from tower counts and of 1969-2000 from weir counts.

[b] Harvest during 1965-1996 from an onsite creel survey and during 1997-2000 from Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001a-d; Walker et al. 2003) Estimates are only of fish harvested near the Russian River itself.

-continued-

Graph of return plotted against escapement, and line of replacement, early-run Russian River sockeye salmon.



Appendix C7.-Data available for analysis of escapement goals, late-run Russian River sockeye salmon.

Year	Harvest [a]	Escapement [b] Above Weir	Escapement [b] Below Weir	Local Return
1963	1,390	51,120	Unknown	52,510
1964	2,450	46,930	Unknown	49,380
1965	2,160	21,820	Unknown	23,980
1966	7,290	34,430	Unknown	41,720
1967	5,720	49,480	Unknown	55,200
1968	5,820	48,880	4,200	58,900
1969	1,150	28,870	1,100	31,120
1970	600	26,200	220	27,020
1971	10,730	54,420	10,000	75,150
1972	16,050	79,115	6,000	101,165
1973	8,930	25,070	6,680	40,680
1974	8,500	24,900	2,210	35,610
1975	8,390	31,960	690	41,040
1976	13,700	31,940	3,470	49,110
1977	27,440	21,360	17,090	65,890
1978	24,530	34,340	18,330	77,200
1979	26,840	87,850	3,920	118,610
1980	33,500	83,980	3,220	120,700
1981	23,720	44,520	4,160	72,400
1982	10,320	30,800	45,000	86,120
1983	16,000	33,730	44,000	93,730
1984	21,970	92,660	3,000	117,630
1985	58,410	136,970	8,650	204,030
1986	30,810	40,280	15,230	86,320
1987	40,580	53,930	76,530	171,040
1988	19,540	42,480	30,360	92,380
1989	55,210	138,380	28,480	222,070
1990	56,180	83,430	11,760	151,370
1991	31,450	78,180	22,270	131,900
1992	26,101	63,478	4,980	94,559
1993	26,772	99,259	12,258	138,289
1994	26,375	122,277	15,211	163,863
1995	11,805	61,982	12,479	86,266
1996	19,136	34,691	31,601	85,428
1997	12,910	65,905	11,337	90,152
1998	25,110	113,477	19,593	158,180
1999	32,335	139,863	19,514	191,712
2000	30,229	56,580	13,930	100,739

[a] Harvest during 1963-1996 from an onsite creel survey and during 1997-2000 from Statewide Harvest Survey (Howe et al. 2001b-d; Walker et al. 2003). Estimates are only of fish harvested near the Russian River itself.

[b] Escapements of brood years 1963-1968 from tower counts and of 1969-2000 from weir counts.

[c] Sum of harvest from Russian River area and escapement both above and below weir.

Appendix C8.-Data available for analysis of escapement goals, Yentna River sockeye salmon.

Year	Escapement
1981	139,401
1982	113,847
1983	104,414
1984	149,375
1985	107,124
1986	92,076
1987	66,054
1988	52,330
1989	96,269
1990	140,290
1991	109,632
1992	66,074
1993	141,694
1994	128,032
1995	121,220
1996	90,660
1997	157,822
1998	119,623
1999	99,029
2000	133,094

APPENDIX D.
SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR CHUM SALMON OF UPPER COOK INLET

Appendix D1.-Data available for analysis of escapement goals, Clearwater Creek chum salmon.

Year	Escapement [a]
1971	5,000
1972	
1973	8,450
1974	1,800
1975	4,400
1976	12,500
1977	12,700
1978	6,500
1979	1,350
1980	5,000
1981	6,150
1982	15,400
1983	10,900
1984	8,350
1985	3,500
1986	9,100
1987	6,350
1988	
1989	2,000
1990	5,500
1991	7,430
1992	8,000
1993	1,130
1994	3,500
1995	3,950
1996	5,665
1997	8,230
1998	2,710
1999	6,400
2000	31,800

[a] Escapement not surveyed or monitored during years with no escapement value.