Fishery Manuscript Series No. 10-08

Review of Salmon Escapement Goals in the Chignik Management Area, 2010

by

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December 2010

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

FISHERY MANUSCRIPT SERIES NO. 10-08

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December 2010

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This document should be cited as:
Nemeth, M. J., M. E. Loewen, H. Finkle, J. S. Schmidt, J. W. Erickson, M. J. Witteveen, and D. Barnard. 2010. Review of salmon escapement goals in the Chignik Management Area, 2010. Alaska Department of Fish and Game, Fishery Manuscript Series No. 10-08, Anchorage.

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ABSTRACT

In May 2010, 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 2007. In 2010, the team reviewed recent data (2007 through 2009) for the six goals in existence to determine whether substantial new information existed. Four goals were analyzed further. The team ultimately recommended no changes to any of the existing goals, and no new goals. These recommendations keep the existing suite of escapement goals in the CMA: one for Chinook salmon *O. tshawytscha*, two for sockeye salmon *O. nerka*, two for pink salmon *O. gorbuscha*, and one for chum salmon *O. keta*.

The six escapement goals in the CMA consist of a biological escapement goal (BEG) of 1,300 to 2,700 fish for Chignik River Chinook salmon; a sustainable escapement goal (SEG) of 350,000 to 400,000 fish for early-run Chignik River sockeye salmon; an SEG of 200,000 to 400,000 fish for late-run Chignik River sockeye salmon, which includes an additional inriver run goal of 50,000 fish; an SEG of 500,000 to 800,000 pink salmon for the Chignik Area aggregate stock in odd years, and an SEG of 200,000 to 600,000 pink salmon for the Chignik Area aggregate stock in odd years; and a lower bound SEG of 57,400 chum salmon for the Chignik Area aggregate stock.

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

INTRODUCTION

The sustainability of salmon stocks requires estimating the number of fish that are able to reach their spawning grounds (Hasbrouck and Edmundson 2007; Hilborn and Walters 1992). The portion of a population that reaches the spawning grounds is typically referred to as the escapement and is affected by factors such as exploitation (harvest), predation, disease, and other forms of mortality influenced by physical and biological changes in the environment. Escapement is measured by a variety of methods (e.g., counts from weirs or surveys from airplanes). These estimates of escapement are used to help determine the number of spawning fish needed to sustain the stock and to estimate the remaining number that can be removed from the population by harvest. The number of spawning fish is represented as an escapement goal and is usually based on the number of recruits produced from a number of spawners (spawner-recruit relationship) and/or specific habitat capacities (i.e., rearing and spawning areas). Methods used to determine escapement goals vary and are modified and improved as new data become available. Escapement goals are therefore evaluated on a regular basis to assess the need for revision.

DEFINITIONS

The Alaska Department of Fish and Game (department) adopted a Salmon Escapement Goal Policy in 1992 (Fried 1994), which categorized escapement goals (Hasbrouck and Edmundson 2007). The Alaska Board of Fisheries (board) adopted 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) into regulation in 2000 and 2001. These regulations were intended to ensure that the state's salmon stocks would be conserved, managed, and developed using the sustained yield principle. Section (b)(2) of the EGP states that the board recognizes the responsibility of the department to:

"(2) establish biological escapement goals (BEG) for salmon stocks for which the department can reliably enumerate salmon escapement levels, as well as total annual returns;" and

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

Section (f) of the SSFP provides the following detailed definitions:

> (3) "biological escapement goal" or "(BEG)" means the escapement that provides the greatest potential for maximum sustained yield; BEG will be the primary management objective for the escapement unless an optimal escapement or inriver run goal has been adopted; BEG will be developed from the best available biological information, and should be scientifically defensible on the basis of available biological information; BEG will be determined by the department and will be expressed as a range based on factors such as salmon stock productivity and data uncertainty; the department will seek to maintain evenly distributed salmon escapements within the bounds of a BEG;"
>
> (36) "sustainable escapement goal" or "(SEG)" means a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated due to the absence of a stock specific catch estimate; the SEG is the primary management objective for the escapement, unless an optimal escapement or inriver run goal has been adopted by the board, will be developed from the best available biological information, and should be scientifically defensible on the basis of that information; the SEG will be determined by the department and will take into account data uncertainty and be stated as either an 'SEG range' or 'lower bound SEG'; the department will seek to maintain escapements within the bounds of the SEG range or above the level of the lower bound SEG", and
>
> (19) "inriver run goal" means 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."

ESCAPEMENT GOAL REVIEW PROCESS

As part of its responsibilities, the department has reviewed escapement goals for specific regions or areas every three years since the inception of the EGP in 2001. These reviews are designed so that they can be presented at the triennial board meetings for each region or area (Munro and Volk 2010). This report documents the review in 2010 of the existing salmon escapement goals in the Chignik Management Area (CMA), to be presented at the 2011 board meeting for the CMA. Salmon escapement goals in the CMA were last reviewed in 2007, in preparation for the 2008 CMA board meeting (Witteveen et al. 2007).

For the current review, an interdivisional review team from the department was formed in May 2010 to evaluate the existing CMA salmon escapement goals. Team members from the Division of Commercial Fisheries were Matt Nemeth, Mark Witteveen, Jeff Wadle, Heather Finkle, Mary Beth Loewen, Eric Volk, Andrew Munro, Doug Eggers, David Barnard, and Todd Anderson. Members from the Division of Sport Fish were Jack Erickson, Steve Fleischman, Jim Hasbrouck, Bob Clark, Donn Tracy, Suzanne Schmidt, Matt Miller, and David Evans. The purposes of 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 (change, retain, or eliminate) for each goal evaluated and present these recommendations to the directors of Commercial Fisheries and Sport Fish divisions for approval. Formal meetings to discuss and develop recommendations were held on May 11 and August 25, 2010. The team communicated on a regular basis by telephone and e-mail, and delivered a memorandum of progress to the directors of the divisions of Commercial Fisheries and Sport Fish on September 28, 2010. This process and timeline was performed concurrent with a review of escapement goals in the Kodiak Management Area (Nemeth et al. *in prep*).

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 26 statistical reporting areas (Anderson 2010).

The Chignik River is the major watershed in the CMA, and consists of two 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 five species of Pacific salmon *Oncorhynchus* spp. return to the Chignik River; sockeye salmon *O. nerka* returns consist of an early run and a late run. Pink *O. gorbuscha* and chum *O. keta* salmon also return to other streams throughout the CMA.

METHODS

STOCK STATUS ASSESSMENT: ESCAPEMENT AND HARVEST DATA

For the review in 2010, the team reviewed stock assessment data for one Chinook salmon *O. tshawytscha*, two sockeye salmon, two pink salmon aggregate, and one chum salmon aggregate stocks with existing goals (Table 1). Initial efforts were concentrated on reviewing data from 2007 through 2009, determining if previous analyses from the review in 2007 (Witteveen et al. 2007) should be updated or if additional analyses were necessary, and identifying any management concerns with the existing goals. Available escapement, harvest, and age data associated with each stock or combination of stocks were compiled from research reports, management reports, and unpublished historical databases. Limnological and spawning habitat data were compiled for each stock when available. The team evaluated the type, quality, and amount of data for each stock according to criteria described in Bue and Hasbrouck[1] (*unpublished*; Table 2). This evaluation was used to help determine the appropriate type of escapement goal to apply to each stock, as defined in the SSFP and EGP.

---

[1] Bue, B. G., and J. J. Hasbrouck. *Unpublished.* Escapement goal review of salmon stocks of Upper Cook Inlet. Alaska Department of Fish and Game, Report to the Board of Fisheries, 2001, Anchorage.

During the review, the team identified two main categories of escapement data, censuses and indices. A census was a total count in which each fish was individually enumerated, typically using a counting weir (e.g., a census of escapements). An index was a partial count that provided a relative measure of magnitude that could be compared across years or systems, but did not necessarily estimate the actual number of fish in the escapement (e.g., an index of escapements). An index was frequently measured from aerial surveys (usually the peak count of fish from a stream), with fish being counted in groups and added to any carcass counts or ancillary and qualitative data. An index was considered less accurate than a census.

Since the last review of escapement goals in 2007 (Witteveen et al. 2007), salmon escapements to the CMA have generally been strong; the lower ranges of existing goals were met for all stocks in each year from 2007 through 2009 (Table 1).

ESCAPEMENT GOAL DETERMINATION

Biological Escapement Goal

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. For this review, ranges surrounding S_{MSY} were calculated as the escapement estimates that produced yields of at least 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 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), 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 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 (SEGs) 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 (Bue and Hasbrouck *unpublished*) or spawner-recruit methods (Ricker 1954); additional analyses used 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 two 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 (*unpublished*), 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 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 euphotic volume indicated a level of phytoplankton forage (primary production) available to zooplankton, and thus a level of zooplankton forage available for rearing juvenile fish. 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 EV model assumes that the sampled lake will be deep enough for 1% of the subsurface photosynthetically active radiation to penetrate the water column.

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, uses 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). The goal was originally established as a BEG (1,450 to 3,000 fish) in 1992, using a spawner-recruit model. The BEG was revised to 1,300 to 2,700 fish in 2002, then left unchanged after an analysis in 2004 (Witteveen et al. 2005) and a data review in 2007 (Witteveen et al. 2007). Chinook salmon escapement to the Chignik River is counted using a weir outfitted with a video camera (Anderson 2010).

2010 Review

Escapements from 2007 through 2009 were within 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 2010.

SOCKEYE SALMON

Escapement Goal Background and Previous Review

The sockeye salmon SEGs are for two distinct runs of sockeye salmon, an early and late run, that return to the Chignik River watershed (Table 1; Appendix B1). The Chignik River run is the only sockeye salmon run in the CMA with an escapement goal. 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). 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 spawns in the Chignik Lake tributaries and shoal areas (Pappas et al. 2003). Although the peak periods of passage for each stock are usually a few weeks apart, the two runs overlap in late June and early July (Templin et al. 1999). To achieve escapement goals for the two stocks of sockeye salmon with overlapping return times, inseason estimates of the numbers of each stock in the daily escapement are required. Prior to 1980, the proportion of each stock in the catch and escapement was estimated from time-of-entry relationships based on tagging studies and age groups (Dahlberg 1968). From 1980 through 2003, with the exception of 1982, stock separation was accomplished using scale pattern analysis (SPA; Witteveen and Botz 2004). Beginning in 2004, an estimate of the total escapement of the early run (Black Lake stock) was based on weir counts through July 4. After July 4, the fish that passed upstream through the weir were assumed to be late run (Chignik Lake stock) fish (Witteveen *unpublished memorandum*)[2]. This method was determined not to be significantly different ($P>0.05$) than the SPA method in estimating recruitment. Escapement estimates for both runs were based mainly on weir counts with the addition of post-weir estimates for the late run (Appendix B2 and B3) that were modeled after the weir was removed in early September.

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

2 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.

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, escapement goals were reviewed using the spawner-recruit model, yield analysis, euphotic volume analysis, and smolt biomass as a function of zooplankton biomass (Witteveen et al. 2005). 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. When the goals were reviewed again in 2007, the early run SEG was left unchanged and the late run SEG was changed to 200,000 to 400,000 fish. The two 25,000-fish management objectives were reclassified as inriver run goals, and the total (50,000 fish) was added to the lower bound of the 200,000-fish escapement goal (Witteveen et al. 2007).

2010 Review

Brood tables for each run were developed based on escapement, catch, and age data via run reconstruction (Appendices B2 through B5). Escapement and age data were both taken from the Westward Region Commercial Fisheries salmon database. Individual sales receipts (fish tickets) documented sockeye salmon commercial harvest data for the CMA. Sport and subsistence harvests were not included in the total return estimates because they are relatively small and are not available soon enough to be used in this analysis.

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. Because 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, spawner-recruit models were updated with the additional three years of data to determine if there were significant changes in the escapement range estimates. Euphotic volume and zooplankton biomass models were also used 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 escapement goals in the CMA were originally established in 1999, with separate goals for each of the five 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 five 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).

2010 Review

Aerial survey data from 1968 to 2009 were used for the 2010 escapement goal review (Appendices C1–C3). A yield analysis (Hilborn and Walters 1992) was used to examine the escapement-

versus-yield relationship. Pink salmon were not examined with a spawner-recruit analysis due to the inability of aerial surveys to reliably estimate true escapement.

For the yield analysis, intervals that had fewer than four escapements within the interval were not considered to have reliable estimates of yield for that escapement interval. The 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 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).

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 five 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 five 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).

2010 Review

Escapements since the last review were similar to those in the recent past (Table 1). 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 2010.

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 the goal range in three years (2007 through 2009), above the upper end of the goal range in five years, and have not been below the lower end of the 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 in 2010 (Table 1).

SOCKEYE SALMON

Stock Status

The combined escapements of early and late runs of Chignik River sockeye salmon have exceeded the upper range of the current combined SEG for 33 of the past 42 years

(Appendix B3). Escapements have fallen within the current goal range for the early run since 2002, and for the late run since 1993 (Appendix B3).

In addition to catch and escapement data, sockeye salmon smolt outmigration, zooplankton, and water quality data have been used to corroborate the existing SEGs for the late run.

Evaluation of Recent Data

Early Run

The percentile approach was used to estimate SEGs for early-run (Black Lake) escapement data for four time periods: 1952 to 2009, 1965 to 2009, 1977 to 2009, and 1980 to 2009 (Appendix B1). The different data sets represented varying degrees of data quality and different levels of observed productivity. The data from 1952 to 2009 had the highest contrast (22.53) and estimated the SEG range from 326,740 to 462,917 fish using the 25th and 75th percentiles (Appendices B1 and B6). The other three time periods had low contrast (2.2) and yielded similar estimates of escapement. The 1977 to 2009 time period was considered the most accurate data set, and yielded an SEG range of 364,169 to 769,465 fish, using the 15th and maximum percentiles (Appendix B6).

Late Run

Spawner-recruit models with a multiplicative error structure were fit to late run (Chignik Lake) spawner-recruit data from four time periods: 1952 to 2001, 1965 to 2001, 1977 to 2001, and 1980 to 2001 (Appendix B2). The spawner-recruit relationship for the 1952 to 2001 model was significant (P<0.05), with S_{MSY} estimated at 279,000 fish with a computed 90–100% MSY range of 201,000 to 377,000 fish; however, the estimate of S_{EQ} (772,000 fish) was outside the range of known escapements (Appendix B7). Similar to the 2007 review, the 1965 to 2001 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 306,000 with a computed 90–100% MSY range of 241,000 to 450,000 fish (Appendix B7). The estimate of S_{EQ} (908,000) was outside the range of known escapements for the 1965 to 2001 model. The 1977 to 2001 model was also significant (P<0.05) with S_{MSY} estimated at 355,000 fish with a computed 90–100% MSY range of 241,000 to 691,000 fish; however, it also possessed a value of S_{EQ} (974,000 fish) outside the range of known escapements (Appendix B7).The spawner-recruit relationship was not significant (P>0.05) for the 1980 to 2001 model.

An updated euphotic volume analysis yielded a late-run adult production level of roughly 368,000 sockeye salmon with an estimated SEG range of 294,000 to 442,000 fish (Appendix B6).

Results of the zooplankton biomass model yielded an escapement goal range of 495,000 to 743,000 sockeye salmon for the Chignik Lake late run. Optimal escapement was estimated at approximately 620,000 sockeye salmon (Appendix B6).

Escapement Goal Recommendation

Results from the percentile approach suggested maintaining the early-run SEG range of 350,000 to 400,000 fish (Table 1). Based on these results, the team felt 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 corroborated the current ranges of the SEG, but yielded carrying capacity estimates

(S_{EQ}) beyond the range of known escapements (Table 1, Appendix B1). The euphotic volume model yielded an estimated escapement goal range encompassing the current SEG range. The zooplankton biomass model suggested increasing the current SEG range, however, because Chignik Lake zooplankton serve as forage for both early- and late-run juvenile sockeye salmon, results from the euphotic volume method may better represent an estimate of total escapement to the watershed. In light of this observation, the smolt biomass model corroborates the combined early- and late-run escapement goals. Because the results of analyses corroborated the existing late-run goal, the team recommended no change to the late-run SEG of 2000,000 to 400,000 fish (Table 1).

PINK SALMON

Stock Status

Since the current SEGs were established in 2008, escapements have exceeded the upper end of the goal range for both the even and odd year runs (Table 1).

Evaluation of Recent Data

By assessing the number 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 observed peak aerial escapement estimated since the last escapement goal review, and the high return per spawner rate of pink salmon within the CMA, no change was recommended to the current SEGs (Table 1). The current SEG ranges were chosen because they provided high yield estimates and excluded intervals without observed escapement and associated yield.

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 2010.

SUMMARY OF RECOMMENDATIONS

The team concluded that the three additional years of data since the 2007 review would not affect the existing escapement goals for the Chignik River Chinook salmon stock and the chum salmon aggregate stock, both of which were left unchanged and not analyzed further. The team elected to further analyze the four remaining stocks, using a combination of new escapement and brood year

data available since the prior review in 2007 (Witteveen et al. 2007). After full review, the team also recommended no change to any of these four goals.

The final recommendation of the 2010 review team was to retain the six existing escapement goals, as follows: a BEG of 1,300 to 2,700 fish for Chignik River Chinook salmon; an SEG of 350,000 to 400,000 fish for early-run Chignik River sockeye salmon; an SEG of 200,000 to 400,000 fish for late-run Chignik River sockeye salmon; pink salmon aggregate SEGs of 500,000 to 800,000 fish for the CMA in odd years and 200,000 to 600,000 fish for the CMA in even years; and a lower bound SEG of 57,400 fish for the CMA chum salmon aggregate. There are no coho salmon *O. kisutch* 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.

REFERENCES CITED

Anderson, T. J. and N. W. Nichols 2010. Chignik Management Area salmon and herring annual management report, 2010. Alaska Department of Fish and Game, Fishery Management Report No. 10-48, Anchorage.

Bernard, D. R., J. J. Hasbrouck, B. G. Bue, and R. A. Clark. 2009. Estimating risk of management error from precautionary reference points (PRPs) for non-targeted salmon stocks. Alaska Department of Fish and Game, Special Publication No. 09-09, Anchorage.

Bouwens, K. A., and E. J. Newland. 2004. Sockeye salmon smolt investigations on the Chignik River Watershed, 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K04-24, Kodiak.

Chinook Technical Committee (CTC). 1999. Maximum sustained yield of biologically based escapement goals for selected Chinook salmon stocks used by the Pacific Salmon Commission's Chinook Technical Committee for escapement assessment, Volume I. Pacific Salmon Commission Joint Chinook Technical Committee Report TCCHINOOK (99)-3, Vancouver, British Columbia, Canada.

Dahlberg, M. L. 1968. Analysis of the dynamics of sockeye salmon returns to the Chignik Lakes, Alaska. Ph.D. Thesis. University of Washington. Seattle.

Finkle, H. 2007. Chignik watershed ecological assessment project season report, 2006. Alaska Department of Fish and Game, Fishery Management Report No. 07-51. Anchorage.

Fried, S. M. 1994. Pacific salmon spawning escapement goal for the Prince William Sound, Cook Inlet, and Bristol Bay areas of Alaska. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Special Publication No. 8, Juneau.

Hasbrouck, J. J. and J. A. Edmundson. 2007. Escapement goals for salmon stocks in Upper Cook Inlet, Alaska: report to the Alaska Board of Fisheries, January 2005. Alaska Department of Fish and Game, Special Publication No. 07-10, Anchorage.

Hilborn, R. and C. J. Walters. 1992. Quantitative fisheries stock assessment: choice, dynamics and uncertainty. Chapman and Hall, New York, NY.

Koenings, J. P., and G. B. Kyle. 1997. Consequences to juvenile sockeye salmon and the zooplankton community resulting from intense predation. Alaska Fisheries Research Bulletin 4(2):120-135.

Kyle, G. B. 1992. Assessment of lacustrine productivity relative to juvenile sockeye salmon (Oncorhynchus nerka) production in Chignik and Black Lakes: results from 1991 surveys. Alaska Department of Fish and Game, Fisheries Rehabilitation, Enhancement, and Development Division Report 119 (available from: Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau).

Munro, A. R., and E. C. Volk. 2010. Summary of Pacific salmon escapement goals in Alaska, with a review of escapements from 2001 to 2009. Alaska Department of Fish and Game, Special Publication No. 10-12, Anchorage.

Nemeth, M. J.. et al. *In prep*. Review of escapement goals for salmon stocks in the Kodiak Management Area, 2010. Alaska Department of Fish and Game, Fishery Manuscript, Anchorage.

Pappas, G. E., M. J. Daigneault, and M. LaCroix. 2003. Chignik Management Area annual finfish management report, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K03-62, Kodiak.

Quinn II, T. J., and R. B. Deriso. 1999. Quantitative fish dynamics. Oxford University Press. New York, NY.

Ricker, W.E. 1954. Stock and recruitment. Journal of the Fisheries Research Board of Canada, 11: 559-623.

Templin, W. L., L. Seeb, P. Crane, and J. Seeb. 1999. Genetic analysis of sockeye salmon populations from the Chignik watershed Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J99-08, Juneau.

REFERENCES CITED (Continued)

Witteveen, M. J., and J. C. Botz. 2004. Chignik Lakes scale pattern analysis, run assignment, and sockeye salmon catch sampling results, 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K04-30, Kodiak.

Witteveen, M. J., H. Finkle, P. A. Nelson, J. J. Hasbrouck, and I. Vining. 2005. Review of salmon escapement goals in the Chignik Management Area. Alaska Department of Fish and Game, Fishery Manuscript No. 05-06, Anchorage.

Witteveen, M. J., H. Finkle, P. A. Nelson, J. J. Hasbrouck, and I. Vining. 2007. Review of salmon escapement goals in the Chignik Management Area, 2007. Alaska Department of Fish and Game, Fishery Manuscript No. 07-09, Anchorage.

TABLES AND FIGURES

Table 1.–Escapements, escapement goals, and recommendations for 2011 for salmon stocks in the Chignik Management Area (CMA). Escapement data from 2010 not yet finalized.

			Escapements				Current escapement goal				Escapement goal
Species	System	Data source	2007	2008	2009	2010	Type	Lower	Point	Upper	recommendation for 2011
Chinook salmon	Chignik River	WC	1,675	1,620	1,590	–	BEG	1,300	1,695	2,700	No change
Sockeye salmon	Chignik River										
	Early run	WC	361,091	377,579	391,476	–	SEG	350,000	375,000	400,000	No change
	Late run	WC	293,883	328,479	328,586	–	SEG	200,000 [a]	NA	400,000	No change
Pink salmon	CMA aggregate – odd years	PAS + WC	1,217,064		869,063	–	SEG	500,000	NA	800,000	No change
	CMA aggregate – even years	PAS + WC		863,031		–	SEG	200,000	NA	600,000	No change
Chum salmon	CMA aggregate	PAS + WC	238,216	197,259	214,959	–	Lower bound SEG	57,400	NA	NA	No change

Note: PAS = Peak Aerial Survey, WC = Weir Count.

a This lower bound does not include an 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.

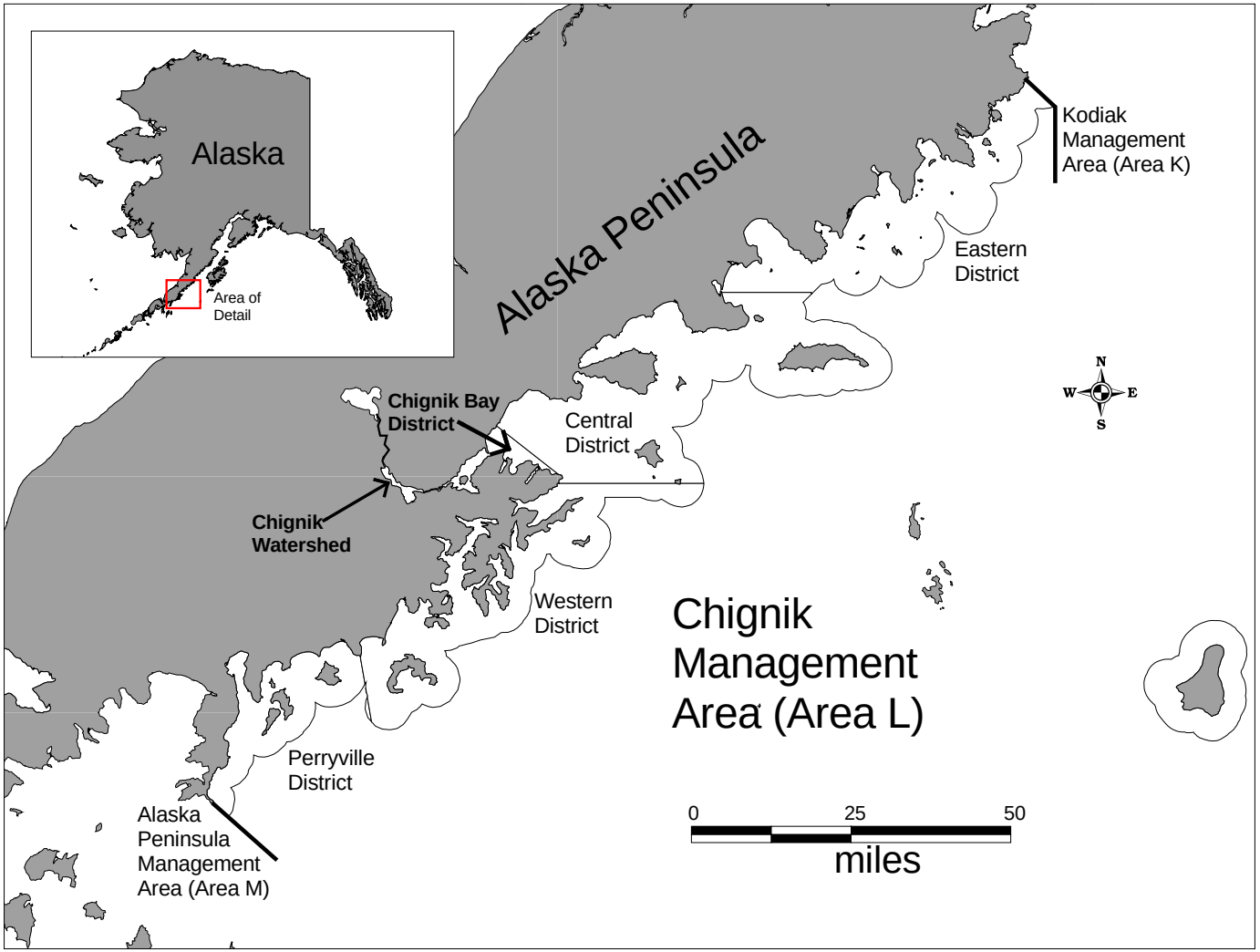


Figure 1.–The Chignik Management Area with the Eastern, Central, Chignik Bay, Western, and Perryville districts depicted.

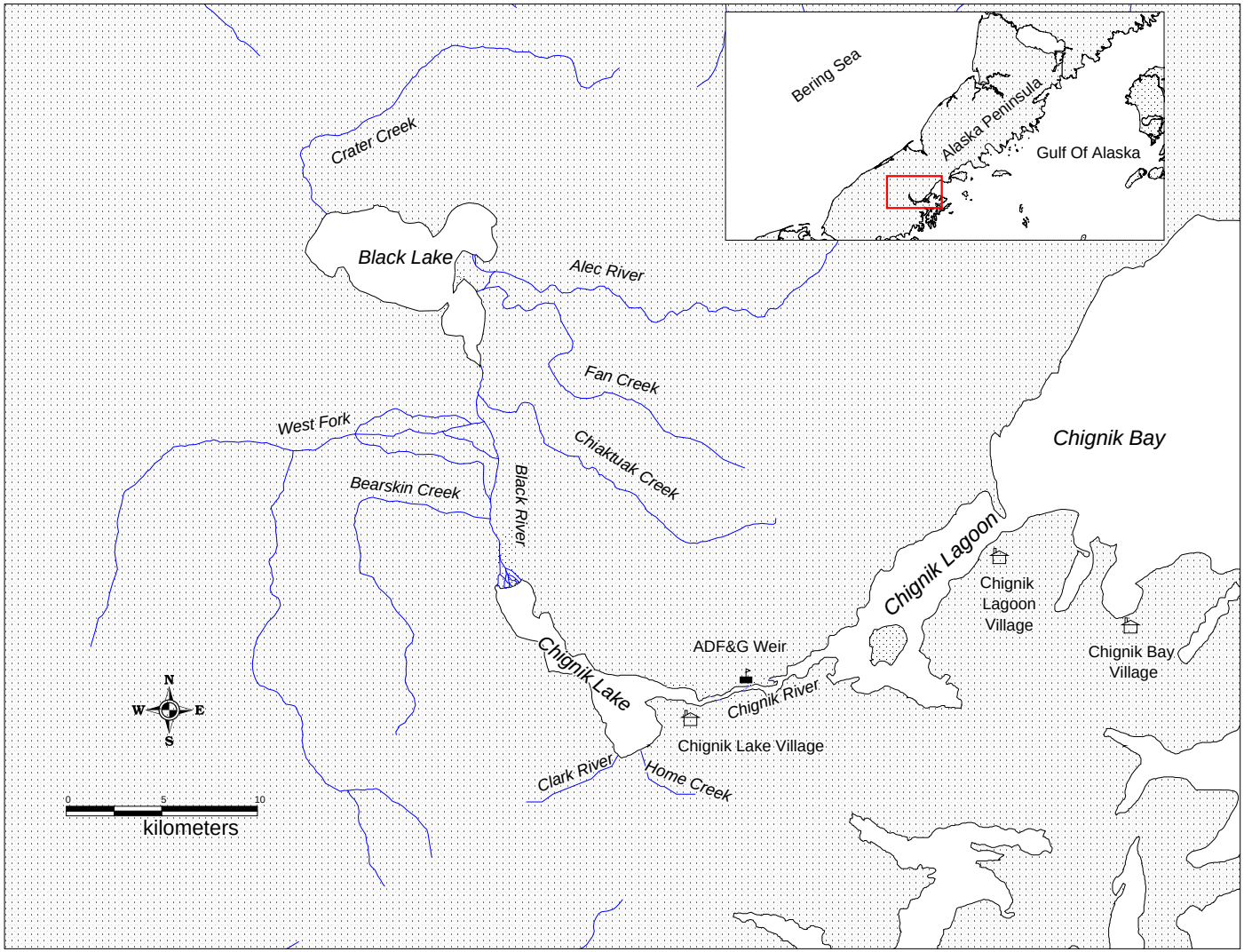


Figure 2.–The Chignik River watershed, showing Black and Chignik lakes, Black and Chignik rivers, and Chignik Lagoon.

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 – Westward Region
Management division:	Sport and Commercial
Primary fishery:	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:	All survey data 1978 to 2009: 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 (2007–2009).

Appendix A2.–Annual estimates of harvest, escapement, and total return of Chignik River Chinook salmon, 1978–2009.

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[c]	Recreational Harvest[d]	Escapement[e]
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	496	72	1,680	2,248	90 [j]	1,590

-continued-

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

[b] Subsistence harvest = 1978–2008 average.

[c] Total run is weir count plus commercial and subsistence harvest. Recreational harvest mostly upstream of weir, thus already captured in weir counts.

[d] 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.

[e] Escapement is weir count minus recreational harvest.

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

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

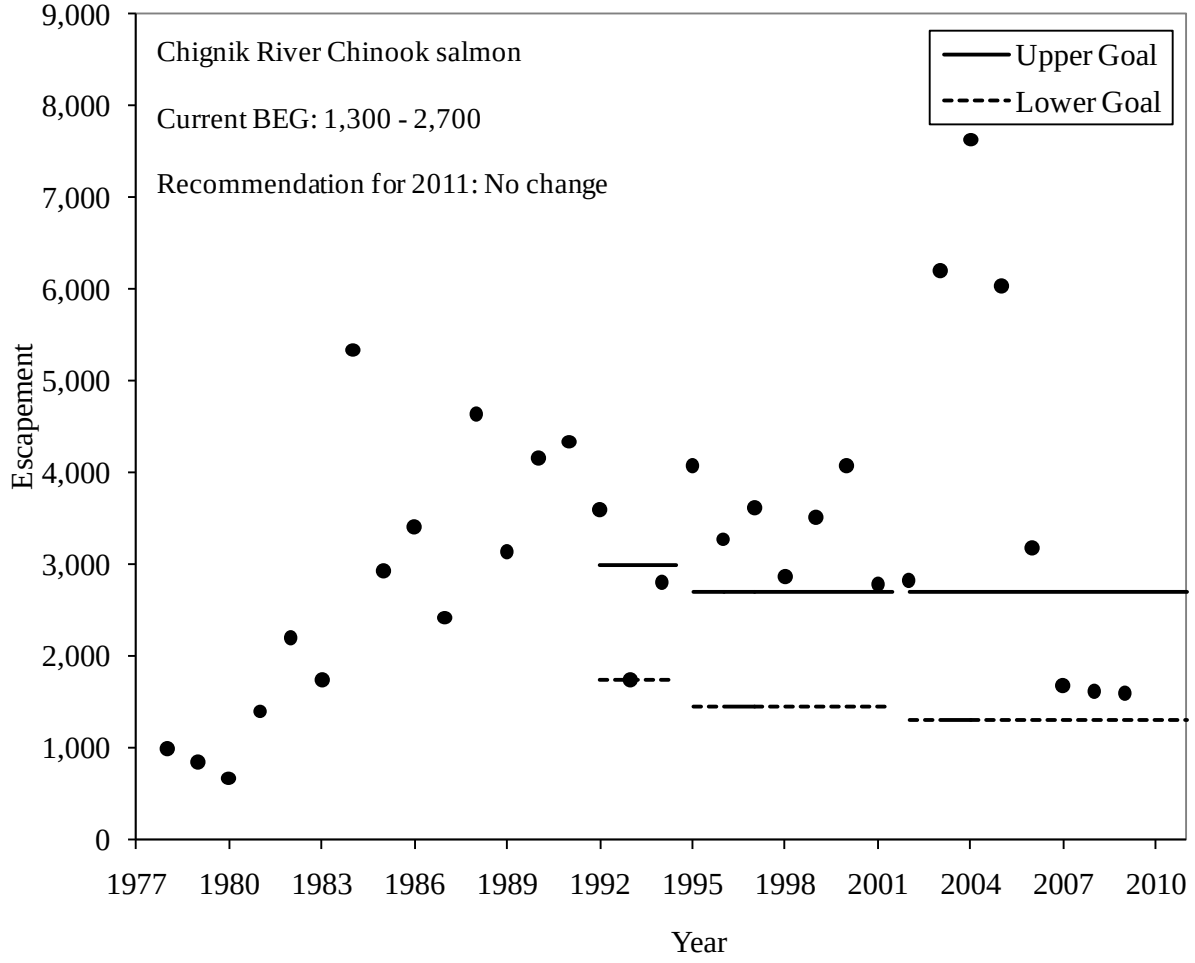
[h] Recreational harvest = 135 unguided + 190 guided above weir. Guided harvest from sport fish freshwater logbook program. Unguided harvest estimated as proportion of guided.

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

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

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

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



Appendix A4.–Brood table for Chignik River Chinook salmon.

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

Brood Year		Return by age					Total		
Escapement		3	4	5	6	7	Return	Yield	R/S
1978	990	84	877	1,880	4,023	231	7,095	6,105	7.2
1979	843	133	849	3,165	2,151	289	6,588	5,745	7.8
1980	669	129	1,430	1,692	2,695	213	6,159	5,490	9.2
1981	1,396	217	765	2,120	1,982	429	5,513	4,117	3.9
1982	2,205	116	958	1,559	3,998	320	6,951	4,746	3.2
1983	1,736	145	704	3,145	2,983	382	7,360	5,624	4.2
1984	5,341	107	1,421	2,347	3,554	307	7,735	2,394	1.4
1985	2,937	215	1,060	2,796	2,857	328	7,256	4,319	2.5
1986	3,405	161	1,263	2,247	3,056	289	7,016	3,611	2.1
1987	2,417	191	1,015	2,405	3,869	144	7,623	5,206	3.2
1988	4,635	154	1,086	2,054	1,900	579	5,774	1,139	1.2
1989	3,135	165	1,007	2,475	4,677	682	9,005	5,870	2.9
1990	4,157	89	322	1,070	2,726	0	4,207	50	1.0
1991	4,338	144	890	1,266	2,196	0	4,496	158	1.0
1992	3,599	178	438	1,797	1,448	213	4,073	474	1.1
1993	1,739	0	1,098	2,224	1,791	287	5,400	3,661	3.1
1994	2,809	50	955	2,040	1,940	177	5,162	2,353	1.8
1995	4,081	239	1,822	2,083	1,425	188	5,756	1,675	1.4
1996	3,278	206	575	1,033	1,746	431	3,992	714	1.2
1997	3,617	144	784	1,374	4,014		6,315	2,698	1.7
1998	2,868	891	621	3,158					
1999	3,521	94	1,427						
2000	4,078	216							
2001	2,785								
2002	2,821								
2003	6,205								
2004	7,633								
2005	6,037								
2006	3,175								
2007	1,675								
2008	1,620								
2009	1,590								

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 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:	Early run SEG: 350,000 to 400,000 fish (2005)
	Late run SEG: 200,000 to 400,000 fish (2008)
Recommended escapement goal:	Early run SEG: No change
	Late run SEG: No change
Optimal escapement goal:	None
Inriver run goal:	50,000 (since 2008; to be added to lower range of SEG)
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 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:	1952–2009: 22.5 (early run)
	1965–2009: 2.5 (early run)
	1977–2009: 2.2 (early run)
	1980–2009: 2.2 (early run)
Methodology:	Ricker stock-recruit model, percentile method, euphotic volume analysis, zooplankton biomass
Autocorrelation:	None detected

-continued-

Recommendation:	No change to SEGs for early or late runs.
Comments:	Percentile analysis for the early run corroborated the current SEG range. Late-run Ricker models were significant for data from 1952 to 2001 and from 1965 to 2001. Smolt biomass and euphotic volume model analysis corroborated the current SEG lower range. Current goals recommended as no changes were indicated for the early-run, late-run SEG or inriver run goal during August and September.

Appendix B2.–Escapement data available for analysis of Chignik River 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	326,563	257,675	584,238
1976	548,953	276,793	825,746
1977	364,557	328,916	693,473

-continued-

System: **Chignik River watershed**

Species: **Sockeye salmon**

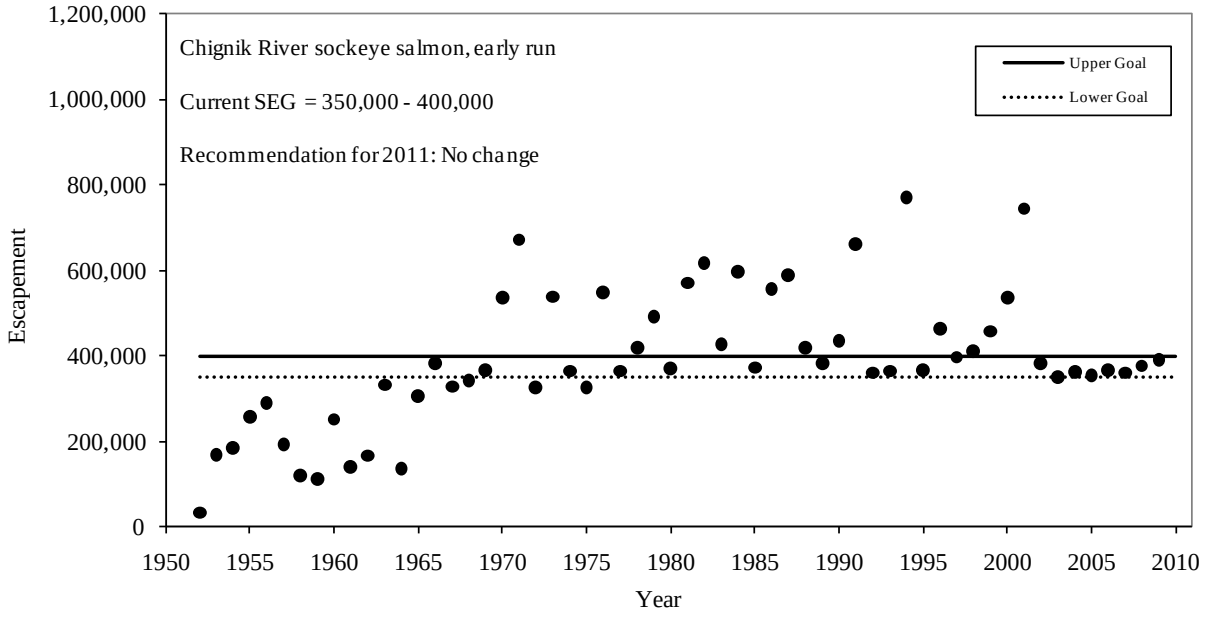
Data available for analysis of escapement goals.

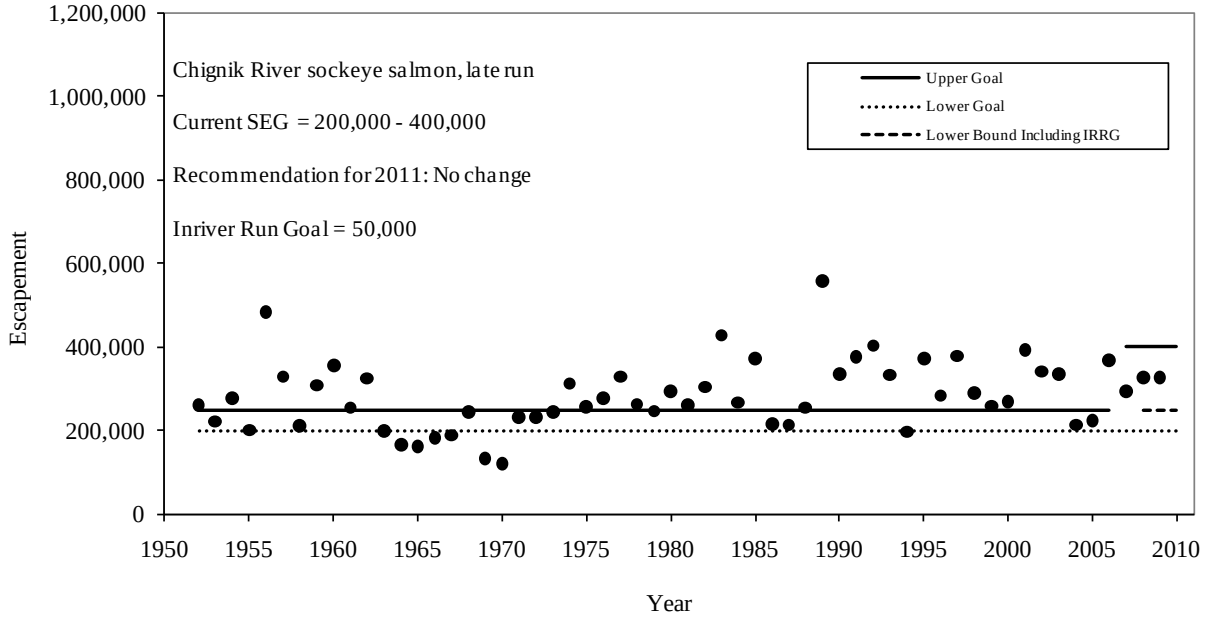
	Estimated Escapement		
Year	Early Run	Late Run	Total
1978	419,732	262,815	682,547
1979	491,467	246,349	737,816
1980	369,580	294,481	664,061
1981	570,210	261,239	831,449
1982	616,117	305,193	921,310
1983	426,178	428,034	854,212
1984	597,713	267,861	865,574
1985	373,040	372,798	745,838
1986	557,772	215,547	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	536,139	269,084	805,223
2001	744,013	392,905	1,136,918
2002	384,088	341,132	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
2007	361,091	293,883	654,974
2008	377,579	328,479	706,058
2009	391,476	328,586	720,062

Appendix B3.–Annual escapements and escapement goals for early, late, and combined runs of Chignik River sockeye salmon, 1952 to present.

System: **Chignik River**

Species: **Sockeye salmon**





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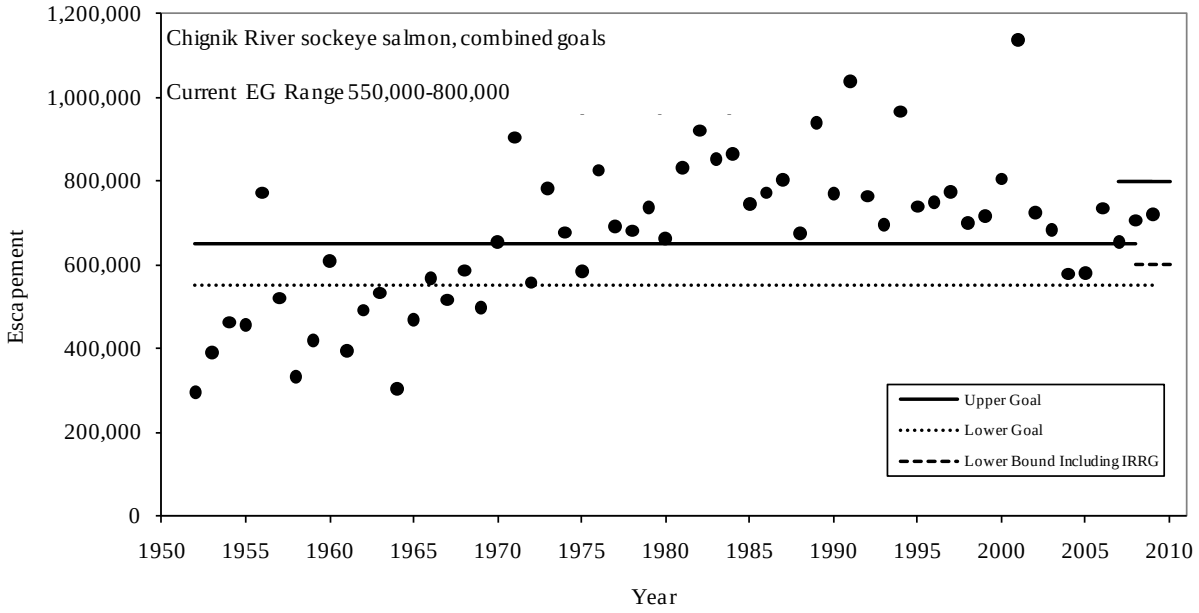

Chignik River sockeye salmon, combined goals
Current EG Range 550,000-800,000
Upper Goal
Lower Goal
Lower Bound Including IRRG
Escapement
Year
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

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

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	0.1	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	2,181,473

-continued-

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	0.1	0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	0.4	1.4	2.3	3.2	2.4	3.3	3.4	4.3	Total
1978	419,732	0	0	408	0	56,426	3,133	498,425	57,526	0	0	6,581	464,129	0	0	554	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	326	411	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	697	299	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	1,202	213	0	0	1,910,702
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	482	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	2,178	574	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	746	2,155	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	1,057	9,254	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	5,673	1,422	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	5,859	33,825	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	828	436	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	2,079	18,160	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	3,065	8,750	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	641	3,667	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	4,878	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	1,172	436	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	618	96	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	2,234	2,776	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	801	2,399	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	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	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	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	3,513	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	2,738	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			380,224
2003	350,004	0	4,532	0	58,353	90,847	0	416,783	17,263	0	0	235	103,322	0					
2004	363,800	0	13,304	0	51,252	45,346	0	604,316	47,109	0	1,720								
2005	355,091	0	0	171	17,163	94,309	0												
2006	366,497	0	1,250	0															
2007	361,091	0																	
2008	377,579																		
2009	391,476																		

Appendix B5.–Brood table for late-run Chignik River sockeye salmon.

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	0.1	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
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

-continued-

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	0.1	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
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
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				756,068
2003	334,119	0	816	804	20,583	61,186	241	301,317	62,734	0	0	4,106	549,704	0								
2004	214,459	0	8,236	530	56,510	43,626	621	367,978	188,016	0	0											
2005	225,366	0	386	0	11,064	97,493	1,001															
2006	368,996	0	1430	733																		
2007	293,883	0																				
2008	328,479																					
2009	328,586																					

Appendix B6.–Existing escapement goals for Chignik River sockeye salmon using spawner-recruit, with a comparison of results from euphotic volume, zooplankton stock-recruit, and percentile models.

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	325,000	400,000	600,000	700,000	800,000
EV[a,b]	n/a	n/a	n/a	294,663	368,329	441,994	n/a	n/a	n/a
Zooplankton[b]	n/a	n/a	n/a	495,882	619,853	743,823	n/a	n/a	n/a
Spawner-recruit[c]									
1952-2002	n/a	n/a	n/a	197,742	278,643	374,761	n/a	n/a	n/a
1965-2002	n/a	n/a	n/a	236,143	306,477	441,686	n/a	n/a	n/a
1977-2002	n/a	n/a	n/a	244,515	354,841	731,889	n/a	n/a	n/a
1980-2002	n/a	n/a	n/a	NS	NS	NS	n/a	n/a	n/a
Percentile[d]									
1952-2009	326,740	n/a	462,917	n/a	n/a	n/a	n/a	n/a	n/a
1965-2009	358,445	n/a	769,465	n/a	n/a	n/a	n/a	n/a	n/a
1977-2009	364,169	n/a	769,465	n/a	n/a	n/a	n/a	n/a	n/a
1980-2009	363,961	n/a	769,465	n/a	n/a	n/a	n/a	n/a	n/a
Actual Escapements	34,155	388,842	769,465	119,952	283,343	557,174	294,695	672,185	1,136,918

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

[b] Data from 1991 and 2000 to 2009 (Kyle 1992, Bouwens and Newland 2004; Finkle 2007).

[c] Late run R/S analyses using multiplicative error structure based on data from 1952 to 2009. NS = not significant (P>0.05).

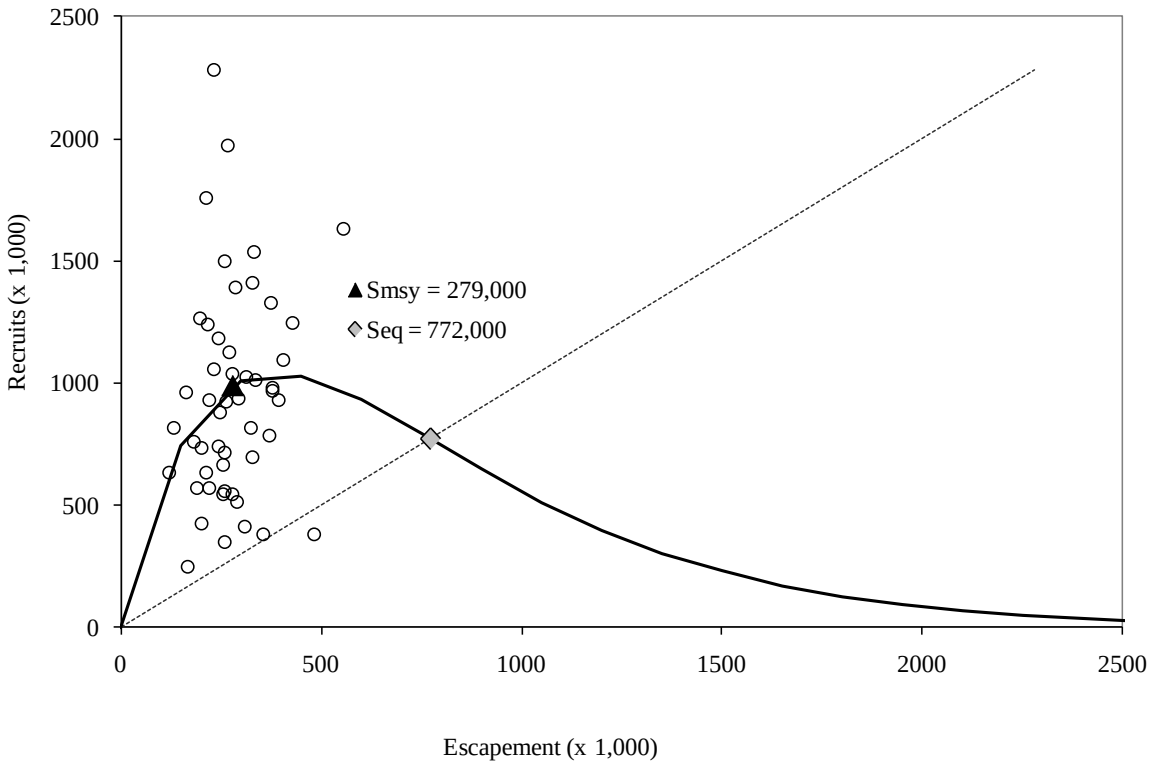
[d] Percentile model uses 25th to 75th percentile for the 1952-2009 data set; 15th to maximum percentile for all other data sets.

Appendix B7.–Stock-recruit curves for late-run Chignik River sockeye salmon.

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

Species: **Sockeye salmon**

Ricker stock–recruitment relationship, 1952–2001 brood years. The solid curved line represents the multiplicative error Ricker curve and the dashed straight line represents replacement.

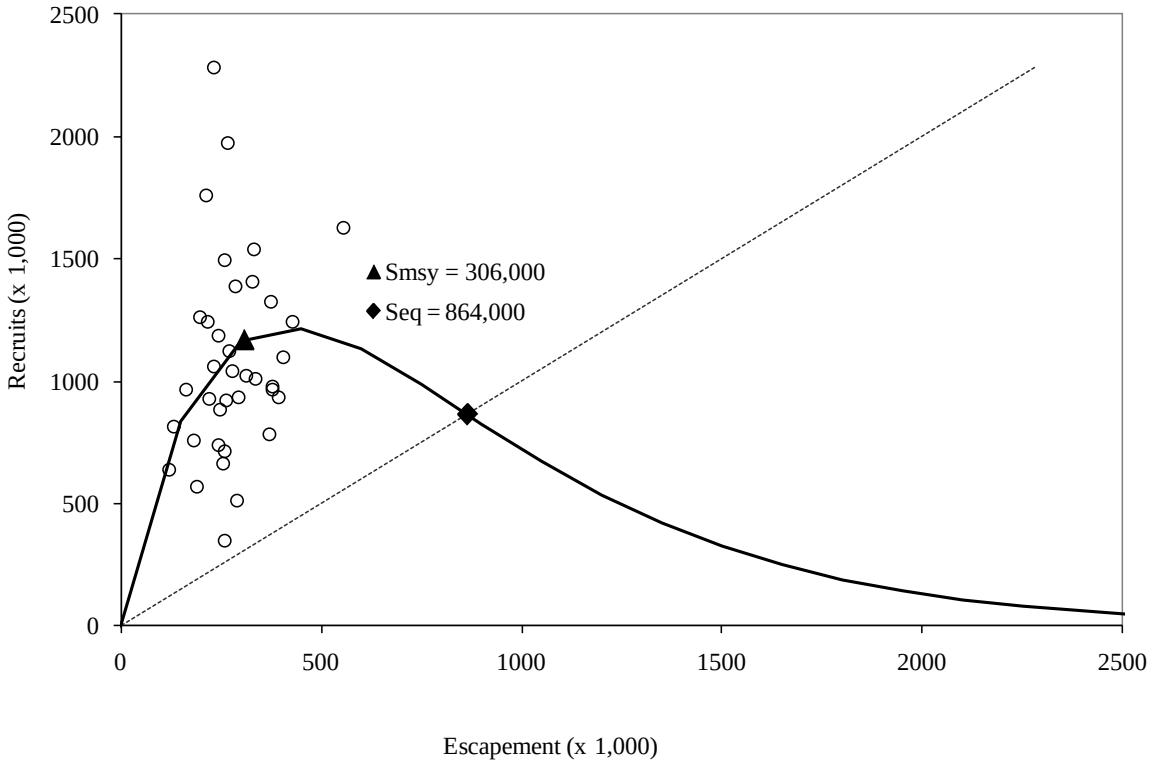


-continued-

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

Species: **Sockeye salmon**

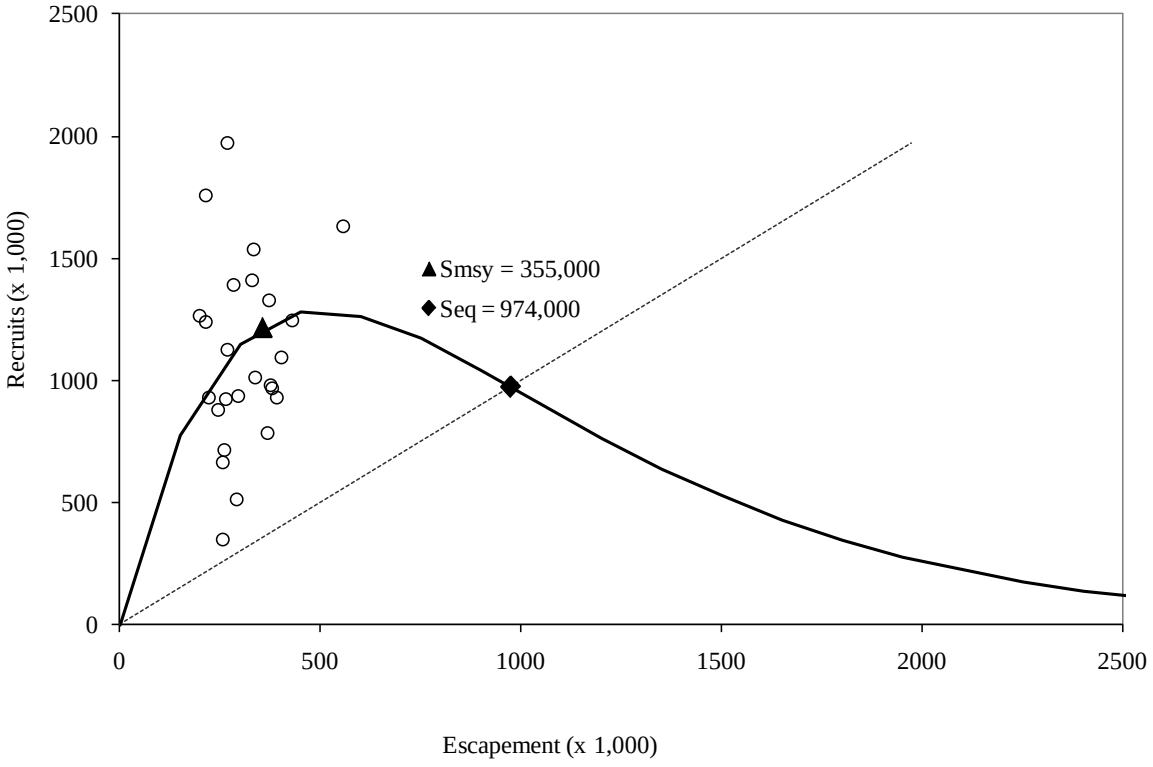
Ricker stock–recruitment relationship, 1965–2001 brood years. The solid curved line represents the multiplicative error Ricker curve and the dashed straight line represents replacement.



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

Species: **Sockeye salmon**

Ricker stock–recruitment relationship, 1977–2001 brood years. The solid curved line represents the multiplicative error Ricker curve 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, 1962–2009.
Data summary:	
Data quality:	Fair
Data type:	Fixed-wing aerial surveys with estimated total escapement from 1968 to 2009. A total of 49 streams are used as an index for district-wide escapement.
Contrast:	101
Methodology:	Yield Analysis
Autocorrelation:	None detected
Recommendation:	No change to existing SEGs
Comments:	Only one year of returns for each goal (odd- and even-year) since last change in 2008.

Appendix C2.–Peak aerial surveys for pink salmon in the entire CMA, 1972 through 2009.

System: **Entire CMA**

Species: **Pink salmon**

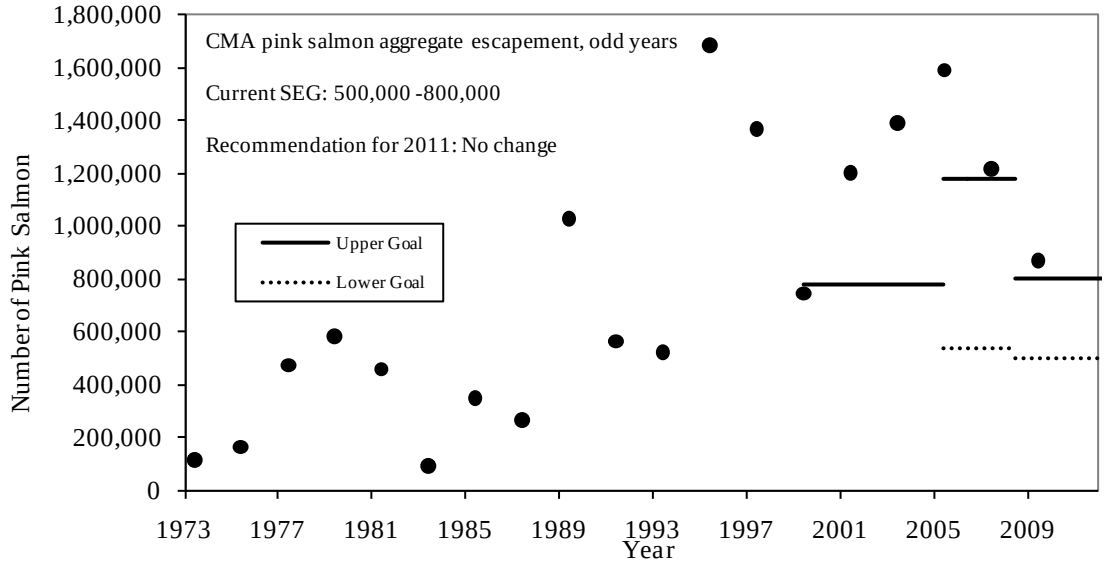
Data available for analysis of escapement goals.

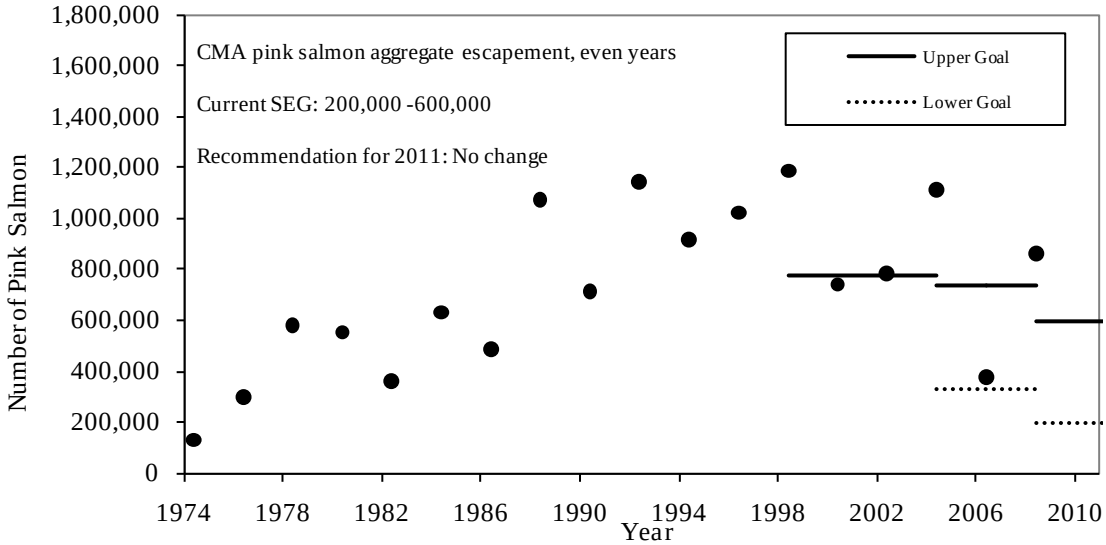
Year	Peak Aerial Survey
1972	16,725
1973	117,225
1974	130,401
1975	165,920
1976	300,280
1977	474,080
1978	580,650
1979	582,913
1980	552,400
1981	460,375
1982	363,755
1983	91,295
1984	632,880
1985	349,200
1986	487,550
1987	268,762
1988	1,075,640
1989	1,031,220
1990	713,750
1991	566,600
1992	1,143,585
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	1,114,860
2005	1,591,850
2006	374,826
2007	1,217,064
2008	863,031
2009	869,063

Appendix C3.–Annual peak aerial surveys and escapement goals for CMA pink salmon, 1973 to present.

System: **Entire CMA**

Species: **Pink salmon**





Appendix C4.–Yield table for CMA pink salmon, even years. Escapement intervals have a range of 400,000 to 600,000.

System: **Entire CMA**

Species: **Pink salmon**

				Yield					
				Returns per Spawner		Return Minus Parent Escapement		Harvest	
Number of Years	Lower Goal	Upper Goal	Escapement Range	Mean	Median	Mean	Median	Mean	Median
4	100,000	500,000	400,000	5.5	5.3	1,532,457	989,707	1,205,591	714,959
7	500,000	900,000	400,000	1.9	1.8	563,819	501,795	659,967	647,125
5	900,000	1,300,000	400,000	1.3	1.2	322,073	203,578	475,038	431,063
5	200,000	600,000	400,000	4.3	3.0	1,462,867	1,064,934	1,278,729	985,114
6	600,000	1,000,000	400,000	1.6	1.2	415,488	202,044	473,712	286,321
4	1,000,000	1,400,000	400,000	1.3	1.2	328,625	195,848	546,531	490,536
6	300,000	700,000	400,000	3.9	2.9	1,302,688	889,432	1,173,462	929,249
7	700,000	1,100,000	400,000	1.5	1.2	445,819	188,118	503,163	383,574
8	400,000	800,000	400,000	2.7	2.0	941,497	593,267	952,116	760,255
5	800,000	1,200,000	400,000	1.3	1.2	322,073	203,578	475,038	431,063
6	100,000	600,000	500,000	4.5	4.1	1,313,250	889,432	1,131,489	929,249
8	600,000	1,100,000	500,000	1.6	1.2	452,816	241,993	521,158	466,791
2	1,100,000	1,600,000	500,000	1.1	1.1	92,446	92,446	429,564	429,564
6	200,000	700,000	500,000	3.9	2.9	1,302,688	889,432	1,173,462	929,249
9	700,000	1,200,000	500,000	1.4	1.2	367,292	188,118	486,808	428,064
5	800,000	1,300,000	500,000	1.3	1.2	322,073	203,578	475,038	431,063
8	400,000	900,000	500,000	2.7	2.0	941,497	593,267	952,116	760,255
5	900,000	1,400,000	500,000	1.3	1.2	322,073	203,578	475,038	431,063
8	500,000	1,000,000	500,000	1.8	1.6	530,325	398,832	601,105	515,350
4	1,000,000	1,500,000	500,000	1.3	1.2	328,625	195,848	546,531	490,536
7	100,000	700,000	600,000	4.1	3.0	1,197,328	713,929	1,062,294	873,384
9	700,000	1,300,000	600,000	1.4	1.2	367,292	188,118	486,808	428,064
6	800,000	1,400,000	600,000	1.3	1.2	322,073	203,578	475,038	431,063
5	900,000	1,500,000	600,000	1.3	1.2	322,073	203,578	475,038	431,063
9	400,000	1,000,000	600,000	2.6	1.8	869,761	501,795	867,333	647,125
4	1,000,000	1,600,000	600,000	1.3	1.2	328,625	195,848	546,531	490,536

Appendix C5.–Yield table for CMA pink salmon, odd years. Escapement intervals have a range of 300,000 to 600,000.

System: **Entire CMA**

Species: **Pink salmon**

				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	3.5	3.0	496,083	478,254	236,365	156,470
5	400,000	700,000	300,000	4.0	3.8	1,566,796	1,607,917	1,419,073	1,648,377
4	200,000	500,000	300,000	2.9	2.7	730,659	478,254	625,216	283,977
6	500,000	800,000	300,000	4.3	3.4	1,601,578	1,289,457	1,452,844	1,389,784
6	300,000	600,000	300,000	3.6	3.3	1,333,386	1,323,996	1,223,690	1,405,495
6	100,000	500,000	400,000	3.3	3.0	658,410	478,254	528,639	283,977
4	500,000	900,000	400,000	4.3	3.6	1,901,033	1,672,100	1,537,689	1,465,072
7	200,000	600,000	400,000	3.6	3.8	1,255,784	1,040,075	1,052,836	1,162,613
4	1,000,000	1,400,000	400,000	1.3	1.6	319,587	697,933	891,146	835,943
6	300,000	700,000	400,000	3.6	3.3	1,333,386	1,323,996	1,223,690	1,405,495
6	400,000	800,000	400,000	3.9	3.6	1,595,044	1,672,100	1,396,189	1,465,072
9	100,000	600,000	500,000	3.8	3.8	1,090,924	912,966	893,425	604,806
7	200,000	700,000	500,000	3.6	3.8	1,255,784	1,040,075	1,052,836	1,162,613
4	1,200,000	1,700,000	500,000	1.2	1.4	274,313	607,385	809,941	673,535
7	300,000	800,000	500,000	3.5	3.3	1,390,943	1,607,917	1,231,987	1,281,767
6	400,000	900,000	500,000	3.9	3.6	1,595,044	1,672,100	1,396,189	1,465,072
4	900,000	1,400,000	500,000	1.3	1.6	319,587	697,933	891,146	835,943
4	500,000	1,000,000	500,000	4.3	3.6	1,901,033	1,672,100	1,537,689	1,465,072
4	1,000,000	1,500,000	500,000	1.3	1.6	319,587	697,933	891,146	835,943
9	100,000	700,000	600,000	3.8	3.8	1,090,924	912,966	893,425	604,806
8	200,000	800,000	600,000	3.6	3.6	1,315,846	1,323,996	1,081,452	1,222,190
5	800,000	1,400,000	600,000	1.3	1.6	319,587	697,933	891,146	835,943
7	300,000	900,000	600,000	3.5	3.3	1,390,943	1,607,917	1,231,987	1,281,767
4	900,000	1,500,000	600,000	1.3	1.6	319,587	697,933	891,146	835,943
6	400,000	1,000,000	600,000	3.9	3.6	1,595,044	1,672,100	1,396,189	1,465,072
4	1,000,000	1,600,000	600,000	1.3	1.6	319,587	697,933	891,146	835,943
5	500,000	1,100,000	600,000	3.7	3.3	1,661,752	1,607,917	1,464,001	1,281,767
5	1,100,000	1,700,000	600,000	1.2	1.4	274,313	607,385	809,941	673,535
4	1,200,000	1,800,000	600,000	1.2	1.4	274,313	607,385	809,941	673,535