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Review of Salmon Escapement Goals in the Chignik Management Area, 2013

by

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October 2013

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)

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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ABSTRACT

In April 2013, an interdivisional team of staff from the Alaska Department of Fish and Game reviewed existing Pacific salmon *Oncorhynchus* spp. escapement goals in the Chignik Management Area (CMA). The CMA salmon escapement goals had previously been reviewed in 2010. In 2013, the team reviewed recent data for the 6 goals in existence to determine whether substantial new information existed. Only the Chignik River early- and late-run sockeye salmon escapement goals were analyzed further. The team recommends changing the Chignik River early-run sockeye salmon sustainable (SEG) of 350,000 to 400,000 to a biological escapement goal (BEG) of 350,000 to 450,000. The team recommends no change to the late-run sockeye salmon SEG. No goals were eliminated and none were added for systems currently without escapement goals.

Key words: Pacific salmon, *Oncorhynchus*, escapement goal, Chignik, Chignik Lake, Black Lake, stock status

INTRODUCTION

This report documents the 2013 review of salmon escapement goals in the Chignik Management Area (CMA) based on the Alaska Board of Fisheries' (hereafter referred to as the board) *Policy for the Management of Sustainable Salmon Fisheries* (5 AAC 39.222) and the *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223). Recommendations from this review are made to the directors of the divisions of Commercial Fisheries and Sport Fish of the Alaska Department of Fish and Game (department), and are intended to take effect for salmon stocks returning in 2014. Salmon escapement goals in the CMA were last reviewed in 2010 (Nemeth et al. 2010).

Three important terms defined in the *Policy for the Management of Sustainable Salmon Fisheries* are:

- *biological escapement goal* (BEG): the escapement that provides the greatest potential for maximum sustained yield (MSY);
- *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 or managed for; and
- *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 optimal escapement goal, plus specific allocations to inriver fisheries.

A report documenting the established escapement goals for stocks of 5 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 the 2001 report were based on average escapement estimates and spawning habitat availability, and had been implemented in the early 1970s and 1980s.

Since 2001, escapement goals for the CMA have gone through review 3 times (2004, 2007, and 2010; Witteveen et al. 2005; Witteveen et al. 2007; Nemeth et al. 2010).

In April 2013, the Salmon Escapement Goal Interdivisional Review Team (hereafter referred to as the team) was formed to review the existing CMA salmon escapement goals and recent escapements for stocks with escapement goals. The team included staff from the Division of Commercial Fisheries (CF) and the Division of Sport Fish (SF): Nicholas Sagalkin (CF), Heather Finkle (CF), Birch Foster (CF), Michelle Moore (CF), Mary Beth Loewen (CF), Jack Erickson

(SF), Jeff Wadle (CF), Todd Anderson (CF), Adam St. Saviour (CF), James Jackson (CF), David Barnard (CF), Charlie Russell (CF), Eric Volk (CF), Steve Fleischman (SF), and Donn Tracy (SF).

For this review the team 1) determined 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) determined the most appropriate methods to evaluate the escapement goal ranges; 3) estimated the escapement goal for each stock and compared these estimates with the current goal; 4) determined if a goal could be developed for any stocks or stock-aggregates that currently have no goal; 5) developed recommendations for each goal evaluated to present to the directors of the divisions of Commercial Fisheries and Sport Fish for approval; and 6) reviewed recent escapements to all stocks with escapement goals.

MANAGEMENT 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 5 commercial fishing districts: Eastern, Central, Chignik Bay, Western, and Perryville districts (Figure 1). These districts are further divided into 14 sections and 26 statistical reporting areas (Anderson et al. 2013).

The Chignik River is the major watershed in the CMA, and consists of 2 interconnecting lakes (Black and Chignik lakes) with a single outlet river (the Chignik River) that empties into the estuary of Chignik Lagoon (Figure 2). All 5 species of Pacific salmon *Oncorhynchus* spp. return to the Chignik River; sockeye salmon returns consist of an early run and a late run. Pink and chum salmon also return to other streams throughout the CMA.

BACKGROUND

One Chinook salmon stock in the CMA has an established BEG and is located in the Chignik River. This goal was reviewed in 2010 and was left unchanged. Chinook salmon escapement is enumerated through the Chignik River weir. Harvest occurs during directed sport fisheries and incidentally in commercial fisheries targeting sockeye salmon.

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. Both of these stocks are part of the Chignik River watershed (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 Chignik Lake tributaries and 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 2 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. Prior to 1980, time-of-entry relationships based on tagging studies and age groups were employed to divide the catch and escapement between the 2 runs (Dahlberg 1968). From 1980 through 2003, with the exception of 1982, stock separation was accomplished using scale pattern analysis (Witteveen and Botz 2004). 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.[1] This method was determined not to be significantly different (P>0.05) than the scale pattern analysis method in estimating recruitment. Beginning in 2010, genetics were used to separate the early- and late-run stocks. In comparison to the current management early/late switch date of July 4, logistic run timing during the overlap period suggest that utilizing inseason genetic information would result in more biologically sound escapement-based management (Anderson et al. 2013). Direct comparison of escapement estimates using genetic stock identification (GSI) and the traditional July 4 cutoff showed differences of approximately 40,000 fish in 2010 and 32,000 in 2011 (Foster 2013) and in three out of four years has shown a run timing curve later than that predicted via the July 4 date (Anderson et al. *In prep*).

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), and amended to SEGs during the 2007 review (Witteveen et al. 2007). The areawide goals represent 5 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).

Chum salmon escapements in the CMA are managed to achieve objectives based on aggregates of streams by district, similar to pink salmon (Table 1; Figure 1). This aggregate lower-bound SEG comprises the respective sums of aerial survey escapement estimates for 42 individual index streams (Nelson and Lloyd 2001).

METHODS

During the review process, escapement goals were evaluated for one Chinook and 2 sockeye salmon stocks (Table 1). In addition, 2 pink and one chum salmon stock-aggregate goals were evaluated (Table 1). We conducted our review similarly to the 2010 review (Nemeth et al. 2010), primarily examining recent (2010–2012) data and updating previous analyses. A formal meeting, via teleconference, to discuss and develop recommendations was held on April 2, 2013. The team also communicated on a regular basis by telephone and email.

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

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

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[2] (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 *Policy for the Management of Sustainable Salmon Fisheries* and the *Policy for Statewide Salmon Escapement Goals*.

BIOLOGICAL ESCAPEMENT GOAL DETERMINATION

In Alaska, most salmon BEGs are developed using Ricker (1954) spawner-recruit models (Munro and Volk 2010). BEG ranges, as defined in the *Policy for the management of sustainable fisheries* (5AAC 39.222), are estimates of the number of spawners that provide the greatest potential for maximum sustained yield, abbreviated as S_{MSY}. For this review, ranges surrounding S_{MSY} were calculated as the escapement estimates that produced yields of at least 90% of maximum sustained yield (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 return or replacement (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) and Quinn and Deriso (1999) provide good descriptions of the Ricker model and diagnostics to assess model fit. All Ricker models were tested for residual autocorrelation, and S_{MSY} estimates were corrected for autocorrelation if it was detected in the model. When auxiliary data were available (e.g., limnology and/or smolt abundance, age, and size) they were summarized and biological trends were compared to estimates of adult production.

Sustainable Escapement Goal

Sustainable escapement goals were developed using any of several methods, depending on the system, species, and type of data available. For this review, most SEGs were determined using the percentile approach[2] or spawner-recruit methods (Ricker 1954); additional analyses used for sockeye salmon were the yield analysis (Hilborn and Walters 1992), euphotic volume model (Koenings and Kyle 1997), and zooplankton biomass model (Koenings and Kyle 1997). The latter 2 habitat-based models assess the likely number of fish that can be supported given the habitat and/or food available; these models were used as secondary, alternative analyses that were less dependent on fish count data. When used, results from the euphotic volume and zooplankton biomass models were reported as generally corroborating or not corroborating the primary analysis.

The percentile approach followed the method of Bue and Hasbrouck,[2] whereby the contrast of the escapement data (i.e., the ratio of highest observed escapement to the lowest observed escapement) and the exploitation rate of the stock were used to select the percentiles of observed annual escapements 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 an SEG

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[2] Bue, B. G., and J. J. Hasbrouck. Escapement goal review of salmon stocks of Upper Cook Inlet. Alaska Department of Fish and Game, Report to the Alaska Board of Fisheries, November 2001 (and February 2002), Anchorage, unpublished.

for a stock with low contrast should be relatively wide, to improve future knowledge of stock productivity. For stocks with low data contrast and a low exploitation rate, the lower end of the SEG range was the 15th percentile of the escapement data and the upper end of the range was the maximum observed escapement estimate. Alternately, in cases where contrast was medium (4 to 8) or high (>8), the percentiles of observed annual escapements used to estimate an SEG were narrowed. For stocks with high contrast and at least moderate exploitation, the lower end of the SEG range was placed at the 25th percentile as a precautionary measure for stock protection. The percentiles used at different levels of contrast were:

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

The yield analysis was similar to that used by Hilborn and Walters (1992), and entailed applying a tabular approach to examine escapement-versus-yield relationships. Escapements were arranged into multiple size intervals to provide varying aggregations of escapements. For each interval of escapement size, 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 were calculated. Averages and medians were both calculated because averages are highly influenced by extreme values.

The euphotic volume (EV) model followed the methods of Koenings and Kyle (1997), estimating adult escapement in part by determining the volume of lake water capable of primary production that could sustain a rearing juvenile fish population. The model assumed 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 zooplankton biomass 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 biomass model, like the EV model, used the premise that the availability of forage could impact survival of juvenile fish and subsequent adult production. Adult production was calculated using species fecundity and marine survival rates. The zooplankton biomass model assumes 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 (Appendix A1). Chinook salmon escapement to the Chignik River is counted using a weir outfitted with a video camera (Anderson et al. 2013). Note that several previous escapement goal reports have misreported the history of the Chinook escapement goals. The goal was established in 1992 (1,750 to 3,000 fish; Nelson and Lloyd 2001), and changed to a BEG (1,450 to 2,700 fish) using a spawner-recruit model in 1994 (Nelson and Lloyd 2001). The BEG was made an

SEG for one year in 2001 (Nelson and Lloyd 2001), then revised back to a BEG of 1,300 to 2,700 fish in 2002 (Witteveen et al. 2005). Since 2002 the goal has remained unchanged (Witteveen et al. 2005; Witteveen et al. 2007; Nemeth et al. 2010).

2013 Review

Escapements from 2010 through 2012 were within or above the range of the BEG (Table 1; Appendices A2 and A3). There was no compelling new information since the last review, and the team agreed that no further analysis was necessary in 2013.

SOCKEYE SALMON

Escapement Goal Background and Previous Review

The Chignik River sockeye salmon are the only sockeye salmon stock in the CMA with escapement goals (Appendix B1). Sockeye salmon also return to several smaller stream systems in the CMA, but due to small run sizes and limited effort, escapement goals for these streams have not been established (Witteveen et. al. 2007). Although the peak periods of passage for Chignik River early- and late-run stocks are usually a few weeks apart, the 2 runs overlap in late June and early July (Templin et al. 1999). Escapement estimates for both runs were based on weir counts with the addition of post-weir estimates for the late run (Appendix B1 and B2) that were modeled after the weir was removed in early September (Anderson et al. 2013).

Escapement goals for Chignik River sockeye salmon were originally established in 1968, and set at 350,000 to 400,000 fish for the early run and 200,000 to 250,000 fish for the late run (Dahlberg 1968). In 1989, the board established a September management objective of 25,000 fish, supplemental to the lower bound of the late-run goal, to accommodate subsistence fishers upstream of the Chignik weir. In 2004, the numerical ranges of the goals were left in place, but the goals were reclassified as SEGs because scientifically defensible estimates of S_{MSY} were not possible. Also in 2004, the board established an August management objective of 25,000 fish (in addition to the existing September management objective) to further provide subsistence opportunities upstream of the weir. In 2007, the late-run SEG was changed to 200,000 to 400,000 fish, and the two 25,000-fish management objectives were reclassified as inriver run goals (Witteveen et al. 2007). It should be noted there remains some confusion over the inriver run goals because they were not adopted into regulation and not all reports documenting the history are exactly the same.

2013 Review

Escapement and age data were obtained at the Chignik weir. Individual sales receipts (fish tickets) documented sockeye salmon commercial harvest data for the CMA. Brood tables for each run were developed with run reconstructions based on this escapement, age, and harvest data (Appendices B2 through B5). Sport and subsistence harvests were not included in the total return estimates because they are relatively small and are not available in time for this analysis. A household survey was conducted for 2011 that documented all subsistence harvest in the CMA. The survey found that the harvest above the weir was 939 sockeye salmon prior to July 5; 334 sockeye salmon on or after July 5; and 2,243 sockeye salmon on or after August 1, for a total of 3,516 sockeye salmon (ADF&G, Division of Commercial Fisheries, Alaska Subsistence Fisheries Database, 2013, unpublished data).

Stock-specific harvest and escapement estimates for Chignik system sockeye salmon were available from 1922 to 2012. These run data were examined to determine if a change in the escapement goals was warranted. The full data set was used in a yield analysis (Nelson et al. 2005) and in a Ricker spawner-recruit model of the early run. A more recent subset of the data (brood years 1978 to 2005) was also analyzed with a Ricker model. Similarly, the late run was analyzed using 1922 to 2005 (Dahlberg 1979) and 1978 to 2005 spawner-recruit data in a Ricker model. Yield ranges define the escapements that produced yields that are 90 to 100% of MSY (MSY was estimated from the Ricker analysis). The different data sets represented varying degrees of data quality and different levels of productivity but are considered sound and appropriate for this analysis. All models were evaluated for autocorrelation and long-term data were compared with Pacific decadal oscillation. Euphotic volume, zooplankton biomass, and stock-interaction models were also examined for each run. Escapement ranges of the euphotic volume and zooplankton models were calculated as ± 20% of the point estimates.

PINK SALMON

Escapement Goal Background and Previous Review

Pink salmon escapement goals in the CMA were originally established in 1999, with separate goals for each of the 5 commercial salmon fishing districts (Witteveen et al. 2005). In 2004, the goals for individual districts were removed and replaced with a single aggregate goal for the entire CMA; this aggregate goal was developed using a stock-recruit analysis of peak aerial surveys for 49 index streams throughout the 5 commercial fishing districts (Table 1; Figure 1). This aggregate goal in 2004 was established as a BEG, separate for odd- and even-year returns of pink salmon (Witteveen et al. 2005). In 2007, the goals were reanalyzed using the yield analysis methods of Hilborn and Walters (1992). Due to lack of precision in aerial survey data, the goals were increased and reclassified as SEGs of 200,000 to 600,000 fish during even years and 500,000 to 800,000 fish for odd years (Witteveen et al. 2007).

2013 Review

Escapements from 2010 through 2012 were within (or above) the range of the SEG (Appendices C1–C3). There was no compelling new information since the last review, and the team agreed that no further analysis was necessary in 2013.

CHUM SALMON

Escapement Goal Background and Previous Review

Chum salmon escapement goals in the CMA were originally established in 1999, with separate goals for each of the 5 commercial salmon fishing districts (Witteveen et al. 2005). As with pink salmon, the chum salmon escapement goals were revised in 2004 to represent an aggregate goal for the entire CMA, based on results of aerial surveys for 49 index streams among the 5 commercial fishing districts (Table 1; Figure 1). This single aggregate goal in 2004 was developed using percentile and risk analysis, and reclassified as a lower-bound SEG (Witteveen et al. 2005). In 2007, the aggregate lower-bound SEG was reanalyzed using a risk analysis (Bernard et al. 2009), and raised to 57,400 fish (Witteveen et al. 2007).

2013 Review

Escapements since the last review were similar to those in the recent past (Table 1; Appendices D1–D3). There was no compelling information to suggest that any changes were necessary to the current SEG and the team agreed that no further analysis was necessary in 2013.

RESULTS

CHINOOK SALMON

Stock Status

Since the establishment of the current BEG of 1,300–2,700 fish in 2002, escapements of Chignik River Chinook salmon have been within or above the escapement goal range (Appendices A1–A4).

Escapement Goal Recommendation

Given that escapements since the last review have been within the BEG range and that no other information indicates a substantial change in stock productivity or utilization, the team agreed that the goal should remain unchanged (Table 1).

SOCKEYE SALMON

Stock Status

The current early run escapement goal range (350,000 to 400,000 fish) has been in place since 1968; although it has been termed a BEG, SEG, or other throughout this time period. Since 1968, escapements have only been below the current SEG 3 times. Escapements have exceeded the upper end of the goal 29 times. In the last 10 years, escapements have been within or above (2 times) the goal every year. Late-run sockeye salmon escapements have been within the range every year since implemented (2008).

Evaluation of Recent Data

Early Run

The early-run Ricker model using brood years 1922 to 2005 spawner-recruit data indicated an S_{MSY} point estimate of 408,721 and a 90% yield range of approximately 262,000 to 583,000 (contrast= 514.2; P << 0.001; Appendix B5). This model was corroborated by a yield analysis that indicated an optimal escapement range of 350,000 to 500,000 fish with a midpoint of 425,000 fish (Appendix B6). This analysis fits the criteria for a BEG. The Ricker model using brood years 1978 to 2005 spawner-recruit data had low contrast (2.2) and was nonsignificant (P=0.475); this model was not used. Euphotic volume and zooplankton biomass models were not well-suited to Black Lake due to the lake basin morphology and the importance of insects in smolt diet (Finkle 2004).

Late Run

The late-run Ricker model using brood years 1922 to 2005 spawner-recruit data indicated an S_{MSY} point estimate of 314,632 and a 90% yield range of approximately 200,000 to 450,000 fish (contrast= 11.6; P << 0.001; Appendix B6). The Ricker model using brood years 1978 to 2005 spawner-recruit data was significant (P=0.003) but had lower contrast (2.8). This model indicated a similar S_{MSY} point estimate of 299,398 and a 90% yield range of 190,000 to 431,000 fish.

Three other models were run to corroborate the selected (1922 to 2005 Ricker) model and to investigate interactions between Black Lake and Chignik Lake stocks in Chignik Lake. An updated EV analysis indicated an optimal late-run escapement of 353,461 fish (80%

range=283,000 to 424,000). Results of the zooplankton biomass model indicated an optimal late-run escapement of 574,531 fish (80% range=460,000 to 689,000; Appendix B5). This zooplankton model indicates some capacity for Chignik Lake to withstand immigration of Black Lake smolt. To further assess competition among stocks in Chignik Lake, a Black Lake escapement interaction term was added to the 1922 to 2005 late-run Ricker model. The interaction term was nonsignificant ($P=0.142$) so this model was not used.

Escapement Goal Recommendation

Results from the Ricker spawner-recruit and yield analysis suggested increasing the early-run escapement goal. Based on these results, the team felt that the SEG range of 350,000 to 400,000 fish should be increased to a BEG range of 350,000 to 450,000 fish. This proposed change is based on the results of the Ricker model but also recognizes the early- and late-run brood interactions, Chignik Lake limnology, GSI results, and historical longevity of the current SEG bounds that has sustained good yields for both runs. The new range contains the estimate of S_{MSY} confirming the reclassification as a BEG. When GSI is available, the department will manage early- and late-run stock using logistic run timing. This will be done by fitting a logistic curve to the proportion of early- and late-run escapement as estimated through periodic genetic samples during the overlap period. In the absence of inseason GSI, the department will use the average annual run timing curve estimated from GSI.

For the late run, the Ricker spawner-recruit analyses corroborated the current ranges of the SEG (Table 1; Appendix B5 and B6). The EV model indicated an escapement goal range encompassing the current SEG range. The zooplankton biomass model indicated a higher range, but because Chignik Lake zooplankton serve as forage for both early- and late-run juvenile sockeye salmon, this is not advised. Because the results of analyses corroborated the existing late-run goal, the team recommended no change to the late-run SEG of 200,000 to 400,000 fish (Table 1).

PINK SALMON

Stock Status

Since the current SEGs were established in 2008, escapements have achieved or exceeded the goal range for both the even- and odd-year runs (Table 1; Appendix C).

Escapement Goal Recommendation

Given that escapements have been within or above their respective lower-bound SEGs since their relatively recent (2008) establishment, and that no other information indicates a substantial change in stock productivity or utilization, the team agreed that the goal should remain unchanged in 2013.

CHUM SALMON

Stock Status

Chum salmon aggregate escapements have been above the lower-bound SEG since inception of the current goal in 2008 (Table 1).

Escapement Goal Recommendation

Given that escapements have been above the lower-bound SEG since its relatively recent (2008) establishment, and that no other information indicates a substantial change in stock productivity or utilization, the team agreed that the goal should remain unchanged in 2013 (Table 1 and Appendix D).

SUMMARY OF RECOMMENDATIONS

The team concluded that the 3 additional years of data since the 2010 review would not affect the existing escapement goals for the Chignik River Chinook salmon stock and the pink and chum salmon aggregate stocks. There are no coho salmon escapement goals in the CMA because harvests are generally incidental to the sockeye salmon fishery, and because the late run timing of coho salmon prevents reliable estimates of escapement. The team elected to further analyze the 2 sockeye salmon stocks, using a combination of new escapement and brood year data available since the prior review (Nemeth et al. 2010). The final recommendation of the 2013 review team was to change the Chignik River sockeye salmon early-run SEG of 350,000 to 400,000 to a BEG of 350,000 to 450,000 fish, and retain the late-run SEG of 200,000 to 400,000 fish.

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TABLES AND FIGURES

Table 1.–Escapements, escapement goals, and recommendations for 2013 for salmon stocks in the Chignik Management Area (CMA).

			Escapements			Current escapement goal			
Species	System	Data source[a]	2010	2011	2012	Type	Lower	Upper	Escapement goal recommendation for 2013
Chinook salmon	Chignik River	WC	3,485	2,490	1,404	BEG	1,300	2,700	No change
Sockeye salmon	Chignik River								
	Early run	WC	432,535	488,930	353,441	SEG	350,000	400,000	Change to BEG 350,000 to 450,000
	Late run	WC	311,291	264,887	358,948	SEG	200,000[b]	400,000	No change
Pink salmon	CMA aggregate – odd years	PAS + WC		986,248		SEG	500,000	800,000	No change
	CMA aggregate – even years	PAS + WC	330,570		302,699	SEG	200,000	600,000	No change
Chum salmon	CMA aggregate	PAS + WC	177,220	278,145	210,973	Lower-bound SEG	57,400	NA	No change

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

[b] The lower bound does not include an additional inriver run goal of 50,000 fish.

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.

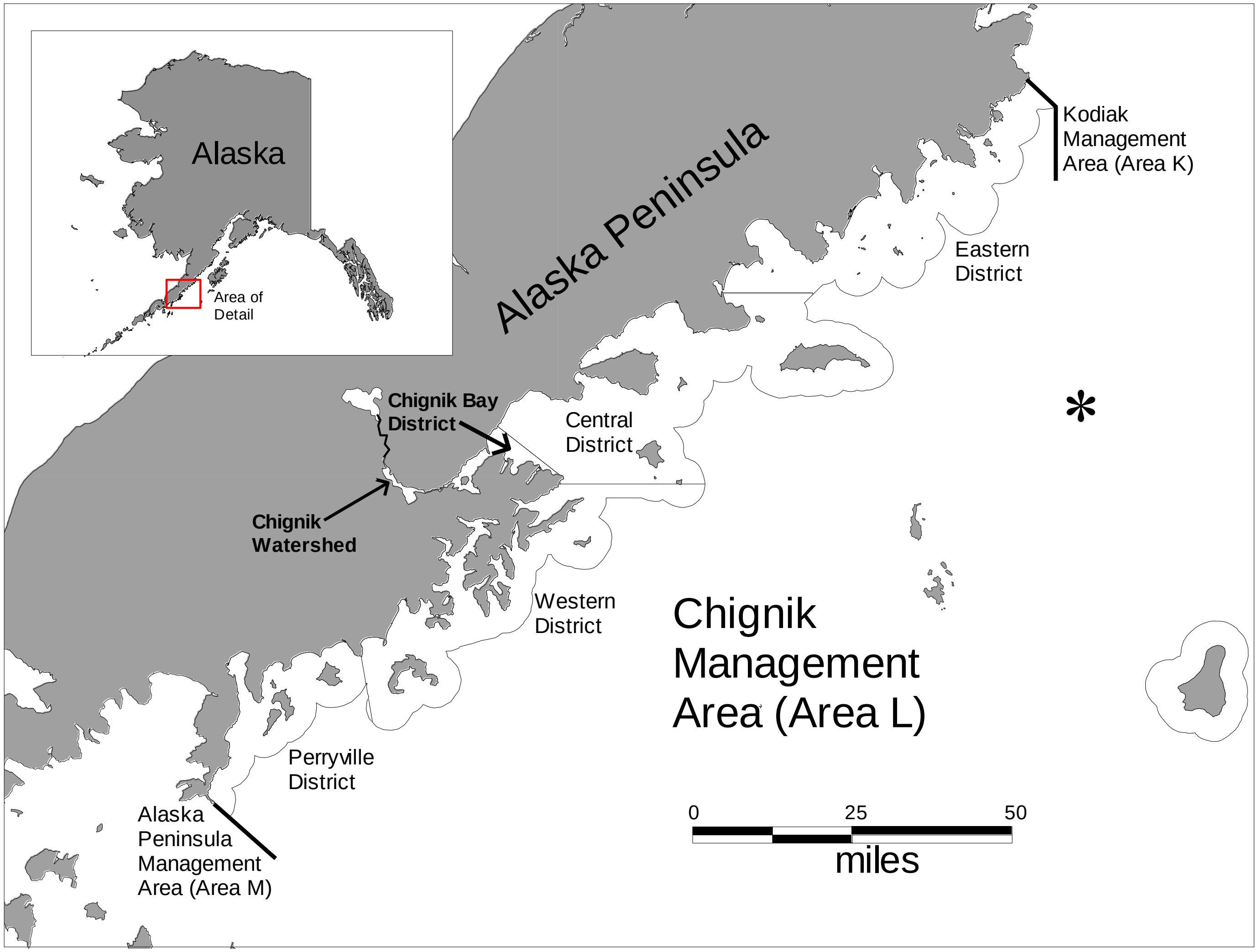


Figure 1.–The Chignik Management Area with the Eastern, Central, Chignik Bay, Western, and Perryville districts depicted.

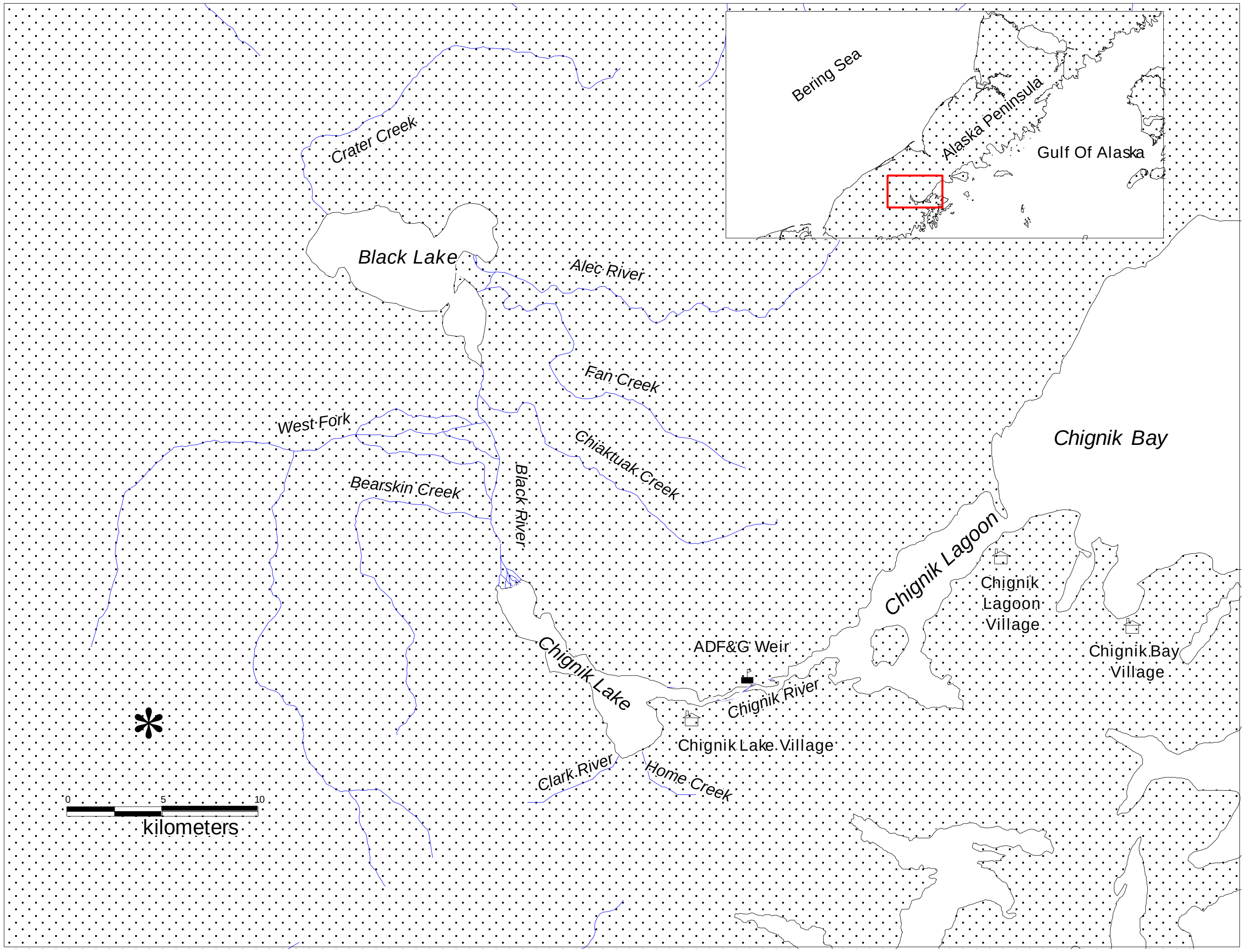


Figure 2.–The Chignik River watershed, showing Black and Chignik lakes, Black and Chignik rivers, and Chignik Lagoon.

APPENDIX A. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR CHIGNIK RIVER CHINOOK SALMON

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

System: Chignik River
Species: Chinook salmon
Description of stock and escapement goals

Regulatory area:	Chignik Management Area
Management division(s):	Sport and Commercial
Primary fisheries:	Sport, Commercial, and Subsistence
Current escapement goal:	BEG: 1,300–2,700 fish (since 2002)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1978 to present
Data summary:	
Data quality:	Good escapement and harvest data.
Data type:	Weir estimates, harvest estimates, age composition.
Data contrast:	1978 to 2012: 11.41
Methodology:	Used Ricker model estimate of S_{MSY} (0.8, 1.6)
Autocorrelation:	None detected
Recommendation:	No change to BEG of 1,300–2,700 fish.
Comments:	BEG has been achieved each of the past 3 years (2010–2012).

Appendix A2.–Annual estimates of harvest, escapement, and total run of Chignik River Chinook salmon, 1978–2012.

System: **Chignik River**
Species: **Chinook salmon**
Data available for analysis of escapement goals

Return Year	Commercial Harvest[a]	Subsistence Harvest[b]	Weir Count	Total Run	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 [f]	6,037
2006	1,941	258	3,535	5,476	360 [g]	3,175
2007	641	84	2,000	2,725	325 [h]	1,675
2008	208	41	1,730	1,979	110 [i]	1,620
2009[e]	496	72	1,680	2,248	90 [j]	1,590
2010	1,480	69	3,679	5,228	194 [k]	3,485
2011	1,382	23	2,728	4,133	238 [l]	2,490
2012	303	37	1,449	1,789	45 [m]	1,404

-continued-

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

[b] Subsistence harvest is from Chignik Lagoon downstream of the weir.

[c] Recreational harvest in 1988 and 1989 was estimated from an onsite creel survey (Schwarz 1990). Recreational harvest prior to 2005 is the average of 1988 and 1989.

[d] Escapement is weir count minus recreational harvest.

[e] Subsistence harvest in previous versions of this table from 1978–2008 used average of 72, actual 2009 harvest = 54.

[f] Recreational harvest = 150 unguided + 299 guided above weir. Guided harvest from sport fish freshwater logbook program.

[g] Recreational harvest = 150 unguided + 210 guided above weir. Guided harvest from sport fish freshwater logbook program.

[h] Recreational harvest = 135 unguided + 190 guided above weir. Guided harvest from sport fish freshwater logbook program.

[i] Recreational harvest = 45 unguided + 65 guided above weir. Guided harvest from sport fish freshwater logbook program.

[j] Recreational harvest = 37 unguided + 53 guided above weir. Guided harvest from sport fish freshwater logbook program.

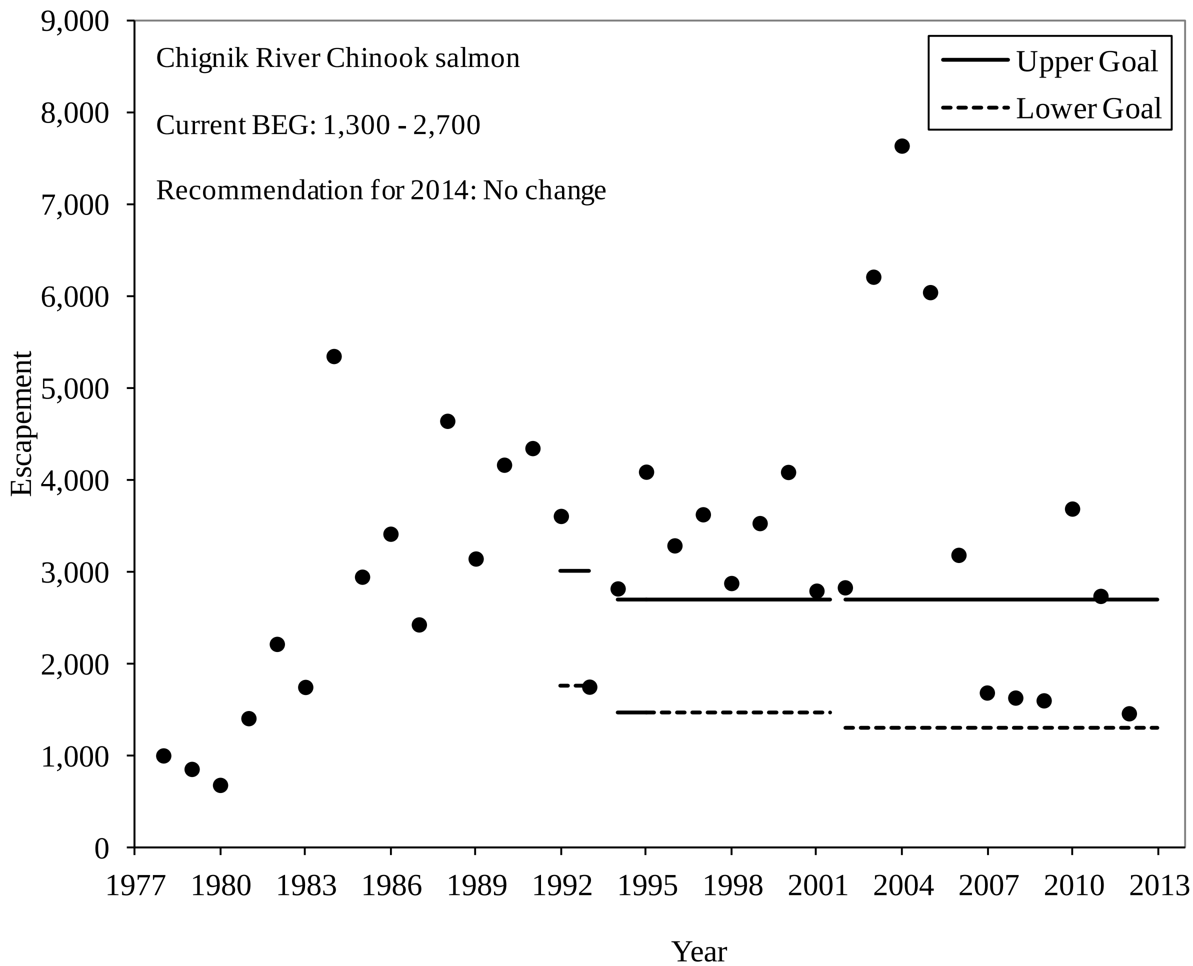
[k] Recreational harvest = 30 unguided + 164 guided above weir. Guided harvest from sport fish freshwater logbook program.

[l] Recreational harvest = 30 unguided + 208 guided above weir. Guided harvest from sport fish freshwater logbook program.

[m] Recreational harvest = 30 unguided + 15 guided above weir. Guided harvest from sport fish freshwater logbook program.

Appendix A3.–Annual escapements and escapement goals for Chignik River Chinook salmon, 1978 to present.

System: **Chignik River**
Species: **Chinook salmon**



APPENDIX B. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR CHIGNIK RIVER WATERSHED SOCKEYE SALMON

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

System: **Chignik River**

Species: **Sockeye salmon**

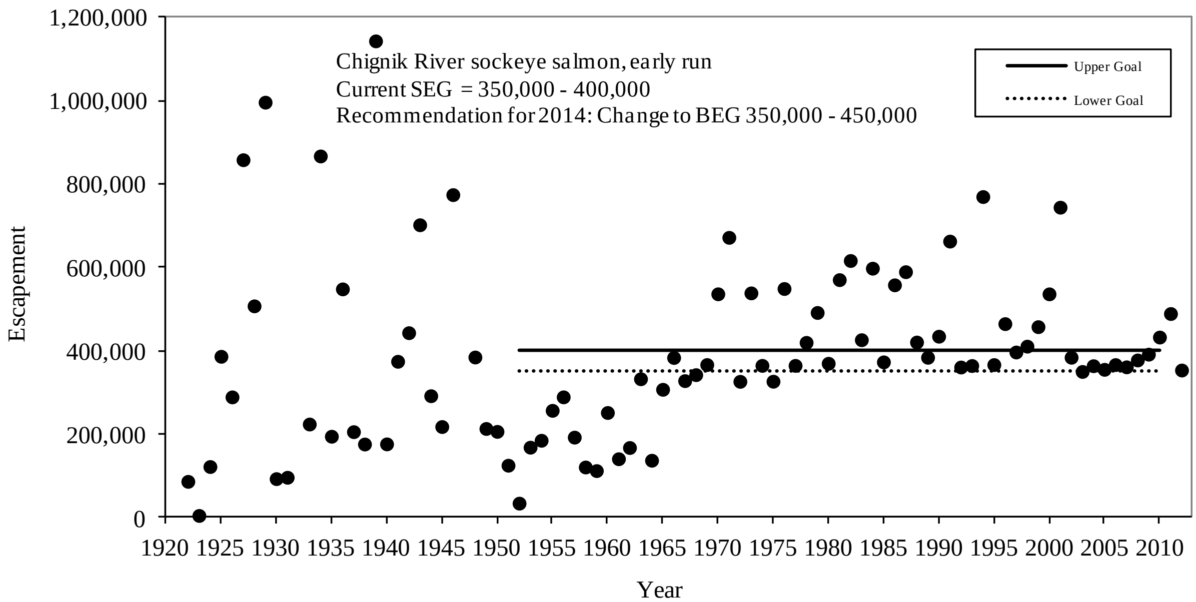
Description of stock and escapement goals.

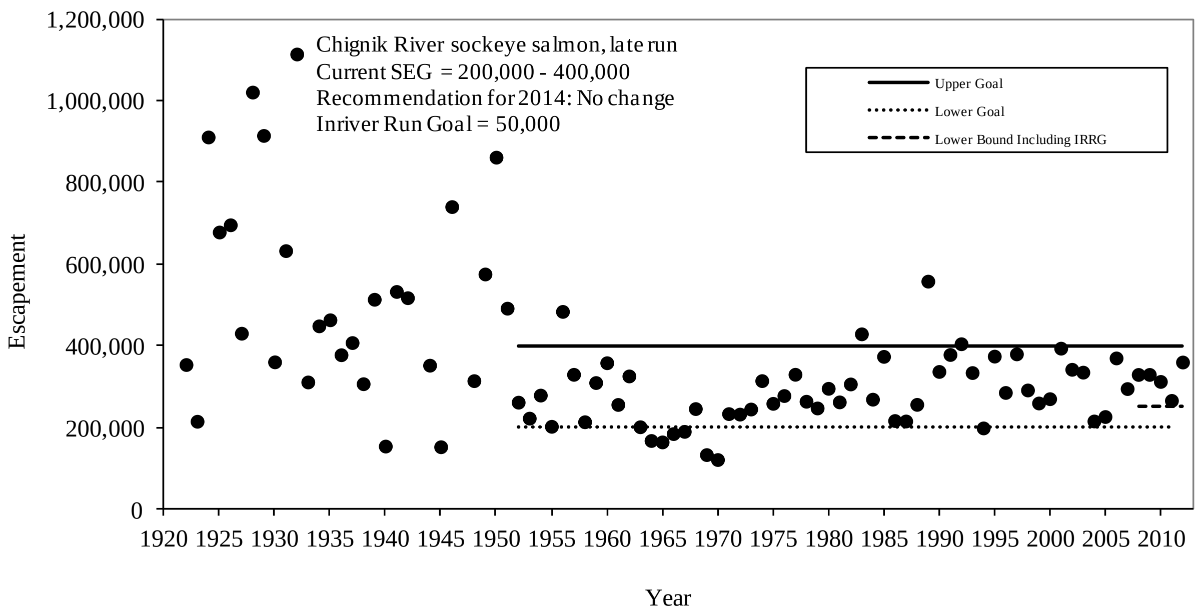
Regulatory area:	Chignik Management Area
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine
Current escapement goal:	Early-run SEG: 350,000 to 400,000 fish (1968)
	Late-run SEG: 200,000 to 400,000 fish (2008)
Recommended escapement goal:	Early-run SEG: Change to BEG 350,000 to 450,000
	Late-run SEG: No change
Optimal escapement goal:	None
Inriver run goal:	1989: 25,000 management objective in addition to lower bound;
	2004: In addition to the existing 25,000 August objective a 25,000 objective was added for September;
	2008: The two management objectives were reclassified as inriver run goals but not added into regulation.
Action points:	None
Escapement enumeration:	Weir counts 1922, 1923, 1925–1930, 1932, 1933, 1935–1937, 1939, 1949–1950, 1952 to 2012; run reconstruction in remaining years through professional observation and cannery records.
Data summary:	
Data quality:	Fair
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 2009. Stock-specific harvest information was available for 1962 to 1969 and 1980 to 2009. Smolt outmigration data from 1994 to present. Limnology data from 2000 to present.
Contrast:	1922–2012: 514.2 (early run)
	1978–2012: 2.2 (early run)
	1922–2012: 11.6 (late run)
	1978–2012: 2.8 (late run)
Methodology:	Ricker stock-recruit model, yield analysis, euphotic volume model, zooplankton biomass model
Autocorrelation:	None detected

Appendix B2.–Annual escapements and escapement goals for early- and late-run Chignik River sockeye salmon, 1922 to 2012.

System: **Chignik River**

Species: **Sockeye salmon**





Appendix B3.–Brood table for early-run Chignik River sockeye salmon.

System: **Black Lake (early run)**

Species: **Sockeye salmon**

Data available for analysis of escapement goals.

		Return ages																				
Year	Escapement	0.1	0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	0.4	1.4	2.3	3.2	1.5	2.4	3.3	4.2	2.5	3.4	4.3	Total return
1922	86,421	0	0	0	0	40,685	0	659,040	56,121	0	0	0	202,612	2,465	0	1,222	1,669	0	0	0	0	963,814
1923	4,642	0	0	0	0	18,213	0	172,343	53,445	0	0	2,677	132,776	410	0	436	59	0	0	0	0	380,359
1924	121,983	0	0	0	0	85,083	0	1,206,555	8,855	0	0	426	19,931	939	0	384	384	0	0	0	0	1,322,557
1925	386,364	0	0	0	0	1,529	0	54,164	9,924	0	0	384	50,707	937	0	17	0	0	0	0	0	117,662
1926	289,009	0	0	0	0	7,544	420	104,094	45,572	0	0	11,714	352,025	7,117	0	0	1,708	0	0	0	0	530,194
1927	857,881	0	0	0	0	99,929	66	2,375,878	85,253	0	0	721	107,239	165	0	3,699	4,234	0	0	0	0	2,677,184
1928	507,353	0	0	0	0	23,860	0	304,338	49,284	0	0	9,848	428,369	2,755	0	409	2,118	0	0	0	0	820,981
1929	995,832	0	0	0	0	9,910	0	918,487	58,777	0	0	5,626	60,214	865	0	144	144	0	0	0	0	1,054,167
1930	92,955	0	0	0	0	23,769	0	286,339	13,886	0	0	6,663	43,297	3,527	0	4	0	0	0	0	0	377,485
1931	96,201	0	0	0	0	33,685	943	923,763	46,710	0	0	28	122,389	0	0	655	58	0	0	0	0	1,128,231
1932	2,151,734	0	0	0	0	50,602	0	191,354	36,823	0	0	10,350	43,060	291	0	8,584	234	0	0	0	0	341,298
1933	223,913	0	0	0	0	62,079	0	247,818	7,609	0	0	138,675	164,540	0	0	625	54	0	0	0	0	621,400
1934	866,890	0	0	0	0	16,228	4	1,583,632	6,057	0	0	9,886	40,971	276	0	1,299	113	0	0	0	0	1,658,466
1935	194,636	0	0	10	0	68,710	0	235,971	7,188	0	0	20,562	85,058	572	0	1,508	130	0	0	0	0	419,709
1936	548,039	0	0	0	0	15,422	3	490,061	14,873	0	0	23,865	98,553	661	0	2,346	201	0	0	0	0	645,985
1937	205,613	0	0	9	0	32,001	7	567,984	17,179	0	0	37,146	153,156	1,026	0	960	82	0	0	0	0	809,550
1938	175,972	0	0	19	0	37,059	7	882,938	26,618	0	0	15,193	62,552	418	0	706	60	0	0	0	0	1,025,570
1939	1,142,852	0	0	22	0	57,563	12	360,712	10,840	0	0	11,171	45,926	307	0	2,470	209	0	0	0	0	489,232
1940	176,307	0	0	35	0	23,499	5	264,904	7,938	0	0	39,130	160,651	1,070	0	7,513	634	0	0	0	0	505,379
1941	374,420	0	0	14	0	17,246	3	926,890	27,697	0	0	119,048	488,137	3,247	0	1,196	101	0	0	0	0	1,583,579
1942	442,981	0	0	11	0	60,302	12	2,817,023	83,954	0	0	18,948	77,598	515	0	684	58	0	0	0	0	3,059,105
1943	701,859	0	0	36	0	183,156	37	447,919	13,315	0	0	10,839	44,522	297	0	499	38	0	0	0	0	700,658
1944	291,844	0	0	111	0	29,106	6	256,848	7,683	0	0	7,947	31,664	203	0	482	43	0	0	0	0	334,093
1945	217,882	0	0	18	0	16,715	3	183,734	5,143	0	0	7,619	31,784	216	0	275	27	0	0	0	0	245,534
1946	774,130	0	0	10	0	11,775	2	182,835	5,644	0	0	4,307	18,686	133	0	707	64	0	0	0	0	224,163
1947	2,386,733	0	0	7	0	11,988	2	106,718	3,550	0	0	11,150	46,809	320	0	525	43	0	0	0	0	181,112
1948	384,637	0	0	7	0	7,129	1	268,953	8,407	0	0	8,346	33,877	223	0	352	0	0	0	0	0	327,295
1949	213,269	0	0	4	0	17,688	4	195,878	5,713	0	0	0	89,095	0	0	0	152	0	0	0	0	308,534
1950	206,270	0	0	11	0	12,671	3	287,407	12,644	0	0	1,862	76,722	648	0	373	286	0	0	0	0	392,627
1951	125,126	0	0	8	0	46,798	0	448,360	3,404	0	0	2,319	124,345	0	0	455	0	0	0	0	0	625,689

-continued-

System: **Black Lake (early run)**

Species: **Sockeye salmon**

Data available for analysis of escapement goals.

		Return ages																				
Year	Escapement	0.1	0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	0.4	1.4	2.3	3.2	1.5	2.4	3.3	4.2	2.5	3.4	4.3	Total return
1952	34,155	0	0	0	0	4,390	0	137,957	3,423	0	0	208	81,691	0	0	639	2,512	0	0	0	0	230,820
1953	168,375	0	0	0	0	1,024	32	154,589	17,848	0	0	1,625	180,887	252	0	0	1,350	0	0	0	0	357,607
1954	184,953	0	0	143	0	6,468	0	50,272	10,720	0	0	515	72,973	9	0	312	1,009	0	0	0	0	142,421
1955	256,757	0	0	783	0	30,302	0	430,793	3,476	0	0	339	88,693	109	0	0	0	0	0	0	0	554,495
1956	289,096	0	0	17	0	16,499	0	81,569	14,910	0	0	9	90,001	0	0	196	4,967	0	0	0	0	208,168
1957	192,479	0	0	0	0	6,559	161	117,979	10,507	0	0	52	210,686	3,641	0	21	906	0	0	0	0	350,512
1958	120,862	0	0	905	0	19,146	0	79,955	81,992	0	0	0	60,132	77	0	61	103	0	0	0	0	242,370
1959	112,226	0	0	1,522	0	31,039	142	148,403	13,872	0	0	402	144,581	874	0	58	54	0	0	0	0	340,946
1960	251,567	0	0	124	0	55,546	221	610,591	32,598	0	0	6,221	65,418	49	0	606	3,383	0	0	0	0	774,756
1961	140,714	0	0	276	0	14,301	1	387,053	3,483	0	0	536	164,278	486	0	1,020	209	0	0	0	0	571,645
1962	167,602	0	0	698	0	8,379	0	257,371	25,726	0	0	3,194	395,626	1,524	0	954	0	0	0	0	0	693,473
1963	332,536	0	0	0	0	29,538	173	448,298	17,628	0	0	905	199,104	0	0	2,506	551	0	0	0	0	698,703
1964	137,073	0	0	37	0	13,311	3,735	190,971	133,203	0	0	3,809	409,974	414	0	0	271	0	0	0	0	755,726
1965	307,192	0	0	394	0	102,570	421	1,535,858	80,851	0	0	3,332	201,220	271	0	497	22,731	0	0	0	0	1,948,144
1966	383,545	0	0	1,631	0	65,254	378	990,567	15,248	0	0	2,193	225,659	28	0	0	2,607	0	0	0	0	1,303,566
1967	328,000	0	0	2,728	0	16,157	163	99,357	6,078	0	0	13,958	100,607	1,600	0	0	0	0	0	0	0	240,647
1968	342,343	0	0	271	0	12,997	0	1,011,407	4,705	0	0	2,337	174,675	2,118	0	0	1,777	0	0	0	0	1,210,286
1969	366,589	0	0	0	0	13,272	160	301,917	68,349	0	0	1,403	89,900	519	0	0	2,359	0	0	0	0	477,879
1970	536,257	0	0	0	0	18,672	282	208,452	8,724	0	0	4,835	201,464	650	0	0	3,601	0	0	0	0	446,681
1971	671,668	0	0	615	0	23,659	0	838,898	70,719	0	0	3,771	442,122	374	0	108	2,367	0	0	0	0	1,382,632
1972	326,320	0	0	0	0	33,147	0	412,671	16,042	0	0	4,280	443,366	441	0	1,141	1,863	0	0	0	0	912,950
1973	538,462	0	0	0	0	19,112	0	761,907	95,637	0	0	0	362,660	1,156	0	493	2,288	0	0	0	0	1,243,252
1974	364,603	0	0	50	0	51,566	167	198,938	87,361	0	0	0	290,322	848	0	6	807	0	0	0	0	630,065
1975	326,563	0	0	0	0	22,505	1,459	37,917	87,312	0	0	1,163	209,658	772	0	405	35	0	0	0	0	361,227
1976	553,754	0	0	721	0	23,692	377	1,057,596	20,277	0	0	836	138,230	0	0	0	457	0	0	0	0	1,242,186
1977	364,557	0	0	92	0	79,837	6	1,727,820	13,002	0	0	7,231	349,895	0	0	2,671	919	0	0	0	0	2,181,473
1978	419,732	0	0	408	0	56,426	3,133	498,425	57,526	0	0	6,581	464,129	0	0	0	554	0	0	0	0	1,087,183
1979	491,467	0	0	1,270	0	439,889	772	2,784,428	57,539	0	0	1,335	61,781	0	0	326	411	0	0	0	0	3,347,752
1980	369,580	0	0	289	108,326	86,359	1,778	655,708	144,088	0	0	1,025	726,425	1,630	0	697	299	0	0	0	0	1,726,624
1981	570,210	0	0	717	3,094	161,169	1,444	934,785	73,946	0	0	3,891	729,684	557	0	1,202	213	0	0	0	0	1,910,702

-continued-

System: **Black Lake (early run)**

Species: **Sockeye salmon**

Data available for analysis of escapement goals.

		Return ages																				
Year	Escapement	0.1	0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	0.4	1.4	2.3	3.2	1.5	2.4	3.3	4.2	2.5	3.4	4.3	Total return
1982	616,117	0	1,212	444	2,766	178,831	1,922	1,577,372	120,249	0	0	1,939	365,273	0	0	482	0	0	0	0	0	2,250,490
1983	426,178	0	0	0	20,583	75,756	2,650	230,229	42,568	0	213	340	217,407	0	0	2,178	574	0	0	0	0	592,498
1984	597,713	0	296	4,015	1,198	46,004	2,436	314,542	42,209	0	0	2,212	298,044	707	0	746	2,155	0	0	0	0	714,564
1985	376,578	700	213	523	434	40,206	659	336,101	54,805	0	794	21,637	329,169	1,405	0	1,057	9,254	0	0	0	0	796,956
1986	557,772	425	421	1,538	5,180	311,828	0	1,783,119	60,949	16	16	2,652	227,622	12,166	0	5,673	1,422	0	0	0	0	2,413,027
1987	589,299	0	1,197	2,119	1,028	173,143	992	692,978	77,196	60	779	9,285	460,926	3,334	0	5,859	33,825	0	0	86	0	1,462,807
1988	420,580	0	0	1,877	507	73,541	1,704	494,878	110,142	211	0	5,587	950,452	1,946	0	828	436	0	0	0	0	1,642,109
1989	384,001	0	60	6,877	5,719	195,391	2,468	1,038,206	138,038	0	979	3,408	269,650	1,042	0	2,079	18,160	0	0	46	18	1,682,141
1990	434,550	0	1,224	481	38,096	143,872	5,554	457,814	186,919	0	481	6,314	633,235	18	0	3,065	8,750	0	0	27	0	1,485,849
1991	662,660	0	1,719	508	2,038	108,027	301	1,279,480	40,630	0	1,140	1,110	131,139	679	0	641	3,667	0	0	0	0	1,571,079
1992	360,681	0	1,626	641	125,081	53,481	2,490	363,023	71,273	21	314	1,552	324,846	9,958	0	0	4,878	0	0	0	0	959,184
1993	364,261	0	3,666	128	7,695	42,118	1,432	225,957	139,814	0	198	983	516,162	2,001	0	1,172	436	0	0	0	0	941,762
1994	769,465	0	166	861	0	103,599	1,430	1,183,383	222,344	0	0	11,226	517,513	56	0	618	96	0	0	0	0	2,041,293
1995	366,496	0	1,663	1,496	28,367	511,526	0	1,399,909	20,350	0	0	7,136	85,675	0	0	2,234	2,776	0	0	0	0	2,061,132
1996	464,748	0	9,594	524	91,050	69,098	0	1,111,890	11,046	0	762	12,284	335,617	1,060	0	801	2,399	0	0	0	0	1,646,125
1997	396,668	0	953	0	7,925	49,609	677	459,184	51,638	0	110	2,955	208,648	191	0	0	0	0	0	0	0	781,890
1998	410,659	0	164	683	3,038	188,296	4	532,566	38,305	0	0	1,015	111,141	0	0	0	0	0	0	0	0	875,212
1999	457,424	0	1,660	81	15,979	98,359	910	630,749	70,220	0	0	734	176,623	0	0	0	0	0	0	0	0	995,315
2000	536,139	0	1,030	244	10,185	257,222	297	1,101,146	49,689	0	0	8,102	150,557	0	0	3,513	0	0	0	0	0	1,581,986
2001	744,015	0	5,364	0	59,606	77,174	0	523,867	31,580	0	0	10,669	164,276	0	0	2,738	0	0	0	0	0	875,274
2002	384,088	0	0	0	6,231	55,979	0	248,106	1,416	0	1,717	4,421	62,354	0	0	0	0	0	0	0	0	380,224
2003	350,004	0	4,532	0	58,353	90,847	0	416,783	17,263	0	0	235	103,322	0	0	0	15	0	0	0	0	691,350
2004	363,800	0	13,304	0	51,252	45,346	0	604,316	47,109	0	1,720	3,104	150,795	0	0	2,845	0	0	0	0	0	919,792
2005	355,091	0	0	171	17,163	94,309	0	834,023	11,240	0	0	0	525,008	6,180	0	0	17,839	0				1,505,934
2006	366,497	0	1,250	0	14,447	184,384	362	2,308,564	127,623	0	0	51,774	539,542	0								3,227,947
2007	361,091	0	2,670	0	25,090	37,792	2,692	399,491	34,547	0	1,729											
2008	377,579	0	0	0	15,023	511,577	0															
2009	391,476	0	0	0																		
2010	432,535	0																				
2011	488,930																					
2012	353,441																					

Appendix B4.–Brood table for late-run Chignik River sockeye salmon.

System: **Chignik Lake (late run)**

Species: **Sockeye salmon**

Data available for analysis of escapement goals.

		Return Ages																				
Year	Escapement	0.1	0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	0.4	1.4	2.3	3.2	1.5	2.4	3.3	4.2	2.5	3.4	4.3	Total return
1922	352,807	0	0	0	0	43,667	0	382,956	73,351	0	0	0	991,979	14,972	0	2,886	4,175	0	0	0	0	1,513,986
1923	213,781	0	0	0	0	74,884	218	410,194	245,187	0	0	2,360	577,390	1,111	0	1,647	2,376	0	0	0	0	1,315,367
1924	910,521	0	0	0	0	126,685	1,819	1,003,422	8,350	0	0	1,115	102,217	5,830	0	425	55	0	0	0	0	1,249,918
1925	677,566	0	0	0	0	3,736	0	51,222	195,414	0	0	332	427,580	7,817	0	5,367	456	0	0	0	0	691,924
1926	695,314	0	0	0	0	25,764	919	279,018	304,619	0	0	3,461	879,220	3,821	0	55	2,246	0	0	0	0	1,499,123
1927	429,525	0	0	207	0	113,952	1,499	951,950	100,633	0	0	744	203,942	1,586	0	1,225	5,557	0	0	0	0	1,381,295
1928	1,020,520	0	0	0	0	40,063	0	353,506	77,224	0	0	12,047	300,603	3,129	0	1,042	1,618	0	0	0	0	789,232
1929	914,307	0	0	0	0	16,254	0	584,561	38,873	0	0	5,675	361,557	1,165	0	2,192	1,251	0	0	0	0	1,011,528
1930	359,405	0	0	0	0	26,688	0	426,128	41,867	0	0	6,177	344,419	16,565	0	2,065	0	0	0	0	0	863,909
1931	631,986	0	0	0	0	30,856	2,454	296,899	138,440	0	0	3,747	264,858	0	0	2,678	635	0	0	0	0	740,567
1932	1,113,859	0	0	0	0	24,809	0	475,759	46,764	0	0	8,530	185,288	2,049	0	13,674	1,502	0	0	0	0	758,375
1933	310,088	0	0	0	0	35,679	0	311,946	35,705	0	0	48,795	321,467	0	0	1,267	301	0	0	0	0	755,160
1934	447,642	0	0	0	0	19,716	90	708,212	33,934	0	0	4,066	88,027	969	0	4,299	1,026	0	0	0	0	860,339
1935	462,469	0	0	69	0	37,642	308	148,352	16,893	0	0	13,842	299,288	3,284	0	4,082	976	0	0	0	0	524,736
1936	376,838	0	0	0	0	9,342	43	504,624	57,326	0	0	13,186	284,707	3,117	0	9,326	2,233	0	0	0	0	883,904
1937	406,618	0	0	33	0	31,723	145	480,250	54,435	0	0	30,220	651,642	7,116	0	2,664	639	0	0	0	0	1,258,867
1938	305,827	0	0	111	0	30,143	137	1,099,657	124,382	0	0	8,660	186,504	2,032	0	1,128	270	0	0	0	0	1,453,024
1939	512,754	0	0	106	0	68,919	315	314,851	35,542	0	0	3,674	79,035	859	0	5,420	1,305	0	0	0	0	510,026
1940	152,957	0	0	244	0	19,705	90	133,474	15,039	0	0	17,705	380,481	4,130	0	10,049	2,422	0	0	0	0	583,339
1941	531,904	0	0	70	0	8,342	38	642,782	72,293	0	0	32,912	706,532	7,654	0	2,225	537	0	0	0	0	1,473,385
1942	516,621	0	0	30	0	40,124	183	1,194,007	134,060	0	0	7,305	156,659	1,695	0	4,662	1,112	0	0	0	0	1,539,837
1943	1,205,418	0	0	143	0	74,442	340	264,830	29,686	0	0	15,007	324,527	3,562	0	5,405	1,321	0	0	0	0	719,263
1944	351,212	0	0	266	0	16,492	75	547,139	62,179	0	0	18,110	385,087	4,101	0	2,886	711	0	0	0	0	1,037,046
1945	151,326	0	0	59	0	34,405	157	652,782	72,138	0	0	9,784	207,054	2,186	0	1,246	315	0	0	0	0	980,126
1946	739,884	0	0	121	0	40,246	183	351,541	38,531	0	0	4,401	91,579	937	0	1,531	371	0	0	0	0	529,441
1947	1,393,990	0	0	147	0	21,549	98	156,343	16,644	0	0	5,048	108,068	1,165	0	1,316	333	0	0	0	0	310,711
1948	313,319	0	0	80	0	9,390	42	182,792	20,430	0	0	4,658	96,858	989	0	826	0	0	0	0	0	316,065
1949	574,715	0	0	36	0	11,360	52	165,402	17,581	0	0	1,766	103,345	0	0	496	650	0	0	0	0	300,688
1950	861,070	0	0	41	0	9,924	45	199,966	31,411	0	0	2,206	245,826	407	0	2,903	1,820	0	0	0	0	494,549
1951	490,899	0	0	38	0	33,082	0	618,729	13,748	0	0	7,046	242,042	0	0	1,028	0	0	0	0	0	915,713

-continued-

System: **Chignik Lake (late run)**

Species: **Sockeye salmon**

Data available for analysis of escapement goals.

		Return Ages																				
Year	Escapement	0.1	0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	0.4	1.4	2.3	3.2	1.5	2.4	3.3	4.2	2.5	3.4	4.3	Total return
1952	260,540	0	0	0	0	22,213	0	258,747	30,836	0	0	986	229,563	0	0	3,932	8,403	0	0	0	0	554,680
1953	221,408	0	0	0	0	9,167	428	125,399	32,350	0	0	470	396,916	1,935	0	934	5,424	0	0	0	0	573,023
1954	277,912	0	0	547	0	2,848	0	39,658	75,361	0	0	771	418,442	804	0	1,661	5,069	0	0	0	0	545,161
1955	201,409	0	0	369	0	32,187	0	303,988	32,708	0	0	168	363,162	1,252	0	0	0	0	0	0	0	733,834
1956	483,024	0	0	1,330	0	12,515	0	106,327	36,113	0	0	435	221,169	0	0	1,349	4,781	0	0	0	0	384,019
1957	328,779	0	0	0	0	17,746	622	232,393	109,475	0	0	351	332,661	2,104	0	1,189	1,319	0	0	0	0	697,861
1958	212,594	0	0	1,459	0	50,630	0	23,204	139,797	0	0	0	419,108	980	0	93	432	0	0	0	0	635,703
1959	308,645	0	0	3,286	0	18,094	907	109,204	81,669	0	0	117	197,975	738	0	689	187	0	0	0	0	412,866
1960	357,230	0	0	146	0	24,455	491	122,278	8,273	0	0	1,314	210,883	141	0	1,618	12,824	0	0	0	0	382,423
1961	254,970	0	0	718	0	1,899	799	109,935	18,702	0	0	220	401,732	2,698	0	5,335	2,420	0	0	0	0	544,458
1962	324,860	0	0	123	0	4,312	0	44,074	69,811	0	0	998	692,188	1,074	0	1,109	0	0	0	0	0	813,689
1963	200,314	0	0	0	0	5,536	1,300	103,116	68,605	0	0	29	243,939	0	0	1,529	883	0	0	0	0	424,937
1964	166,625	0	0	88	0	6,607	4,550	24,880	65,639	0	0	713	140,826	960	0	194	5,776	0	0	0	0	250,233
1965	163,151	0	0	1,636	0	25,157	5,547	162,041	59,008	0	0	361	614,234	971	0	650	94,754	0	0	0	0	964,359
1966	183,525	0	0	1,715	0	14,784	942	284,131	28,590	0	0	455	407,966	2,419	0	0	16,843	0	0	0	0	757,845
1967	189,000	0	0	510	0	5,845	726	77,202	30,658	0	0	653	449,704	2,591	0	1,299	0	0	0	0	0	569,188
1968	244,836	0	0	863	0	3,781	0	107,958	19,045	0	0	616	564,765	15,102	0	2,471	27,626	0	0	0	0	742,226
1969	132,055	0	0	0	0	1,155	990	82,331	262,259	0	0	751	447,837	6,691	0	0	14,980	0	0	0	0	816,992
1970	119,952	0	0	0	0	17,648	11,648	25,381	138,710	0	0	1,181	413,207	10,933	0	0	17,736	0	0	0	0	636,444
1971	232,501	0	0	1,452	0	14,182	11,586	166,200	367,841	0	0	211	1,694,467	3,656	0	2,930	17,355	0	0	0	0	2,279,880
1972	231,270	0	0	0	0	26,952	2,190	107,681	85,848	0	0	29	799,853	32,588	0	21	3,974	0	0	0	0	1,059,136
1973	243,729	0	0	0	0	5,157	9,586	86,674	184,713	0	0	0	888,233	3,246	0	1,240	5,754	0	0	0	0	1,184,603
1974	313,343	0	0	3,945	0	19,441	2,438	42,549	208,999	0	0	0	730,297	2,132	0	2,526	10,257	0	0	0	0	1,022,585
1975	257,675	0	0	0	0	25,210	6,263	95,379	248,864	0	0	547	1,107,896	3,421	0	5,569	2,026	0	0	0	0	1,495,175
1976	276,793	0	0	470	0	59,598	947	456,314	85,677	0	0	2,145	431,387	0	0	2,852	9	0	0	0	0	1,039,399
1977	328,916	0	0	232	0	34,852	3,341	134,257	51,802	0	0	1,757	1,181,013	0	0	1,423	83	0	0	0	0	1,408,760
1978	262,815	0	0	472	0	14,469	5,028	218,660	281,558	0	0	1,017	397,067	865	0	1,315	264	0	0	0	0	920,715
1979	246,318	0	0	1,752	0	175,512	5,358	397,619	42,026	0	0	990	255,735	701	0	1,245	547	0	0	0	0	881,486
1980	294,481	0	0	2,083	9,889	17,500	9,188	157,118	297,626	0	0	434	437,119	2,649	0	920	353	0	0	0	0	934,879
1981	261,239	0	0	1,452	813	90,365	3,932	233,599	70,055	0	0	472	312,253	101	0	560	92	0	0	0	0	713,694

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System: Chignik Lake (late run)

Species: Sockeye salmon

Data available for analysis of escapement goals.

		Return Ages																				
Year	Escapement	0.1	0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	0.4	1.4	2.3	3.2	1.5	2.4	3.3	4.2	2.5	3.4	4.3	Total return
1982	221,611	0	114	2,585	1,217	52,358	3,885	210,914	94,527	0	0	764	561,643	121	0	1,377	0	0	0	0	0	929,505
1983	428,034	0	0	0	2,193	8,510	3,195	117,670	91,650	0	92	240	1,009,599	796	0	11,640	98	0	196	0	0	1,245,879
1984	268,495	0	127	840	501	26,884	8,247	148,351	290,786	0	0	2,901	1,479,377	1,997	0	8,370	6,089	0	0	0	0	1,974,470
1985	369,260	59	92	506	169	18,640	13,904	201,663	165,790	0	812	4,466	371,001	1,081	0	3,134	3,235	0	0	0	0	784,552
1986	215,547	183	57	2,789	15,514	185,179	754	432,882	146,017	71	71	1,426	437,925	6,388	0	10,620	1,999	0	0	290	0	1,242,165
1987	214,444	0	6,931	435	872	59,254	7,545	465,482	193,580	185	351	6,211	949,903	6,215	0	5,074	55,342	0	0	77	0	1,757,457
1988	255,177	0	0	2,134	918	55,582	2,506	300,257	96,409	77	0	1,745	188,577	2,915	0	8,044	5,331	0	0	236	243	664,974
1989	557,174	0	466	8,533	8,382	147,864	3,336	246,145	80,583	374	213	2,698	1,035,071	5,454	0	10,527	80,612	125	0	39	0	1,630,422
1990	335,860	0	502	391	6,079	24,794	1,216	352,035	175,776	0	185	2,106	429,703	1,114	0	1,910	15,593	0	0	222	0	1,011,625
1991	377,438	0	275	199	1,509	99,477	1,734	306,111	91,207	0	187	555	467,217	2,840	0	4,811	4,435	0	0	0	0	980,557
1992	403,755	0	509	1,387	24,392	17,719	11,162	209,851	195,817	4,117	83	2,266	553,227	54,833	0	1,056	19,565	0	0	0	0	1,095,984
1993	333,116	0	588	406	4,058	30,338	20,806	155,323	299,921	0	65	1,936	1,018,014	4,750	0	1,094	78	0	0	0	0	1,537,377
1994	197,444	0	85	972	0	65,572	6,927	449,431	303,639	0	0	3,365	428,662	193	0	2,415	2,122	0	0	0	0	1,263,383
1995	373,425	0	487	1,961	5,536	177,134	0	287,466	34,515	128	0	4,408	790,224	2,733	0	9,682	11,729	0	0	0	0	1,326,004
1996	284,389	0	1,250	77	42,250	42,681	190	755,131	37,554	0	283	7,338	488,256	3,524	0	3,725	6,975	0	0	0	0	1,389,234
1997	378,950	0	2,699	128	3,890	35,497	2,161	221,341	91,023	0	275	1,935	598,081	2,429	0	3,779	2,789	0	0	218	0	966,245
1998	290,469	0	219	1,939	2,094	67,102	161	238,666	38,619	0	0	443	161,660	460	0	277	592	0	0	0	0	512,232
1999	258,542	0	660	78	7,877	50,524	2,172	131,351	39,710	0	0	1,974	111,636	109	0	2,265	1,554	0	0	0	0	349,910
2000	269,086	0	236	838	3,725	59,500	1,669	551,058	17,973	0	0	10,263	463,675	0	0	11,913	2,729	0	0	0	0	1,123,579
2001	392,903	0	0	316	13,049	13,614	922	383,305	48,615	0	1,608	22,155	441,534	482	0	6,749	0	0	0	0	0	932,349
2002	341,132	0	0	394	11,402	36,890	0	350,418	28,709	0	1,130	3,538	317,174	343	1,230	3,105	1,735	0	0	0	0	756,068
2003	334,119	0	816	804	20,583	61,186	241	301,317	62,734	0	0	4,106	549,704	0	0	3,715	3,212	0	0	0	0	1,008,419
2004	214,459	0	8,236	530	56,510	43,626	621	367,978	188,016	0	0	2,113	589,976	0	0	7,796	10,222	0	0	0	0	1,275,627
2005	225,366	0	386	0	11,064	97,493	1,001	432,922	61,749	0	0	2,336	333,777	30,086	0	2,884	33,560	0				1,007,258
2006	368,996	0	1,430	733	15,995	75,181	3,162	239,752	202,954	185	0	4,793	976,710	1,006								1,521,902
2007	293,883	0	2,507	2,498	15,469	19,113	682	60,123	94,193	0	0											
2008	328,479	0	1,477	2,538	960	215,567	567															
2009	328,586	0	0	1,856																		
2010	311,376	0																				
2011	264,887																					
2012	358,948																					

Appendix B5.–Existing escapement goals for Chignik River sockeye salmon using spawner-recruit, with a comparison of model results from Ricker spawner-recruit, yield analysis, euphotic volume, and zooplankton biomass models.

System: **Chignik River**

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	325,000	400,000	550,000	700,000	800,000
EV	n/a	n/a	n/a	282,769	353,461	424,153	n/a	n/a	n/a
Zooplankton	n/a	n/a	n/a	459,625	574,531	689,437	n/a	n/a	n/a
Spawner-recruit[a]									
1922-2005	262,000	408,721	583,000	200,000	314,632	450,000	n/a	n/a	n/a
1978-2005	n/a	n/a	n/a	190,000	299,398	431,000	n/a	n/a	n/a
Yield Analysis									
1922-2005	350,000	425,000	500,000	n/a	n/a	n/a	n/a	n/a	n/a

Note: Years listed under methods refer to brood years.

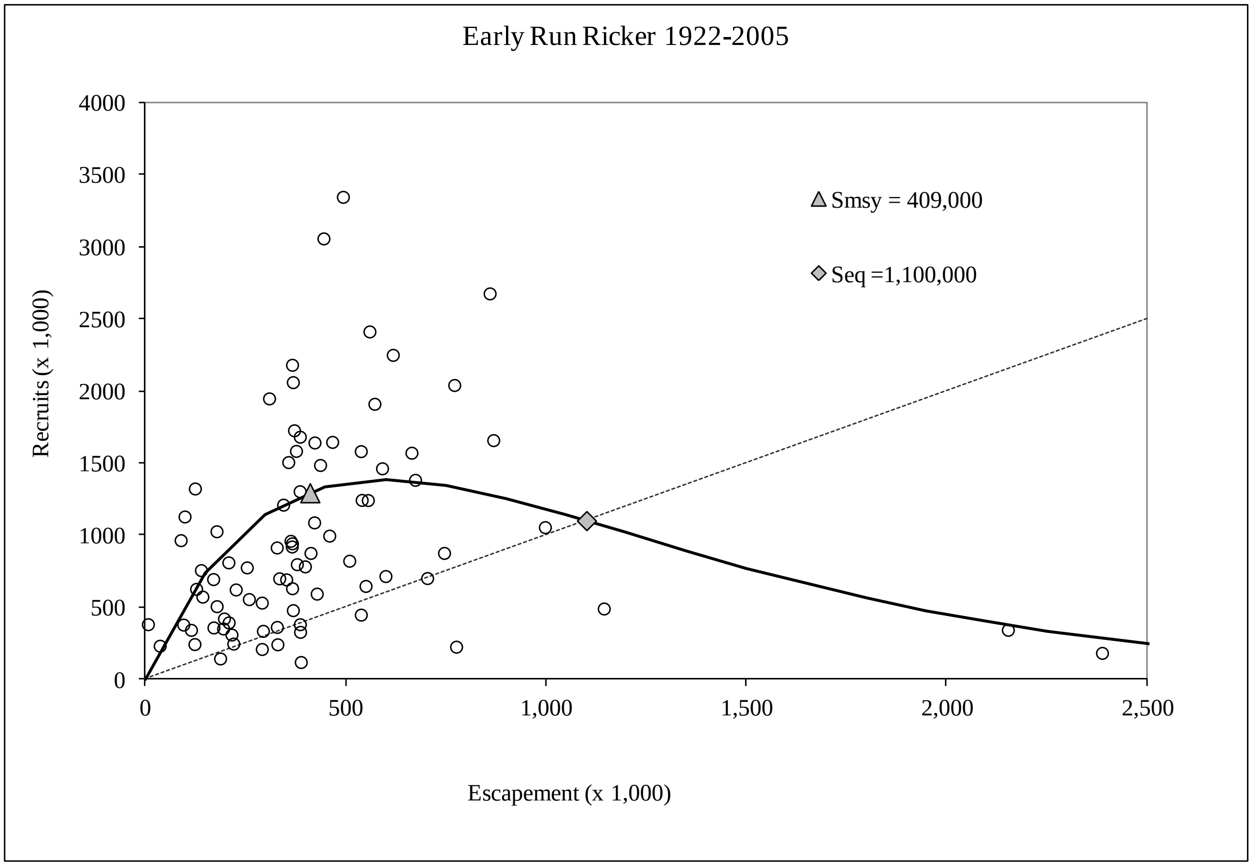
[a] Low and high ranges were calculated as modeled yields 10% higher and lower than S_{MSY}.

Appendix B6.–Stock-recruit analyses for Chignik River sockeye salmon.

System: **Chignik Lake (early run)**

Species: **Sockeye salmon**

Ricker spawner–recruitment relationship, 1922–2005 brood years. The solid curved line represents the modeled spawner-recruit relationship and the dashed straight line represents replacement.



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System: **Chignik Lake (early run)**

Species: **Sockeye salmon**

Spawner-recruit yield analysis table, 1922–2005 brood years. Percentages represent the percentage of escapements that contributed to a specified range of returns.

	Escapement (in thousands)														
Return (in thousands)	0-100	100-150	150-200	200-250	250-300	300-350	350-400	400-450	450-500	500-550	550-600	600-700	700-800	800-900	900-2,500
0-250	20.0%	16.7%	14.3%	20.0%	20.0%	16.7%	5.3%						25.0%		25.0%
250-500	40.0%	16.7%	42.9%	40.0%	20.0%	16.7%	15.8%			20.0%					50.0%
500-750		33.3%	28.6%	20.0%	40.0%	16.7%	10.5%	16.7%		20.0%	20.0%		25.0%		
750-1,000	20.0%	16.7%		20.0%	20.0%	16.7%	26.3%	16.7%	33.3%	20.0%			25.0%		
1,000-1,250	20.0%		14.3%			16.7%		16.7%		20.0%	20.0%				25.0%
1,250-1,500		16.7%					5.3%	16.7%			20.0%	33.3%			
1,500-2,000						16.7%	21.1%	16.7%	33.3%	20.0%	20.0%	33.3%		50.0%	
2,000-2,500							10.5%				20.0%	33.3%	25.0%		
2,500-3,500							5.3%	16.7%	33.3%					50.0%	
Escapement Summary															
Number of Years per Interval	5	6	7	5	5	6	19	6	3	5	5	3	4	2	4
Average Yield per Interval	553,267	516,825	319,192	262,140	204,687	568,167	801,789	1,031,213	1,525,184	414,527	974,908	1,084,585	212,980	1,305,440	-1,152,836
Median Yield per Interval	293,938	475,112	243,402	179,358	241,185	478,545	575,173	863,137	1,181,377	284,724	892,597	908,419	31,226	1,305,440	-1,232,028

-continued-

System: **Chignik Lake (late run)**

Species: **Sockeye salmon**

Ricker stock–recruitment relationship, 1922–2005 brood years. The solid curved line represents the modeled spawner-recruit relationship and the dashed straight line represents replacement.

APPENDIX C. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR CHIGNIK MANAGEMENT AREA PINK SALMON

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:	SEG (even years): 200,000 to 600,000 fish (since 2008)
	SEG (odd years): 500,000 to 800,000 fish (since 2008)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Aerial survey, 1962–2012.
Data summary:	
Data quality:	Fair
Data type:	Peak aerial surveys are available from 1968 to present. A total of 49 streams are used as an index for areawide escapement. No stock-specific harvest information is available.
Contrast:	101
Methodology:	Yield Analysis
Autocorrelation:	None detected
Recommendation:	No change to existing SEGs
Comments:	None

Appendix C2.–Peak aerial surveys for pink salmon in the entire CMA, 1968 through 2012.

System: **Entire CMA**

Species: **Pink salmon**

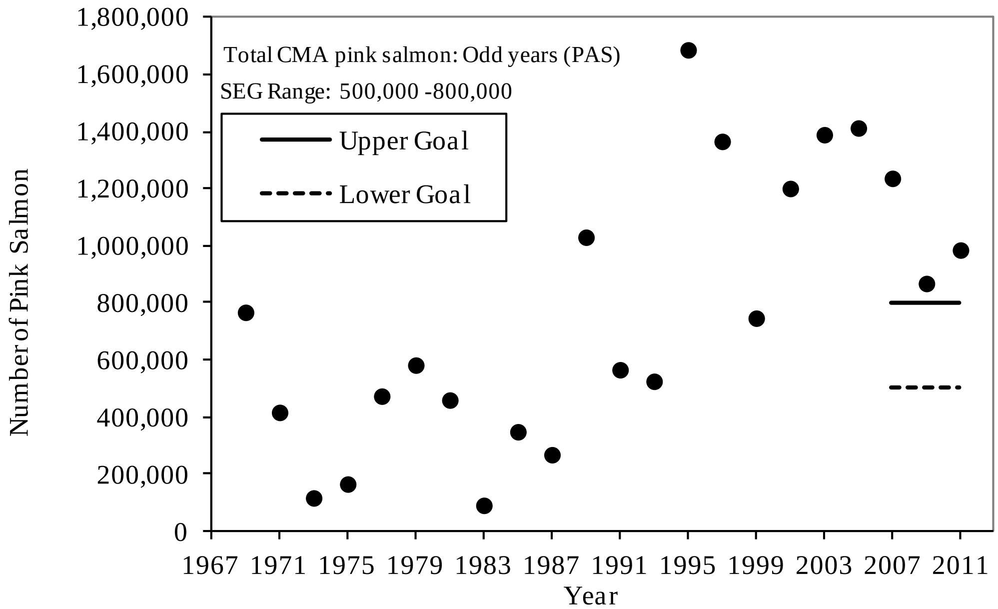
Data available for analysis of escapement goals.

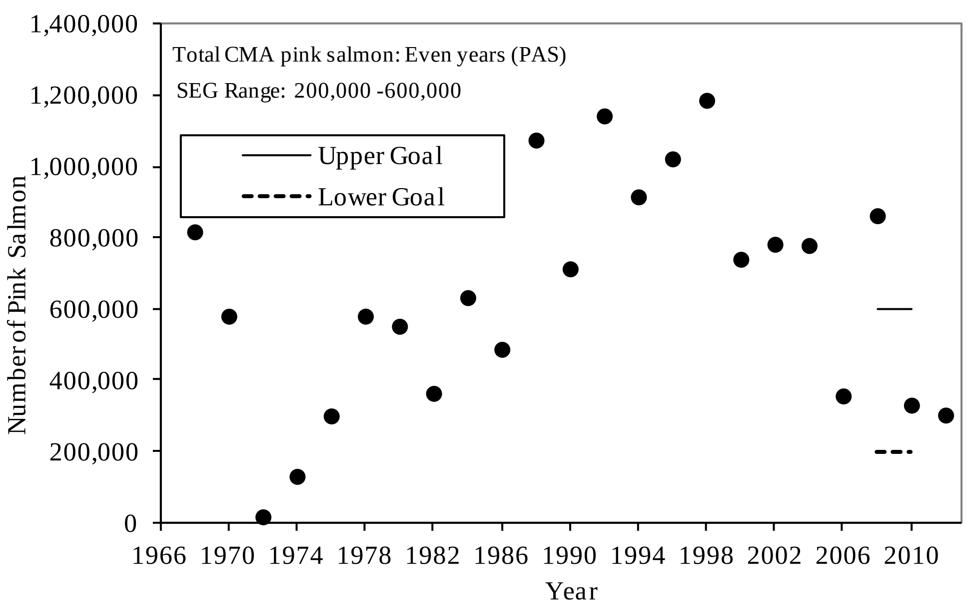
Year	Peak Aerial Survey
1968	817,800
1969	767,900
1970	580,600
1971	417,100
1972	16,725
1973	117,225
1974	130,401
1975	165,920
1976	300,280
1977	474,080
1978	580,650
1979	582,913
1980	552,400
1981	460,375
1982	363,755
1983	91,295
1984	632,880
1985	349,200
1986	487,550
1987	268,762
1988	1,075,640
1989	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
2007	1,237,528
2008	863,031
2009	869,063
2010	330,570
2011	986,248
2012	302,699

Appendix C3.–Annual peak aerial surveys and escapement goals for CMA pink salmon, 1968 to 2012.

System: **Entire CMA**

Species: **Pink salmon**





APPENDIX D. SUPPORTING INFORMATION FOR THE ESCAPEMENT GOAL FOR CHIGNIK MANAGEMENT AREA CHUM SALMON

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

System: **Entire CMA**

Species: **Chum salmon**

Description of stock and escapement goal.

Regulatory area	Chignik Management Area – Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine
Current escapement goal:	SEG: 57,400 (since 2008)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Aerial survey, 1973–2012.
Data summary:	
Data quality:	Fair
Data type:	Peak aerial surveys are available from 1973 to present. A total of 42 streams are used as an index for areawide escapement. No stock-specific harvest information is available.
Methodology:	Risk Analysis
Recommendation:	No change to existing SEGs
Comments:	None

Appendix D2.–Peak aerial surveys for chum salmon in the entire CMA, 1973 through 2012.

System: **Entire CMA**

Species: **Chum salmon**

Data available for analysis of escapement goal.

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	300,325
2004	349,518
2005	308,700
2006	93,489
2007	238,216
2008	197,259
2009	214,959
2010	177,220
2011	278,145
2012	210,973

Appendix D3.–Annual peak aerial surveys and escapement goals for CMA chum salmon, 1973 to 2012.

System: **Entire CMA**

Species: **Chum salmon**