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Review of Salmon Escapement Goals in the Chignik Management Area, 2007

by

Mark J. Witteveen,

Heather Finkle,

James J. Hasbrouck,

and

Ivan Vining

REVISION

This report was revised 4/15/2008; for explanation of changes to the original text, see the following page.

December 2007

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

Amended 4/15/2008:

ABSTRACT

On Page 1, the last sentence in the third paragraph of the abstract was changed from, "a range of 200,000 to 250,000 to a range of 250,000 to 400,000" to " a range of 200,000 to 250,000 to a range of 200,000 to 400,000… and identify the 50,000 fish late-run management objective as a 50,000 fish in-river run goal."

INTRODUCTION

On page one, in the second paragraph, the definition for an inriver run goal was added as

3) "*inriver run goal* (IRRG): a specific management objective for salmon stocks that are subject to harvest upstream of the point where escapement is estimated; the inriver run goal will be set in regulation by the board and is comprised of the SEG, BEG, or OEG, plus specific allocations to inriver fisheries."

METHODS

On page 6, in the fourth line of the sockeye salmon escapement goal background and previous review section, the line, "supplemental to the late run goal, to accommodate subsistence fishers" was changed to "supplemental to the late run goal, to accommodate subsistence fishers upstream of the Chignik weir."

RESULTS

On Page 10, under the Escapement Goal Recommendation heading, the original text was changed from "The team recommended changing the late-run goal range to a SEG of 250,000 to 400,000 fish from July 5th through September 30th" to "The team recommended changing the late-run goal range to a SEG of 200,000 to 400,000 fish from July 5th through September 30th".

The last two sentences of that same paragraph were changed to read, "The increased upper escapement goal range change would encompass S_{msy} and also reduce the risk of overexploitation in years with large late-run returns. These changes would not include the August 25,000 fish and September 25,000 subsistence management objectives , which were recommended to be reclassified as a 50,000 fish IRRG."

SUMMARY OF RECOMMENDATIONS

On page 12, the line, "…and an increased SEG for the Chignik River sockeye salmon late run that would encompass the subsistence management objectives" was changed to, "… and an increased SEG and separate IRRG for the Chignik River sockeye salmon late run."

TABLES AND FIGURES

Table 1 on page 16 was amended to reflect the changed late-run escapement goal range of 200,000 to 400,000 fish and the IRRG was footnoted and defined for the late run.

APPENDIX B

Changes to Appendix B1. included added the IRRG of 50,000 late-run fish to the "Recommended escapement goal" section.

Figures for the escapement by year for the late and total runs reflected the changes to the late- and total-run proposed escapement goals.

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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by

Mark J. Witteveen,
Heather Finkle,
Division of Commercial Fisheries, Kodiak
James J. Hasbrouck,
Division of Sport Fish, Anchorage
and
Ivan Vining
Division of Commercial Fisheries, Kodiak

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

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Mark J. Witteveen,
Heather Finkle,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
211 Mission Road, Kodiak, AK 99615, USA

James J. Hasbrouck,
Alaska Department of Fish and Game, Division of Sport Fish
333 Raspberry Road, Anchorage, AK 99518, USA

and

Ivan Vining,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
211 Mission Road, Kodiak, AK 99615, USA

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ABSTRACT

In April 2007, a salmon escapement goal interdivisional review team, including staff from the Division of Commercial Fisheries and Division of Sport Fish, was formed to review Pacific salmon *Oncorhynchus* spp. escapement goals in the Chignik Management Area (CMA; Area L). This report is the result of this review, based on the Policy for the Management of Sustainable Salmon Fisheries (5 AAC 39.222) and the Policy for Statewide Salmon Escapement Goals (5 AAC 39.223).

This comprehensive review of the six existing salmon escapement goals in the CMA resulted in recommendations to leave the Chignik River Chinook salmon *O. tshawytscha* biological escapement goal (BEG) range unchanged, leave the Chignik River watershed early-run sockeye salmon *O. nerka* sustainable escapement goal (SEG) unchanged, and change the Chignik River watershed sockeye salmon late-run SEG. The team also recommended changing the two areawide aggregate BEGs (odd- and even-years) for pink salmon *O. gorbuscha* to two areawide aggregate SEGs. The team recommended a slight change to the one areawide chum salmon *O. keta* aggregate SEG.

The early-run sockeye salmon escapement data did not exhibit enough contrast to perform a spawner-recruit analysis; therefore, it was not possible to estimate the escapement that would produce maximum sustainable yield (S_{msy}); however, the percentile method validated the current SEG of 350,000 to 400,000. The team recommended that the Chignik River watershed late-run sockeye salmon SEG should be increased from a range of 200,000 to 250,000 to a range of 200,000 to 400,000 based on a Ricker spawner-recruit curve and identify the 50,000 fish late-run management as a 50,000 fish in-river run goal.

A yield analysis was used to evaluate the pink salmon BEGs of 541,000 to 1,177,000 fish for odd years and 327,000 to 737,000 fish for even years. The team recommended changing the odd-year goal to a SEG range of 500,000 to 800,000 fish and the even-year goal to a SEG range of 200,000 to 600,000 fish. The team also recommended changing the areawide aggregate chum salmon SEG threshold of 50,400 fish to a SEG threshold of 57,400 fish based on risk analysis.

Key words: Pacific salmon, *Oncorhynchus*, escapement goal, Chignik, Area L, stock status.

INTRODUCTION

This report documents a review of the existing escapement goals for Chignik Management Area (CMA) salmon stocks based on the Policy for the Management of Sustainable Salmon Fisheries (SSFP; 5 AAC 39.222) and the Policy for Statewide Salmon Escapement Goals (EGP; 5 AAC 39.223). The Alaska Board of Fisheries (BOF) adopted these policies into regulation in 2000 and 2001, respectively, to ensure that the state's salmon stocks would be conserved, managed, and developed using the sustained yield principle.

Three important terms are defined in the SSFP:

1) "*biological escapement goal* (BEG): the escapement that provides the greatest potential for maximum sustained yield (MSY); …",

2) "*sustainable escapement goal* (SEG): 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 a stock specific catch estimate;…", and

3) "*inriver run goal* (IRRG): a specific management objective for salmon stocks that are subject to harvest upstream of the point where escapement is estimated; the inriver run goal will be set in regulation by the board and is comprised of the SEG, BEG, or OEG, plus specific allocations to inriver fisheries."

A report documenting the established escapement goals for stocks of five Pacific salmon species (Chinook *Oncorhynchus tshawytscha*, sockeye *O. nerka*, coho *O. kisutch*, pink *O. gorbuscha*, and chum *O. keta* salmon) spawning in the Kodiak, Chignik, Alaska Peninsula and Aleutian Islands Management Areas of Alaska was prepared in 2001 (Nelson and Lloyd 2001). Most of the escapement goals documented in Nelson and Lloyd (2001) were based on average escapement estimates and spawning habitat availability, and were implemented in the late 1990s.

During 2004, the 13 existing salmon escapement goals in the CMA were reviewed. This review resulted in recommendations to change 10 goals (five pink and five chum salmon that resulted one area-wide goal for chum salmon and an odd and even year area wide goal for pink salmon), maintain the current numerical goal ranges for the two sockeye salmon stocks but reclassify them from BEGs to SEGs, and leave the one Chinook salmon BEG range unchanged (Witteveen et al. 2005).

Beginning in May 2007, a salmon escapement goal interdivisional review team was formed to reevaluate the existing CMA salmon escapement goals. The team included staff from the Division of Commercial Fisheries (CFD) and Division of Sport Fish (SFD): Iris Caldentey (CFD), Joe Dinnocenzo (CFD), Doug Eggers (CFD), Heather Finkle (CFD), M. Birch Foster (CFD), Steve Honnold (CFD), Jim McCullough (CFD), Dave Sterritt (CFD), Mark Stichert (CFD), Ivan Vining (CFD), Jeff Wadle (CFD), Mark Witteveen (CFD), Robert Clark (SFD), Jim Hasbrouck (SFD), and Donn Tracy (SFD).

The objectives for the team were to:

1) Determine the appropriate goal type (BEG or SEG) for each CMA salmon stock with an existing goal, based on the quality and quantity of available data,
2) Determine the most appropriate methods to evaluate the escapement goal ranges,
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 for each goal evaluated and present these recommendations to the Directors of Commercial Fisheries and Sport Fish Divisions for approval.

During the review process, escapement goals were evaluated for two sockeye salmon stocks, two pink salmon stock aggregates, and one chum salmon stock aggregate (Table 1). Upon examination of recent data the team agreed that the one Chinook salmon goal did not need to be formally evaluated during this review; however, the data were examined to ensure that no major changes in production have occurred. Formal meetings via teleconference, to discuss and develop recommendations, were held on May 4 and August 9, 2007. The team also communicated on a regular basis by telephone and email.

STUDY AREA

The CMA comprises all coastal waters and inland drainages on the south side of the Alaska Peninsula, bounded by a line extending 135° southeast for three miles from a point near Kilokak Rocks (57° 10.34’ N lat., 156° 20.22’ W long.) then due south, to a line extending 135° southeast for three miles from Kupreanof Point at 55° 33.98’ N lat., 159° 35.88’ W long. (Figure 1). The area is divided into five commercial fishing districts: Eastern, Central, Chignik Bay, Western, and Perryville Districts (Figure 1). These districts are further divided into 14 sections and 25 statistical reporting areas (Pappas et al. 2003).

BACKGROUND

One Chinook salmon stock in the CMA has an established BEG and is located in the Chignik River. This goal was reviewed in 2004 and was left unchanged. Chinook salmon escapement is enumerated through the Chignik River weir and most of the fishing effort is from commercial and sport fisheries.

Two sockeye salmon stocks in the CMA have established SEGs. Prior to the escapement goal review in 2004, these goals were BEGs with the same ranges (Witteveen et al. 2005). Both of these stocks are part of the Chignik River watershed consisting of two interconnecting lakes (Black Lake and Chignik Lake) with a single outlet river (Chignik River) that empties into a nearly enclosed estuary (Chignik Lagoon; Figure 2). The majority of the early run (Black Lake stock) enters the watershed from June through July and spawns in Black Lake and its tributaries (Pappas et al. 2003). The majority of the late run (Chignik Lake stock) enters the watershed in July and August and typically spawns in the Chignik Lake tributaries and the Chignik Lake shoal areas (Pappas et al. 2003). Although the peak periods of passage for each stock are usually a few weeks apart, there is a period of overlap when both stocks are entering the watershed.

Sockeye salmon bound for Black and Chignik Lakes are enumerated through the use of a weir outfitted with a video camera system and are harvested primarily in the commercial and subsistence fisheries. In order to achieve escapement goals for these two runs (stocks) simultaneously, inseason estimates of the numbers of each stock in the daily escapement are required. These estimates have been determined using various methods over time. From 1980 through 2003, with the exception of 1982, stock separation was accomplished using scale pattern analysis (SPA; Witteveen and Botz 2004). Prior to 1980, time-of-entry relationships based on tagging studies and age groups were employed to divide the catch and escapement between the two runs (Dahlberg 1968). Beginning in 2004, an estimate of the total escapement of the Black Lake early run was based on weir counts through July 4. After July 4, the fish that passed upstream through the weir were assumed to be Chignik Lake late-run fish (Witteveen *unpublished memorandum*)[1]. This method was determined not to be significantly different (P>0.05) than the SPA method in estimating recruitment.

Due to the late season run timing of coho salmon returns to the CMA, there are no established coho salmon escapement goals. The vast majority of coho salmon escapement occurs after the Chignik River weir is pulled for the season and the inclement fall weather precludes reliable aerial surveys for estimating coho salmon escapement. Catches of coho salmon are generally incidental to the sockeye salmon fishery. If a directed coho salmon fishery occurs, catch per unit effort is used to manage the fishery.

Pink salmon escapements in the CMA are managed to achieve objectives based on aggregates of streams by district. Separate areawide BEGs were established for odd and even years during the 2004 review (Witteveen et al. 2005). The areawide goals represent five districts (Table 1; Figure 1). These aggregate goals comprise the respective sums of aerial survey escapement estimates for 49 individual index streams (Nelson and Lloyd 2001).

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1 Witteveen, M. J. unpublished memorandum. Chignik River inseason run apportionment. Alaska Department of Fish and Game, Kodiak memorandum addressed to Denby S. Lloyd, dated May 28, 2004.

Similar to pink salmon in the CMA, an areawide escapement goal (SEG) has been established for chum salmon representing five districts (Table 1; Figure 1). This aggregate goal comprises the respective sums of aerial survey escapement estimates for 42 individual index streams (Nelson and Lloyd 2001).

METHODS

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 team evaluated the type, quality, and amount of data for each stock according to criteria described in Bue and Hasbrouck (*unpublished*; Table 2). This evaluation was used to assist in determining the appropriate type of escapement goal to apply to each stock, as defined in the SSFP and EGP.

BIOLOGICAL ESCAPEMENT GOAL DETERMINATION

If sufficient time series of escapement and total return estimates were available, contrast in the escapement data (the ratio of the largest escapement to the smallest escapement) was sufficiently large (> 4.0; CTC 1999), and 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). This level of spawning escapement is identified as S_{msy} (CTC 1999; Hilborn and Walters 1992). Spawner-return data were analyzed using a Ricker (1954) spawner-recruitment model to estimate S_{msy}. BEG ranges surrounding S_{msy} were calculated as the escapement estimates that produced yields equal to 90% of MSY (CTC 1999; Hilborn and Walters 1992). The carrying capacity was estimated by the Ricker model as the escapement level which will provide an equivalent level of yield (Quinn and Deriso 1999). Carrying capacity is defined as S_{eq} and is the expected annual abundance of spawners when the stock has not been exploited. Estimates of S_{msy} and S_{eq} were not used if the model fit the data poorly or if model assumptions were violated. Hilborn and Walters (1992), Quinn and Deriso (1999), and the Chinook Technical Committee (CTC 1999) provide good descriptions of the Ricker model and diagnostics to assess model fit. All Ricker models were tested and corrected for residual autocorrelation when necessary.

When auxiliary data were available (e.g., limnology, smolt age and size) additional analyses were performed and results were compared to sockeye salmon spawner-recruit model results. In cases where sufficient data existed but determining a scientifically defensible BEG was still not possible, other methods were used to establish an SEG.

SUSTAINABLE ESCAPEMENT GOAL DETERMINATION

If total return estimates were not available because harvest or age was not consistently measured, then the data were considered of fair to poor quality. These data would not provide an accurate estimate of S_{msy} and subsequent BEG. As a result, these data were evaluated using other methods to establish a SEG. Methods used to develop SEGs included the percentile approach, yield analysis, risk analyses, the euphotic volume model, and the smolt biomass as a function of zooplankton biomass model.

The percentile approach followed the methods of Bue and Hasbrouck (*unpublished*) whereby the contrast of the escapement data and the exploitation rate of the stock were used to select the percentiles of annual escapement estimates to be used for estimating the SEG. Low contrast (<4) implies that stock productivity is known for only a limited range of escapements. According to this approach, percentiles of the total range of observed annual escapements that are used to estimate a SEG for a stock with low contrast should be relatively wide in an attempt to improve future knowledge of stock productivity. In cases where data contrast was less than 4 and the exploitation rate was low, the lower end of the SEG range was the 15^{th} percentile of the escapement data and the upper end of the range was the maximum escapement estimate. Alternately, in cases where contrast was greater, the percentiles of observed annual escapement estimates used to estimate a SEG were narrowed. For stocks with high contrast and at least moderate exploitation, the lower end of the SEG range was increased from the 15^{th} to the 25^{th} percentile as a precautionary measure for stock protection.

A yield analysis similar to Hilborn and Walters (1992) was used by applying a tabular approach to examine escapement versus yield relationships. Escapements were arranged into size-intervals. Multiple ranges for the size intervals were used, to provide varying aggregations of escapements. For each escapement interval various measures of yield from the observed escapements in that interval were calculated, specifically: the average and median return per spawner, average and median surplus yield (estimated as the return minus parental spawning escapement), and average and median observed harvest. The average and median were both calculated since averages are highly influenced by large or small values.

The risk analysis method (Bernard et al. *unpublished*) was used to establish a SEG, in the form of a precautionary reference point (PRP), from a time series of observed escapement estimates using probability distributions. This method is based on estimating the risk of management error and is particularly appropriate in situations where a particular stock (or stock aggregate) is not "targeted" and observed escapement estimates are the only reliable data available. In essence, this analysis begins with estimating the probability of detecting escapement falling below the SEG in a predetermined number of consecutive years (k). For example, if we believe there is cause for concern when escapement falls below the SEG for 3 consecutive years, k would be equal to 3. Simultaneously, a second probability is estimated, that is the probability of taking action (e.g., closing a fishery to protect the stock) for 3 consecutive years when no action was needed. This analysis assumes that escapement observations follow a lognormal distribution and have a stationary mean (no temporal trend). If there is temporal trend, the method can still be used but in a more deterministic way. A time series model is estimated from the data, then new data are simulated from the time series model, assuming the error in the model is lognormal. Probability models are developed from the simulated data to estimate the chance of detecting the escapement falling below the SEG in a predetermined number of consecutive years, while simultaneously estimating the chance of taking action for the same number of consecutive years.

The euphotic volume (EV) model following the methods of Koenings and Kyle (1997) estimated adult escapement in part by determining the volume of lake water capable of primary production that could sustain a rearing juvenile fish population. The euphotic volume indicated a level phytoplankton forage (primary production) available to zooplankton, and thus a level of zooplankton forage available for rearing juvenile fish. It was inferred from the model that shallower light penetration would result in lower adult production compared to lakes with deeper light penetration because the shallower lakes would not have the primary production necessary to sustain a larger rearing population. The EV model assumes that 1% light penetration is achieved in the water column.

The zooplankton model, as described in Witteveen et al. (2005), estimated smolt production based on an available zooplankton biomass fed upon by smolt of a targeted threshold size, in a lake of known area (Koenings and Kyle 1997). The zooplankton model, like the EV model, functions along the premise that the availability of forage to juvenile fish could impact their survival and subsequently, adult production. Adult production was calculated using given species fecundity and marine survival rates. The zooplankton model assumes that zooplankton are the only available forage.

CHINOOK SALMON

Escapement goal background and previous review

The Chignik River has the only Chinook salmon escapement goal established in the CMA. The goal was originally established as a BEG (1,450 to 3,000) in 1992 using a spawner-recruit relationship. The BEG was most recently modified to weir count of 1,300 to 2,700 fish in 2002 using a spawner-recruit relationship.

2007 Review

Escapements since the last review were similar to those in the recent past (Appendix A). There was no compelling information to suggest that any changes were necessary to the current BEG and the team agreed that no review was necessary in 2007.

SOCKEYE SALMON

Escapement goal background and previous review

The Black and Chignik lake stocks are the only two sockeye salmon stocks in the CMA that are consistently monitored. Escapement goals (early run: 350,000 to 400,000 fish and late run: 200,000 to 250,000 fish) for the Chignik sockeye salmon stocks were originally established in 1968 (Dahlberg 1968). In 1989, a September management objective (MO) of 25,000 fish was established, supplemental to the late run goal, to accommodate subsistence fishers upstream of the Chignik weir. An additional MO of 25,000 fish during August was added in 2004 for the same purpose (Appendix B1). Escapement estimates for both runs were based mainly on weir counts with the addition of post-weir estimates for the late run (Appendix B2). Individual sales receipts (fish tickets) documented sockeye salmon commercial harvest data for the CMA. Both catch and escapement data were obtained from the Westward Region CF salmon databases. Sport and subsistence harvests were not included in the total return estimates since they are relatively small and are not available in a timely enough manner to be utilized in this analysis. Available age data from the Westward Region CF salmon age database was also obtained. Brood tables for each Chignik run were developed based on the escapement, catch, and age data via run reconstruction (Appendices B3 and B4).

An escapement goal review of this system was conducted during 2004 (Witteveen et al. 2005). All available stock assessment data were analyzed using the Ricker spawner-recruit model, yield analysis, euphotic volume analysis, and smolt biomass as a function of zooplankton biomass (Witteveen et al. 2005). The authors concluded that the escapement goals should be reclassified as SEGs, retaining their existing goal ranges because the analyses did not warrant increasing or decreasing the previous goals, but scientifically defensible estimates of S_{msy} were not possible (Appendix B1).

2007 review

Stock-specific harvest estimates for Chignik watershed sockeye salmon were available from 1922 to the present. Recent run data were examined to determine if a change in the escapement goals was warranted. Since Ricker spawner-recruit analysis was not possible using recent reliable data for the early run due to lack of contrast, the percentile method was used to evaluate changes in the escapement range estimates. For the late run, Ricker spawner-recruit models were run with the additional three years of data to determine if there were significant changes in the escapement range estimates. Euphotic volume and smolt biomass as a function of zooplankton biomass models were also employed to examine the late-run escapement goal with the additional three years of limnology data.

PINK SALMON

Escapement goal background and previous review

Pink salmon escapements in the CMA are enumerated by aerial surveys. Escapements after 1984 were estimated using area-under-the-curve methodology assuming a 15-day stream life (Johnson and Barrett 1988) and were referred to as estimated total escapement. Escapements before 1985 were estimated using varying stream life, as well as estimates of carcasses in some years; these goals were also estimates of total escapement. Achievement of the escapement goals were determined by these estimated total escapements. Escapement goals for each district were established in 1999, with the Central District having a goal of 119,500 fish, Chignik Bay District a goal of 6,500 fish, Eastern District a goal of 488,000 fish, Perryville District a goal of 104,000 fish, and Western District a goal of 61,500 fish (Witteveen et al. 2005). This totaled to an areawide escapement goal of 779,500 pink salmon.

During the escapement goal review in 2004 (Witteveen et al. 2005), Ricker spawner-recruit analyses were performed using peak count escapement data from brood years 1972 to 2001 for both even and odd-year escapements individually, as well as combined. Peak escapement counts were used rather than estimated total escapement due to inconsistencies in the estimated total escapement calculations. Four different regions had spawner-recruit analyses performed: Eastern District, Central and Chignik Bay districts aggregated, Western and Perryville districts aggregated, and the entire CMA aggregated. From the spawner-recruit analyses of the CMA aggregate, an even-year BEG of 327,000 to 737,000 pink salmon, and an odd-year BEG of 541,000 to 1,177,000 pink salmon were established (Appendix C1).

2007 review

Data were available from 1968 to 2006 for the 2007 escapement goal review (Appendix C1 – C3). Some changes were made to the index streams used to better reflect management utility, so new aggregate peak escapement data sets were generated for all years. A yield analysis similar to Hilborn and Walters (1992) was used to examine the escapement versus yield relationship. Pink salmon were not examined with a spawner-recruitment analysis due to the unreliability of aerial survey escapement to represent true escapement.

CHUM SALMON

Escapement goal background and previous review

Escapement goals for each district were established in 1999 (Nelson and Lloyd 2001). The Central District had a goal of 39,500 fish, Chignik Bay District a goal of 2,000 fish, Eastern District a goal of 93,700 fish, Perryville District a goal of 59,000 fish, and Western District a goal of 12,500 fish. CMA chum salmon escapement was measured by peak aerial survey counts and total escapement was estimated using the area-under-the-curve method described in Johnson and Barrett (1988). Total estimated escapement estimates were used for inseason fishery management until 2003. Similar to the analyses of Witteveen et al. (2005), in this review peak aerial survey counts were used because budget cuts have reduced the number of aerial surveys making estimated total escapement less reliable.

During the escapement goal review in 2004 (Witteveen et al. 2005), data from 1973 to 2003 were used to perform percentile and risk analyses for each district and the entire CMA chum salmon escapement. From the risk analysis, a CMA aggregate SEG threshold of 50,400 peak count chum salmon escapement was established (Appendix D1).

2007 review

Data were available from 1973 through 2006 for the current escapement goal review (Appendix D1 – D3). Changes were made to the index streams used to represent the CMA aggregate escapement estimate, so new aggregate peak escapement datasets were generated for all years. Chum salmon peak count escapement estimates were obtained from the ADF&G aerial survey database for the CMA and an areawide SEG was estimated using a risk analysis (Bernard et al. *unpublished*).

RESULTS

The comprehensive review of six CMA salmon escapement goals resulted in recommendations to change four of the goals. The team recommended leaving the Chignik River Chinook salmon BEG and early-run Chignik sockeye salmon SEG unchanged and to increase the upper range of the late-run Chignik sockeye salmon SEG. It was also recommended to decrease the odd-year and the even-year CMA aggregate BEGs for pink salmon, each composed of management objectives by district, and to classify them as SEGs. The team recommended a slight increase to the one areawide chum salmon aggregate SEG composed of management objectives by district. Appendices A through D provide a description of each stock, or stock aggregate, current escapement goal of each stock, escapement estimates, data used for analyses of escapement goals, and supplemental information used to evaluate each escapement goal.

CHINOOK SALMON

Chignik River

The data available for the Chignik River Chinook salmon escapement goal analysis and stock status is located in Table 1 and Appendix A.

Stock Status

Chinook salmon escapement was generally below the current goal range in the early 1980s and has generally been above the goal range since 1990. In the years since the last escapement goal review, Chinook salmon escapement has been well above the goal range.

Escapement Goal Recommendation

The 2004 through 2006 escapements (Appendix A2 and A3) were similar to the recent past and since no other information indicates a substantial change in stock productivity or utilization, the team agreed that an escapement goal review was not necessary in 2007. The team recommended that the goal remain unchanged.

SOCKEYE SALMON

Chignik River watershed

The data available for the Chignik watershed sockeye salmon escapement goal analyses and their associated results are located in Table 1 and Appendix B.

Stock Status

Since 1965, the combined escapements of each run to the watershed have exceeded the upper range of the SEG for 33 of the past 42 years (Appendix B2). During this same time frame, both runs exceeded their own SEGs in 1976, 1978, 1982, 1983, 1984, 1990, 1991, 1996, and from 1999 to 2001 (Appendix B2). In addition to catch and escapement data, sockeye salmon smolt outmigration, zooplankton, and water quality data have been utilized to corroborate the existing SEGs for the late run. Those data indicated targeting the lower limits of the SEGs from 2003 to 2006. The current models utilizing sockeye salmon smolt outmigration, zooplankton, and water quality data do not reflect the rearing conditions in Black Lake and were found to be unsuitable for future escapement goal analyses.

Escapements during 2004 through 2006, since the last escapement goal review, were within the current goal range for the early run during all three years and within goal range (but below the MO range) during two years and above the goal range during one year for the late run (Appendix B2 – B3).

Evaluation of Recent Data

Early Run

Percentile Algorithm

The percentile algorithm was used to estimate SEGs for early-run (Black Lake) escapement data from 1952, 1965, 1977, and 1980 to 2006. The different data sets represent varying degrees of data reliability and different levels of observed productivity. Data from 1977 to 2006 were considered more accurate than earlier data. The data from 1952 to 2006 had high contrast (22.53) and estimated the SEG range from 323,000 to 478,000 fish using the 25th and 75th percentiles (Appendices B1, B5 and B6). Low contrast (2.2) in the escapement estimates of the early-run stock resulted in SEG ranges of 356,000 to 769,000 fish for 1965 to 2006 and 364,000 to 769,000 fish for 1977 to 2006 (both using the 15th and maximum percentiles; Appendices B5 and B6). The data from 1980 to 2006 also had low contrast (2.2) and estimated the SEG range from 364,000 to 769,000 fish using the 15th and maximum percentiles (Appendices B5 and B6).

Late Run

Spawner-Recruit Analysis

Ricker spawner-recruit models with a multiplicative error structure were fit to late run (Chignik Lake) fully recruited brood year spawner-recruit data from 1952 to 1999, 1965 to 1999, 1977 to 1999, and 1980 to 1999. Sockeye salmon escapements averaged 280,000 fish (range: 120,000 to 557,000 fish) from 1952 to 1999 with a contrast of 4.6 and averaged 281,000 fish (range: 120,000 to 557,000 fish) from 1965 to 1999 with a contrast of 4.6. Sockeye salmon escapements from 1977 to 1999 averaged 315,000 fish (range: 197,000 to 557,000 fish) with a contrast of 2.8 and from 1980 to 1999 averaged 320,000 fish (range 197,000 to 557,000 fish) with a contrast of 2.8. No significant ($P>0.5$) spawner-recruit relationships were realized for the 1977 to 1999 and 1980 to 1999 models. Similar to the previous review, the 1965 to 1999 model was significant ($P<0.05$); however, no declining tail was observed in the spawner-recruit curve, which indicated that the results should be viewed with caution. The point estimate of S_{msy} was 325,000 with a computed 90-100% MSY range of about 206,000 to 467,000 fish (Appendices B5 and B7). The value of S_{eq} (907,000) was outside the range of known escapements for the 1965 to 1999 model. The 1952 to 1999 model was significant ($P<0.05$) with S_{msy} estimated at 288,000 fish with a range of 183,000 to 413,000 fish; however, it also lacked a declining tail and possessed a value of S_{eq} (791,000 fish) outside the range of known escapements (Appendices B5 and B7).

Euphotic Volume Analysis

An updated euphotic volume analysis yielded a late-run adult production level of roughly 243,000 sockeye salmon with an estimated SEG range of 182,000 to 303,000 fish (Appendices B5 and B8).

Smolt Biomass as a Function of Zooplankton Biomass

Dependent upon smolt size, the zooplankton model yielded estimated escapement goal ranges of 460,000 to 690,000 sockeye salmon for the Chignik Lake late-run (Appendices B5 and B9). Optimal escapement was estimated at approximately 575,000 sockeye salmon.

Escapement Goal Recommendation

Results from the percentile algorithm suggested maintaining the early run SEG range. Based on these results, the team felt that no change to the early-run SEG was warranted at this time and that the SEG should remain the same through the July 4th run-timing cut-off date. For the late run, the Ricker spawner-recruit analyses yielded carrying capacity (S_{eq}) beyond the range of known escapements and produced questionable estimates of S_{msy} because of poor escapement and harvest data quality; they corroborated the lower range of the SEG and suggested increasing the upper range of the late-run SEG. (Table 1, Appendix B5). The euphotic volume model yielded an estimated escapement goal range encompassing the current SEG lower range. The smolt biomass model suggested increasing the current SEG range. The team recommended changing the late-run goal range to a SEG of 200,000 to 400,000 fish from July 5th through September 30th, which is the last day of estimated escapement. The increased upper escapement goal range change would encompass S_{msy} and also reduce the risk of overexploitation in years with large late-run returns. These changes would not include the August 25,000 fish and September 25,000 subsistence management objectives, which were recommended to be reclassified as a 50,000 fish IRRG.

PINK SALMON

Stock Status

The aggregate peak aerial survey estimates generally fell below the current BEG range during the 1970s and 1980s for odd years and within the goal for even years, but have reached or exceeded the goal in all years since 1988 (Appendices C1 – C3). In 2006 the peak escapement count was near the lower escapement goal; however, the low estimate of escapement was probably due to a low number of aerial surveys flown in 2006, rather than the escapements being low.

Evaluation of recent data

Yield Analysis

Different intervals of escapement were considered for escapement goal estimates (Appendices C4 and C5). Intervals which had fewer than four escapements within the interval were not considered to have reliable estimates of yield for that escapement interval. The escapement range for even-year escapements was assessed from 100,000 fish to 1,600,000 fish with intervals of 400,000, 500,000, and 600,000 fish (Appendix C4). The escapement range for odd-year escapements was assessed from 100,000 to 1,800,000 fish, with intervals of 300,000, 400,000, 500,000 and 600,000 fish (Appendix C5).

By assessing the amount of years in each range bin and the returns per spawner, returns minus parent escapement, and harvest in each scenario, it was determined that an escapement goal range of 200,000 to 600,000 pink salmon during even years would, on average, provide the best yield. For odd years, a goal range of 500,000 to 800,000 pink salmon was determined to be the most appropriate range.

Escapement Goal Recommendation

Due to the lack of information on the stock specific harvest in any given district and the current lack of a substantial directed pink salmon fishery in the CMA, the team agreed with the previous recommendation (Witteveen et al. 2005) that an area-wide aggregate escapement goal for pink salmon should be recommended. Also, as recommended during the previous review, separate escapement goals are recommended for even and odd-year escapements. Due to the lack of precision in aerial survey data, the new escapement goals are recommended to be SEGs. The recommended even-year escapement goal is 200,000 to 600,000 pink salmon, and the recommended odd-year escapement goal is 500,000 to 800,000 pink salmon. These ranges were chosen because they provided high yield estimates for all three measures of yield, as well as excluding intervals without observed escapement and associated yield.

CHUM SALMON

Stock Status

The current management objectives by district, established in 2004, sum to a CMA SEG of 50,400 fish (Appendix D1; Witteveen et al. 2005). Peak aerial survey escapement estimates were below this goal only four times from 1973 to 2006 (Appendix D2 and D3). The peak aerial survey escapement estimates were well above the goal in all years since the last review (Appendix D2 and D3).

Evaluation of Recent Data

Peak escapement estimates from aerial surveys were used to evaluate the current CMA chum salmon escapement goal. Upon review of the data, it was found that both the Eastern and Central districts had a few appropriate index streams that had not been included in the peak escapement estimates for the 2004 escapement goal review; however, managers felt that they were important to include in this review. These streams' peak escapement estimates were included in this analysis.

Risk Analysis

The risk analysis considered two possible scenarios, detecting a 95% decrease from the mean escapement in three consecutive years and detecting a 96.4% decrease (Appendix D4). A peak count escapement goal of 57,400 chum salmon for the CMA, would provide a 0.018% chance of not detecting a 95% decrease from the mean in three consecutive years, along with a 0.018% chance of a management action being taken when none was needed in three consecutive years. A peak count escapement goal of 50,400 chum salmon for the CMA, would provide a 0.004% chance of not detecting a 96.4% decrease from the mean in three consecutive years, along with a 0.004% chance of a management action being taken when none was needed in three consecutive years.

Escapement Goal Recommendation

The CMA has been managed primarily on sockeye salmon escapement levels and secondarily on pink salmon escapement levels. There are currently no commercial fisheries consistently directed on chum salmon in this area and aerial survey effort has been limited. The addition of the streams in the Eastern and Central Districts, along with the addition of the total peak aerial survey estimates for 2004-2006 had little affect on the risk analysis or the management objectives. An areawide SEG threshold estimated by risk analysis was recommended. Using the 95% decrease in the mean results in a SEG threshold of 57,400 chum salmon.

SUMMARY OF RECOMMENDATIONS

This comprehensive review of six salmon escapement goals in the Chignik Management Area resulted in consensus to leave two goals unchanged, and change four goals (Table 1). The changes included two decreased areawide SEGs for pink salmon, an increased areawide SEG for chum salmon, and an increased SEG and separate IRRG for the Chignik River sockeye salmon late run. This would result in six escapement goals for the Chignik Management Area including: one BEG for Chinook salmon, two SEGs for sockeye salmon, two aggregate SEGs for pink salmon, and one aggregate SEG for chum salmon.

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TABLES AND FIGURES

Table 1.–Current and recommended Chinook and sockeye salmon escapement goals by spawning system, and area-wide pink and chum salmon escapement goals, in the Chignik Management Area (revised 04/15/2008).

System	Escapement Data[a]	Current Escapement Goal				Escapements			2007 Recommendation
		Type	Lower	Point	Upper	2004	2005	2006	
CHINOOK									
Chignik River	WC	BEG	1,300	1,695	2,700	7,840	6,486	3,535	No change
SOCKEYE									
Chignik early run	WC	SEG	350,000	375,000	400,000	363,800	355,091	366,497	No change
Chignik late run	WC	SEG	200,000	225,000	250,000	214,459	225,366	368,996	Change to SEG Range: 200,000 to 400,000[b]
PINK									
Entire Chignik Area - even years	PAS	BEG	327,000	515,000	737,000	1,114,860		374,826	Change to SEG Range: 200,000 to 600,000
Entire Chignik Area - odd years	PAS	BEG	541,000	838,000	1,177,000		1,591,850		Change to SEG Range: 500,000 to 800,000
CHUM									
Entire Chignik Area	PAS	SEG	50,400			349,518	308,700	93,489	Change to SEG threshold: 57,400

[a] PAS = Peak Aerial Survey, WC= Weir Count.

[b] The 25,000 fish August and 25,000 fish September MOs were redesignated as a single 50,000 fish IRRG and not included in the late-run SEG.

Table 2.–General criteria used to assess quality of data in estimating CMA salmon escapement goals.

Data Quality	**Criteria**
Excellent	Escapement, harvest, and age all estimated with relatively good accuracy and precision (i.e., escapement estimated by a weir or hydroacoustics, harvest estimated by Statewide Harvest Survey or Fish Tickets with harvest apportioned to stock of origin); escapement and return estimates can be derived for a sufficient time series to construct a brood table and estimate S_{msy}.
Good	Escapement, harvest, and age estimated with reasonably good accuracy and/or precision (i.e., escapement estimated by capture-recapture experiment or multiple foot/aerial surveys; harvest estimated by Statewide Harvest Survey or Fish Tickets); no age data or data of questionable accuracy and/or precision; data may allow construction of brood table; data time series relatively short to accurately estimate S_{msy}.
Fair	Escapement estimated or indexed and harvest estimated with reasonably good accuracy but precision lacking for one if not both; no age data; data insufficient to estimate total return and construct brood table.
Poor	Escapement indexed (i.e., single foot/aerial survey) such that the index provides only a fairly reliable measure of escapement; no harvest and age data.

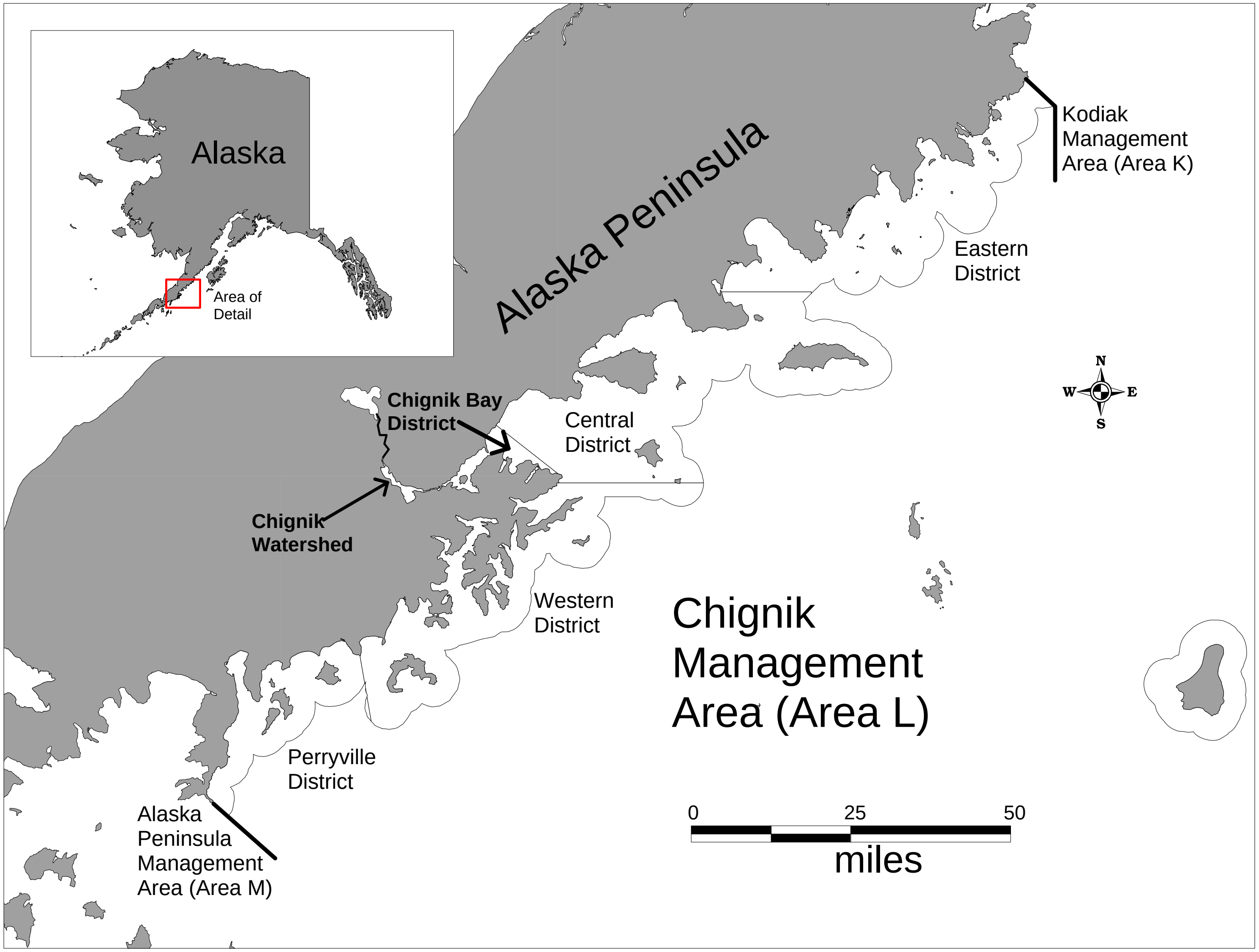


Figure 1.–The Chignik Management Area with the Eastern, Central, Chignik Bay, Western, and Perryville districts depicted.

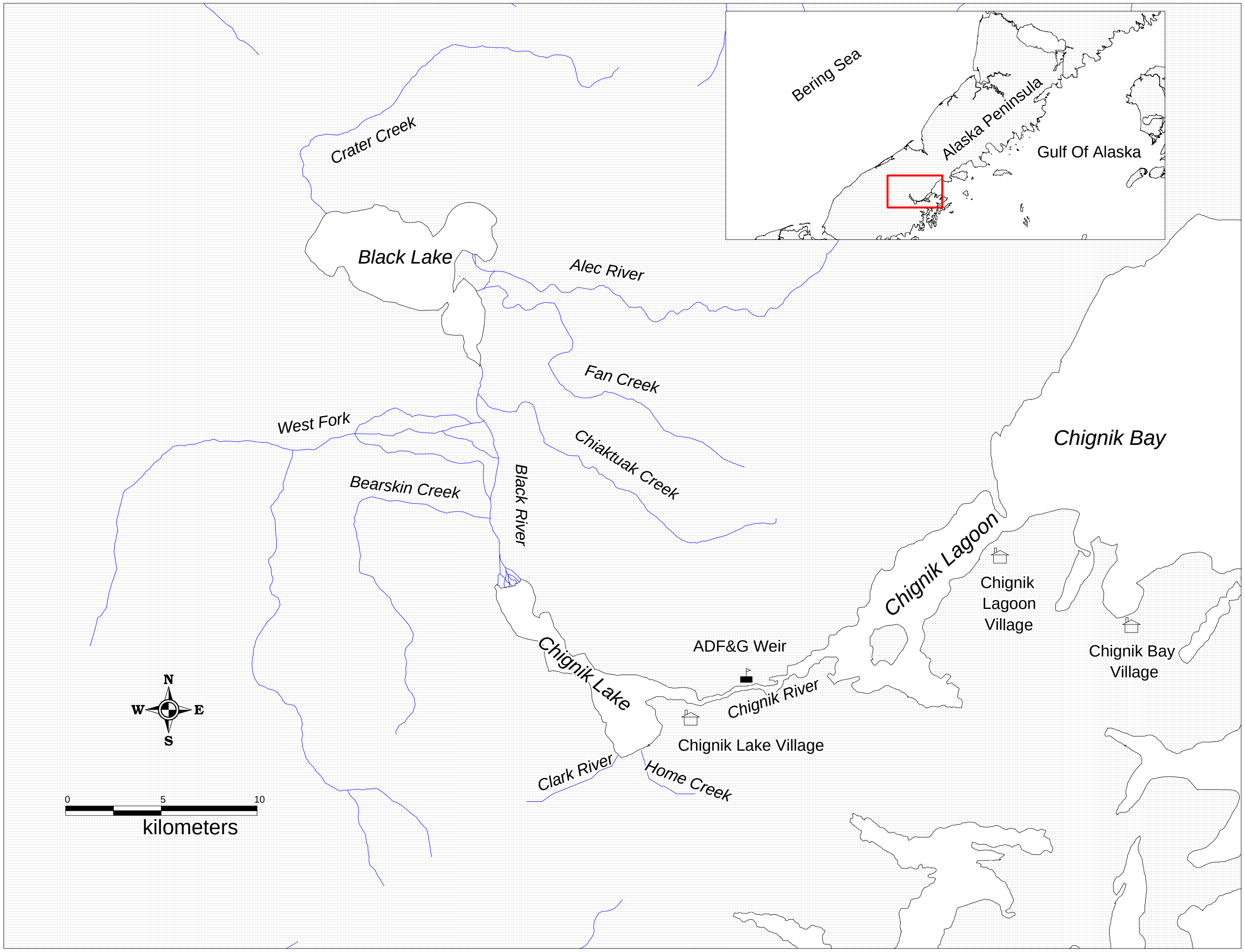


Figure 2.–The Chignik River watershed including Black and Chignik lakes, Black and Chignik rivers, and the Chignik Lagoon.

APPENDIX A:
CHINOOK SALMON ESCAPEMENT GOAL REVIEW

Appendix A1.–Description of stock and escapement goals for Chignik River Chinook salmon.

System: Chignik River

Species: Chinook salmon

Description of stock and escapement goals.

Regulatory area:	Chignik Bay District, Chignik Lagoon
Management division:	Sport and Commercial Fisheries
Primary fishery:	Sport, Commercial, and Subsistence
Current escapement goal:	BEG: 1,300-2,700 (2002)
Recommended escapement goal:	No change recommended
Optimal escapement goal:	none
Inriver goal:	none
Action points:	none
Escapement enumeration:	Weir counts, 1978 to present
Data summary:	
Data quality:	Good escapement, harvest and age data.
Data type:	Weir estimates, harvests, age compositions
Contrast:	11.7
Methodology:	None
Autocorrelation:	
Comments:	Recent escapements were consistent with past data. The team felt there was no compelling data to justify reviewing the goal.

Appendix A2.-Data available for analysis of Chinook salmon escapement goal by return year, Chignik River.

System: Chignik River

Species: Chinook salmon

Data available for analysis of escapement goals.

Return Year	Commercial Harvest[a]	Subsistence Harvest	Inriver Return[b]	Total Return	Recreational Harvest[c]	Escapement[d]
1978	1,386	50	1,197	2,633	207	990
1979	856	14	1,050	1,920	207	843
1980	929	6	876	1,811	207	669
1981	2,006	0	1,603	3,609	207	1,396
1982	3,269	3	2,412	5,684	207	2,205
1983	3,560	0	1,943	5,503	207	1,736
1984	3,696	23	5,548	9,267	207	5,341
1985	1,810	1	3,144	4,955	207	2,937
1986	2,592	4	3,612	6,208	207	3,405
1987	1,931	10	2,624	4,565	207	2,417
1988	4,331	9	4,868	9,208	233	4,635
1989	3,532	24	3,316	6,872	181	3,135
1990	3,719	103	4,364	8,186	207	4,157
1991	1,993	42	4,545	6,580	207	4,338
1992	3,179	55	3,806	7,040	207	3,599
1993	5,240	122	1,946	7,308	207	1,739
1994	1,804	165	3,016	4,985	207	2,809
1995	3,008	98	4,288	7,394	207	4,081
1996	1,579	48	3,485	5,112	207	3,278
1997	1,289	28	3,824	5,141	207	3,617
1998	1,700	91	3,075	4,866	207	2,868
1999	2,101	243	3,728	6,072	207	3,521
2000	581	163	4,285	5,029	207	4,078
2001	1,142	171	2,992	4,305	207	2,785
2002	920	74	3,028	4,022	207	2,821
2003	2,834	0	6,412	9,246	207	6,205
2004	2,337	88	7,840	10,265	207	7,633
2005	2,442	224	6,486	9,172	449 [e]	6,037
2006	1,941	258	3,535	5,476	360 [f]	3,175

[a] Commercial harvest is the commercial harvest of Chinook salmon from the Chignik Lagoon statistical area (statistical area 271-10).

[b] Inriver return is the estimated return to the weir.

[c] Recreational harvest in 1988 and 1989 was estimated from an onsite creel survey (Schwarz 1990). Recreational harvest in the remaining years is the average of 1988 and 1989.

[d] Escapement is inriver return minus recreational harvest.

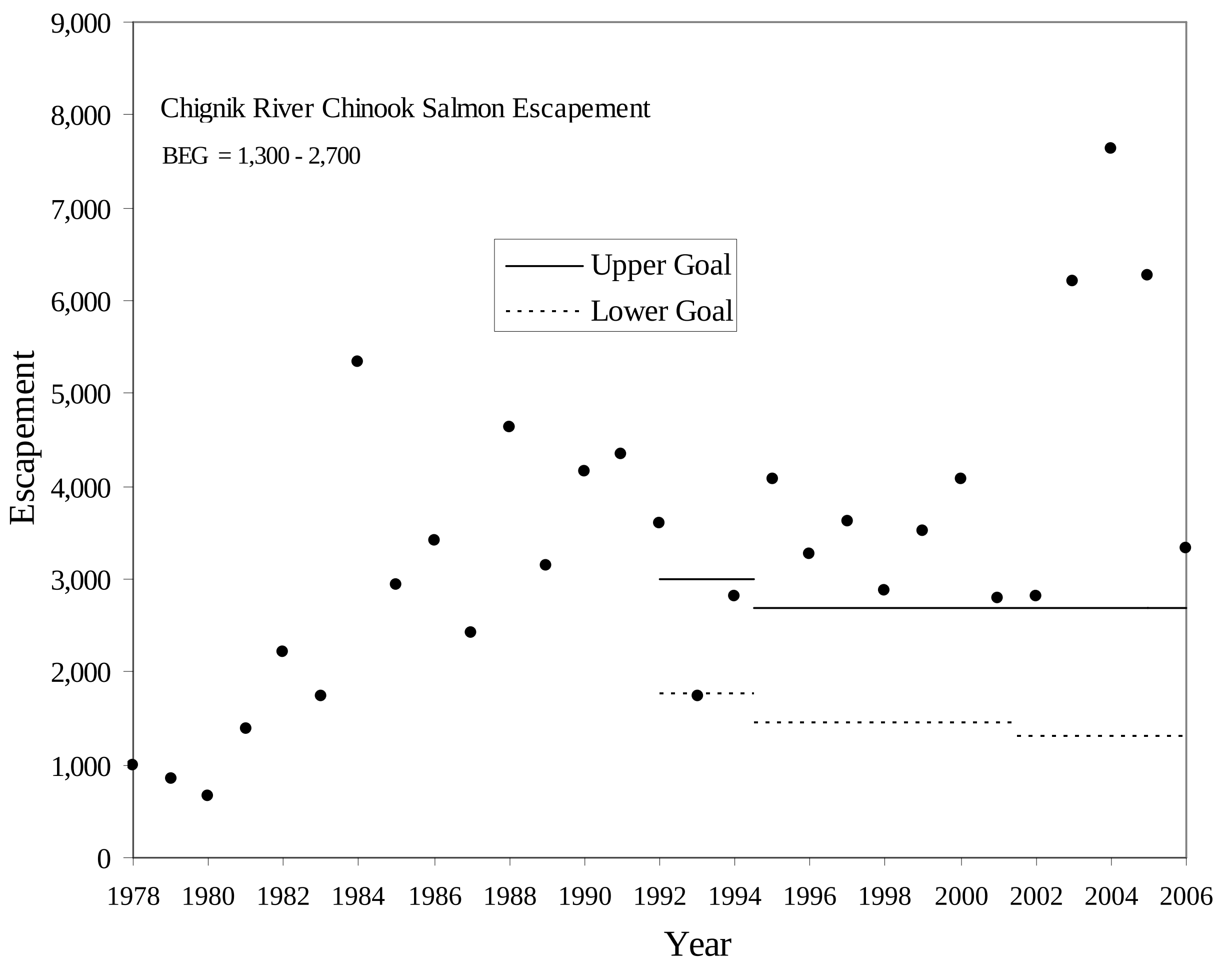
[e] Recreational harvest will be estimated from the sport charter logbooks; however, those data have not been analyzed.

Appendix A3.-Estimated escapement of Chinook salmon in the Chignik River with escapement goals depicted.

System: Chignik River

Species: Chinook salmon

Data available for analysis of escapement goals.



APPENDIX B:
SOCKEYE SALMON ESCAPEMENT GOAL REVIEW

Appendix B1.–Description of stocks and escapement goals for Chignik River watershed sockeye salmon.

System: Chignik River watershed

Species: sockeye salmon

Description of stock and escapement goals.

Regulatory area:	Chignik Management Area
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine
Current escapement goal:	SEG: Early run: 350,000 to 400,000 (2004)
	SEG: Late run: 200,000 to 250,000 (2004)
	MO: Late run: August: 25,000 (1989); September: 25,000 (2004)
Recommended escapement goal:	SEG: Early run: No change recommended
	SEG: Late run: 200,000 to 400,000
	IRRG: Late run: 50,000
Optimal escapement goal:	none
Inriver goal:	none
Action points:	none
Escapement enumeration:	Weir counts 1922, 1923, 1925 – 1930, 1932, 1933, 1935 – 1937, 1939, 1949 – 1950, 1952 to present
Data summary:	
Data quality:	Fair to Good
Data type:	Weir counts intermittently for 16 of the 29 years between 1922 and 1951 and from 1952 to present. Escapement age data available from 1955 to 1960, 1962 to 1969, and 1980 to 2003. Stock specific harvest information was available for 1962 to 1969 and 1980 to 2003. Smolt outmigration data from 1994 to present. Limnology data from 2000 to present.

-continued-

Appendix B1.–Page 2 of 2.

Contrast:	1952-2006: 22.5 (early run), 1952-1999: 4.6 (late run)
	1965-2006: 2.5 (early run), 1965-1999: 4.6 (late run)
	1977-2006: 2.2 (early run), 1977-1999: 2.8 (late run)
	1980-2006: 2.2 (early run), 1980-1999: 2.8 (late run)
Methodology:	Ricker stock-recruit model, percentile method, Euphotic volume analysis, Smolt biomass as a function of zooplankton biomass
Autocorrelation:	None
Comments:	Percentile analysis for the early run corroborated the current SEG range. Late run Ricker models were significant for data from 1952 to 1999 and from 1965 to 1999; however, regression diagnostics indicated a leverage issue. Euphotic volume model analysis corroborated the current SEG lower range. Smolt biomass as a function of zooplankton biomass model suggested increasing the SEG. Current goals recommended as no changes were indicated for the early-run SEG and increasing the late-run SEG range to 250,000 to 400,000 fish including the 50,000 subsistence management objective during August and September.

Appendix B2.–Escapement data available for analysis for Chignik sockeye salmon.

System: Chignik River watershed

Species: sockeye salmon

Data available for analysis of escapement goals.

	Estimated Escapement		
Year	Early Run	Late Run	Total
1952	34,155	260,540	294,695
1953	168,375	221,408	389,783
1954	184,953	277,912	462,865
1955	256,757	201,409	458,166
1956	289,096	483,024	772,120
1957	192,479	328,779	521,258
1958	120,862	212,594	333,456
1959	112,226	308,645	420,871
1960	251,567	357,230	608,797
1961	140,714	254,970	395,684
1962	167,602	324,860	492,462
1963	332,536	200,314	532,850
1964	137,073	166,625	303,698
1965	307,192	163,151	470,343
1966	383,545	183,525	567,070
1967	328,000	189,000	517,000
1968	342,343	244,836	587,179
1969	366,589	132,055	498,644
1970	536,257	119,952	656,209
1971	671,668	232,501	904,169
1972	326,320	231,270	557,590
1973	538,462	243,729	782,191
1974	364,603	313,343	677,946
1975	319,890	257,508	577,398
1976	548,953	281,810	830,763
1977	364,557	328,916	693,473

-continued-

System: Chignik River watershed

Species: sockeye salmon

Data available for analysis of escapement goals.

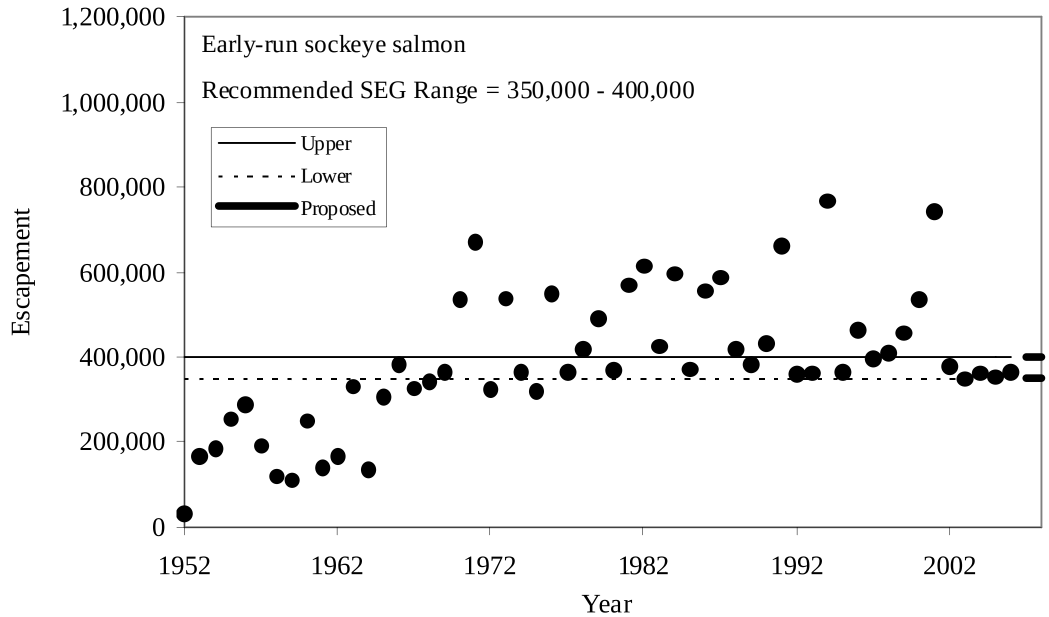
	Estimated Escapement		
Year	Early Run	Late Run	Total
1978	419,732	262,815	682,547
1979	491,467	246,349	737,816
1980	369,580	294,481	664,061
1981	570,210	261,239	831,449
1982	616,117	305,193	921,310
1983	426,178	428,034	854,212
1984	597,713	267,861	865,574
1985	373,040	372,798	745,838
1986	557,772	215,547	773,319
1987	589,299	214,444	803,743
1988	420,580	255,177	675,757
1989	384,001	557,174	941,175
1990	434,550	335,860	770,410
1991	662,660	377,438	1,040,098
1992	360,681	403,755	764,436
1993	364,261	333,116	697,377
1994	769,465	197,444	966,909
1995	366,495	373,425	739,920
1996	464,748	284,389	749,137
1997	396,668	378,950	775,618
1998	410,659	290,469	701,128
1999	457,424	258,542	715,966
2000	536,141	269,084	805,225
2001	744,013	392,905	1,136,918
2002	380,701	344,519	725,220
2003	350,004	334,141	684,145
2004	363,800	214,459	578,259
2005	355,091	225,366	580,457
2006	366,497	368,996	735,493

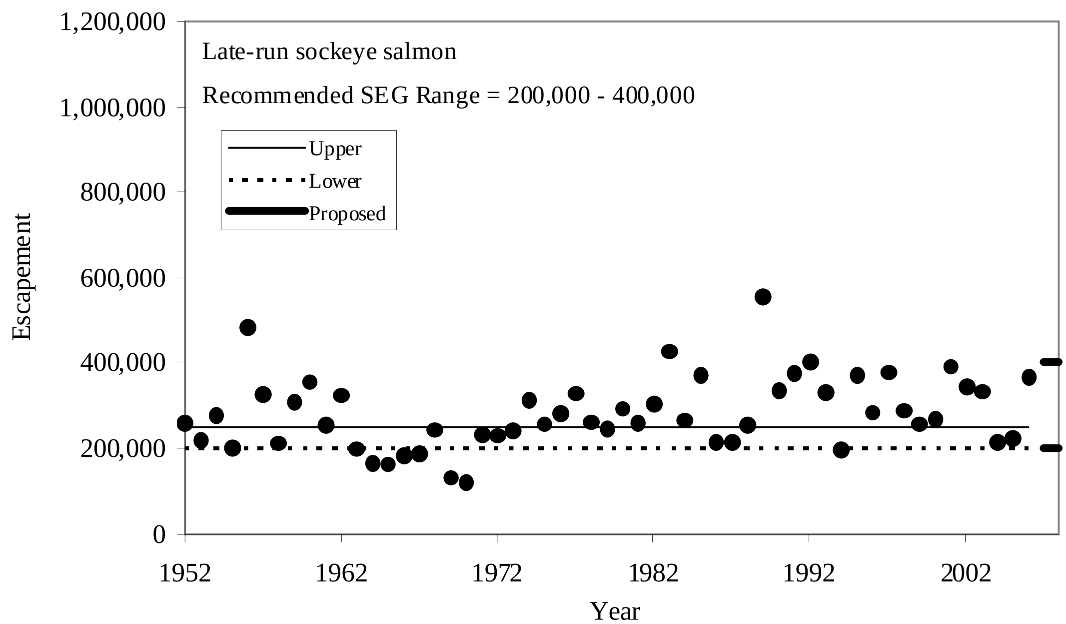
-continued-

System: Chignik River watershed

Species: sockeye salmon

Observed escapement by year and current SEG range.





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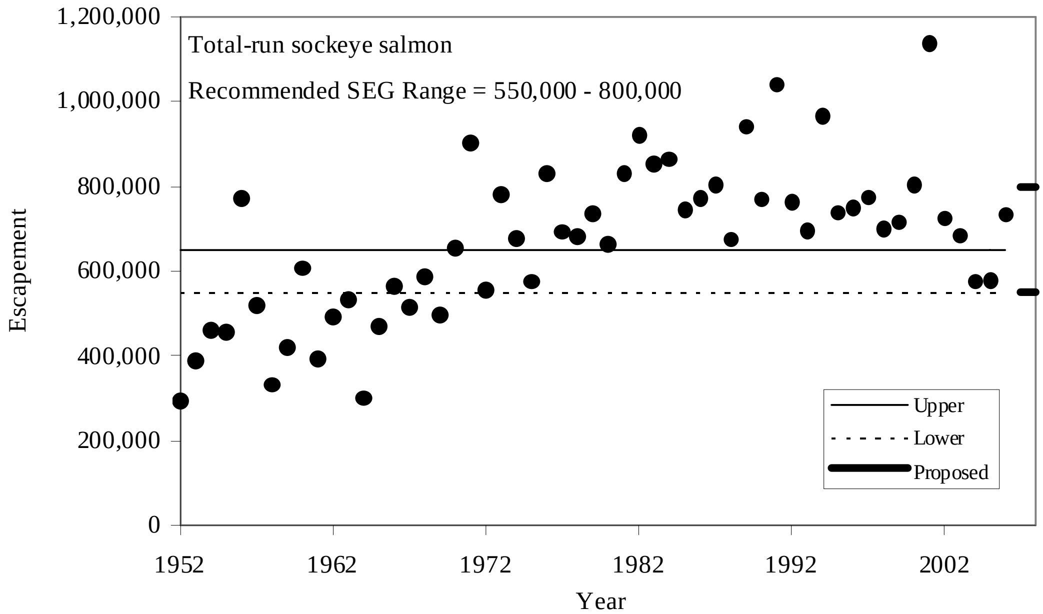
Total-run sockeye salmon
Recommended SEG Range = 550,000 - 800,000
Escapement
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1952
1962
1972
1982
1992
2002
Year
Upper
Lower
Proposed

Appendix B3.–Chignik sockeye salmon early-run brood table.

System: Black Lake (early run)

Species: sockeye salmon

Data available for analysis of escapement goals.

Chignik River Watershed Early-Run Sockeye Salmon Brood Table

	Return Ages														
Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other	Total	R/S
34,155	0	0	0	4,390	0	137,957	3,423	208	81,691	0	639	2,512	0	230,820	6.76
168,375	0	0	0	1,024	32	154,589	17,848	1,625	180,887	252	0	1,350	0	357,607	2.12
184,953	0	143	0	6,468	0	50,272	10,720	515	72,973	9	312	1,009	0	142,421	0.77
256,757	0	783	0	30,302	0	430,793	3,476	339	88,693	109	0	0	0	554,495	2.16
289,096	0	17	0	16,499	0	81,569	14,910	9	90,001	0	196	4,967	0	208,168	0.72
192,479	0	0	0	6,559	161	117,979	10,507	52	210,686	3,641	21	906	0	350,512	1.82
120,862	0	905	0	19,146	0	79,955	81,992	0	60,132	77	61	103	0	242,370	2.01
112,226	0	1,522	0	31,039	142	148,403	13,872	402	144,581	874	58	54	0	340,946	3.04
251,567	0	124	0	55,546	221	610,591	32,598	6,221	65,418	49	606	3,383	0	774,756	3.08
140,714	0	276	0	14,301	1	387,053	3,483	536	164,278	486	1,020	209	0	571,645	4.06
167,602	0	698	0	8,379	0	257,371	25,726	3,194	395,626	1,524	954	0	0	693,473	4.14
332,536	0	0	0	29,538	173	448,298	17,628	905	199,104	0	2,506	551	0	698,703	2.10
137,073	0	37	0	13,311	3,735	190,971	133,203	3,809	409,974	414	0	271	0	755,726	5.51
307,192	0	394	0	102,570	421	1,535,858	80,851	3,332	201,220	271	497	22,731	0	1,948,144	6.34
383,545	0	1,631	0	65,254	378	990,567	15,248	2,193	225,659	28	0	2,609	0	1,303,567	3.40
328,000	0	2,728	0	16,157	163	99,357	6,078	13,965	100,663	1,601	0	0	0	240,712	0.73
342,343	0	271	0	12,997	0	1,011,967	4,707	2,338	174,786	2,119	0	1,742	0	1,210,927	3.54
366,589	0	0	0	13,279	160	302,109	68,392	1,375	88,106	509	0	2,351	0	476,282	1.30
536,257	0	0	0	18,684	283	204,293	8,550	4,819	200,804	648	0	3,605	0	441,685	0.82
671,668	0	615	0	23,187	0	836,146	70,487	3,775	442,621	375	235	6,015	0	1,383,455	2.06
326,320	0	0	0	33,038	0	413,137	16,060	2,842	522,924	4,087	951	2,933	0	995,971	3.05
538,462	0	0	0	19,133	0	670,530	107,814	0	371,174	1,630	472	1,675	0	1,172,428	2.18
364,603	0	50	0	45,176	297	141,350	134,435	107	282,061	510	513	3,098	0	607,596	1.67
319,890	0	0	0	22,848	2,088	66,316	51,249	1,148	508,045	1,200	405	35	2,492	655,827	2.05
548,953	0	595	0	40,756	81	760,415	28,183	834	138,053	0	0	371	13,073	982,361	1.79
364,557	0	95	0	67,262	442	1,725,603	12,985	7,759	374,386	0	3,161	1,498	40,594	2,233,783	6.13

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Appendix B3.–Page 2 of 2.

System: Black Lake (early run)

Species: sockeye salmon

Data available for analysis of escapement goals.

Chignik River Watershed Early-Run Sockeye Salmon Brood Table

		Return Ages														
Year	Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other	Total	R/S
1978	419,732	0	267	0	56,354	3,129	497,590	68,525	6,032	321,208	0	0	208	14,987	968,298	2.31
1979	491,467	0	1,269	0	591,692	745	2,892,436	51,728	4,092	67,367	220	419	799	1,340	3,612,107	7.35
1980	369,580	0	283	108,988	90,497	1,074	635,271	150,063	1,492	736,108	2,082	940	1,110	4,833	1,732,741	4.69
1981	570,210	0	482	0	154,368	1,101	931,107	75,006	4,276	662,410	509	1,107	258	2,808	1,833,432	3.22
1982	616,117	0	120	0	171,708	2,006	1,622,919	134,083	2,124	390,096	0	393	0	193	2,323,643	3.77
1983	426,178	0	0	19,079	79,437	3,893	208,918	37,322	285	211,184	2	3,588	0	465	564,174	1.32
1984	597,713	476	2,273	1,220	45,960	2,185	324,482	42,024	2,599	210,441	1,213	704	2,463	0	636,040	1.06
1985	373,040	155	499	509	36,630	637	375,369	73,405	20,683	250,052	1,092	1,197	9,205	3,487	772,920	2.07
1986	557,772	384	1,515	6,370	341,300	0	1,894,843	55,308	2,967	202,442	11,104	5,792	1,147	45	2,523,215	4.52
1987	589,299	2,320	0	962	145,741	1,028	724,381	75,377	8,946	433,936	2,905	6,074	31,621	745	1,434,036	2.43
1988	420,580	0	1,468	667	69,885	1,878	492,058	122,713	5,446	961,409	1,426	804	447	258	1,658,460	3.94
1989	384,001	32	4,399	5,833	213,468	2,750	1,036,084	143,920	4,174	270,475	1,267	2,063	20,461	1,474	1,706,400	4.44
1990	434,550	1,004	557	34,094	137,472	5,126	461,400	180,724	5,707	689,768	23	3,314	7,077	579	1,526,844	3.51
1991	662,660	720	502	1,836	109,285	335	1,216,395	36,625	1,208	123,093	1,082	619	2,994	810	1,495,503	2.26
1992	360,681	1,843	449	114,749	52,151	10,551	370,948	67,340	1,387	294,451	10,197	0	5,091	603	929,759	2.58
1993	364,261	2,900	106	10,111	44,152	1,372	193,143	127,112	974	519,551	2,119	1,299	700	0	903,537	2.48
1994	769,465	234	653	0	89,104	1,091	1,191,546	219,496	14,117	521,350	54	601	97	567	2,038,909	2.65
1995	366,495	1,518	1,260	30,725	501,905	0	1,415,799	21,015	7,099	132,418	0	2,650	2,399	343	2,117,130	5.78
1996	464,748	7,202	567	78,280	58,023	0	1,092,142	14,877	12,799	302,104	1,115	812	2,456	0	1,570,375	3.38
1997[a]	396,668	1,359	0	7,166	50,504	839	488,972	49,781	3,277	174,087	193	0	0	0	776,179	1.96
1998	410,659	149	632	3,122	200,141	3	643,270	29,951	1,015	111,141	0	0	0	0	989,424	2.41
1999	457,424	1,906	81	18,112	115,606	876	630,749	70,220	734	176,623	0	0	0	0	1,014,906	2.22
2000	536,141	1,184	228	10,185	257,222	297	1,101,146	49,689	8,102	150,557	0					
2001	744,013	5,364	0	59,606	77,174	0	523,867	31,580								
2002	380,701	0	0	6,231	55,979	0										
2003	350,004	4,532	0													
2004	363,800															
2005	355,091															
2006	366,497															

Appendix B4.–Chignik sockeye salmon late-run brood table.

System: Chignik Lake (late run)

Species: sockeye salmon

Data available for analysis of escapement goals.

Chignik River Watershed Late-Run Sockeye Salmon Brood Table

		Return Ages														
Year	Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other	Total	R/S
1952	260,540	0	0	0	22,213	0	258,747	30,836	986	229,563	0	3,932	8,403	0	554,680	2.13
1953	221,408	0	0	0	9,167	428	125,399	32,350	470	396,916	1,935	934	5,424	0	573,023	2.59
1954	277,912	0	547	0	2,848	0	39,658	75,361	771	418,442	804	1,661	5,069	0	545,161	1.96
1955	201,409	0	369	0	32,187	0	303,988	32,708	168	363,162	1,252	0	0	0	733,834	3.64
1956	483,024	0	1,330	0	12,515	0	106,327	36,113	435	221,169	0	1,349	4,781	0	384,019	0.80
1957	328,779	0	0	0	17,746	622	232,393	109,475	351	332,661	2,104	1,189	1,319	0	697,861	2.12
1958	212,594	0	1,459	0	50,630	0	23,204	139,797	0	419,109	980	93	432	0	635,704	2.99
1959	308,645	0	3,286	0	18,094	907	109,204	81,669	117	197,975	738	689	187	0	412,866	1.34
1960	357,230	0	146	0	24,455	491	122,278	8,273	1,314	210,883	141	1,618	12,824	0	382,423	1.07
1961	254,970	0	718	0	1,899	799	109,935	18,702	220	401,732	2,698	5,335	2,420	0	544,458	2.14
1962	324,860	0	123	0	4,312	0	44,074	69,811	998	692,188	1,074	1,109	0	0	813,689	2.50
1963	200,314	0	0	0	5,536	1,300	103,116	68,605	29	243,939	0	1,529	883	0	424,937	2.12
1964	166,625	0	88	0	6,607	4,550	24,880	65,639	713	140,826	960	194	5,776	0	250,233	1.50
1965	163,151	0	1,636	0	25,157	5,547	162,041	59,008	361	614,235	971	650	94,754	0	964,359	5.91
1966	183,525	0	1,715	0	14,784	942	284,131	28,590	455	407,967	2,419	0	16,843	0	757,845	4.13
1967	189,000	0	510	0	5,845	726	77,202	30,658	653	449,694	2,591	1,305	0	0	569,183	3.01
1968	244,836	0	863	0	3,781	0	107,955	19,044	619	567,425	15,173	2,470	27,620	0	744,949	3.04
1969	132,055	0	0	0	1,155	990	82,718	263,494	751	447,727	6,689	0	15,060	0	818,583	6.20
1970	119,952	0	0	0	17,731	11,703	25,375	138,675	1,187	415,418	10,992	0	17,763	0	638,845	5.33
1971	232,501	0	1,458	0	14,179	11,583	167,089	369,810	211	1,697,096	3,662	3,205	15,662	0	2,283,954	9.82
1972	231,270	0	0	0	27,096	2,202	107,848	85,981	111	810,308	34,712	250	3,456	0	1,071,963	4.64
1973	243,729	0	0	0	5,165	9,601	63,986	195,139	0	859,539	3,600	1,354	5,159	0	1,143,543	4.69
1974	313,343	0	3,951	0	21,748	3,117	98,583	184,079	55	735,042	2,209	2,188	8,748	2,553	1,062,274	3.39
1975	257,508	0	0	0	22,942	6,658	134,113	201,103	863	811,950	3,375	6,436	2,329	7,594	1,197,363	4.65
1976	281,810	0	1,031	0	64,277	875	732,795	89,113	2,479	498,558	0	2,730	9	4,452	1,396,318	4.95
1977	328,916	0	273	0	49,867	3,755	155,162	59,867	1,715	1,057,588	0	2,850	1,106	10,476	1,342,658	4.08

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Appendix B4.–Page 2 of 2.

System: Chignik Lake (late run)

Species: sockeye salmon

Data available for analysis of escapement goals.

Chignik River Watershed Late-Run Sockeye Salmon Brood Table

		Return Ages														
Year	Escapement	0.2	1.1	0.3	1.2	2.1	1.3	2.2	1.4	2.3	3.2	2.4	3.3	Other	Total	R/S
1978	262,815	0	399	0	16,722	5,810	227,692	279,023	961	390,267	687	1,668	168	228	923,623	3.51
1979	246,349	0	2,025	0	90,196	4,429	394,998	39,406	1,176	264,856	369	1,442	769	3,163	802,829	3.26
1980	294,481	0	1,571	11,611	18,519	8,491	149,295	305,514	620	439,791	3,038	756	974	1,082	941,262	3.20
1981	261,239	0	1,564	0	84,701	4,848	227,684	72,940	604	337,180	137	594	68	32	730,352	2.80
1982	305,193	0	2,420	0	50,521	3,139	177,018	98,754	677	533,173	146	1,269	0	276	867,394	2.84
1983	428,034	0	0	2,471	11,037	3,481	135,504	100,439	191	1,014,238	740	11,053	72	0	1,279,226	2.99
1984	267,861	109	832	505	27,815	9,809	137,789	297,259	2,359	1,558,686	1,658	8,876	6,550	547	2,052,793	7.66
1985	372,798	90	630	190	17,099	15,044	165,757	154,043	6,117	459,442	1,063	3,827	3,526	161	826,989	2.22
1986	215,547	94	2,518	12,421	170,342	305	316,570	161,091	1,707	463,238	7,247	11,927	1,988	573	1,150,022	5.34
1987	214,444	5,947	652	976	66,074	8,933	425,983	209,848	5,591	959,150	6,350	6,354	62,566	109	1,758,534	8.20
1988	255,177	0	2,225	1,038	53,583	3,095	273,248	101,364	1,846	179,809	3,556	9,433	7,838	1,129	638,164	2.50
1989	557,174	389	7,425	8,550	158,189	4,415	238,293	91,912	3,551	1,070,406	6,596	11,103	85,361	308	1,686,496	3.03
1990	335,860	413	409	5,271	22,662	1,151	326,230	166,352	1,873	446,003	1,731	2,016	15,270	827	990,206	2.95
1991	377,438	117	175	898	93,587	1,722	286,297	104,860	603	446,211	2,746	4,936	3,986	3,767	949,904	2.52
1992	403,755	559	986	21,610	17,908	12,056	203,800	190,144	2,232	524,930	57,442	1,069	20,705	379	1,053,820	2.61
1993	333,116	456	481	4,023	29,686	17,852	134,040	311,581	2,070	1,020,180	4,795	1,065	62	155	1,526,445	4.58
1994	197,444	79	886	0	55,525	7,069	451,141	292,046	3,212	401,872	248	2,258	1,921	226	1,216,483	6.16
1995	373,425	358	1,454	5,628	183,410	0	320,493	30,763	3,907	771,267	4,314	10,290	11,436	381	1,343,702	3.60
1996	284,389	979	55	41,569	42,153	105	740,974	40,140	7,531	503,463	3,571	3,846	7,301	0	1,391,686	4.89
1997[a]	378,950	2,829	155	3,189	35,303	1,848	211,833	94,455	1,984	659,766	2,426	3,779	2,789	0	1,020,355	2.68
1998	290,469	173	1,788	2,342	63,671	133	205,444	51,079	443	161,661	460	277	592	218	488,281	1.68
1999	258,542	699	66	8,477	42,692	2,139	131,351	39,710	1,974	111,636	109	2,265	1,554	0	342,671	1.33
2000	269,084	246	829	3,725	59,500	1,669	551,058	17,973	10,263	463,675						
2001	392,905	0	316	13,049	13,614	922	383,305	48,615								
2002	344,519	0	394	11,402	36,890	0										
2003	334,119	816	804													
2004	214,459															
2005	225,366															
2006	368,996															

Appendix B5.–Analysis results for Chignik sockeye salmon spawner-recruit models, EV models, zooplankton models, percentile models, and the existing goals..

System: Chignik River watershed

Species: sockeye salmon

Escapement goal review model summary.

	Early Run			Late Run			Total Run		
Method	Low	Point	High	Low	Point	High	Low	Point	High
Existing Goals	350,000	375,000	400,000	200,000	225,000	250,000	550,000	600,000	650,000
EV[a,b]	n/a	n/a	n/a	181,883	242,510	303,138	n/a	n/a	n/a
Zooplankton[b]	n/a	n/a	n/a	460,173	575,216	690,259	n/a	n/a	n/a
Spawner-recruit[c]									
1952-1999	n/a	n/a	n/a	183,369	288,453	412,565	n/a	n/a	n/a
1965-1999	n/a	n/a	n/a	206,346	325,391	466,931	n/a	n/a	n/a
1977-1999	n/a	n/a	n/a	NS	NS	NS	n/a	n/a	n/a
1980-1999	n/a	n/a	n/a	NS	NS	NS	n/a	n/a	n/a
Percentile									
1952-1999	323,105	n/a	478,108	n/a	n/a	n/a	n/a	n/a	n/a
1965-1999	355,929	n/a	769,465	n/a	n/a	n/a	n/a	n/a	n/a
1977-1999	364,365	n/a	769,465	n/a	n/a	n/a	n/a	n/a	n/a
1980-1999	364,365	n/a	769,465	n/a	n/a	n/a	n/a	n/a	n/a
Actual Escapements[d,e]	34,155	388,842	769,465	119,952	283,343	557,174	154,107	672,185	1,326,639

[a] Low and high ranges were calculated as values 25% higher and lower than the point goals.

[b] Data from 1991, 2000 to 2006 (Bouwens and Newland 2004; Finkle 2007; Kyle 1992).

[c] Late run R/S analyses using multiplicative error structure based on data from 1952 to 2006. NS = not significant (P>0.05).

[d] Point estimates were the average of escapements between 1952 to 2006 for each run.

[e] The low and high ranges are the lowest and highest escapements since 1952.

Appendix B6.–Chignik sockeye salmon early-run percentile analysis.

System: Black Lake (early run)

Species: sockeye salmon

Percentile analysis for early-run sockeye salmon showing applied percentile ranges and data range.

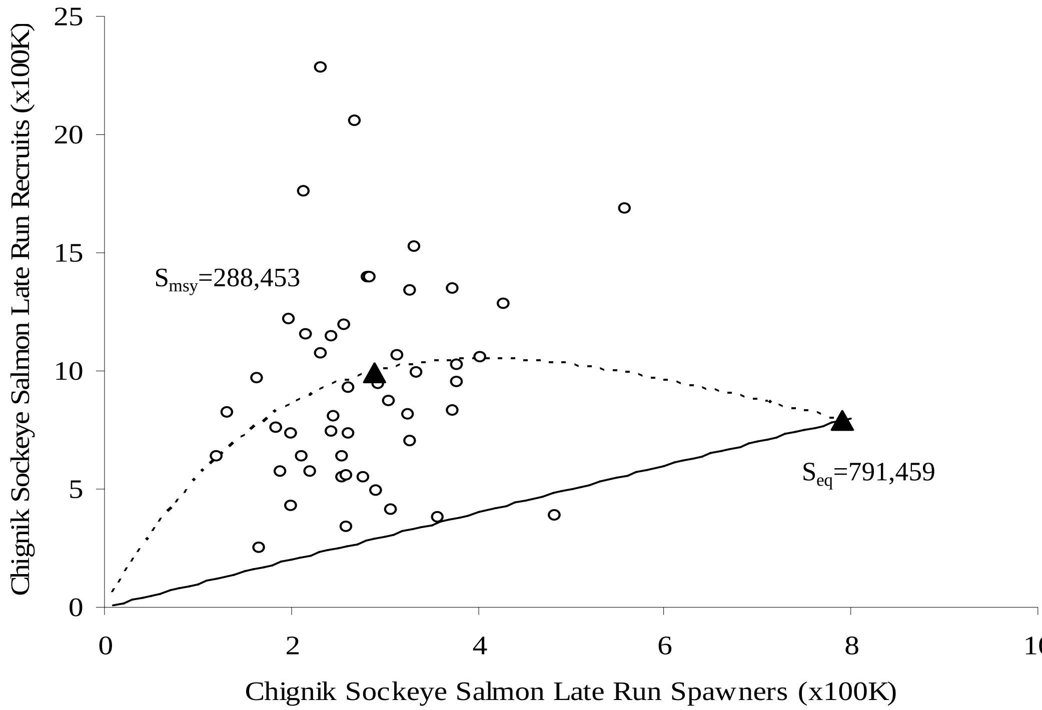
			Percentiles of escapement data used		Escapement goal estimate	
Location	Data range	Species	Lower	Upper	Lower	Upper
Chignik	1952-1999	sockeye salmon	25th	75th	323,105	478,108
Chignik	1965-1999	sockeye salmon	15th	Max	355,929	769,465
Chignik	1977-1999	sockeye salmon	15th	Max	364,365	769,465
Chignik	1980-1999	sockeye salmon	15th	Max	364,365	769,465

Appendix B7.–Chignik sockeye salmon late-run Ricker curves.

System: Chignik Lake (late run)

Species: sockeye salmon

Ricker stock – recruitment relationship, 1952-1999 brood years. The solid curved line represents the multiplicative error Ricker curve and the solid straight line represents replacement.



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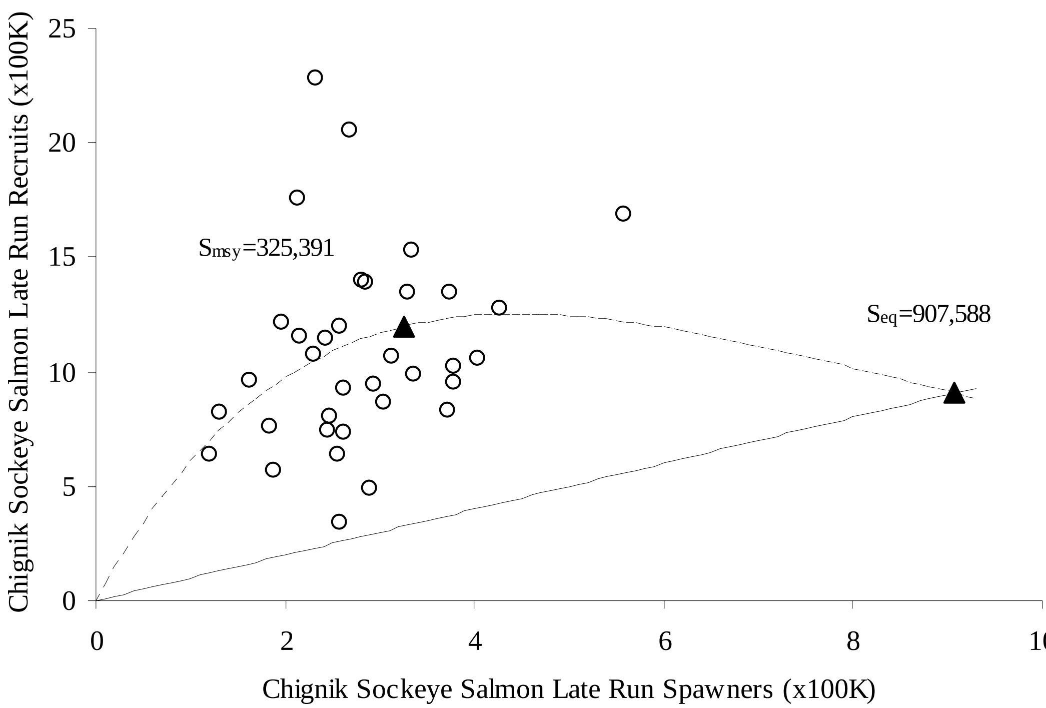
System: Chignik Lake (late run)

Species: sockeye salmon

Ricker stock – recruitment relationship, 1965-1999 brood years. The solid curved line represents the multiplicative error Ricker curve and the solid straight line represents replacement.



Appendix B8.–Chignik sockeye salmon late-run euphotic volume analysis.

System: Chignik Lake (late run)

Species: sockeye salmon

Euphotic volume model, 1991 and 2000-2006.

Location	Year	EZD (m)	EV (10^6 m^3)	Spring Fry	Smolt Biomass (kg)	Number of Smolt	Adult Production (EV)	Adult Escapement (EV)
Chignik Lake[a]	1991	n/a	158.90	17,479,000	17,002	5,724,680	397,250	158,900
	2000	8.22	198.10	21,791,220	21,197	7,137,008	495,255	198,102
	2001	15.52	374.03	41,143,520	40,021	13,475,227	935,080	374,032
	2002	15.00	361.50	39,765,000	38,681	13,023,737	903,750	361,500
	2003	4.98	120.02	13,201,980	12,842	4,323,881	300,045	120,018
	2004	11.11	267.75	29,452,610	28,649	9,646,248	669,378	267,751
	2005	9.78	235.70	25,926,780	25,220	8,491,477	589,245	235,698
	2006	8.12	195.74	21,531,422	20,944	7,051,920	489,351	195,740
	Average	10.39	238.97	26,676,144	25,949	8,736,907	606,276	242,510

[a] Number of smolt for Chignik Lake based on an average weight of 2.97 g.

Appendix B9.–Chignik sockeye salmon late-run smolt biomass as a function of zooplankton biomass analysis.

System: Chignik Lake (late run)

Species: sockeye salmon

Zooplankton model, 1991, 2000 – 2006.

Lake	Year	Zooplankton Biomass (mg/m^2)	Number of Smolt	Optimal Escapement	Lower Escapement Limit	Upper Escapement Limit	specific Adult Production[c]
Chignik Lake[a]	1991	661.0	11,317,344	754,490	603,592	905,388	1,358,081
	2000	523.2	8,958,337	597,222	477,778	716,667	1,075,000
	2001	266.6	4,563,920	304,261	243,409	365,114	547,670
	2002	552.3	9,455,889	630,393	504,314	756,471	1,134,707
	2003	430.4	7,369,115	491,274	393,019	589,529	884,294
	2004	467.9	8,011,183	534,079	427,263	640,895	961,342
	2005	544.0	9,314,390	620,959	496,767	745,151	1,117,727
	2006	586.1	10,035,756	669,050	535,240	802,860	1,204,291
	Average	503.9	8,628,242	575,216	460,173	690,259	1,035,389

[a] Number of smolt for Chignik Lake based on an average weight of 2.97 g.

APPENDIX C:
PINK SALMON ESCAPEMENT GOAL REVIEW

Appendix C1.–Description of stocks and escapement goals for pink salmon in the entire CMA.

System: Entire CMA

Species: pink salmon

Description of stock and escapement goals.

Regulatory area	Chignik Management Area – Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine
Current escapement goal:	BEG: even years: 327,000 to 737,000 (2004)
	BEG: odd years: 541,000 to 1,177,000 (2004)
Recommended escapement goal:	SEG: even years: 200,000 to 600,000
	SEG: odd years: 500,000 to 800,000
Optimal escapement goal:	none
Inriver goal:	none
Action points:	none
Escapement enumeration:	Aerial survey, 1962-2006.
Data summary:	
Data quality:	Fair
Data type:	Fixed-wing aerial surveys with estimated total escapement from 1968 to 2006. A total of 49 streams are used as an index for district-wide escapement.
Contrast:	101
Methodology:	Yield Analysis
Autocorrelation:	None
Comments:	Assessing bin ranges of escapement and resultant R/S, returns minus parent escapement, and harvest led the committee to recommend a SEG of 200,000 to 600,000 fish during even years and 500,000 to 800,000 fish for odd years.

Appendix C2.–Peak aerial surveys for pink salmon in the entire CMA.

System: Entire CMA

Species: pink salmon

Data available for analysis of escapement goals.

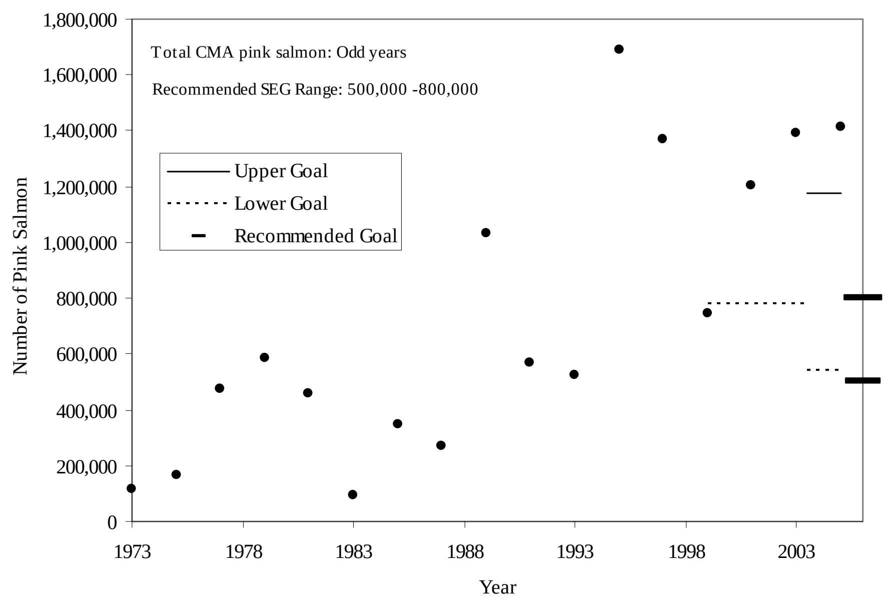
Year	Peak Aerial Survey
1972	16,725
1973	117,225
1974	130,401
1975	165,920
1976	300,280
1977	474,080
1978	580,650
1979	582,913
1980	552,400
1981	460,375
1982	363,755
1983	91,295
1984	632,880
1985	349,200
1986	487,550
1987	268,762
1988	1,075,640
1989	1,031,220
1990	713,750
1991	566,600
1992	1,143,585
1993	526,140
1994	916,100
1995	1,688,000
1996	1,022,900
1997	1,367,100
1998	1,187,400
1999	747,485
2000	740,650
2001	1,202,000
2002	782,820
2003	1,390,600
2004	779,330
2005	1,414,050
2006	356,425

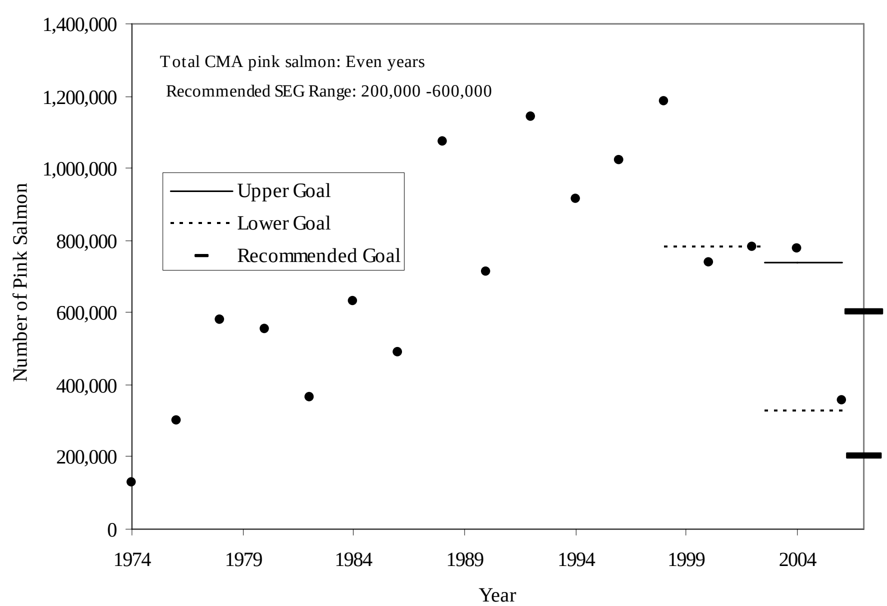
Appendix C3.–Peak aerial surveys of pink salmon in the entire CMA with existing and recommended escapement goals depicted.

System: Entire CMA

Species: pink salmon

Observed escapement by year (even and odd years), previous escapement goals lower bound or threshold (dashed lines) and upper bound (solid lines) and current SEG range (thick solid lines).





Appendix C4.–Yield table for entire CMA pink salmon, even years

System: Entire CMA

Species: pink salmon

Yield analysis for even years, 1968-2004. Escapement intervals have a range of 400,000 to 600,000.

				Yield					
Number			Escapement	Return/Spawner		Return minus Parent Escapement		Harvest	
of Years	Lower Goal	Upper Goal	Range	Mean	Median	Mean	Median	Mean	Median
4	100,000	500,000	400,000	5.47	5.27	1,532,457	989,707	1,205,591	714,959
7	500,000	900,000	400,000	1.90	1.79	563,819	501,795	659,967	647,125
5	900,000	1,300,000	400,000	1.32	1.18	322,073	203,578	475,038	431,063
5	200,000	600,000	400,000	4.32	2.96	1,462,867	1,064,934	1,278,729	985,114
6	600,000	1,000,000	400,000	1.59	1.23	415,488	202,044	473,712	286,321
4	1,000,000	1,400,000	400,000	1.31	1.18	328,625	195,848	546,531	490,536
6	300,000	700,000	400,000	3.90	2.90	1,302,688	889,432	1,173,462	929,249
7	700,000	1,100,000	400,000	1.55	1.17	445,819	188,118	503,163	383,574
8	400,000	800,000	400,000	2.70	2.02	941,497	593,267	952,116	760,255
5	800,000	1,200,000	400,000	1.32	1.18	322,073	203,578	475,038	431,063
6	100,000	600,000	500,000	4.49	4.09	1,313,250	889,432	1,131,489	929,249
8	600,000	1,100,000	500,000	1.58	1.25	452,816	241,993	521,158	466,791
2	1,100,000	1,600,000	500,000	1.08	1.08	92,446	92,446	429,564	429,564
6	200,000	700,000	500,000	3.90	2.90	1,302,688	889,432	1,173,462	929,249
9	700,000	1,200,000	500,000	1.44	1.17	367,292	188,118	486,808	428,064
5	800,000	1,300,000	500,000	1.32	1.18	322,073	203,578	475,038	431,063
8	400,000	900,000	500,000	2.70	2.02	941,497	593,267	952,116	760,255
5	900,000	1,400,000	500,000	1.32	1.18	322,073	203,578	475,038	431,063
8	500,000	1,000,000	500,000	1.83	1.56	530,325	398,832	601,105	515,350
4	1,000,000	1,500,000	500,000	1.31	1.18	328,625	195,848	546,531	490,536
7	100,000	700,000	600,000	4.10	2.96	1,197,328	713,929	1,062,294	873,384
9	700,000	1,300,000	600,000	1.44	1.17	367,292	188,118	486,808	428,064
5	800,000	1,400,000	600,000	1.32	1.18	322,073	203,578	475,038	431,063
5	900,000	1,500,000	600,000	1.32	1.18	322,073	203,578	475,038	431,063
9	400,000	1,000,000	600,000	2.55	1.79	869,761	501,795	867,333	647,125
4	1,000,000	1,600,000	600,000	1.31	1.18	328,625	195,848	546,531	490,536

Appendix C5.–Yield table for entire CMA pink salmon, odd years

System: Entire CMA

Species: pink salmon

Yield analysis for odd years 1969-2003. Escapement intervals have a range of 300,000 to 600,000.

				Yield					
Number			Escapement	Return per Spawner		Return minus Parent Escapement		Harvest	
of Years	Lower Goal	Upper Goal	Range	Mean	Median	Mean	Median	Mean	Median
4	100,000	400,000	300,000	3.47	2.96	496,083	478,254	236,365	156,470
5	400,000	700,000	300,000	3.98	3.84	1,566,796	1,607,917	1,419,073	1,648,377
4	200,000	500,000	300,000	2.89	2.71	730,659	478,254	625,216	283,977
4	500,000	800,000	300,000	4.27	3.58	1,901,033	1,672,100	1,537,689	1,465,072
6	300,000	600,000	300,000	3.56	3.31	1,333,386	1,323,996	1,223,690	1,405,495
6	100,000	500,000	400,000	3.34	2.96	658,410	478,254	528,639	283,977
4	500,000	900,000	400,000	4.27	3.58	1,901,033	1,672,100	1,537,689	1,465,072
7	200,000	600,000	400,000	3.61	3.84	1,255,784	1,040,075	1,052,836	1,162,613
4	1,000,000	1,400,000	400,000	1.30	1.63	319,587	697,933	891,146	835,943
6	300,000	700,000	400,000	3.56	3.31	1,333,386	1,323,996	1,223,690	1,405,495
6	400,000	800,000	400,000	3.87	3.58	1,595,044	1,672,100	1,396,189	1,465,072
9	100,000	600,000	500,000	3.75	3.84	1,090,924	912,966	893,425	604,806
7	200,000	700,000	500,000	3.61	3.84	1,255,784	1,040,075	1,052,836	1,162,613
4	1,200,000	1,700,000	500,000	1.20	1.44	274,313	607,385	809,941	673,535
7	300,000	800,000	500,000	3.53	3.32	1,390,943	1,607,917	1,231,987	1,281,767
6	400,000	900,000	500,000	3.87	3.58	1,595,044	1,672,100	1,396,189	1,465,072
4	900,000	1,400,000	500,000	1.30	1.63	319,587	697,933	891,146	835,943
4	500,000	1,000,000	500,000	4.27	3.58	1,901,033	1,672,100	1,537,689	1,465,072
4	1,000,000	1,500,000	500,000	1.30	1.63	319,587	697,933	891,146	835,943
9	100,000	700,000	600,000	3.75	3.84	1,090,924	912,966	893,425	604,806
8	200,000	800,000	600,000	3.58	3.58	1,315,846	1,323,996	1,081,452	1,222,190
4	800,000	1,400,000	600,000	1.30	1.63	319,587	697,933	891,146	835,943
7	300,000	900,000	600,000	3.53	3.32	1,390,943	1,607,917	1,231,987	1,281,767
4	900,000	1,500,000	600,000	1.30	1.63	319,587	697,933	891,146	835,943
6	400,000	1,000,000	600,000	3.87	3.58	1,595,044	1,672,100	1,396,189	1,465,072
4	1,000,000	1,600,000	600,000	1.30	1.63	319,587	697,933	891,146	835,943
5	500,000	1,100,000	600,000	3.75	3.32	1,661,752	1,607,917	1,464,001	1,281,767
4	1,100,000	1,700,000	600,000	1.20	1.44	274,313	607,385	809,941	673,535
4	1,200,000	1,800,000	600,000	1.20	1.44	274,313	607,385	809,941	673,535

APPENDIX D:
CHUM SALMON ESCAPEMENT GOAL REVIEW

Appendix D1.–Description of stocks and escapement goals for chum salmon in the entire CMA.

System: Entire CMA

Species: chum salmon

Description of stock and escapement goals.

Regulatory area	Chignik Management Area – Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine
Current escapement goal:	SEG: 50,400 (2004)
Recommended escapement goal:	SEG: 57,400
Optimal escapement goal:	none
Inriver goal:	none
Action points:	none
Escapement enumeration:	Aerial survey, 1973-2006
Data summary:	
Data quality:	Fair
Data type:	Peak surveys are available from 1973 to 2006. A total of 42 streams are used as an index for district-wide escapement. No stock specific harvest information is available.
Contrast:	Peak aerial survey: 11.9
Methodology:	Risk analysis
Comments:	The index streams used in this review were different than the last review; therefore, the committee recommended increasing the goal to 57,400 chum salmon.

Appendix D2.–Peak aerial surveys of chum salmon in the entire CMA.

System: **Entire CMA**

Species: **chum salmon**

Data available for analysis of escapement goals.

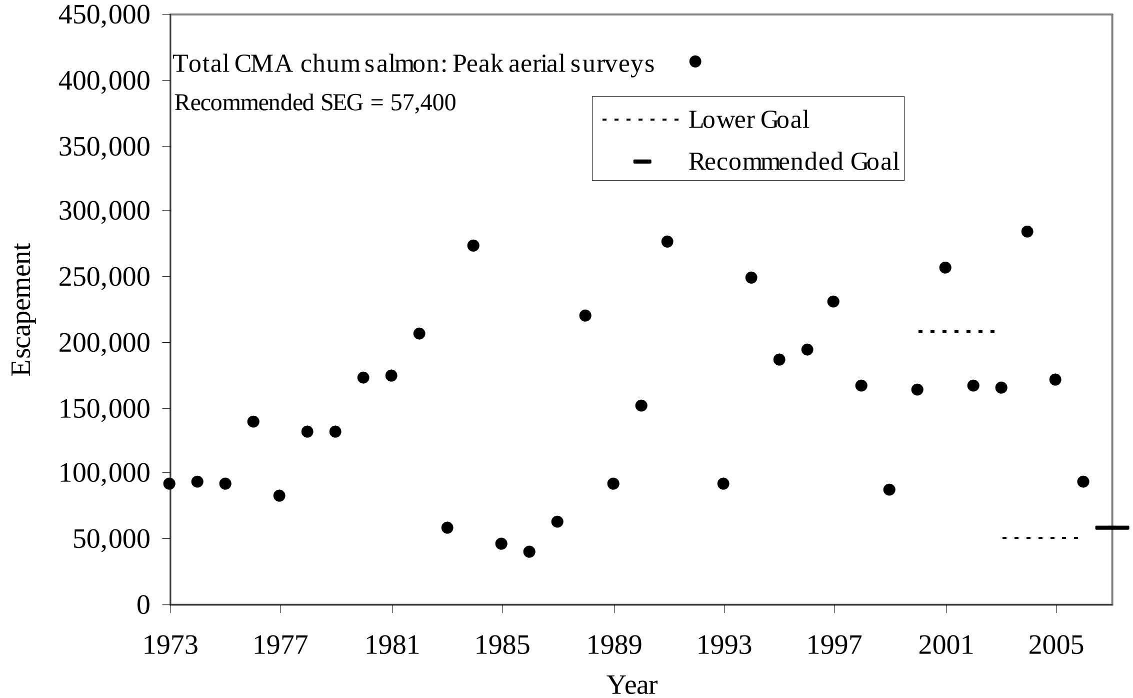
Year	Peak Aerial Survey
1973	85,555
1974	91,870
1975	84,655
1976	138,500
1977	74,030
1978	117,600
1979	117,650
1980	162,780
1981	151,400
1982	186,800
1983	42,185
1984	238,650
1985	41,819
1986	30,575
1987	40,560
1988	210,040
1989	74,235
1990	136,975
1991	275,600
1992	364,485
1993	83,530
1994	226,700
1995	173,600
1996	186,425
1997	186,940
1998	155,675
1999	79,740
2000	150,341
2001	195,406
2002	129,970
2003	157,751
2004	349,518
2005	308,700
2006	93,489

Appendix D3.–Peak aerial surveys of chum salmon in the entire CMA with existing and recommended escapement goals depicted.

System: Entire CMA

Species: chum salmon

Observed escapement by year (solid circles for aerial surveys)



Appendix D4.–Risk analysis for chum salmon in the CMA

System: Entire CMA

Species: chum salmon

Entire CMA chum salmon risk analysis using 95% decrease in mean and 96.4% decrease in mean.