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Review of Salmon Escapement Goals in the Kodiak Management Area, 2019

by

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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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TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

LIST OF APPENDICES (Continued)

ABSTRACT

An interdivisional team of staff from the Alaska Department of Fish and Game met beginning in March 2019 to review existing Pacific salmon (*Oncorhynchus*) escapement goals in the Kodiak Management Area (KMA) and make recommendations to the directors of the divisions of Commercial Fisheries and Sport Fish. The KMA salmon escapement goals had been reviewed previously in 2016. The current review team recommends 21 goals remain unchanged, and 1 goal be revised (Olds River coho salmon [*O. kisutch*] lower bound sustainable escapement goal of 500). In addition, a change in designation from a biological escapement goal to a sustainable escapement goal is recommended for 3 goals (Afognak River sockeye salmon [*O. nerka*], Upper Station late-run sockeye salmon, and Buskin River coho salmon). When combined with existing escapement goals, these staff recommendations to the directors of the divisions of Commercial and Sport Fisheries result in 22 escapement goals for the KMA in 2019: 12 for sockeye salmon, 2 for Chinook salmon (*O. tshawytscha*), 4 for coho salmon, 3 for pink salmon (*O. gorbuscha*), and 1 for chum salmon (*O. keta*).

Key words: Pacific salmon, *Oncorhynchus* spp., escapement goal, Kodiak, stock status

INTRODUCTION

This report documents the 2019 review of salmon (*Oncorhynchus*) escapement goals in the Kodiak Management Area (KMA) based on the Alaska Board of Fisheries (BOF) *Policy for the management of sustainable salmon fisheries* (SSFP; 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 (ADF&G) and are intended to take effect for salmon stocks returning in 2020. Salmon escapement goals in the KMA were last reviewed in 2016 (Schaberg et al. 2016).

Two important terms defined in the SSFP are as follows:

- biological escapement goal (BEG): the escapement that provides the greatest potential for maximum sustained yield
- 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

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*) 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 KMA have gone through BOF review 5 times: 2005, 2007, 2010, 2013, and 2016 (Nelson et al. 2005; Honnold et al. 2007; Nemeth et al. 2010; Sagalkin et al. 2013; Schaberg et al. 2016).

In March 2019, an interdivisional team including staff from the divisions of Commercial Fisheries and Sport Fish (hereafter referred to as "the team") was formed to review the existing KMA salmon escapement goals and recent escapements for stocks with escapement goals. For this review, the team 1) determined the appropriate goal type (BEG or SEG) based on the quality and quantity of available data for each KMA salmon stock with an existing goal, 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 for all stocks with escapement goals.

STUDY AREA

The KMA comprises the waters of the western Gulf of Alaska surrounding the Kodiak Archipelago and along that portion of the Alaska Peninsula that drains into the Shelikof Strait between Cape Douglas and Kilokak Rocks (Figure 1).

The Kodiak Island archipelago extends approximately 240 km (150 miles) from Shuyak Island south to Tugidak Island. The Mainland portion of the KMA is about 256 km (160 miles) long and is separated from the archipelago by Shelikof Strait, which averages 48 km (30 miles) in width (Figure 2). Chirikof Island, located approximately 64 km (40 miles) south southwest of Tugidak Island, is also included in the KMA.

The KMA is divided into 7 commercial fishing districts: Afognak, Northwest Kodiak, Southwest Kodiak, Alitak, Eastside Kodiak, Northeast Kodiak, and Mainland districts (Figure 1; Jackson and Keyse 2013). These are further subdivided into sections, each of which is composed of smaller statistical areas, including terminal or special harvest areas. For commercial salmon fisheries, legal gear in districts or sections can consist of purse seines, hand purse seines, beach seines, or set gillnets. Subsistence fisheries occur throughout the KMA.

Commercial fisheries in the KMA primarily target sockeye salmon from June through early July; some early chum salmon stocks may influence management in localized areas (Jackson and Keyse 2013). Pink salmon stocks are targeted from early July through mid-August, with some areas managed specifically for local sockeye or chum salmon stocks. Late-run sockeye, coho, and late returning chum salmon are targeted from mid-August through early September; coho salmon are the targeted species in late September and October.

Sport fishing occurs throughout the KMA and is divided into 2 areas: the Kodiak Road Zone and the Kodiak Remote Zone. The majority of the sport fishing effort occurring in the Kodiak Road Zone in proximity to the City of Kodiak. Anglers primarily target coho, sockeye, and Chinook salmon in several fisheries, although all species of salmon are harvested by anglers. Chinook salmon have historically been the most sought-after species by anglers, with focus on returns to the Karluk and Ayakulik rivers during the month of June. Since the mid-2000s, sport fishing options for Chinook salmon have declined due to lower returns in these locations. The Chinook salmon enhancement project in the Kodiak Road Zone has provided opportunity for anglers to target Chinook salmon. Sockeye salmon are targeted in 3 Kodiak Road Zone drainages as well as numerous remote locations by both guided and unguided anglers. However, coho salmon are the species most targeted throughout the island by anglers. Anglers target them in nearshore salt waters surrounding Afognak and Shuyak islands during August and in fresh waters through early October.

METHODS

The current review was conducted much like the 2016 review (Schaberg et al. 2016), primarily examining recent (2016–2018) data and updating previous analyses. The first formal meeting to discuss and develop recommendations was held in March 2019. The team also communicated on a regular basis by telephone and e-mail.

Escapement, harvest, and age data associated with each stock or combination of stocks to be examined were compiled from research reports, management reports, and unpublished historical databases. Limnological and spawning habitat data were compiled for each system when available. The team evaluated the type, quality, and amount of data for each stock according to criteria described in Clark et al. (2014). This evaluation assisted in determining the appropriate type of escapement goal to apply to each stock as defined in the SSFP and the *Policy for statewide salmon escapement goals*.

Biological Escapement Goal

In Alaska, most salmon BEGs are developed using Ricker (1954) spawner-recruit models (Munro and Volk 2016). As defined in the SSFP (5 AAC 39.222), BEGs are estimates of the number of spawners that provide the greatest potential for maximum sustained yield (S_{MSY}). For this review, most 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, defined as S_{EQ}, was estimated by the Ricker model as the escapement level (abundance of spawners) that provides an equivalent level of return or replacement when the stock has not been exploited (Quinn and Deriso 1999). Estimates of S_{MSY} and S_{EQ} were not used if the model fit the data poorly or if critical 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 assumed a multiplicative error structure and were tested for residual autocorrelation, which was not corrected for if present based on the recommendations of Korman et al. (1995) for Alaskan sockeye salmon stocks. When auxiliary data were available (e.g., limnology 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 several methods, depending on the system, species, and type of data available. For this review, most SEGs were determined using the Percentile Approach (Clark et al. 2014), risk analysis (Bernard et al. 2009), or the spawner-recruit model (Ricker 1954; described above). Other methods used were yield analysis (Hilborn and Walters 1992), the euphotic volume model (Koenings and Kyle 1997), and the zooplankton forage model (Koenings and Kyle 1997). These latter 2 habitat-based models were used only for sockeye salmon to assess the likely number of juvenile fish that a system can support given available habitat or food. Results from these models were not generally used to determine escapement goals, but instead were used as a secondary, alternative analysis of production that was less dependent on adult fish count data. When used, results from the euphotic volume and zooplankton forage models were reported as generally corroborating or not corroborating the primary analysis.

The Percentile Approach is based on the principle that a range of observed or indexed escapements that have been sustained over a period of time represents an SEG for a stock that has been fished and has probably sustained some unknown level of yields over the same time period. Thus, maintaining escapements of a stock within some range of percentiles observed over the time series of escapements represents a proxy for maintaining escapements within a range that encompasses S_{MSY} (Clark et al. 2014). This method takes into account the measurement error of the data collection method (i.e., weirs and towers have lower measurement error than aerial or foot surveys), 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. Based on these criteria, a tier system designates what percentiles should define the SEG range.

Tier	Escapement contrast	Measurement error	Harvest rate	SEG range
1	>8	High (aerial and foot surveys)	Low to moderate (< 0.40)	20th to 60th percentile
2	>8	Low (weirs and towers)	Low to moderate (< 0.40)	15th to 65th percentile
3	≤8	-	Low to moderate (< 0.40)	5th to 65th percentile

The risk analysis (Bernard et al. 2009) was used to establish a lower-bound SEG, in the form of a precautionary reference point, from a time series of observed escapement estimates using probability distributions. This method is based on estimating the risk of management error and is particularly appropriate in situations where a stock (or stock aggregate) is not "targeted" and observed escapement estimates are the only reliable data available. In essence, this analysis estimates the probability of detecting escapement falling below the SEG in a predetermined number of consecutive years (k). For example, if we believe there is cause for concern when escapement falls below the SEG for 3 consecutive years, k would be equal to 3. Simultaneously, a second probability is estimated, which is the probability of taking action (e.g., closing a fishery to protect the stock) for 3 consecutive years when no action was needed. This analysis assumes that escapement observations follow a lognormal distribution and have a stationary mean (i.e., no temporal trend). Normality and temporal trends (autocorrelation) of log-transformed escapement data can be examined and steps taken to correct violation of these assumptions.

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

The euphotic volume model, following the methods of Koenings and Kyle (1997), estimated adult escapement in part by determining the volume of lake water capable of primary production that could sustain a rearing population of juvenile sockeye salmon. 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 euphotic volume model assumes there is no primary productivity below depths at which light has been attenuated by 99%.

The zooplankton model, as described in Witteveen et al. (2005), estimated smolt production based on an available zooplankton biomass fed upon by smolt of a targeted threshold size, in a lake of known size (Koenings and Kyle 1997). The zooplankton model, like the euphotic volume model, uses the premise that the availability of forage could affect survival of juvenile fish and subsequent

adult production. Adult production was calculated using species fecundity and marine survival rates. The zooplankton model assumes zooplankton is the only available forage.

CHINOOK SALMON

Ayakulik River

The Ayakulik River is located on southwestern Kodiak Island and supports one of the 2 largest Chinook salmon stocks in the KMA. The Ayakulik River drains Red Lake, then flows into Shelikof Strait in the area designated as the Inner Ayakulik Section of Southwest Kodiak District (Anderson et al. 2019; Figures 1 and 3).

A BEG has been developed for the Ayakulik River Chinook salmon stock. Chinook salmon are counted using a weir in the lower Ayakulik River (Fuerst 2019). Annual Chinook salmon escapement was estimated by subtracting estimates of recreational and subsistence harvest from the inriver run counted at the weir (Polum et al. 2019). Weir counts at the Ayakulik River were available from 1972 to 2018, although data from 1972 to 1976 were excluded because the weir was upstream of some Chinook salmon spawning locations in those years. Counts for 1980 and 1982 were expanded based on average run timing to the weir to account for days the weir was not operational (Schwarz et al. 2002). Estimates were also made for times that the weir washed out during the peak of the run for 2016 through 2018.

Sport harvests for Chinook salmon were historically estimated by the ADF&G Statewide Harvest Survey[1]; however, estimates are rarely available now due to low participation rates in the fishery. In years when a sport fishery occurs, harvest is assumed to be 20 fish above the weir based on historical information (Polum et al. 2019). Commercial harvests were tallied from the Division of Commercial Fisheries Statewide Harvest Receipt (fish ticket) database. Because stock-specific harvests by the commercial fishery are not available, all Chinook salmon in the Inner (256-10, 256-15) and Outer (256-20) Ayakulik sections from June 1 through July 15 were assumed to be of Ayakulik River origin; however, retention of Chinook salmon greater than 28 inches in length in the purse seine fishery in recent years has been prohibited in areas surrounding the Ayakulik River (5 AAC 18.395). Harvests occurring from June 1 through July 15 were used to most closely match traditional run timing of Chinook salmon stocks. Annual subsistence harvests were estimated from returns of completed permits received by the Division of Commercial Fisheries.

Scales were collected from Chinook salmon sampled at the Ayakulik River weir from 1993 to 2015 to estimate age composition of the run. Age composition of the commercial harvest was assumed to be the same as that observed at the weir.

Escapement Goal Background and Previous Review

An initial escapement goal of 6,500 to 10,000 fish was established for Ayakulik River Chinook salmon based on average historical escapements providing harvestable surpluses (Nelson and Lloyd 2001). During the 2001/2002 BOF meeting for Kodiak, a BEG of 4,800 to 9,600 fish was established based on a spawner-recruit analysis using the Ricker curve[2]. The BEG was re-evaluated in 2005 using an updated spawner-recruit analysis and left unchanged (Nelson et al. 2005). The BEG was evaluated again in 2007, with the conclusion that the most recent 3 years of data would

[1] Alaska Sport Fishing Survey database [Internet]. 1996–present. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish. Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/

[2] Hasbrouck, J. J., and R. A. Clark. Unpublished. Escapement goal review of Chinook salmon in the Ayakulik, Chignik, and Karluk Rivers. Alaska Department of Fish and Game.

not substantially change the results of previous analysis (Honnold et al. 2007). The BEG was changed to 4,000 to 7,000 fish after review in 2010 (Nemeth et al. 2010). Escapement data were reviewed in 2013, but no changes were made to the BEG (Sagalkin et al. 2013). The goal was reviewed again in 2016 with an age-structured spawner-recruit model using Bayesian analysis (Schaberg et al. 2016) and the goal was raised to 4,800–8,400 fish.

2019 Review

Recent Ayakulik River Chinook salmon run data were examined to determine whether a change in the escapement goal was justified, and the team agreed that no further analysis was necessary. The escapement in Ayakulik River fell below the goal in all 3 years since the previous goal change; however, periods of counting weir washouts due to flooding during the peak of the run resulted in much of the escapement count being estimated. There was discussion about whether to change the goal for Ayakulik River Chinook salmon from a BEG to an SEG due to the lack of recent age data and large uncertainty in estimates of the escapement data; however, it was decided to leave it as a BEG and make an effort to increase the accuracy of passage estimates during floods.

Karluk River

The Karluk River drains Karluk Lake, then flows into the Shelikof Strait in the area designated as Inner Karluk Section of Southwest Kodiak District (Anderson et al. 2019; Figures 1 and 3).

A BEG has been developed for the Karluk River Chinook salmon stock. Chinook salmon are counted via weir in the lower Karluk River (Fuerst 2019). Annual Chinook salmon escapements were estimated by subtracting estimates of recreational and subsistence harvest from the inriver run counted at the weir (Polum et al. 2019). Weir counts were available from 1976 to 2018.

Karluk River Chinook salmon formerly served as the broodstock for Chinook salmon stocking projects on the Kodiak road system. Brood was collected from 2000 to 2004.

Sport harvests for Chinook salmon were estimated by the Statewide Harvest Survey; however, the drainage has been closed to sport fishing since 2007. Commercial harvests were tallied from the Division of Commercial Fisheries Statewide Harvest Receipt (fish ticket) database. Total commercial harvests of Chinook salmon in Inner (255-10) and Outer (255-20) Karluk sections from June 1 through July 15 were assumed to be Karluk River fish; however, retention of Chinook salmon greater than 28 inches in length in the purse seine fishery in recent years has been prohibited in areas surrounding the Karluk River (5 AAC 18.395). Annual subsistence harvests were estimated from returns of completed permits received by the Division of Commercial Fisheries.

Scales were collected from Chinook salmon sampled at the Karluk River weir from 1993 to 2015 to estimate age composition of the run. Age composition of the commercial harvest was assumed to be the same as that observed at the weir.

Escapement Goal Background and Previous Review

In 1996, an escapement goal of 4,500 to 8,000 fish was established for Karluk River Chinook salmon based on average historical escapements providing harvestable surpluses (Nelson and Lloyd 2001). During the 2001/2002 BOF meeting for Kodiak, a BEG of 3,600 to 7,300 spawners was established based on a spawner-recruit analysis using the Ricker curve.[3] The BEG was

[3] Hasbrouck, J. J., and R. A. Clark. Unpublished. Escapement goal review of Chinook salmon in the Ayakulik, Chignik, and Karluk Rivers. Alaska Department of Fish and Game, Report to the Board of Fisheries 2002, Anchorage.

re-evaluated in 2005 using an updated Ricker analysis but was subsequently left unchanged (Nelson et al. 2005). The BEG was evaluated again in 2007, with the conclusion that addition of the most recent 3 years of data would not substantially change the results of previous analyses (Honnold et al. 2007). Following an analysis in 2010, the BEG was changed to 3,000 to 6,000 fish (Nemeth et al. 2010). Escapement data were reviewed in 2013, but no changes were made to the BEG (Sagalkin et al. 2013). The goal was reviewed again in 2016 with an age-structured spawner-recruit model using Bayesian analysis and the review concluded that the goal should remain unchanged (Schaberg et al. 2016).

2019 Review

Recent Karluk River Chinook salmon run data were examined to determine whether a change in the escapement goal was justified, and the team agreed that no further analysis was necessary. Escapement failed to meet the goal in 1 of the 3 recent years with no sport fishery during any of the years. There was discussion to change this goal from a BEG to SEG due to the lack of recent age data, but it was decided to leave it as a BEG.

SOCKEYE SALMON

The team added escapement data from 2016 through 2018 to the existing data sets for sockeye salmon stocks in the KMA (Table 1). Two out of the 13 stocks with escapement goals in the KMA were deemed ready for evaluation based on this new information: Afognak Lake and Upper Station.

Afognak Lake

Afognak Lake is located on the southeast side of Afognak Island and has supported one of the largest sockeye salmon runs on the island (Schrof and Honnold 2003; Nelson et al. 2005). The lake drains (via the Afognak River) into Afognak Bay, which is located within the Southeast Afognak Section of the Afognak District (Jackson and Keyse 2013; Figures 1 and 3). A counting weir was established in 1921 at the lake outlet and was run intermittently through 1977. Escapement monitoring has been continuous from 1978 to present, although the weir was moved in 1986 from the lake outlet to 200 meters upstream from the mouth of the Afognak River (Thomsen and Richardson 2013).

In response to declining adult returns in 1987, ADF&G in cooperation with the Kodiak Regional Aquaculture Association (KRAA) initiated prefertilization investigations (Honnold and Schrof 2001). As a result of these investigations, Afognak Lake was fertilized from 1990 to 2000 (White et al. 1990), and backstocking (Afognak Lake has been a brood source for KRAA stocking projects since 1991) occurred in 1991, 1993, 1995, 1996, and 1997.

Escapement Goal Background and Previous Review

The first published escapement goal for Afognak Lake was developed in 1988 and set at 40,000 to 60,000 sockeye salmon (Nelson and Lloyd 2001). Escapement goal reviews of this system were conducted in 2004, 2007, 2010, 2013, and 2016. All available stock assessment data were analyzed using a spawner-recruit analysis, the percentile approach euphotic volume analysis, and smolt biomass as a function of zooplankton (Nelson et al. 2005). The 2004 review resulted in changing the Afognak Lake escapement goal to a BEG of 20,000 to 50,000 sockeye salmon (starting in the 2005 season). The 2007, 2010, 2013, and 2016 reviews indicated that no changes were warranted to the Afognak Lake BEG (Honnold et al. 2007; Nemeth et al. 2010; Sagalkin et al. 2013; Schaberg et al. 2016).

2019 Review

The team agreed to update the analysis and re-evaluate the Afognak Lake BEG in 2019. Spawner-recruit relationships were estimated for the Afognak Lake run by analyzing the data for both 1982 to 2012 and a truncated 2000 to 2012 data set to reduce bias in the analyses from the lagged effects of fertilization (1990–2000) and backstocking (1992, 1994, 1996–1998)[4]. If a Ricker spawner-recruit model was significant, S_{MSY} was estimated, along with the range of escapements that would produce at least 90% of MSY. Residuals were evaluated for autocorrelation and temporal trends. The percentile approach and Markov yield analysis using data from 2000 to 2012 and euphotic volume and zooplankton biomass models using limnological data from 2000 to 2018 were run to estimate optimal escapement. Euphotic volume estimates using updated bathymetry data were applied to data from 2015 to 2018 for comparison to other models.

Ayakulik River

The Ayakulik River drainage is the second largest river system on Kodiak Island and drains approximately 500 km^2 of land on southwest Kodiak Island, including Red Lake (Hander 1997; Figures 1 and 3). The Ayakulik River sockeye salmon run extends from late May until September. Most sockeye salmon spawning is believed to occur in Red Lake or its associated tributaries.

Escapement Goal Background and Previous Review

The original sockeye salmon escapement goal of 200,000 to 300,000 fish for the Ayakulik River was established in 1983 based on spawning habitat observations of different run segments, historical escapement numbers, and recommendations from previous fishery managers (Nelson and Lloyd 2001). Prior to 1989, the Ayakulik River sockeye salmon stock was divided into early and late segments with separate escapement goals. Review in 2004, using all available stock assessment data in spawner-recruit, yield analysis, euphotic volume, and zooplankton biomass models, led to changing the Ayakulik River goal to an SEG of 200,000 to 500,000 fish (Nelson et al. 2005). The 2007 escapement goal review team recommended no change to the Ayakulik River sockeye salmon SEG (Honnold et al. 2007). In 2010, the team recommended reinstituting separate early- and late-run goals for Ayakulik River sockeye salmon; this was based on run-timing curves and new genetics data (Gomez-Uchida et al. 2012). An early-run SEG of 140,000 to 280,000 fish through July 15 and a late-run SEG of 60,000 to 120,000 fish after July 15 was adopted based on zooplankton biomass models and historical escapement goals (Table 1; Nemeth et al. 2010). The goals were reviewed in 2013 and 2016 and the teams recommended no change to either the early run or late run (Sagalkin et al. 2013; Schaberg et al. 2016).

2019 Review

Recent escapement data were examined to determine whether a change in the escapement goal was justified, and the team agreed that no further analysis was necessary.

Buskin River

The Buskin River is located on the northeast side of Kodiak Island and flows into Chiniak Bay near the city of Kodiak (Figure 3). Annual escapement of sockeye salmon to the Buskin River watershed has been counted at a weir since 1985 (Witteveen et al. 2018). Until 1990, the Buskin River weir was located about 2.5 km upstream of the river mouth. In 1990, the weir was relocated

[4] Hamazaki, T. 2019. Escapement goal analyses (source: https://shiny.rstudio.com/). Available from https://hamachan.shinyapps.io/Spawner_Recruit/

to the outlet of Buskin Lake due to numerous washouts caused by high water conditions and to better account for sockeye entering Buskin Lake. In most years, the weir was operated at this site from late May through late July or early August for sockeye salmon, then moved downstream to count coho salmon through September; however, more recently, it has remained in place near the lake outlet and a second weir has been installed downstream during the coho salmon run (Fuerst 2019).

Annual subsistence harvests of Buskin River sockeye salmon are estimated from returns of completed permits received by the Division of Commercial Fisheries. Approximately 90% of completed permits are returned annually and probably account for most of the annual subsistence harvest.

Stock-specific harvest estimates were available for the Buskin River sockeye salmon fisheries from 1990 through 2018. Sport harvests of Buskin River sockeye salmon are estimated by the Statewide Harvest Survey, whereas commercial harvests are tallied from the Division of Commercial Fisheries Statewide Harvest Receipt (fish ticket) database and include catches for the Woman's Bay (259-22) and Buskin River sections (259-26).

Age composition of Buskin River sockeye salmon are estimated from escapement and subsistence harvests (Witteveen et al. 2018). Age composition of commercial and sport harvests is assumed to be the same as the escapement. Age composition data were available for all years analyzed except 1999, when age composition was estimated using the average from 1996 through 1998.

Escapement Goal Background and Previous Review

A Buskin Lake sockeye salmon escapement goal (SEG) of 8,000 to 13,000 fish was developed in 1996, based on historical weir counts (Nelson and Lloyd 2001). The SEG was re-evaluated in 2005; at that time, spawner-recruit data did not provide adequate information to develop a BEG for this stock, although the model suggested that a point estimate of S_{MSY} may be lower than the 8,000 to 13,000 SEG (Nelson et al. 2005). The SEG was re-evaluated again in 2007 and left unchanged (Honnold et al. 2007). In 2010, the analysis was updated again and the SEG was changed to a BEG and lowered to 5,000 to 8,000 (Nemeth et al. 2010). The 2013 review resulted in no changes to the BEG (Sagalkin et al. 2013) In 2016, a Bayesian age-structured state-space stock-recruit Ricker model was fitted to escapement and return data from 1990 through 2015 as described in Fleischman et al. (2013) and Polum et al. (2014). The 2016 review resulted in no change to the BEG (Schaberg et al. 2016).

2019 Review

Recent escapement data were examined to determine whether a change in the escapement goal was justified, and the team agreed that no further analysis was necessary.

Frazer Lake

Frazer Lake is located on the southwest side of Kodiak Island and supports one of the largest sockeye salmon runs in the Kodiak Archipelago (Jackson and Keyse 2013). Sockeye salmon were introduced into the previously barren lake from 1951 through 1971 (Blackett 1979). The major donor stocks for Frazer Lake were the nearby Red (Ayakulik River drainage) and Karluk lakes. Frazer Lake's outlet creek, Dog Salmon Creek, flows into Olga Bay. The Olga Bay and Dog Salmon Flats sections within the Alitak District are the nearest fisheries management sections (Figures 1 and 3). A fish pass was constructed in 1962 to allow sockeye salmon to migrate around

the barrier falls and into the lake. Frazer Lake was fertilized from 1988 to 1992 because of concerns about low escapement and poor smolt production.

Escapement Goal Background and Previous Review

The Frazer Lake sockeye salmon escapement goal, which initially did not have a range, was 175,000 sockeye salmon from the 1950s through the 1970s while the run was in development. In 1981, the Frazer Lake escapement goal was changed to 350,000 to 400,000 sockeye salmon based upon rearing capacity and spawning habitat calculations (Nelson and Lloyd 2001). The goal range was lowered to 200,000 to 275,000 fish in 1986, with a BEG of 140,000 to 200,000 fish established in 1988.

Subsequent escapement goal reviews of this system were conducted during 2004, 2007, 2010, and 2013. All available stock assessment data were analyzed using the spawner-recruit analysis, percentile method, euphotic volume analysis, smolt biomass as a function of zooplankton biomass, and spawning habitat models (Nelson et al. 2005). The 2004 review team recommended decreasing the Frazer Lake BEG to 70,000 to 150,000 fish based on a spawner-recruit analysis, excluding data from years affected by fertilization. The recommendation was adopted by ADF&G and the new BEG went into effect in 2005. The 2007 review resulted in changing the BEG to 75,000 to 170,000 fish (Honnold et al. 2007). In 2010 and 2013, the spawner-recruit analysis was updated again, and based on the results, the team recommended no change to the BEG (Nemeth et al. 2010; Sagalkin et al. 2013). In 2016, spawner-recruit relationships were estimated for the Frazer Lake run by analyzing spawning stock and recruitment data from brood years 1966 to 2008 using a Ricker spawner-recruit model (Ricker 1954; Hilborn and Walters 1992; Eggers 2001) with a multiplicative error structure (Quinn and Deriso 1999). Spawner-recruit data not affected by fertilization of Frazer Lake (excluding brood year data from 1985 to 1991) were used. Special consideration of the jack life history was accounted for in several runs of the analysis. This included complete discounting of jacks and weighted jack to large male equivalencies. It was apparent that discounting jacks in the production models would introduce more uncertainty than could be explained by considering it, and only a complete brood table was considered. The 2016 review resulted in no change to the BEG (Schaberg et al. 2016).

2019 Review

Recent escapement data were examined to determine whether a change in the escapement goal was justified, and the team agreed that no further analysis was necessary.

Karluk Lake

Karluk Lake is located on the west side of Kodiak Island and supports the largest sockeye salmon run in the KMA (Jackson and Keyse 2013). The lake's outlet stream, the Karluk River, flows into Shelikof Strait in the area designated as the Inner Karluk Section of the Southwest Kodiak District. Two temporally distinct sockeye salmon runs return to Karluk Lake (Barrett and Nelson 1994). The early run returns from late May until mid-July and the late run returns from mid-July through September.

Escapement Goal Background and Previous Review

Published escapement goals for Karluk Lake sockeye salmon date back to the 1970s. Many of the early goals are split into months (Nelson and Lloyd 2001). From 1988 to 1991, there was an early-run escapement goal of 250,000 to 350,000 fish and a late-run escapement goal of 310,000 to 550,000 fish. In 1992, spawner-recruit analyses were used to develop BEGs of 150,000 to 250,000

fish for the Karluk Lake early run and 400,000 to 550,000 fish for the Karluk Lake late run (Nelson and Lloyd 2001). Escapement goals were reviewed again in 2004, when all available stock assessment data were evaluated using a spawner-recruit analysis, euphotic volume analysis, and smolt biomass as a function of zooplankton biomass. The review resulted in changing the BEG for the Karluk Lake sockeye salmon stocks to 100,000 to 210,000 fish for the early run and 170,000 to 380,000 fish for the late run (Nelson et al. 2005). After the next review by Honnold et al. (2007), the early-run BEG was changed to 110,000 to 250,000 sockeye salmon (based on spawner-recruit analysis with the inclusion of recent strong brood-year returns) and the late-run BEG was left at 170,000 to 380,000 fish (Honnold et al. 2007). The goals were reviewed again in 2010 and 2013 (Nemeth et al. 2010; Sagalkin et al. 2013) and left unchanged. In 2016, spawner-recruit relationships were estimated for the early run, late run, and combined runs using the 1981 through 2008 brood years. Spawning stock and recruitment data were analyzed using a Ricker spawner-recruit model (Ricker 1954; Hilborn and Walters 1992; Eggers 2001) with a multiplicative error structure (Quinn and Deriso 1999). To account for serial correlation in the model residuals, a lag-1 autoregressive model (AR(1); Noakes et al. 1987) was utilized.

Several events relating to Karluk Lake sockeye salmon complicated analysis of the escapement goals. From 1986 to 1990, Karluk Lake was fertilized to enhance juvenile sockeye salmon survival (Schrof and Honnold 2003). However, the brood years thought to be affected by fertilization were not excluded because the level of artificial nutrient additions were less than 10% of the total estimated nutrient inputs of other sources (salmon carcass and spring loading) during that timeframe (Schmidt et al. 1998). ADF&G also backstocked sockeye salmon fry into the Upper Thumb River in the Karluk Lake watershed after eggs were incubated at the Kitoi Bay Hatchery from 1979 to 1987. The stocking program was initially viewed as a success with increases in the spawning density to Upper Thumb, but this coincided with major increases in escapement observed starting in 1985 that demonstrated increased spawning density in all areas of Karluk Lake pointing to other causes (White 1991). Brood years thought to be affected by backstocking were not excluded.

Based on this analysis, the Karluk Lake early-run BEG was changed to 150,000 to 250,000 and the late-run BEG was changed to 200,000 to 450,000 sockeye salmon (Schaberg et al. 2016).

2019 Review

Recent escapement data were examined to determine whether a change in the escapement goal was justified, and the team agreed that no further analysis was necessary.

Malina Creek

Malina Creek is located on the southwest side of Afognak Island in the Kodiak Archipelago. The creek drains 2 lakes (Upper and Lower Malina lakes), then flows westerly into Malina Bay, in the Southwest Afognak Section of the Afognak District (Figures 1 and 3). The system supports a small run of sockeye salmon.

Malina Lake is used as a backup brood source by KRAA for early-run stocking projects; broodstock was obtained from Malina Lake in 2004 and 2005. To increase the natural production of sockeye salmon into the system, Upper Malina Lake was fertilized from 1991 through 2001, and Lower Malina Lake was fertilized from 1996 through 2001. The lakes were backstocked with juvenile sockeye salmon fry from 1992 to 1999 (Schrof and Honnold 2003).

Escapement Goal Background and Previous Review

The first published escapement goal (SEG) for Malina Creek was developed in 1988 and was set at 5,000 to 10,000 sockeye salmon; it was based on historical aerial survey indexed escapements and, to a lesser extent, cursory spawning habitat evaluations (Nelson and Lloyd 2001). The escapement goal was revised to 10,000 to 20,000 in 1992, based on further limnological studies and rehabilitation investigations (Kyle and Honnold 1991). A review in 2004 recommended reducing the SEG to 1,000 to 10,000 fish; this recommendation was based on the results using the percentile approach and the zooplankton biomass model. With 3 years of additional data, the 2007 escapement goal review team determined that the additional stock assessment data would not substantially affect the results of previous escapement goal analyses. Thus, the Malina Creek sockeye salmon SEG was left unchanged in 2007 (Honnold et al. 2007). A review in 2010 and 2013 with updated limnology and aerial survey data corroborated the SEG, and the team recommended no change (Nemeth et al. 2010; Sagalkin et al. 2013). In 2016, limnological data from 1990 to 2015 were analyzed using zooplankton biomass and euphotic volume models to assess optimal escapement levels and the Percentile Approach was employed using available peak aerial survey and weir data from 1990 to 2015. Based on these analyses the team recommended no change (Schaberg et al. 2016).

2019 Review

Recent escapement data were examined to determine whether a change in the escapement goal was justified, and the team agreed that no further analysis was necessary.

Pasagshak River

The Pasagshak River drains from Lake Rose Teed into Ugak Bay of the Eastside Kodiak District. The system is also located on the Kodiak Island road system and supports one of the largest sockeye salmon subsistence fisheries for Kodiak Island residents (Figure 3). Historically, escapement was estimated using aerial and foot surveys of the spawning grounds, but there has been a weir since the 2011 season.

Escapement Goal Background and Previous Review

The first Pasagshak River sockeye salmon escapement goal (SEG) was 1,000 to 5,000 fish and was established in 1988 (Nelson and Lloyd 2001) based on historical aerial survey index counts and, to a lesser extent, cursory spawning habitat evaluations. Nelson and Lloyd (2001) noted that this goal may be too low. In 2004, the SEG was revised to 3,000 to 12,000 fish, based on the percentile approach and a risk analysis (Nelson et al. 2005). This goal was assessed again in 2010 and a lower-bound SEG of 3,000 fish was implemented in 2011 (Nemeth et al. 2010). The goal was reviewed again in 2013 and 2016, and the teams recommended no change (Sagalkin et al. 2013; Schaberg et al. 2016).

2019 Review

Recent escapement data were examined to determine whether a change in the escapement goal was justified, and the team agreed that no further analysis was necessary.

Saltery Lake

Saltery Lake is located southwest of the city of Kodiak and is one of the most productive sockeye salmon systems on the east side of Kodiak Island (Honnold and Sagalkin 2001; Jackson and Keyse 2013). The Inner Ugak Bay Section of the Eastside Kodiak District is the nearest fisheries

management area to the confluence of the lake's outlet creek (Saltery Creek) and Ugak Bay (Figures 1 and 3). Saltery Lake is the primary brood source for fry stocked into Spiridon Lake by the KRAA. Sockeye salmon escapements to Saltery Lake were estimated using aerial surveys from 1976 through 1986, 1992, and 2004 through 2007; escapements were estimated using weirs from 1986 to 1991, 1993 to 2003, and 2008 to 2015.

Escapement Goal Background and Previous Review

The first published escapement goal (SEG) for Saltery Lake was developed in 1988 and set at 20,000 to 40,000 sockeye salmon (Nelson and Lloyd 2001). In 2001, the SEG was changed to a BEG of 15,000 to 30,000 fish, based upon spawner-recruit data, euphotic zone depth and volume, smolt biomass as a function of zooplankton biomass, smolt biomass as a function of lake rearing availability, and spawning habitat availability analyses (Honnold and Sagalkin 2001). The goal was reviewed again in 2004 and left unchanged, with the review team recommending that S_{MSY} (23,000), or the lower end of goal, be targeted in the short term, citing decreased biomass of zooplankton in the lake. In 2007, the consensus of the review team was to change the Saltery Lake sockeye salmon escapement goal from a BEG of 15,000 to 30,000 to an SEG of 20,000 to 50,000, based on the percentile approach using aerial survey data (Honnold et al. 2007). At the time of the 2007 review, Saltery Lake sockeye escapement was estimated only by aerial survey and no age data were collected. There was no indication of any future plan to operate a weir, and the team decided that using only aerial survey data with the percentile approach was a more appropriate method (Honnold et al. 2007).

In early 2008, the goal was reanalyzed when KRAA agreed to operate a weir project at Saltery Lake. The team recommended retaining the prior BEG of 15,000 to 30,000 used to manage the stock since 2001, because the 2007 review team's recommended change to an SEG (of 20,000 to 50,000 fish) was predicated on escapement assessments by aerial survey only. In addition, the team determined that the "weir only" spawner-recruit analysis was similar to the "combination weir/aerial survey" spawner-recruit analysis that resulted in the current BEG, and the zooplankton data indicated that habitat limitations still existed in Saltery Lake. The goal was reanalyzed again in 2010 resulting in a change to a BEG of 15,000 to 35,000 fish (Nemeth et al. 2010). The goal was reviewed again in 2013 and 2016, and the teams recommended no change (Sagalkin et al. 2013; Schaberg et al. 2016).

2019 Review

Recent escapement data were examined to determine whether a change in the escapement goal was justified, and the team agreed that no further analysis was necessary.

Upper Station

The Upper Station system, also referred to as South Olga lakes, is composed of 2 major lakes located on the southern end of Kodiak Island, and drains into the Inner Upper Station Section of the Alitak District (Figures 1 and 3). The system supports one of the largest sockeye salmon runs in the Kodiak Archipelago (Jackson and Keyse 2013). Two temporally distinct sockeye salmon runs return to Upper Station (Barrett and Nelson 1994). The early run returns from late May through mid-July; the late run returns from mid-July through September. Sockeye salmon escapements at Upper Station have been enumerated through the weir since 1969 for the early run and 1966 for the late run; counts through July 15 are attributed to the early run and counts after July 15 to the late run.

Escapement Goal Background and Previous Review

From 1978 to 1982, the Upper Station sockeye salmon stock was managed for one escapement goal (range of 100,000 to 180,000 fish) that was stratified by month. Early and late runs were not identified, but the escapement goals were for July and August. In 1983, ADF&G increased the escapement goal to 150,000 to 250,000 fish and extended goals into June (presumably for the early run); this goal remained in place through 1987 (Nelson and Lloyd 2001). In 1988, the goal was split into separate escapement goals (SEGs) of 50,000 to 75,000 fish for the early run and 150,000 to 200,000 fish for the late run (Nelson and Lloyd 2001). An optimal escapement goal (OEG) of 25,000 fish was established for the early Upper Station run in 1999 by the Alaska Board of Fisheries. During the 2004 review, the team recommended changing the Upper Station early-run sockeye salmon ADF&G-recommended SEG to 30,000 to 65,000 fish based on the percentile approach, and changing the late-run sockeye salmon SEG to a BEG of 120,000 to 265,000 fish (S_{MSY} = 186,000) based on a significant Ricker spawner-recruit relationship. No change was recommended to either goal during the 2007 escapement goal review (Honnold et al. 2007). In 2010, both goals were reviewed, and the Upper Station early-run goal was changed to a BEG of 43,000 to 93,000. There was no change recommended to the Upper Station late-run goal (Nemeth et al. 2010). Following the 2013 review, the Upper Station early-run OEG was changed to 30,000 fish, implemented in 2015 and 2016 only; there has been no change to the BEG. The late-run goal was reviewed again in 2013 and 2016, and the teams recommended no change (Sagalkin et al. 2013; Schaberg et al. 2016). The OEG was also eliminated by the Alaska Board of Fisheries in 2017.

2019 Review

Recent escapement data were examined to determine whether changes in the escapement goals were justified, and the team agreed that no further analysis was necessary for the early run. The team agreed to update the analysis and re-evaluate the Upper Station late-run BEG in 2019. Spawner-recruit relationships were estimated for the late run by analyzing data from 1970 to 2012 and 1996 to 2012, which coincided with an increase in the average number of days of weir operation and a noticeable change in productivity[5]. Using only these data also removed outliers from the full data set that would have biased model results higher and would not have reflected current productivity conditions of the Upper Station sockeye salmon. If a Ricker spawner-recruit model was significant, S_{MSY} was estimated, along with the range of escapements that would produce 90% to 100% of MSY. Residuals were evaluated for autocorrelation and temporal trends. The percentile approach and Markov yield analysis using data from 2000 to 2012 and euphotic volume and zooplankton biomass models using the most recent and consecutive limnological data from 2009 to 2018 were run to estimate optimal escapement.

COHO SALMON

American, Buskin, Olds, and Pasagshak Rivers

Coho salmon escapement goals have been established for 4 rivers in the KMA, all of which are located on the road system in the northeast corner of Kodiak Island (Figure 3). The American, Olds, and Buskin rivers empty into Chiniak Bay, in the Inner Chiniak Bay Section (Figures 1 and 3). The Pasagshak River empties into Ugak Bay, in the Outer Ugak Bay Section (Figures 1 and 3).

[5] Hamazaki, T. 2019. Escapement goal analyses (source: https://shiny.rstudio.com/). Available from https://hamachan.shinyapps.io/Spawner_Recruit/

Escapement to the American, Olds, and Pasagshak rivers are estimated via surveys by foot. The surveys have been conducted annually since 1980, and are done in October and early November to coincide with peak spawning periods (as determined through a combination of factors, including timing of past escapement surveys, inseason anecdotal reports of spawning activity, and preference for optimal water levels and viewing conditions). Foot survey routes were standardized for each stream using periodically updated GPS waypoints to identify starting and stopping destinations, as well as tributary and stream branch confluence locations. The count for a stream survey is interpreted as a minimum number of salmon escaping to that stream and therefore, is viewed as an index of total escapement. The highest number (peak count) of coho salmon observed during a single foot survey has been used as the annual index of abundance for that stream.

The fourth system in the KMA with a coho salmon escapement goal is the Buskin River; returning coho salmon have been counted with a weir operated at various sites on the Buskin River since 1985. Buskin River coho salmon have served as a brood source for a number of Division of Sport Fish stocking projects in the KMA since 1993.

Escapement Goal Background and Previous Review

The existing coho salmon escapement goals in the KMA were first established in 1999 (Nelson and Lloyd 2001). The first American River coho salmon SEG was 300 to 400 fish, then changed to 400 to 900 fish in 2005 (Clark et al. 2006). The first Olds River SEG was 450 to 675 fish (Nelson and Lloyd 2001), then changed to 1,000 to 2,200 fish in 2005 (Clark et al. 2006). The first Pasagshak River coho salmon SEG was 1,500 to 3,000 fish (Nelson and Lloyd 2001), then changed to 1,200 to 3,300 fish in 2005 (Clark et al. 2006). In 2007, the review team concluded that the addition of 3 years of escapement data would not substantially affect the results of previous analysis of any of the 3 goals, which were left unchanged (Honnold et al. 2007). In 2011, the upper bounds of the escapement goals for the American, Olds, and Pasagshak rivers were removed due to the lack of inseason management for the upper ends of the goals (Nemeth et al. 2010). No change was recommended in 2016 (Schaberg et al. 2016).

The first Buskin River coho salmon SEG was 6,000 to 9,000 fish (Nelson and Lloyd 2001). In 2005, the SEG was changed to a BEG of 3,200 to 7,200 fish (Clark et al. 2006) and was meant to explicitly take into account 20% of the sport harvest that occurs upstream of the weir. The 2007 review concluded that no change was necessary; however, in 2013 the BEG was changed to 4,700 to 9,600 fish based on updated brood table and spawner-recruit analysis (Sagalkin et al. 2013) and no change was recommended in 2016 (Schaberg et al. 2016). A recently updated creel survey of the Buskin River shows that 17% of the current sport harvests occur above the weir, and escapement estimates from 2017 to present reflect this change (Polum et al. 2019)

2019 Review

The team reviewed the most recent escapement data available for KMA coho salmon stocks, which consisted of 3 years of foot survey data from the American, Olds, and Pasagshak rivers, and 3 years of weir data from the Buskin River. The team revaluated the goals for the American, Olds, Pasagshak, and Buskin rivers using the percentile approach.

The Pasagshak River coho salmon recent escapement counts have been complicated by habitat changes. Pasagshak River index counts have been difficult to obtain recently because physical changes in the upper portion of the lake have limited fish access to spawning grounds, resulting in sporadic, independent spawning events that coincide with periods of high rainfall. Historically, several surveys were conducted on spawning tributaries in the drainage around the peak spawn

timing, and the peak count of those surveys was used to estimate an index of escapement. More recently however, survey counts have captured discrete spawning events without a distinct "peak" that is representative of the relative size of the annual escapement and achievement of the escapement goal. To more accurately estimate total escapement in the Pasagshak River watershed, a mark–recapture study is being conducted in which fish are tagged in Lake Rose Teed and recovered with an unmanned aerial system (UAS) and foot surveys. Through examination of the number of fish observed during surveys and the proportion of each tag color observed in sequential surveys, an estimation of the total population can be made.

Coho salmon are counted on the Buskin via weir. The weir is often inoperable during extended periods of high water. Coho are known to pass over the weir during these high water events but cannot be enumerated directly. For this review cycle, the estimation of fish passage during inoperable periods was more closely examined. Missed fish passage on the Buskin River has been estimated inconsistently during these conditions, and escapement estimates should be considered an index. The team decided to re-evaluate the Buskin River coho salmon BEG using the percentile approach for estimation of an SEG due to the frequency that high-water events require weir count estimates.

PINK SALMON

Kodiak Archipelago and Mainland District Aggregates

There are 2 escapement goals for pink salmon in the KMA, both of which are SEGs based on aggregates of escapements to multiple streams estimated from aerial surveys of spawning fish from fixed-wing aircraft (Jackson and Keyse 2013). The Mainland District aggregate goal is derived entirely from these aerial surveys; the Kodiak Archipelago aggregate goal is derived from aerial surveys supplemented by counts from weirs on Kodiak Island streams. Each year since 1964, pink salmon have been counted during 1 or more flights over a standardized subset of streams in the Kodiak Archipelago and across Shelikof Strait in the Mainland District (Figure 2). The highest number (peak count) of pink salmon observed during a single flight has been used as an annual index of abundance for that stream. Pink salmon from a given brood year mature in the same calendar year, 2 years after birth, leading to separate populations in odd and even years that do not interbreed (Heard 1991).

Escapement Goal Background and Previous Review

The first KMA districtwide pink salmon escapement goals were published in 1978 (Nelson and Lloyd 2001). The peak counts were summed over streams within 7 districts: Eastside, Northeast Kodiak, Afognak, Northwest Kodiak, Southwest Kodiak, Alitak, and Mainland. Annual counts were averaged to produce SEGs for each district and for the Kodiak Archipelago as a whole, separately for even and odd years (Nelson and Lloyd 2001).

In 2005, the Mainland District SEG was retained as its own discrete goal, and the other 6 districts were combined to form the Kodiak Archipelago goal (Nelson et al. 2005). Also, separate goals for even and odd years were eliminated and replaced by an overall goal for both years combined. The newly created Kodiak Archipelago SEG was set at 2,000,000 to 5,000,000 fish and the Mainland District SEG was revised to 250,000 to 750,000 fish (Nelson et al. 2005). Pink salmon escapement goals were re-evaluated during the 2007 review and left unchanged (Honnold et al. 2007). Goals were evaluated in 2010, and the team recommended changing the Kodiak Archipelago pink salmon SEG of 2,000,000 to 5,000,000 fish to an odd-year SEG of 2,000,000 to 5,000,000 and an even-

year SEG of 3,000,000 to 7,000,000 pink salmon (Table 1). The team also recommended changing the Kodiak Mainland pink salmon SEG of 250,000 to 750,000 fish to an SEG of 250,000 to 1,000,000 fish. The goals were reviewed in 2010, 2013, and 2016 and the team recommended no change to any (Nemeth et al. 2010; Sagalkin et al. 2013; Schaberg et al. 2016).

2019 Review

Recent escapement data were examined to determine whether a change in the escapement goals were justified, and the team agreed that no further analysis was necessary.

CHUM SALMON

Kodiak Archipelago and Mainland District Aggregates

There are 2 aggregate escapements goals for chum salmon in the KMA, one for the Mainland District and one for the Kodiak Island Archipelago (Figure 2). Both escapement goals are SEGs based on aggregates of escapements to all streams estimated from aerial surveys of spawning fish from fixed-wing aircraft (Jackson and Keyse 2013). Peak counts of chum salmon from a single flight are used as the annual index of abundance for each stream.

Escapement Goal Background and Previous Review

Chum salmon escapement goals by district were established in 1988 (Nelson and Lloyd 2001), based on historical escapement. Goals were set for individual districts as follows: Mainland District, 133,000 to 399,000 fish; Northwest District, 46,000 to 138,000 fish; Southwest District, 25,000 to 75,000 fish; Alitak District, 26,000 to 78,000 fish; Eastside District, 35,000 to 105,000 fish; and Northeast District, 8,000 to 24,000 fish. In 2004, the goals were revised to lower-bound SEGs (termed SEG thresholds at the time), and set at 153,000 fish for the Mainland District, 53,000 fish for the Northwest District, 7,300 fish for Southwest District, 28,000 fish for the Alitak District, 50,000 fish for the Eastside District, and 9,000 fish for the Northeast District. These lower-bound SEGs were implemented in 2005 (Honnold et al. 2007).

In 2007, the review team reanalyzed chum salmon escapement goals for the KMA. The lower-bound SEG for Mainland District chum salmon was reduced to 104,000 fish. The escapement goals for the remaining 6 districts (all on Kodiak Island) were aggregated into a single lower-bound SEG known as the Kodiak Archipelago goal. This goal was set at 151,000 fish (Honnold et al. 2007). Goals were re-evaluated in 2010 and 2013, and the team recommended no changes. Stock-specific harvest estimates for Kodiak Archipelago and Mainland District chum salmon were not available for the 2016 review. Recent escapement data were evaluated for consistency and analyzed using the Percentile Approach. The team recommended changing the Kodiak Archipelago chum salmon escapement goal to a lower-bound SEG of 101,000 fish that is based on a reduced number of index systems and eliminating the Kodiak Mainland chum salmon escapement goal because of inconsistencies in the quantity and timing of successful annual surveys. (Schaberg et al. 2016).

2019 Review

Recent escapement data were examined to determine whether a change in the escapement goals were justified, and the team agreed that no further analysis was necessary.

RESULTS

The team reviewed stock assessment data for 2 Chinook salmon stocks, 12 sockeye salmon stocks, 4 coho salmon stocks, 3 pink salmon aggregate stocks, and 1 chum salmon aggregate stock with

existing goals (Table 1). Initial efforts concentrated on reviewing data from 2016 through 2018, determining if previous analyses should be updated or if additional analyses were necessary, and identifying any management concerns with the existing goals.

The team concluded that the 3 additional years of data may affect the existing Chinook salmon escapement goals for the Ayakulik and Karluk rivers; the sockeye salmon escapement goals for Afognak Lake and Upper Station; and the coho salmon escapement goals for the American, Buskin, Olds, and Pasagshak rivers. The team elected to formally analyze these stocks, using a combination of new escapement and brood year data available since the last review.

The team agreed to recommend to the directors of the divisions of Commercial Fisheries and Sport Fish that changes be made to 4 of the 9 goals needing re-evaluation: reclassifying the Afognak Lake sockeye salmon goal from a BEG to an SEG of 20,000 to 50,000 fish; reclassifying the late-run Upper Station sockeye salmon goal from a BEG to an SEG of 120,000 to 265,000 fish; reducing the Olds River coho salmon lower-bound SEG from 1,000 fish to 500 fish; and reclassifying the Buskin River coho salmon goal from a BEG to an SEG of 4,700 to 9,600 fish (Table 1).

CHINOOK SALMON

Ayakulik River

Stock Status

Ayakulik River Chinook salmon escapements averaged 8,746 fish (range: 917 to 24,425) from 1977 through 2018 (Appendix A2) and total recruitment averaged 12,174 fish (range: 1,070 to 31,883) for brood years 1977 through 2009 (Appendix A4). Since 2016, escapements have been below the current BEG of 4,800 to 8,400 fish (Appendix A3).

Escapement Goal Recommendation

Examination of the 3 years of additional data since the last review does not indicate a substantial change in stock productivity and the team agreed that the goal should remain unchanged (4,800 to 8,400 fish) and should remain a BEG (Table 1). The team agreed that a standardized method of estimating Chinook salmon passage during periods of flooding should be developed or an existing method implemented and standardized for the Ayakulik Chinook salmon run. The team also recommended that the Ayakulik Chinook salmon run be designated as a *stock of management concern* due to a chronic inability to achieve the BEG.

Karluk River

Stock Status

Karluk River Chinook salmon escapements averaged 6,696 (range: 752 to 13,742) fish from 1976 through 2018 (Appendix B2) and total returns averaged 8,502 (range: 1,099 to 19,443) fish for brood years 1976 through 2009 (Appendix B4). The current BEG of 3,000 to 6,000 fish was implemented in 2011. Since the last review, escapements were within the goal range in 2016 and 2018 and fell below the range in 2017 (Appendices B2 and B3). Karluk River Chinook salmon were designated a *stock of management concern* during the 2010 Kodiak board meeting and remained *a stock of management concern* following the 2016 review. The team also recommended that the Karluk River Chinook salmon stock remain a *stock of management concern*.

Escapement Goal Recommendation

Examination of the 3 years of additional data since the last review does not indicate a substantial change in stock productivity, and the team agreed that the goal should remain unchanged (3,000 to 6,000) and should remain a BEG (Table 1).

SOCKEYE SALMON

Afognak Lake

Stock Status

Escapements have been within the escapement goal range of 20,000 to 50,000 fish each year since the current BEG was implemented in 2005, except in 2010 when it was exceeded (52,255) and 2018 when it was below the lower bound (17,601; Appendices C2 and C3). The returns for 1999 and 2001 brood years were the lowest in the 1978 to 2018 time series (Appendices C2 and C3) and were possibly reduced by top-down effects from high escapements during 1989 through 1999 (Appendices C2 and C3).

Evaluation of Recent Data

Results of the spawner-recruit relationships for both nontruncated and truncated data sets were significant ($P < 0.02$) and indicated that the escapement goal should be lowered to encompass S_{MSY}. However, autocorrelation and non-stationary processes were present in the analysis using data from 1982 to 2012 (nontruncated). The spawner-recruit analysis using data from 2000 to 2012 (truncated) was not autocorrelated and non-stationary and suggested a BEG range of 12,000 to 20,000 fish. However, the upper bound estimated from this model is below the current goal's lower bound, with S_{MSY} (15,000) below any observed values of escapement. The percentile approach provided a range from 17,700 to 31,000 fish, yet contrast was less than 4. The Markov yield analysis suggested a range from 15,000 to 25,000 fish, with large yields between 2000 and 2004 possibly reflecting the lagged effects of enhancement. Euphotic volume models estimated an escapement goal range of 32,000 to 48,000 fish; when this model was updated using high-resolution bathymetry, the escapement goal range decreased to 16,000 to 24,000 fish. Similarly, the zooplankton biomass model suggested a goal range of 18,900 to 38,300 fish.

Escapement Goal Recommendation

Given concerns for managing the population at levels below historical observations, and supporting habitat, and percentile models, the team recommended that the goal range remain unchanged from 20,000 to 50,000 fish, but that the goal be reclassified from a BEG to an SEG because of the uncertainty in the value of S_{MSY} (Table 1).

Ayakulik River

Stock Status

The Ayakulik River sockeye salmon SEG was split into early-run (140,000 to 280,000) and late-run (60,000 to 120,000) goals in 2011 (Table 1; Appendix D1). Both early-run and late-run sockeye salmon escapements have been in decline since 1994 but have recently shown signs of stabilizing or increasing (Appendices D2–D3). Return per spawner also declined after the 1994 brood year (Appendix D4). ADF&G researchers theorize that the decline may have been due to the high escapements from 1989 to 1998, when escapements averaged about 400,000 fish, increasing competition among rearing fish and ultimately decreasing the size of outmigrating smolt.

Escapements have been within the current SEGs since the goals were implemented (Appendix D3).

Escapement Goal Recommendation

The SEGs were re-evaluated in 2010 (using data through 2009) and new goals were implemented in 2011. The 9 additional years of data do not indicate a substantial change in stock productivity, and the team agreed that the goals should remain unchanged in 2019 (Table 1).

Buskin River

Stock Status

The Buskin River sockeye salmon escapement goal was assessed in 2010 and changed from an SEG (8,000 to 13,000 fish) to a BEG (5,000 to 8,000 fish) for the 2011 season (Appendices E2 and E3). Returns have ranged from 9,724 fish (2008) to 37,544 fish (2003). Escapements were above the current BEG from 2008 to 2016, met the goal in 2017, and did not reach the lower bound in 2018 (Table 1).

Escapement Goal Recommendation

A Bayesian spawner-recruit analysis was completed in 2016 incorporating escapements through 2015 and no new goals were recommended. The 9 additional years of data since the BEG was implemented do not indicate a substantial change in stock productivity, and the team agreed that the goal should remain unchanged (Table 1). Important spawner-recruit parameter estimates are summarized in Appendix E4 and an optimal yield profile is given in Appendix E5.

Frazer Lake

Stock Status

Sockeye salmon escapements have been within the current BEG of 75,000 to 170,000 fish since its inception in 2008, except for 2014, 2015, and 2018 when the goal was exceeded (Appendices F2 and F3). Returns have ranged from 39,910 (1966) when the stock was being developed, to over 2 million fish (1986; Appendix F4)

Escapement Goal Recommendation

In 2016, a Ricker spawner-recruit model, a bathymetric model, a euphotic volume model, and a zooplankton biomass model were all completed for Frazer Lake and team recommended no change to the Frazer Lake sockeye salmon BEG of 75,000 to 170,000 fish (Table 1). The addition of 3 more years of data did not indicate substantial change in stock productivity, and the team agreed the goal should remain unchanged in 2019 (Table 1).

Karluk Lake

Stock Status – Early Run

Since the establishment of the current BEG (150,000 to 250,000 fish) in 2017, the escapements of early-run Karluk River sockeye salmon, met the BEG both years (Appendices G2 and G4). The recent 10-year average (2000–2009) return is about 264,000 fish.

Stock Status – Late Run

Since the establishment of the current BEG (200,000 to 450,000 fish) in 2017, the escapements of late-run Karluk River sockeye salmon have met the BEG in 2017 and 2018 (Appendix G3 and G5). The recent 10-year average (2000–2009) return is roughly 568,500 fish.

Escapement Goal Recommendation

The Karluk Lake early and late run BEGs were updated in 2016 using Ricker spawner-recruit models to an early-run BEG of 150,000 to 250,000 and the late-run BEG of 200,000 to 450,000 sockeye salmon. The addition of 3 more years of data did not indicate substantial change in stock productivity, and the team agreed the goals should remain unchanged in 2019 (Table 1).

Malina Creek

Stock Status

Except in 2018, escapements have achieved the current SEG (1,000 to 10,000 fish) since it was implemented in 2005 (Appendix H3).

Escapement Goal Recommendation

The addition of 13 more years of data since the SEG was implemented did not indicate a substantial change in stock productivity, and the team agreed the goals should remain unchanged in 2019 (Table 1).

Pasagshak River

Stock Status

In 2011, the Pasagshak SEG was changed from 3,000 to 12,000 to a lower-bound SEG of 3,000 fish (Table 1). Escapements in 2012, 2014, 2015, and 2018 were below the goal (Appendix I3).

Escapement Goal Recommendation

The addition of 7 more years of data since the SEG was implemented did not indicate substantial change in stock productivity, and the team agreed the goals should remain unchanged in 2019 (Table 1).

Saltery Lake

Stock Status

The current Saltery Lake sockeye salmon BEG of 15,000 to 35,000 was adopted in 2011 (Table 1). Since then, escapements have been within or above the BEG (Appendices J2 and J3).

Escapement Goal Recommendation

The BEG was re-evaluated in 2010 (using data through 2009) and implemented in 2011. The addition of 9 more years of data did not indicate substantial change in stock productivity, and the team agreed the goals should remain unchanged in 2019 (Table 1).

Upper Station

Stock Status – Early Run

The Upper Station early-run sockeye salmon BEG of 43,000 to 93,000 fish was implemented beginning in the 2011 season. Since then, escapements were below the BEG in 2011–2014 and

met the BEG in 2015–2018 (Appendices K2 and K4). Management of the fishery was guided by optimal escapement goals of 25,000 from 1999 to 2014 and 30,000 fish in 2015 and 2016, which were achieved in all years during that time (Table 1; Appendices K1, K2, and K4).

Stock Status – Late Run

Since the Upper Station late-run sockeye salmon BEG of 120,000 to 265,000 fish was implemented in 2005, escapements have been within the BEG in all but one year (2011; Appendices K3 and K4).

Evaluation of Recent Data – Early Run

The BEG was re-evaluated in 2019 and remained unchanged. New information did not indicate a substantial change in stock productivity, and the team agreed that the goal should remain unchanged in 2019 (Table 1).

Evaluation of Recent Data – Late Run

The BEG was re-evaluated in 2019 using multiple models to assess stock productivity. Spawner-recruit curves using data from 1970 to 2012 and 1996 to 2012 were both not significant ($P > 0.17$), non-stationary, autocorrelated and predicted large upper bounds (>850,000 fish) that, with the exception of the 1986 returns, greatly exceeded historical production levels. A tier 3 percentile approach estimated an escapement goal range between 96,000 and 177,000 fish; however, the data lacked sufficient contrast (<4) for this result to be considered robust. Using data from 1996 to 2012, the escapement goal range was 140,000 to 200,000 fish based on a yield analysis, which corroborated the midpoint of the existing goal. For habitat-based models, the euphotic volume model largely underestimated the range of optimal escapement for the combined early- and late-runs, giving a range of 85,000 to 128,000, and the upper end was below historically observed values for the same data range. The zooplankton biomass model estimated a range of 145,000 to 218,000 fish, which was also low compared to the current combined goal. Spawner-recruit curves failed to provide significant and robust estimates of MSY.

Escapement Goal Recommendation

The team recommended no change to the early-run Upper Station sockeye salmon BEG of 43,000 to 93,000 fish. For the late run, the team agreed that the goal range should remain unchanged (120,000 to 265,000 fish) in 2019 but be classified as an SEG because of model uncertainty and lack of significant spawner-recruit relationships (Table 1).

COHO SALMON

American, Buskin, Olds, and Pasagshak Rivers

Stock Status – All Systems

All 4 of these systems are located on the Kodiak road system and all were reviewed in 2010. Escapement goals for the American, Olds, and Pasagshak rivers were changed from a SEG to a lower-bound SEG (implemented in 2011). The goals remained unchanged during the 2016 review. The lower-bound SEGs are 400 fish for the American River, 1,000 fish for the Olds River, and 1,200 fish for the Pasagshak River. American River escapements were above the SEG during 2 of the last 3 seasons (Appendices L2 and L3); Olds River escapements were above the SEG during 2 of the last 3 seasons (Appendices N2 and N3); and Pasagshak River escapements have been below the SEG during 2 of the last 3 seasons (Appendices O2 and O3). The Buskin River escapement

goal was changed from a BEG of 3,200 to 7,200 fish to a BEG of 4,700 to 9,600 fish in 2010. Escapements were below the BEG during 2 of the past 3 seasons (Appendices M2 and M3).

Evaluation of Recent Data

The escapement goal review team reviewed the most recent data available for Kodiak Management Area coho salmon stocks (Table 1); 3 additional years of escapement data were available for coho salmon from all 4 rivers (the Buskin, American, Olds, and Pasagshak rivers) since they were last examined.

The percentile approach was used to examine the American River coho salmon run. The run has high contrast (68.9) and high measurement error but has low harvest rates and low management precision, so the lower 20th percentile was used to estimate a lower bound SEG. The 20th percentile was 297 fish, which is lower than the current lower-bound SEG of 400 fish.

The Olds River coho salmon run was examined with the percentile approach incorporating recent years' data. This run has high contrast (81.3), high measurement error, and a moderate harvest rate and low management precision; thus, the 20th percentile was used to estimate a lower-bound SEG. The 20th percentile is approximately 499 fish, which is about half of the current lower-bound SEG of 1,000 fish.

The percentile approach was also used to examine the Pasagshak River coho salmon run. With high contrast (99.3; excluding 1992 escapement considered to be incomplete with an estimate of 4 fish) in the escapement data, high measurement error, and low to moderate harvest rates and low management precision, the 20th percentile was used to estimate a lower bound SEG. The estimate was 567 fish, which is lower than the current lower bound SEG of 1,200 fish.

Escapement Goal Recommendation

The team recommended no change to the American River coho salmon lower-bound SEG of 400 fish, because the escapement goal team was uncomfortable with reducing the number of spawners to such a low level.

The team recommended reducing the Olds River lower-bound SEG from 1,000 fish to 500 fish based on the results of the percentile approach and the observation that recent years have had strong runs from lower parent (escapement) years.

The team recommended leaving the lower-bound SEG for the Pasagshak River unchanged at 1,200 fish but will explore new enumeration methodology and appropriate escapement goal levels in the future.

For Buskin River coho salmon, the percentile approach yielded a similar range as the current goal. Because recent weir counts have often included interpolated values during flooding events, the team recommended a change from a BEG to an SEG with the same goal range of 4,700 to 9,600 fish.

PINK SALMON

Kodiak Archipelago and Mainland District Aggregates

Stock Status

In 2011, the Kodiak Archipelago pink salmon SEG was split into an odd-year SEG of 2,000,000 to 5,000,000 and an even-year SEG of 3,000,000 to 7,000,000 pink salmon (Table 1; Appendices

P2 and P3). The Kodiak Mainland pink salmon SEG also changed from 250,000 to 750,000 fish to an SEG of 250,000 to 1,000,000 fish (Table 1; Appendix Q2 and Q3). Archipelago escapements were below the SEG in 2014 and 2016, and exceeded the SEG in 2015 and 2017. The mainland district escapement was the below SEG in 2016 and exceeded the SEG in 2017.

Escapement Goal Recommendation

Pink salmon SEGs were re-evaluated in 2010 (using data through 2009) and new goals implemented in 2011. The additional data since 2011 does not indicate a substantial change in stock productivity, and the team recommended no change to the existing SEGs for the Kodiak Archipelago and Mainland District pink salmon stocks (Table 1).

CHUM SALMON

Kodiak Archipelago Aggregates

Stock Status

The current lower-bound SEG of 101,000 chum salmon in the Kodiak Archipelago was implemented in 2017 (Table 1). This lower-bound SEG was exceeded in 2017 and 2018 (Appendices R2–R4). The additional data since 2016 do not indicate a substantial change in stock productivity.

Escapement Goal Recommendation

The chum salmon lower-bound SEG was re-evaluated in 2016 and a new goal implemented in 2017. The additional data since 2016 does not indicate a substantial change in stock productivity, and the team recommended no change to the existing lower-bound SEG for the Kodiak Archipelago aggregate chum salmon stock (Table 1).

SUMMARY OF STAFF RECOMMENDATIONS TO DIRECTORS

The 2019 review team reviewed data for all 22 salmon escapement goals in the KMA, and then analyzed 9 of these goals further. Overall, the team recommended changing 4 goals. The new recommendations result in a total of 22 escapement goals in the KMA, as follows: 2 goals for Chinook salmon (both BEGs); 12 goals for sockeye salmon (6 BEGs, 5 SEGs, and 1 lower-bound SEG); 4 goals for coho salmon (1 SEG and 3 lower-bound SEGs); 3 aggregate SEGs for pink salmon; and 1 aggregate lower-bound SEG for chum salmon.

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TABLES AND FIGURES

Table 1.–Kodiak Management Area escapements 2013–2018, with existing and recommended salmon escapement goals.

Species	System	Escapement data [a]	Current escapement goal			Escapements						Recommend
			Type	Lower	Upper	2013	2014	2015	2016	2017	2018	
Chinook												
	Ayakulik	WC	BEG	4,800	8,400	**2,354**	**917**	**2,392**	4,594	**3,712**	**2,149**	No change [b]
	Karluk	WC	BEG	3,000	6,000	**1,824**	**1,182**	**2,777**	3,434	**2,600**	3,155	No change
Sockeye												
	Afognak	WC	BEG	20,000	50,000	40,888	35,704	36,780	32,459	21,441	**17,601**	SEG 20,000–50,000
	Ayakulik											
	Early run	WC	SEG	140,000	280,000	214,969	210,040	218,178	182,589	204,497	189,008	No change
	Late run	WC	SEG	60,000	120,000	67,195	87,671	108,257	72,378	120,361	77,325	No change
	Buskin	WC	BEG	5,000	8,000	16,189	13,976	8,718	11,584	7,222	**4,284**	No change
	Frazer	WC	BEG	75,000	170,000	136,059	200,296	219,093	122,585	129,227	201,161	No change
	Karluk											
	Early run	WC	BEG	150,000	250,000	234,880	252,097	260,758	173,874	242,599	205,054	No change
	Late run	WC	BEG	200,000	450,000	336,479	543,469	368,896	314,935	385,896	428,225	No change
	Malina	PAS	SEG	1,000	10,000	3,800	4,900	1,000	2,000	1,000	**500**	No change
	Pasagshak	PAS	LB SEG	3,000		9,750	**350**	**600**	3,200	4,800	**1,100**	No change
	Saltery	WC	BEG	15,000	35,000	35,939	29,047	39,920	54,377	35,218	19,299	No change
	Upper Station											
	Early run	WC	BEG	43,000	93,000	27,712	36,823	54,473	48,047	83,614	61,732	No change
	Late run	WC	BEG	120,000	265,000	125,573	181,411	132,864	145,013	209,298	235,669	SEG 120,000–265,000
Coho												
	American	FS	LB SEG	400		841	1,595	530	500	410	**78**	No change
	Buskin	WC	BEG	4,700	9,600	5,959	8,413	**4,341**	**2,513**	5,559	**4,523**	SEG 4,700–9,600
	Olds	FS	LB SEG	1,000		2,145	1,320	1,357	1,634	1,054	**878**	LB 500
	Pasagshak	FS	LB SEG	1,200		1,648	3,934	1,790	**667**	**701**	3,186	No change
Pink												
	Kodiak Archipelago											
	Odd year	PAS	SEG	2,000,000	5,000,000	4,450,711		5,614,531		5,079,016		No change
	Even year	PAS	SEG	3,000,000	7,000,000		**2,733,282**		**1,699,281**		4,874,342	No change
	Mainland District	PAS	SEG	250,000	1,000,000	620,680	254,650	754,600	**65,305**	1,010,100	280,400	No change
Chum												
	Kodiak Archipelago	PAS	LB SEG	101,000			84,700	171,800	89,700	184,500	115,100	No change

-continued-

Table 1.–Page 2 of 2.

Note: Grey shading indicates now goals from 2016 and the years they were implemented. Bold escapement numbers indicate goal was not achieved.

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

[b] Recommended as a stock of management concern.

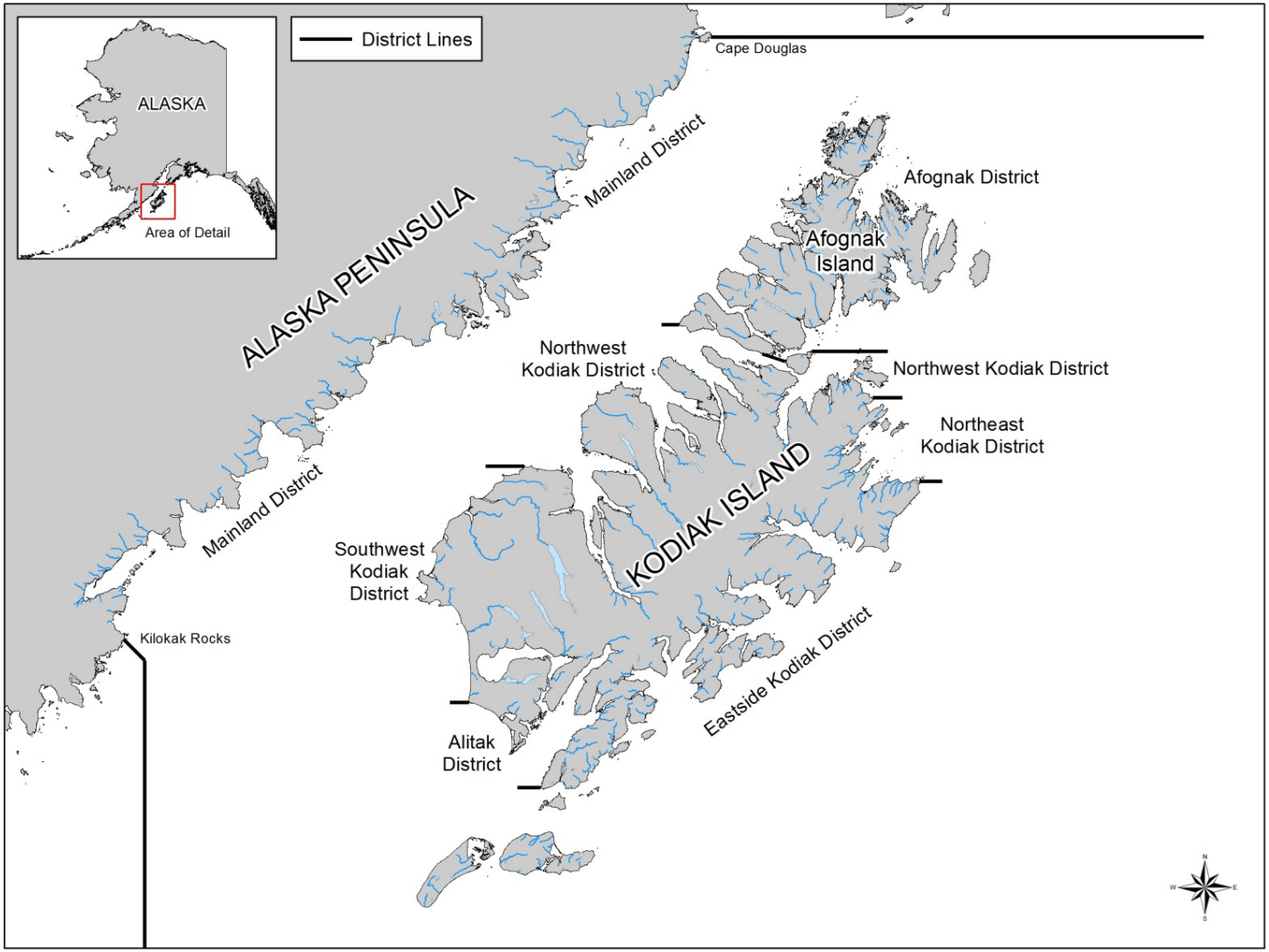


Figure 1.–The Kodiak Management Area, showing the commercial salmon fishing districts.

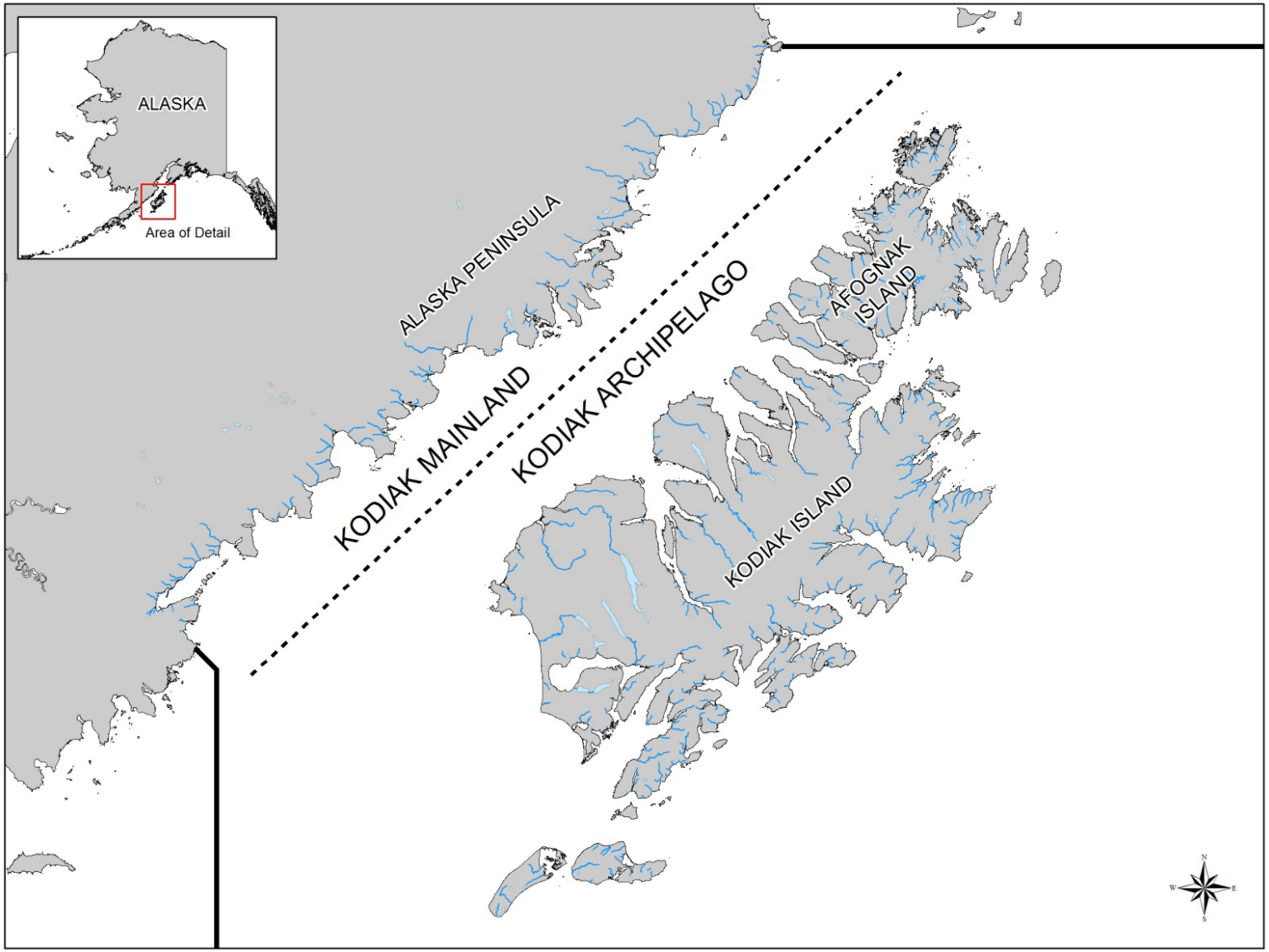


Figure 2.–Geographic boundaries of the Kodiak Management Area in 2019.

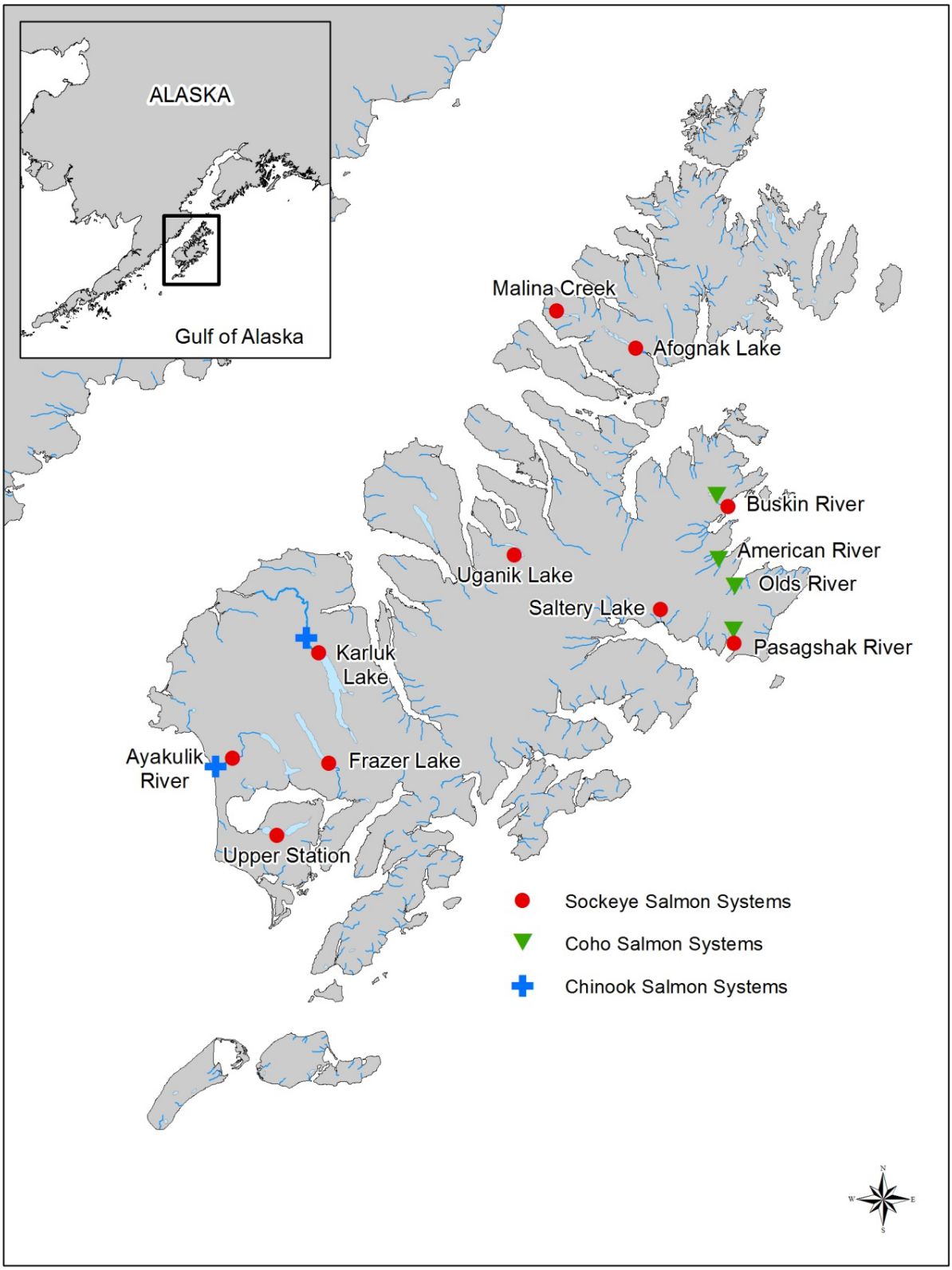


Figure 3.–Locations of Chinook, sockeye, and coho salmon systems with escapement goals in the Kodiak Management Area in 2016.

APPENDIX A: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR AYAKULIK RIVER CHINOOK SALMON

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

System:	**Ayakulik River**
Species:	**Chinook salmon**
Description of stock and escapement goals	
Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Sport and Commercial
Primary fishery:	Commercial, sport, and subsistence
Current escapement goal:	BEG: 4,800–8,400 (2017)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1977 to 2018
Data summary:	
Data quality:	Good escapement and harvest data
Data type:	Weir estimates, harvest estimates, age composition
Data contrast:	All Weir data 1977–2018: 26.6
Methodology:	Bayesian age-structured spawner-recruit analysis
Autocorrelation:	Present
Comments:	Stock of management concern recommendation

Appendix A2.–Annual harvest, weir count, total return, and escapement estimates for Ayakulik River Chinook salmon, 1977–2018.

System: Ayakulik River

Species: Chinook salmon

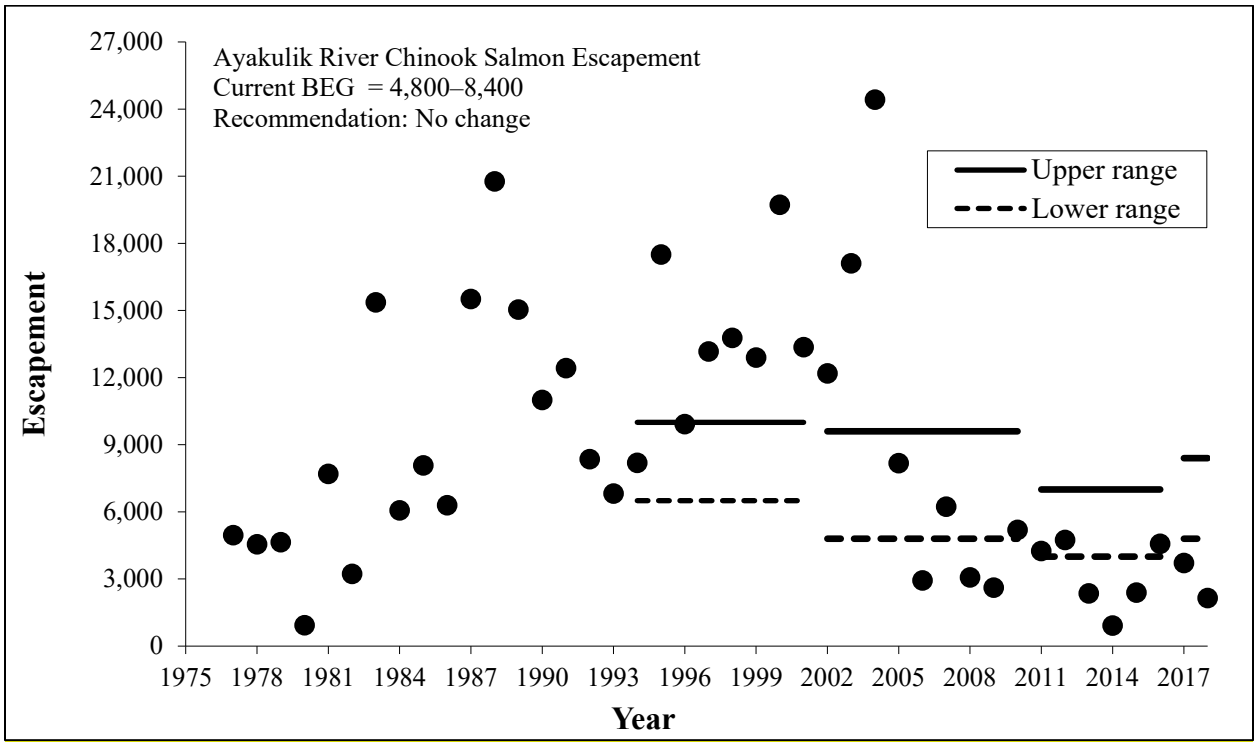
Return year	Commercial harvest	Subsistence harvest	Weir count	Total run	Sport harvest	Escapement
1977	361	0	5,163	5,524	205	4,958
1978	615	0	4,739	5,354	188	4,551
1979	70	0	4,833	4,903	192	4,641
1980	0	0	974	974	39	935
1981	473	0	8,018	8,491	319	7,699
1982	83	0	3,230	3,313	0	3,230
1983	662	0	15,511	16,173	145	15,366
1984	1,409	0	6,502	7,911	437	6,065
1985	3,043	0	8,151	11,194	76	8,075
1986	1,785	0	6,371	8,156	76	6,295
1987	729	0	15,636	16,365	126	15,510
1988	2,257	0	21,370	23,627	600	20,770
1989	0	0	15,432	15,432	390	15,042
1990	5,332	0	11,251	16,583	252	10,999
1991	4,685	0	12,988	17,673	563	12,425
1992	4,909	0	9,135	14,044	776	8,359
1993	2,708	0	7,819	10,527	1,004	6,815
1994	0	3	9,138	9,141	948	8,190
1995	2,412	4	17,701	20,117	200	17,501
1996	3,723	0	10,344	14,067	419	9,925
1997	812	0	14,357	15,169	1,190	13,167
1998	3,795	0	14,038	17,833	259	13,779
1999	3,564	26	13,503	17,093	609	12,894
2000	3,416	38	20,527	23,981	803	19,724
2001	6,727	16	13,929	20,672	568	13,361
2002	71	37	12,552	12,660	362	12,190
2003	0	14	17,557	17,571	451	17,106
2004	158	16	24,830	25,004	405	24,425
2005	0	8	8,340	8,348	165	8,175
2006	0	37	3,106	3,143	169	2,937
2007	0	0	6,535	6,535	303	6,232
2008	0	0	3,071	3,071	0	3,071
2009	0	0	2,615	2,615	0	2,615
2010	65	0	5,301	5,366	104	5,197
2011	62	0	4,316	4,378	65	4,251
2012	115	0	4,760	4,875	16	4,744
2013	633	0	2,369	3,002	15	2,354
2014	70	0	917	987	0	917
2015	356	0	2,392	2,748	0	2,392
2016	93	0	4,594	4,687	1	4,594
2017	138	0	3,712	3,850	0	3,712
2018	207	0	2,149	2,356	0	2,149

Appendix A3.–Ayakulik River Chinook salmon escapement and escapement goal ranges, 1977–2018.

System: **Ayakulik River**

Species: **Chinook salmon**

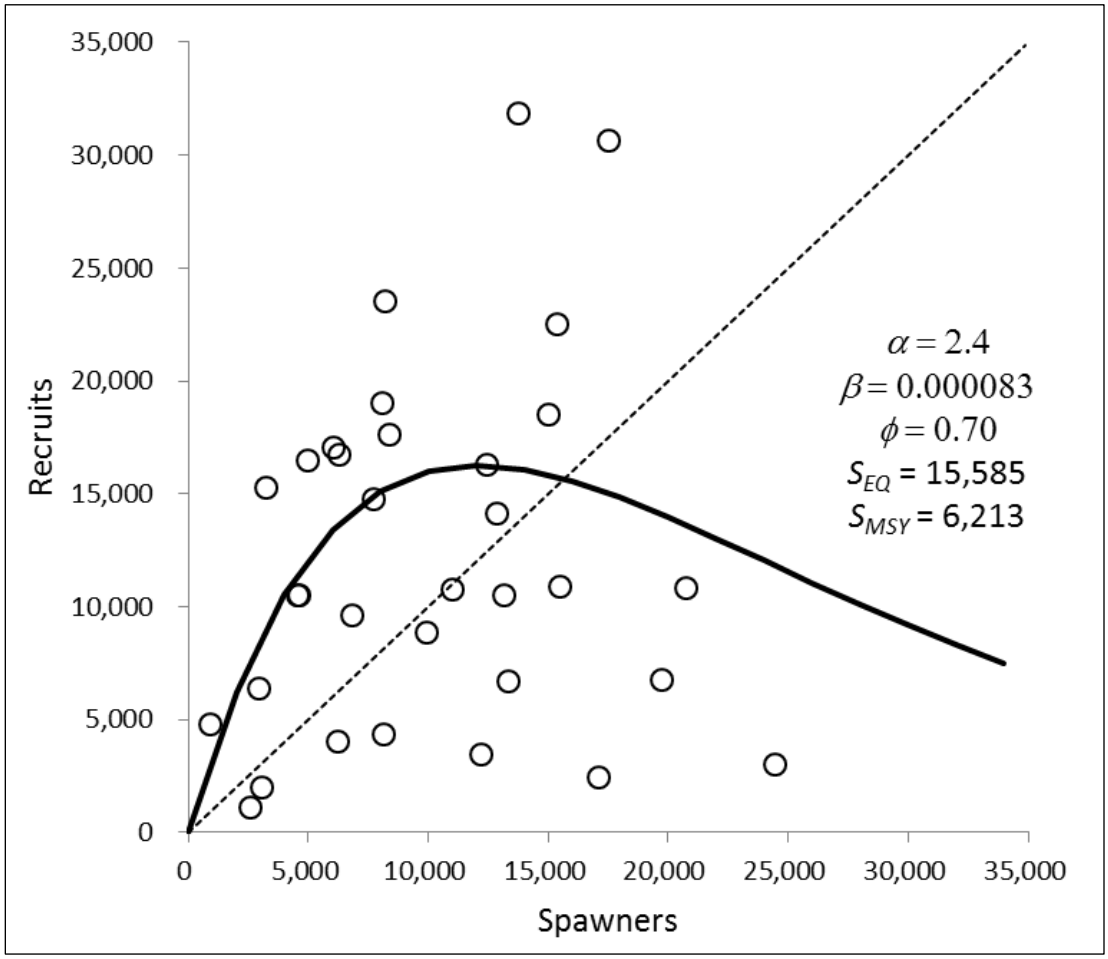
Observed escapement by year (weir counts)



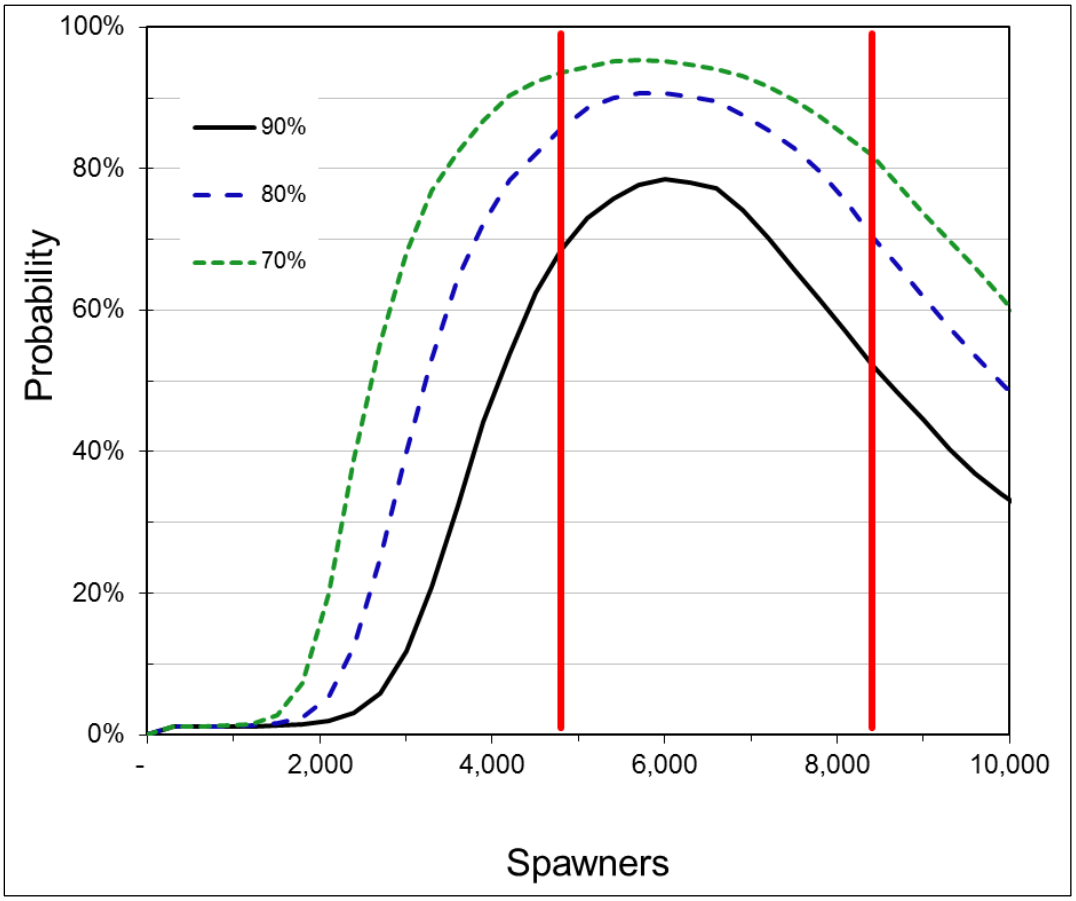
Appendix A4.–Brood table for Ayakulik River Chinook salmon.

Brood year	Escapement	Return by Age					Return	Return/ spawner
		Age 3	Age 4	Age 5	Age 6	Age 7		
1977	4,958	407	5,063	1,698	8,647	655	16,470	3.3
1978	4,551	1,173	833	4,314	3,480	726	10,525	2.3
1979	4,641	282	2,539	2,434	4,752	492	10,499	2.3
1980	935	367	745	1,562	1,799	294	4,767	5.1
1981	7,699	644	3,137	3,258	6,547	1,183	14,770	1.9
1982	3,230	999	1,810	4,327	7,462	676	15,274	4.7
1983	15,366	848	4,084	9,142	7,189	1,240	22,503	1.5
1984	6,065	1,096	4,009	4,165	6,676	1,086	17,032	2.8
1985	8,075	1,595	2,694	5,288	8,351	1,083	19,010	2.4
1986	6,295	801	2,705	5,175	6,430	1,627	16,738	2.7
1987	15,510	712	2,285	3,577	4,115	210	10,899	0.7
1988	20,770	752	2,008	1,893	4,697	1,471	10,822	0.5
1989	15,042	977	2,823	2,346	11,744	594	18,485	1.2
1990	10,999	97	1,016	2,813	5,964	836	10,725	1.0
1991	12,425	987	2,804	3,465	8,500	558	16,314	1.3
1992	8,359	996	3,465	3,104	9,788	267	17,620	2.1
1993	6,815	573	1,578	2,551	4,754	179	9,636	1.4
1994	8,190	1,150	2,771	8,324	10,716	589	23,550	2.9
1995	17,501	1,603	3,289	12,010	12,981	743	30,627	1.8
1996	9,925	464	888	3,711	3,626	127	8,816	0.9
1997	13,167	178	1,664	4,188	3,766	710	10,505	0.8
1998	13,779	1,698	3,452	10,207	16,276	250	31,883	2.3
1999	12,894	714	3,417	6,568	3,239	187	14,125	1.1
2000	19,724	122	732	3,471	1,077	1,327	6,728	0.3
2001	13,361	356	1,046	1,457	3,314	526	6,699	0.5
2002	12,190	336	416	1,335	1,229	151	3,467	0.3
2003	17,106	98	380	829	804	350	2,461	0.1
2004	24,425	110	397	768	1,585	172	3,032	0.1
2005	8,175	113	691	1,525	1,900	85	4,314	0.5
2006	2,937	217	1,637	1,473	2,905	169	6,401	2.2
2007	6,232	134	730	1,172	1,880	81	3,998	0.6
2008	3,071	120	633	649	428	140	1,972	0.6
2009	2,615	48	178	228	617		1,070	0.4
2010	5,197	130	192	868				
2011	4,251	72	710					
2012	4,744	400						
2013	2,354							
2014	917							
2015	2,392							

Appendix A5.–Ricker spawner-recruit function fitted to Ayakulik River Chinook salmon data, 1977–2009 brood years. Parameter estimates are posterior medians.



Appendix A6.–Optimal yield profiles obtained by fitting an age-structured spawner-recruit model to Ayakulik River Chinook salmon data, brood years 1977–2009. Probability of achieving at least 70%, 80%, and 90% of maximum sustained yield is plotted for various levels of escapement. Vertical lines show current escapement goal.



APPENDIX B: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR KARLUK RIVER CHINOOK SALMON

Appendix B1.–Description of stock and escapement goal for Karluk River Chinook salmon.

System: Karluk River

Species: Chinook salmon

Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Sport and Commercial
Primary fishery:	Sport, commercial, and subsistence
Current escapement goal:	BEG: 3,000–6,000 (2011)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1976 to 2018
Data summary:	
Data quality:	Good escapement and harvest data.
Data type:	Weir estimates, harvest estimates, age composition
Data contrast:	All survey data 1976 to 2018: 18.3
Methodology:	Bayesian age-structured spawner-recruit analysis
Autocorrelation:	Present
Comments:	Currently listed as a stock of management concern

Appendix B2.–Annual harvest, weir count, total run, and escapement estimates for Karluk River Chinook salmon, 1976–2018.

System: Karluk River

Species: Chinook salmon

Return year	Commercial harvest [a]	Subsistence harvest [b]	Weir count [c]	Total run	Sport harvest [d]	Escapement [e]
1976	2	0	6,897	6,899	461	6,436
1977	0	0	8,434	8,434	461	7,973
1978	35	0	9,795	9,830	461	9,334
1979	0	0	9,555	9,555	461	9,094
1980	0	0	4,810	4,810	461	4,349
1981	0	0	7,575	7,575	461	7,114
1982	0	0	7,489	7,489	796	6,693
1983	0	0	11,746	11,746	304	11,442
1984	2	0	7,747	7,749	175	7,572
1985	5	0	5,362	5,367	472	4,890
1986	542	0	4,429	4,971	122	4,307
1987	313	0	7,930	8,243	199	7,731
1988	3	0	13,337	13,340	819	12,518
1989	0	0	10,484	10,484	559	9,925
1990	0	0	14,442	14,442	700	13,742
1991	0	0	14,022	14,022	1,599	12,423
1992	264	0	9,601	9,865	856	8,745
1993	3,082	5	13,944	17,031	1,634	12,310
1994	5,114	13	12,049	17,176	1,483	10,566
1995	1,794	31	12,657	14,482	1,284	11,373
1996	1,662	4	10,051	11,717	1,695	8,356
1997	1,445	17	13,443	14,905	1,574	11,869
1998	252	4	10,239	10,495	1,173	9,066
1999	1,067	7	13,063	14,137	1,766	11,297
2000	693	22	10,460	11,175	2,581	7,879
2001	2,588	24	4,453	7,065	1,304	3,149
2002	1,262	165	7,175	9,087	231	6,944
2003	1,336	6	7,256	8,891	270	6,986
2004	2,249	16	7,525	10,183	297	7,228
2005	349	5	4,798	5,406	114	4,684
2006	910	17	4,112	5,270	439	3,673
2007	314	1	1,765	2,217	68	1,697
2008	92	5	752	770	0	752
2009	0	0	1,306	1,306	0	1,306
2010	0	0	2,917	2,917	0	2,917
2011	0	2	3,420	3,422	0	3,420
2012	171	0	3,197	3,368	0	3,197
2013	1,550	0	1,824	3,374	0	1,824
2014	518	0	1,182	1,700	0	1,182
2015	228	0	2,777	3,005	0	2,777
2016	272	0	3,434	3,706	0	3,434
2017	340	0	2,600	2,940	0	2,600
2018	86	0	3,155	3,241	0	3,155

-continued-

[a] ADF&G, Commercial Fish Division Statewide Harvest Receipt (fish ticket) database. Commercial harvest is the harvest of Chinook salmon from Inner and Outer Karluk statistical areas (255-10 and 255-20) through July 15.

[b] Based on subsistence harvest records maintained by the Westward Region, ADF&G Commercial Fish Division; includes all reported harvest in Karluk Section.

[c] ADF&G, Division of Commercial Fisheries, Kodiak escapement (weir count) database. Inriver run is the weir count of Chinook salmon.

[d] Sport harvest is from the Statewide Harvest Survey.

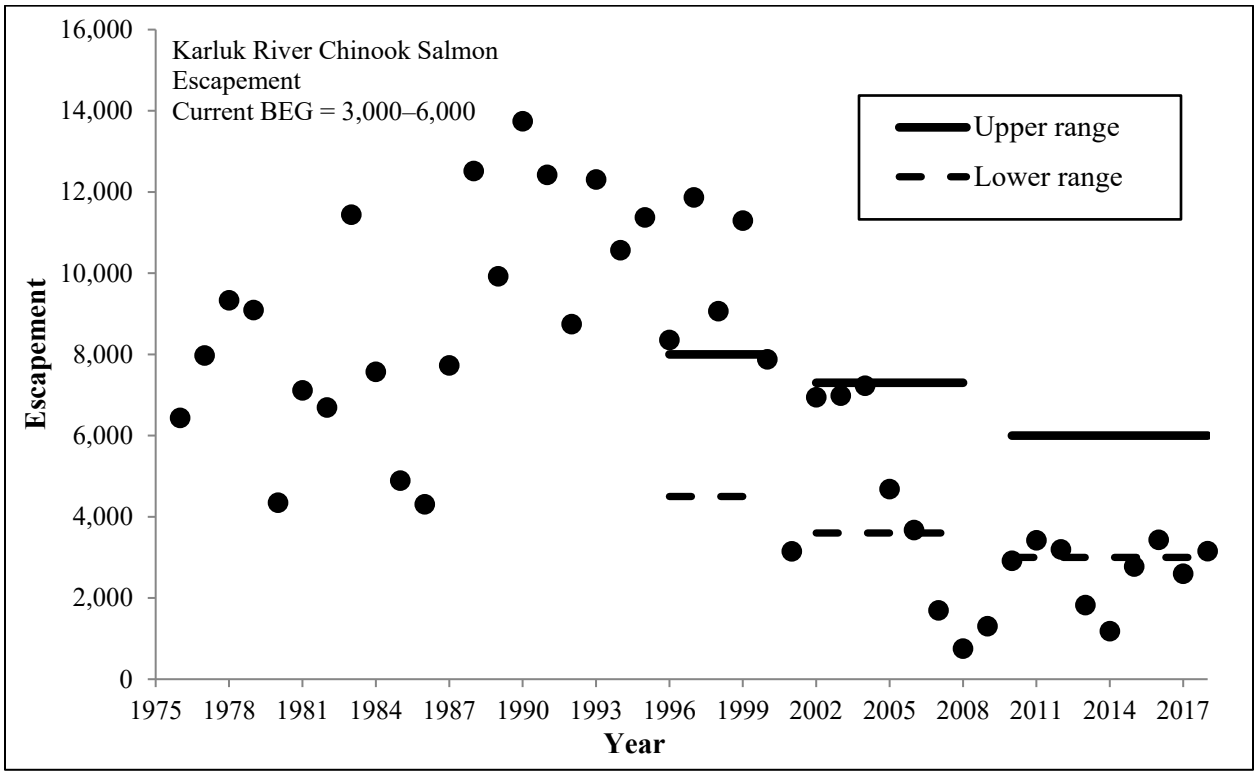
[e] Escapement is weir count minus recreational harvest.

Appendix B3.–Karluk River Chinook salmon escapement and escapement goal ranges, 1976–2018.

System: **Karluk River**

Species: **Chinook salmon**

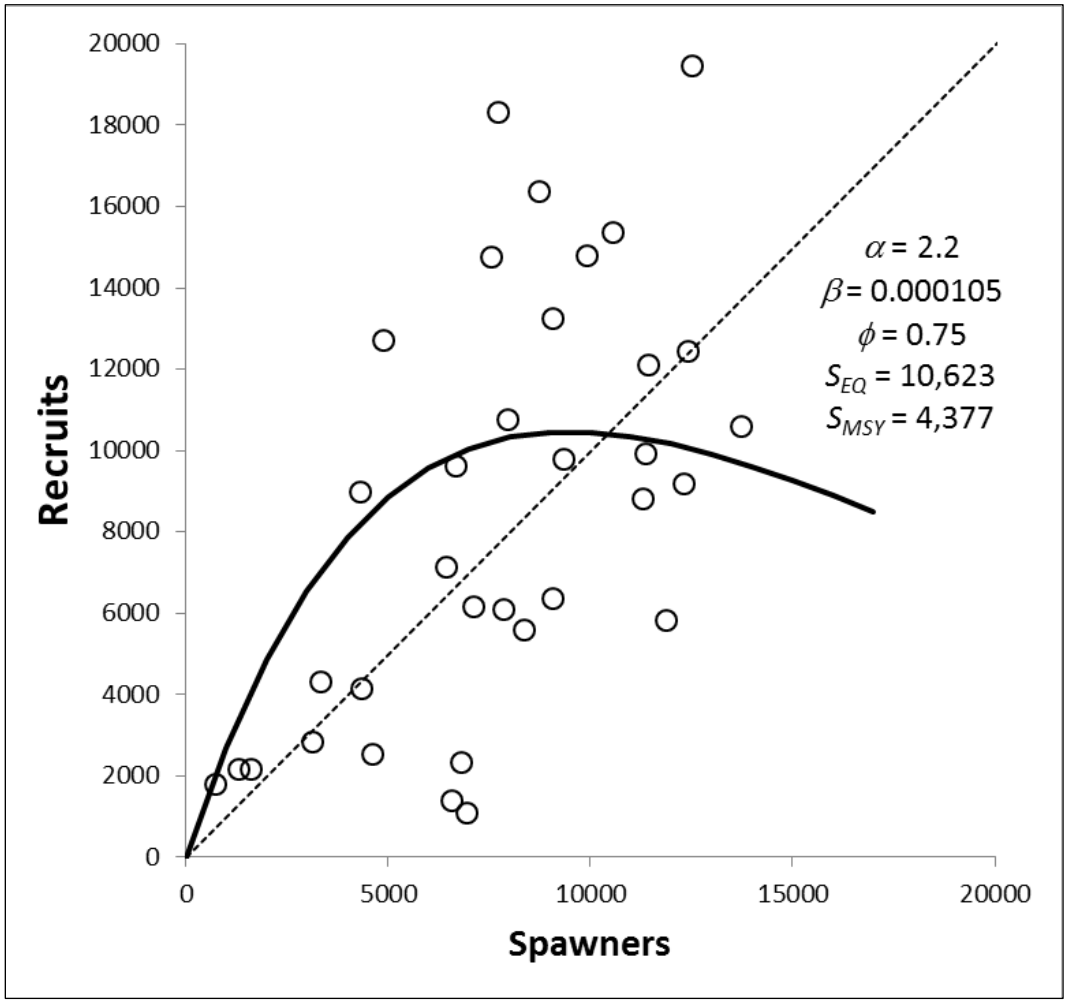
Observed escapement by year (weir counts)



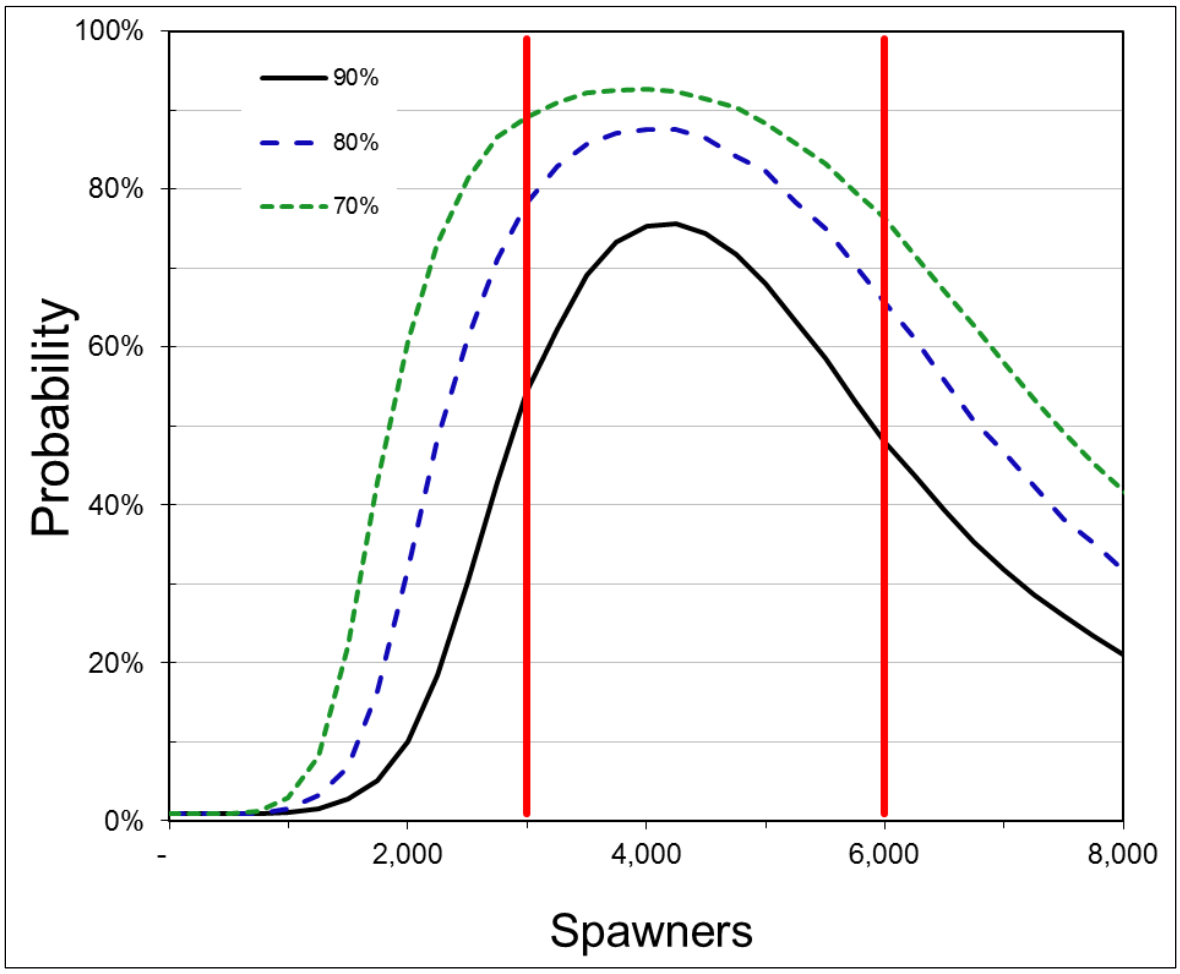
Appendix B4.–Brood table for Karluk River Chinook salmon.

Brood year	Escapement	Return by Age					Recruits	Recruits/ spawner
		Age 3	Age 4	Age 5	Age 6	Age 7		
1976	6,436	418	625	2,297	3,082	721	7,143	1.1
1977	7,973	275	1,169	2,639	5,946	740	10,768	1.4
1978	9,334	409	1,018	3,685	4,115	551	9,779	1.0
1979	9,094	286	1,011	2,040	2,610	409	6,357	0.7
1980	4,349	237	563	1,236	1,746	345	4,128	0.9
1981	7,114	306	668	1,615	2,999	558	6,146	0.9
1982	6,693	335	837	2,782	5,037	621	9,612	1.4
1983	11,442	384	1,471	4,578	4,662	1,023	12,118	1.1
1984	7,572	646	2,270	3,590	7,025	1,225	14,756	1.9
1985	4,890	732	1,278	4,046	5,966	700	12,721	2.6
1986	4,307	415	1,353	3,419	3,673	124	8,984	2.1
1987	7,731	945	2,364	3,622	10,288	1,087	18,305	2.4
1988	12,518	977	1,519	5,205	10,254	1,488	19,443	1.6
1989	9,925	481	1,376	3,487	8,521	934	14,800	1.5
1990	13,742	97	1,643	2,147	5,811	879	10,577	0.8
1991	12,423	661	1,847	2,899	6,865	161	12,432	1.0
1992	8,745	454	1,915	5,248	7,907	850	16,374	1.9
1993	12,310	176	1,259	1,686	5,898	150	9,169	0.7
1994	10,566	589	1,437	5,846	6,777	703	15,352	1.5
1995	11,373	203	1,270	3,531	4,554	376	9,933	0.9
1996	8,356	166	472	1,543	3,248	155	5,584	0.7
1997	11,869	245	173	2,848	2,012	549	5,828	0.5
1998	9,066	151	2,242	5,013	5,603	240	13,249	1.5
1999	11,297	289	1,583	3,422	2,377	1,135	8,806	0.8
2000	7,879	121	459	2,111	2,905	499	6,095	0.8
2001	3,149	133	521	912	1,179	105	2,851	0.9
2002	6,574	162	225	368	533	108	1,396	0.2
2003	6,965	88	107	160	410	334	1,099	0.2
2004	6,805	70	52	497	1,332	376	2,327	0.3
2005	4,611	20	256	862	1,249	155	2,543	0.6
2006	3,351	53	325	1,449	1,865	618	4,310	1.3
2007	1,609	34	260	1,072	655	132	2,152	1.3
2008	752	65	209	792	599	115	1,780	2.4
2009	1,306	50	496	548	1,076		2,170	1.7
2010	2,916	793	318	1,181				
2011	3,420	119	469					
2012	3,197	178						
2013	1,824							
2014	1,182							
2015	2,777							

Appendix B5.–Ricker spawner-recruit function fitted to Karluk River Chinook salmon data, 1976–2009 brood years. Parameter estimates are posterior medians.



Appendix B6.–Optimal yield profiles obtained by fitting an age-structured spawner recruit model to Karluk River Chinook salmon data, 1976–2015. Probability of achieving at least 70%, 80%, and 90% of maximum sustained yield is plotted. Vertical lines show escapement goal.



APPENDIX C: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR AFOGNAK LAKE SOCKEYE SALMON

Appendix C1.–Description of stock and escapement goal for Afognak Lake sockeye salmon.

System: **Afognak Lake**

Species: **Sockeye salmon**

Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Sport and Commercial
Primary fishery:	Commercial purse seine, subsistence, and sport
Current escapement goal:	BEG: 20,000–50,000 (2005)
Recommended escapement goal:	SEG 20,000–50,000
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1921–1933; 1978–2018 Aerial survey, 1966–1977
Data summary:	
Data quality:	Fair for weir counts 1921–1933; fair for aerial surveys 1966–1977; excellent for weir enumeration 1978–2018; good for harvest and age data.
Data type:	Weir counts from 1978 to 2018 with escapement age data during weir counts, 1985–2018. Fixed-wing aerial surveys from 1966 to 1977. Commercial, subsistence, and sport fish harvest data from Afognak Bay (252–34) from 1978 to 2018.
Data contrast:	Weir data, 1982–2018: 8.6 Brood table data, 1982–2012: 8.6
Methodology:	Ricker spawner-recruit models, percentile approach, yield analysis, smolt biomass as a function of zooplankton biomass, and euphotic volume models.
Autocorrelation:	None
Comments:	Spawner-recruit model using data from 2000 to 2012 was significant and not autocorrelated. Yield analysis and habitat-based models corroborate lowering the goal range.

Appendix C2.–Afognak Lake sockeye salmon escapement, 1921–2018.

System: Afognak Lake

Species: Sockeye salmon

Data available for analysis of escapement goals

Year	Weir counts	Peak aerial survey	Year	Weir counts
1921	37,653	–	1986	48,333
1922	–	–	1987	26,474
1923	8,025	–	1988	39,012
1924	10,317	–	1989	88,825
1925	11,000	–	1990	90,666
1926	22,250	–	1991	88,557
1927	7,491	–	1992	77,260
1928	20,812	–	1993	71,460
1929	25,400	–	1994	80,570
1930	2,467	–	1995	100,131
1931	30,515	–	1996	101,718
1932	25,202	–	1997	132,050
1933	36,154	–	1998	66,869
–	–	–	1999	95,361
1966	–	950	2000	54,064
1967	–	550	2001	24,271
1968	–	–	2002	19,520
1969	–	2,600	2003	27,766
1970	–	7,500	2004	15,181
1971	–	22,000	2005	21,577
1972	–	100	2006	22,933
1973	–	100	2007	21,070
1974	–	4,300	2008	26,874
1975	–	10,000	2009	31,358
1976	–	29,000	2010	52,255
1977	–	51,300	2011	49,193
1978	52,699	–	2012	41,553
1979	82,740	–	2013	42,153
1980	93,806	–	2014	36,345
1981	57,267	–	2015	38,151
1982	123,055	–	2016	33,167
1983	40,049	–	2017	22,151
1984	94,463		2018	17,601
1985	53,872			

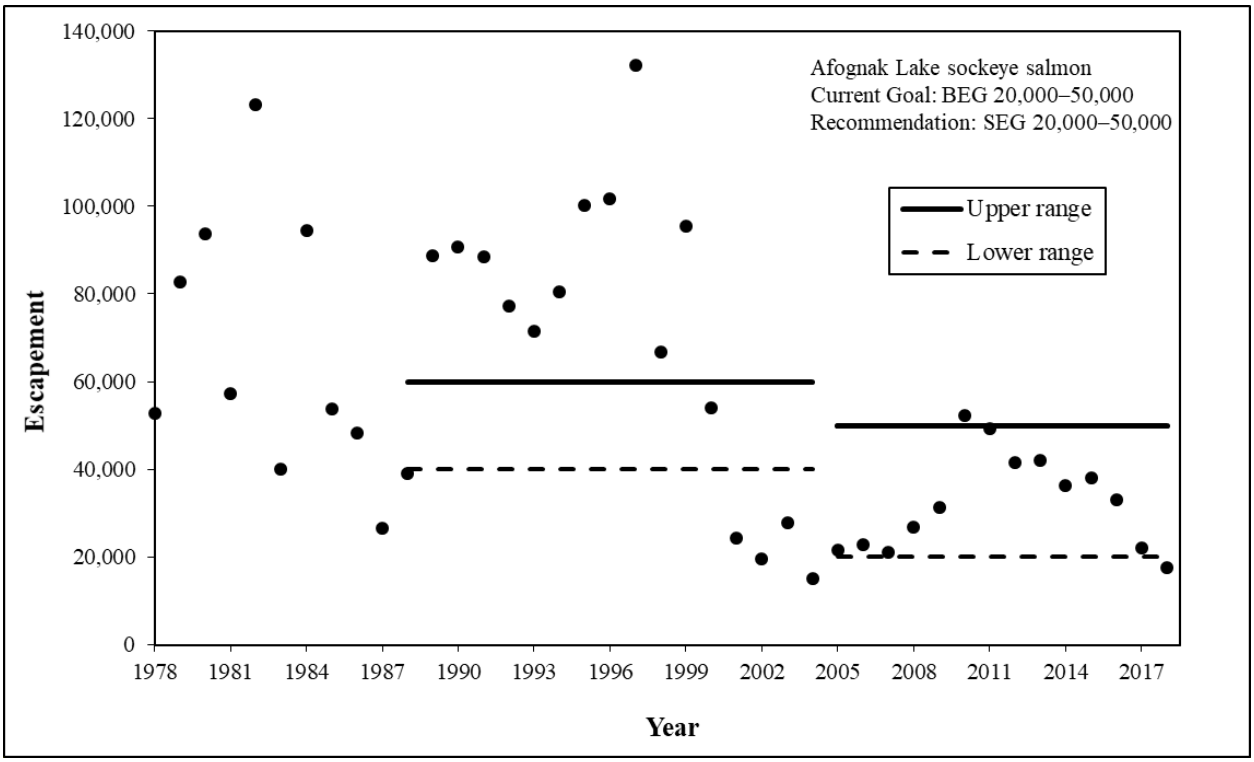
Note: Weir count numbers do not account for spawners removed for broodstock.

Appendix C3.–Afognak Lake sockeye salmon escapement and escapement goal ranges, 1921–2015.

System: **Afognak Lake**

Species: **Sockeye salmon**

Observed escapement by year (solid circles for weir counts) and escapement goal ranges



Appendix C4.–Afognak Lake sockeye salmon brood table.

Brood year	Escapement	Age class returns																Total return	R/S[a]
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	4.1	2.4	3.3		
1982	123,055	2	0	17	112	5,504	112	0	13,845	762	0	0	371	0	0	0	0	20,726	0.17
1983	40,049	0	0	337	0	9,828	297	0	10,013	4,627	0	0	1,707	0	0	35	0	26,844	0.67
1984	94,463	0	0	1,588	54	24,634	1,307	0	47,110	22,360	0	339	24,078	0	0	0	0	121,471	1.29
1985	53,872	36	96	272	0	10,583	2,902	0	26,542	10,030	0	0	6,568	0	0	65	0	57,094	1.06
1986	48,333	0	0	8,022	35	54,737	717	0	108,494	4,958	0	428	10,370	0	0	0	0	187,760	3.88
1987	26,474	0	0	773	0	20,889	313	0	25,139	3,198	99	0	9,772	177	0	0	0	60,359	2.28
1988	39,012	0	0	472	0	18,628	8,360	0	23,626	9,607	57	77	9,686	80	0	0	0	70,593	1.81
1989	88,825	0	0	17,807	0	8,321	13,427	0	35,677	10,450	157	253	13,374	0	0	397	0	99,863	1.12
1990	90,666	0	0	12,902	0	30,978	4,194	0	96,927	18,526	0	397	56,869	175	0	0	199	221,167	2.44
1991	86,481	0	280	9,681	277	37,463	1,440	0	96,284	4,507	0	48	22,573	0	0	0	0	172,552	2
1992	75,370	0	0	3,925	175	20,223	4,698	0	70,857	3,087	0	365	5,377	0	0	0	0	108,706	1.44
1993	69,291	0	0	35,159	0	40,046	10,200	0	47,921	10,364	222	330	8,915	646	0	0	680	154,484	2.23
1994	79,380	0	0	7,863	0	7,842	6,959	74	12,841	57,821	74	0	52,384	2,531	0	0	205	148,593	1.87
1995	98,691	0	0	18,569	0	52,527	718	0	11,888	4,523	0	0	11,396	0	75	0	0	99,696	1.01
1996	100,018	0	0	1,463	0	1,888	264	0	6,789	925	4,213	0	996	6,818	0	0	3,992	27,348	0.27
1997	130,450	0	30	1,571	0	3,202	1,787	0	6,775	5,147	171	0	8,408	787	0	186	875	28,938	0.22
1998	65,809	0	0	399	0	207	666	0	238	7,296	0	3	4,225	0	0	0	0	13,033	0.2
1999	94,011	0	0	20	0	6,409	67	0	2,996	291	0	0	293	0	0	0	0	10,076	0.11
2000	54,644	0	0	1,173	0	6,971	26	0	18,560	495	0	36	2,199	0	0	0	0	29,460	0.54
2001	23,981	0	0	177	164	2,258	142	0	5,176	608	0	8	1,202	0	0	0	0	9,735	0.41
2002	19,340	0	0	716	20	14,769	0	0	11,665	435	0	1	196	0	0	0	0	27,803	1.44
2003	27,498	0	0	580	0	7,074	71	0	14,358	1,054	0	1	890	0	0	0	0	24,028	0.87
2004	15,181	0	0	1,105	0	11,631	90	0	15,538	710	0	64	140	0	0	0	0	29,278	1.93
2005	20,281	0	0	1,238	0	13,151	911	0	51,698	328	0	200	9,530	0	0	0	0	77,056	3.8
2006	21,488	0	0	1,492	0	10,108	127	0	18,494	5,727	0	54	4,876	0	0	0	0	40,878	1.9
2007	20,033	0	0	1,691	0	26,090	2,119	0	26,626	6,553	0	20	5,549	0	0	0	0	68,648	3.43
2008	26,052	0	0	2,753	0	7,379	367	0	31,931	2,570	0	0	4,873	0	0	0	0	49,873	1.91
2009	30,818	0	0	1,094	0	9,801	0	0	16,230	5,203	0	0	5,839	0	0	0	0	38,167	1.24
2010	51,821	0	0	92	0	8,365	245	0	17,474	1,764	0	26	5,892	0	0	0	0	33,858	0.65
2011	48,588	0	0	1,373	0	11,464	521	0	19,098	3,627	0	369	5,254	0	0	0	0	41,706	0.86
2012	41,046	0	0	1,089	72	3,835	0	0	10,886	448	0	377	5,279	0	0				
2013	40,888	0	0	616	0	4,432	35	0	10,901	445									

-continued-

Appendix C4.–Page 2 of 2.

Brood year	Escapement	Age class returns															Total return	R/S[a]
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	4.1	2.4	3.3	
2014	35,704	0	0	726	0	4411	36											
2015	36,780	0	48															
2016	32,459	0																
2017	21,441																	
2018	17,607																	

[a] R/S = return/spawner.

APPENDIX D: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR AYAKULIK RIVER SOCKEYE SALMON

Appendix D1.–Description of stock and escapement goal for Ayakulik River sockeye salmon.

System: Ayakulik River

Species: Sockeye salmon

Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine, subsistence, and sport
Current escapement goal:	Early-run SEG: 140,000–280,000 (2011) Late-run SEG: 60,000–120,000 (2011)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1929–1961 (variable); 1962–2018
Data summary:	
Data quality:	Fair for weir counts 1929–1961; excellent for weir enumeration 1962–2018; good for harvest and age data.
Data type:	Weir counts from 1962 to 2018 with escapement age data during weir counts. Harvest estimates with age data 1970–2018. Limnology information 1990–1996 and 2009–?.
Data contrast:	Weir data, 1970–2018: Early-run - 78.9; Late-run - 55.0
Methodology:	Ricker spawner-recruit models, smolt biomass as a function of zooplankton biomass, and euphotic volume models.
Autocorrelation:	None
Comments:	None

Appendix D2.–Ayakulik River sockeye salmon escapement and harvest estimates, 1929–2018.

System: **Ayakulik River**

Species: **Sockeye salmon**

Data available for analysis of escapement goals

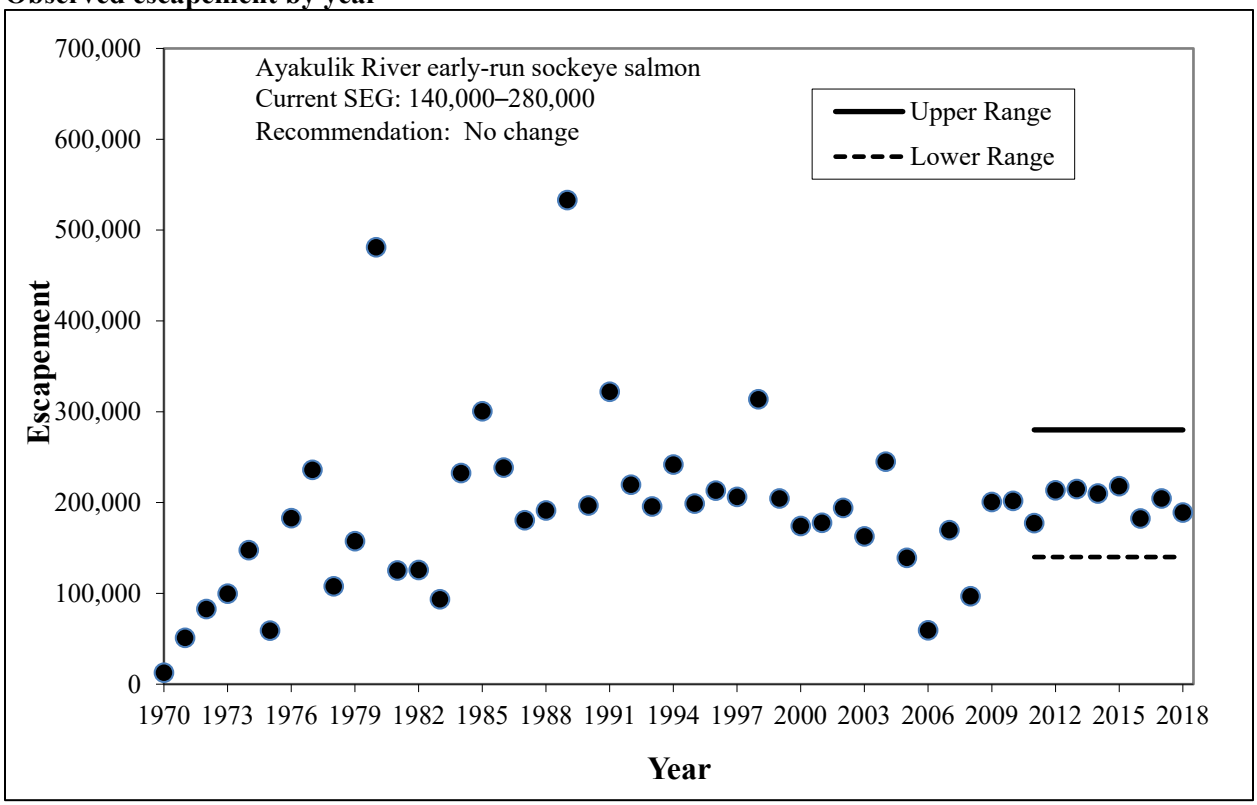
Year	Weir counts		Commercial harvest	Year	Weir counts		Commercial harvest
	Early	Late			Early	Late	
1929	18,481	10,386	–	1979	157,408	64,862	31,901
1930	54,390	79,396	–	1980	481,165	293,163	208,281
1931	257,444	363,549	–	1981	125,272	153,928	177,795
1932	295,953	202,570	–	1982	125,852	43,826	102,075
1934	659,472	500,824	–	1983	93,540	77,875	25,003
1935	314,341	200,626	–	1984	232,466	50,749	392,218
1936	324,240	167,132	–	1985	300,568	88,191	517,250
1937	202,848	51,146	–	1986	238,557	79,578	415,848
1938	133,743	52,760	–	1987	180,515	81,398	119,459
1939	145,559	38,948	–	1988	191,386	100,388	312,132
1940	221,759	62,874	–	1989	533,066	235,035	0
1941	149,100	131,736	–	1990	196,695	174,587	1,467,737
1942	223,121	61,924	–	1991	321,985	52,874	926,419
1945	293,306	136,577	–	1992	219,723	124,461	404,246
1946	133,474	36,881	–	1993	195,701	90,469	338,727
1948	105,272	112,957	–	1994	241,811	138,370	41,331
1949	43,945	57,680	–	1995	198,864	118,968	565,040
1950	110,215	66,404	–	1996	213,229	123,926	906,897
1953	68,465	53,189	–	1997	206,346	101,868	135,595
1954	62,689	44,680	–	1998	313,739	113,469	1,018,898
1955	64,819	21,013	–	1999	204,552	91,165	693,912
1956	62,486	9,087	–	2000	174,297	34,354	236,190
1957	105,193	49,702	–	2001	177,822	41,070	367,522
1958	57,631	37,224	–	2002	194,187	35,105	6,505
1959	65,946	9,154	–	2003	162,708	35,184	90
1960	16,398	18,216	–	2004	245,123	30,115	170,749
1962	229,603	49,351	–	2005	139,246	112,660	53,835
1963	27,085	36,478	–	2006	59,315	28,465	32,325
1964	8,363	27,979	–	2007	169,596	113,446	99,937
1965	35,681	39,675	–	2008	96,912	65,976	81,540
1966	11,591	59,568	–	2009	200,648	114,536	70,588
1967	102,890	121,310	–	2010	201,933	60,394	255,942
1968	166,309	54,541	–	2011	177,480	83,661	170,490
1970	12,620	21,248	28,306	2012	213,501	114,753	229,906
1971	51,011	58,188	0	2013	214,969	67,195	147,877
1972	82,804	30,929	46,733	2014	210,040	87,671	329,711
1973	99,783	20,210	36,455	2015	218,178	108,257	491,289
1974	147,590	34,041	43,251	2016	182,589	72,378	108,191
1975	59,021	35,496	0	2017	204,497	120,361	122,551
1976	182,784	36,263	132,805	2018	189,008	77,325	179,337
1977	236,127	70,855	165,424				
1978	107,847	25,017	178,080				

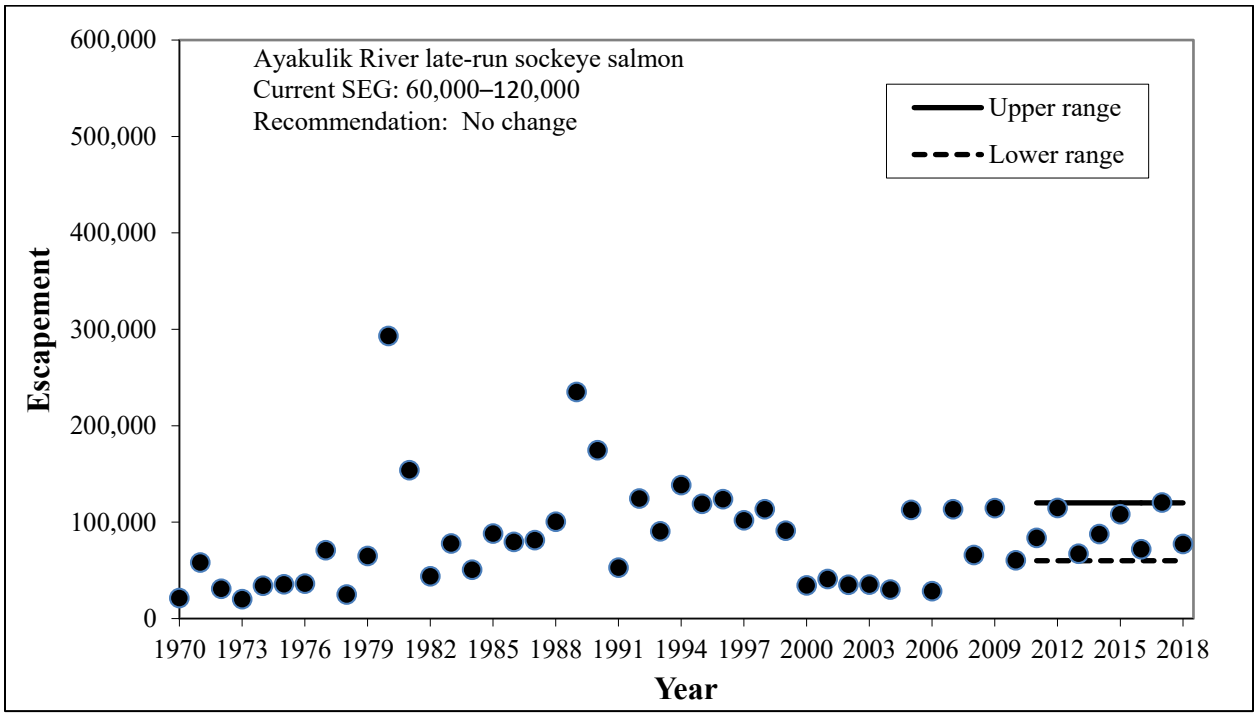
Appendix D3.–Ayakulik River sockeye salmon escapement and escapement goals, 1970–2018.

System: **Ayakulik River**

Species: **Sockeye salmon**

Observed escapement by year





Appendix D4.–Ayakulik River sockeye salmon brood table.

Brood Year	Escap.	Ages																Total Return	R/S[a]
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	2.4	3.3	3.4		
1975	94,517	0	0	0	1,393	10,982	14,989	0	30,950	308,251	0	0	96,141	858	0	0	0	463,563	4.9
1976	219,047	0	0	5,835	3,855	405,330	8,408	0	164,495	187,009	0	0	61,395	0	0	0	0	836,328	3.8
1977	306,982	0	0	0	0	5,060	3,431	0	18,656	170,721	0	0	85,541	3,940	0	0	0	287,349	0.9
1978	132,864	0	0	0	0	1,556	15,799	0	14,937	45,081	0	0	42,151	2,747	0	0	0	122,273	0.9
1979	222,270	0	0	3,625	441	16,345	18,352	0	40,958	131,539	0	0	41,815	1,438	0	0	0	254,511	1.1
1980	774,328	0	0	11,780	13,347	402,761	24,781	0	232,583	305,083	0	0	159,440	2,762	0	0	0	1,152,537	1.5
1981	279,200	0	0	17,149	0	310,784	7,450	0	230,889	328,622	0	0	168,527	28,564	0	0	0	1,091,984	3.9
1982	169,678	0	0	6,857	7,500	1,626	2,596	0	16,351	123,667	0	0	77,129	4,751	0	0	0	240,476	1.4
1983	171,415	0	0	548	1,171	20,198	15,116	0	72,231	168,055	0	0	104,765	1,148	0	0	0	383,233	2.2
1984	283,215	0	0	7,779	3,311	138,185	78,899	0	72,319	197,026	0	0	103,450	3,347	0	0	0	604,316	2.1
1985	388,759	0	0	61,345	3,903	365,489	18,971	0	589,731	513,314	0	0	229,750	4,276	0	0	0	1,786,779	4.6
1986	318,135	0	0	4,480	38,326	571,371	6,489	0	506,463	365,644	0	0	231,471	5,967	0	0	0	1,730,211	5.4
1987	261,913	0	0	12,991	15,380	173,341	13,602	0	103,512	317,142	0	0	341,728	32,807	0	5,063	0	1,015,566	3.9
1988	291,774	0	0	2,822	3,351	81,584	2,832	0	62,159	126,124	0	0	27,783	10,655	0	8,225	0	325,535	1.1
1989	768,101	0	0	2,571	5,565	26,297	29,189	0	18,318	310,379	0	0	254,557	59,553	0	46,238	0	752,667	1.0
1990	371,282	0	0	1,028	8,047	3,618	14,638	0	59,035	295,167	0	0	202,600	16,202	0	102	38	600,475	1.6
1991	384,859	0	640	22,371	17,118	145,925	36,123	0	393,249	482,187	0	19	158,923	5,779	64	2,796	0	1,265,194	3.3
1992	344,184	0	4,591	2,578	9,900	65,889	24,694	205	10,135	200,817	2,188	2,685	230,460	19,788	1,983	6,010	112	582,035	1.7
1993	286,170	0	0	3,093	3,678	2,504	16,283	400	176,539	409,718	516	8,075	138,504	7,591	344	5,426	0	772,671	2.7
1994	380,181	0	465	42,711	7,275	555,246	35,908	17,036	338,728	344,937	546	79	102,628	7,224	401	1,737	0	1,454,921	3.8
1995	317,832	0	0	4,711	4,707	101,292	18,181	516	53,759	227,822	3,186	0	240,294	22,068	1,125	6,135	0	683,795	2.2
1996	337,155	0	269	1,770	17,050	16,902	8,589	332	93,851	198,161	364	0	143,934	802	291	244	0	482,559	1.4
1997	308,214	0	5	1,250	4,810	14,447	5,395	597	11,767	34,814	330	0	16,169	727	0	1,490	0	91,802	0.3
1998	427,208	62	0	4,554	597	29,683	2,929	0	12,657	97,574	1,470	602	46,305	10,818	234	4,760	40	212,288	0.5
1999	295,717	0	0	2,953	4,818	53,015	8,754	353	124,906	192,030	0	240	80,066	4,301	658	1,930	0	474,025	1.6
2000	208,651	130	0	2,261	7,074	56,453	5,858	0	40,660	148,872	148	0	26,019	893	539	2,481	0	291,390	1.4
2001	218,892	0	0	97	0	21,217	4,756	0	12,812	57,133	0	315	95,615	2,218	299	142	0	194,605	0.9
2002	229,292	0	0	499	121	13,352	4,881	141	61,713	162,634	214	1,386	67,474	189	477	311	0	313,392	1.4
2003	197,892	0	40	2,224	1,086	47,900	5,678	0	47,986	88,088	0	152	36,068	2,986	296	1,015	0	233,520	1.2
2004	275,238	0	0	2,445	3,358	24,944	5,073	152	59,544	163,974	0	625	34,630	3,192	195	0	0	298,131	1.1
2005	251,906	0	67	5,423	694	99,530	13,239	0	73,594	260,808	1,059	307	33,847	2,480	0	682	0	491,729	2.0
2006	87,780	0	0	8,645	839	110,179	16,074	0	77,324	161,777	163	317	40,897	4,379	0	0	0	420,593	4.8
2007	283,042	0	0	15,958	1,454	101,723	35,354	0	103,711	318,854	224	336	58,052	1,205	0	0	0	636,871	2.3

Appendix D4.–Page 2 of 2.

Brood Year	Escap.	Ages 0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	2.4	3.3	3.4	Total Return	R/S[a]
2008	162,888	0	0	16,912	866	66,934	11,628	0	67,656	149,978	0	666	37,279	1,460	9	38	0	353,426	2.2
2009	315,184	95	0	9,668	5,863	74,430	21,284	0	74,131	210,247	0	327	83,088	1,432	0	47	0	480,613	1.5
2010	262,327	0	318	50,918	1,376	277,596	20,472	0	394,285	218,636	516	164	26,807	1,449	0	0	0	992,538	3.8
2011	261,141	0	292	3,904	12,313	87,310	13,490	0	45,712	201,976	58	354	125,607	658	0	0	0	491,675	1.9
2012	328,254	0	1,421	4,859	5,419	69,546	8,623	355	96,102	136,435	0	131	17,016	0	0	0		339,906	1.0
2013	282,164	0	462	2,893	13,147	46,023	9,726	0	15,716	122,167	0	0	0	0				210,133	0.7
2014	297,711	0	0	18,572	0	264,673	5,747	0	0	0	0								
2015	326,435	431	4,377	14,483	0	0	0												
2016	254,967	0	0	0															
2017	324,858	0																	
2018	266,333																		
2019	279,639																		

Note: For brood years 1968–1974, refer to Nemeth et al. (2010).

[a] R/S = return/spawner.

APPENDIX E: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR BUSKIN RIVER SOCKEYE SALMON

Appendix E1.–Description of stock and escapement goal for Buskin River sockeye salmon.

System: Buskin River
Species: Sockeye salmon
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Sport and Commercial
Primary fishery:	Sport and Subsistence
Current escapement goal:	BEG: 5,000–8,000 (2011)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1990 to present
Data summary:	
Data quality:	Good escapement and harvest data.
Data type:	Weir estimates, harvest estimates, age composition.
Data contrast:	Weir count escapement data 1990 to 2015: 4.0
Methodology:	Bayesian spawner-recruit analysis yielding 90% credibility interval for S_{MSY} of 4,950–8,700 and probability of sustained yield being greater than 90% of S_{MSY} occurring for a BEG of 5,000–8,000.
Autocorrelation:	Present
Comments:	None

Appendix E2.–Buskin River sockeye salmon estimated escapement and total run, 1990–2018.

System: Buskin River

Species: Sockeye salmon

Data available for analysis of escapement goals

Year	Commercial harvest [a]	Subsistence harvest	Inriver run[b]	Sport harvest [c]	Total run	Escapement [d]
1990	17	3,576	10,528	998	15,119	10,528
1991	16	4,525	9,789	1,575	15,905	9,789
1992	0	4,441	9,782	1,981	16,204	9,782
1993	4	4,779	9,526	1,544	15,853	9,526
1994	3	4,915	13,146	2,573	20,637	13,146
1995	80	5,563	15,520	1,087	22,250	15,520
1996	0	5,403	10,277	1,881	17,561	10,277
1997	0	5,892	9,840	1,843	17,575	9,840
1998	2	6,011	14,767	1,983	22,763	14,767
1999	1	7,985	10,812	1,467	20,265	10,812
2000	0	7,315	11,233	2,041	20,589	11,233
2001	0	10,260	20,556	827	31,643	20,556
2002	0	13,366	17,174	2,204	32,744	17,174
2003	6	10,651	23,870	3,017	37,544	23,870
2004	1,098	9,421	22,023	1,379	33,921	22,023
2005	0	8,239	15,468	1,540	25,247	15,468
2006	6	7,577	17,734	1,577	26,894	17,734
2007	30	11,151	16,502	1,509	29,192	16,502
2008	0	2,664	5,900	1,160	9,724	5,900
2009	45	1,883	7,757	687	10,372	7,757
2010	0	1,514	9,800	332	11,646	9,800
2011	38	4,639	11,982	1,277	17,936	11,982
2012	1	2,631	8,565	1,484	12,681	8,565
2013	17	6,160	16,189	1,310	23,676	16,189
2014	0	5,576	13,976	4,237	23,789	13,976
2015	12	NA	8,718	NA	NA	8,718
2016	0	4,827	11,584	2,503	18,914	11,584
2017	0	4,943	7,222	3,161	15,326	7,222
2018	0	473	4,284	not available yet	4,757	4,284

Note: NA means not available.

[a] Commercial harvest is the harvest of sockeye salmon from the Buskin River and Womans Bay statistical areas (259-22, 259-26).

[b] Inriver run is the estimated run to the weir at Buskin Lake.

[c] Sport harvest from SWHS.

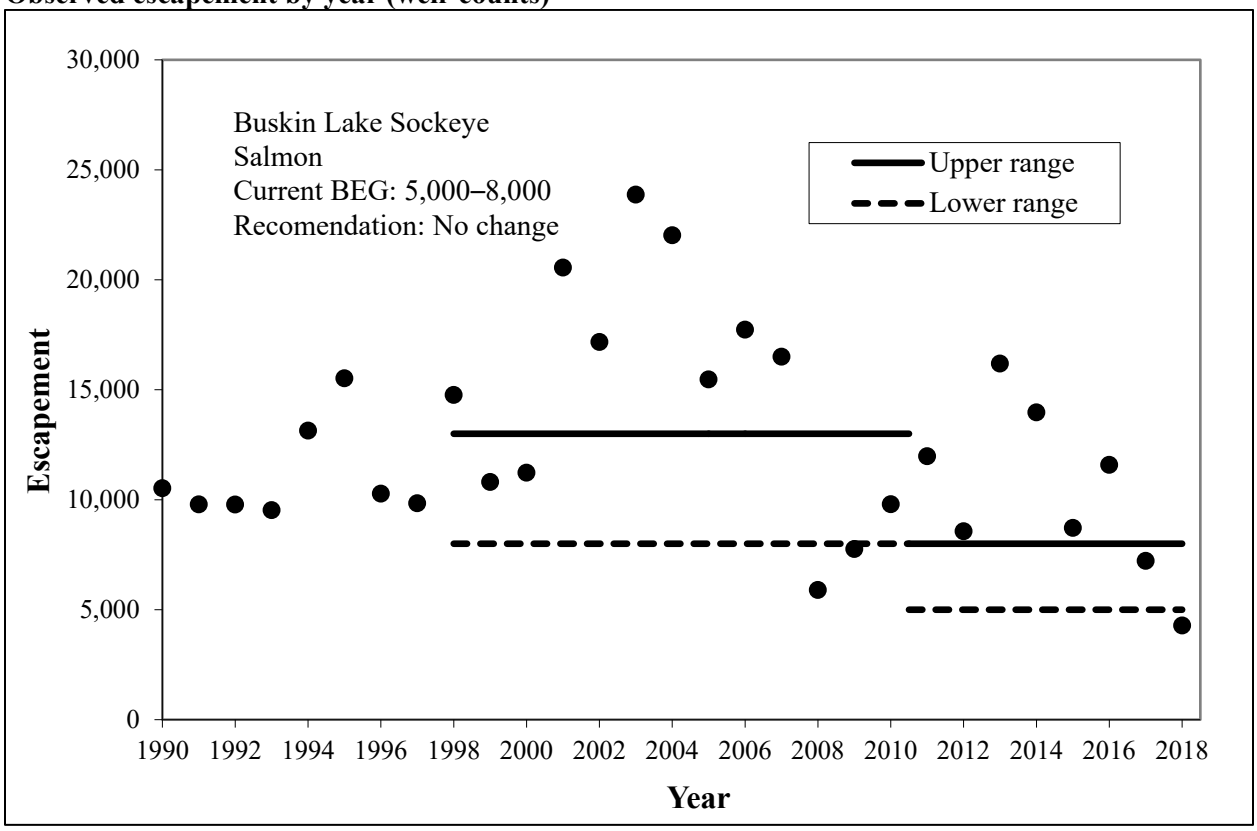
[d] Escapement = inriver run.

Appendix E3.–Buskin River sockeye salmon escapement and escapement goals, 1990–2018.

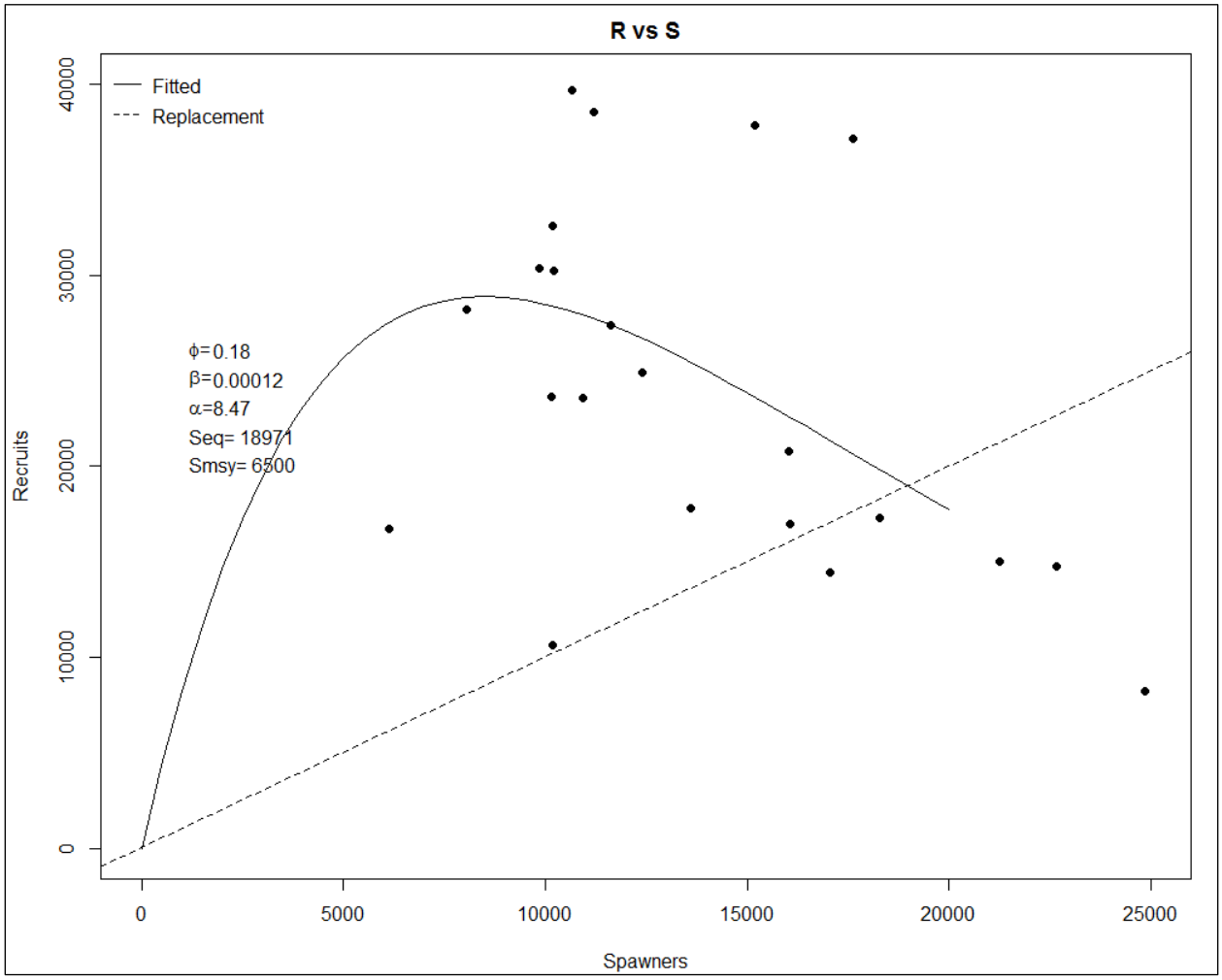
System: **Buskin River**

Species: **Sockeye salmon**

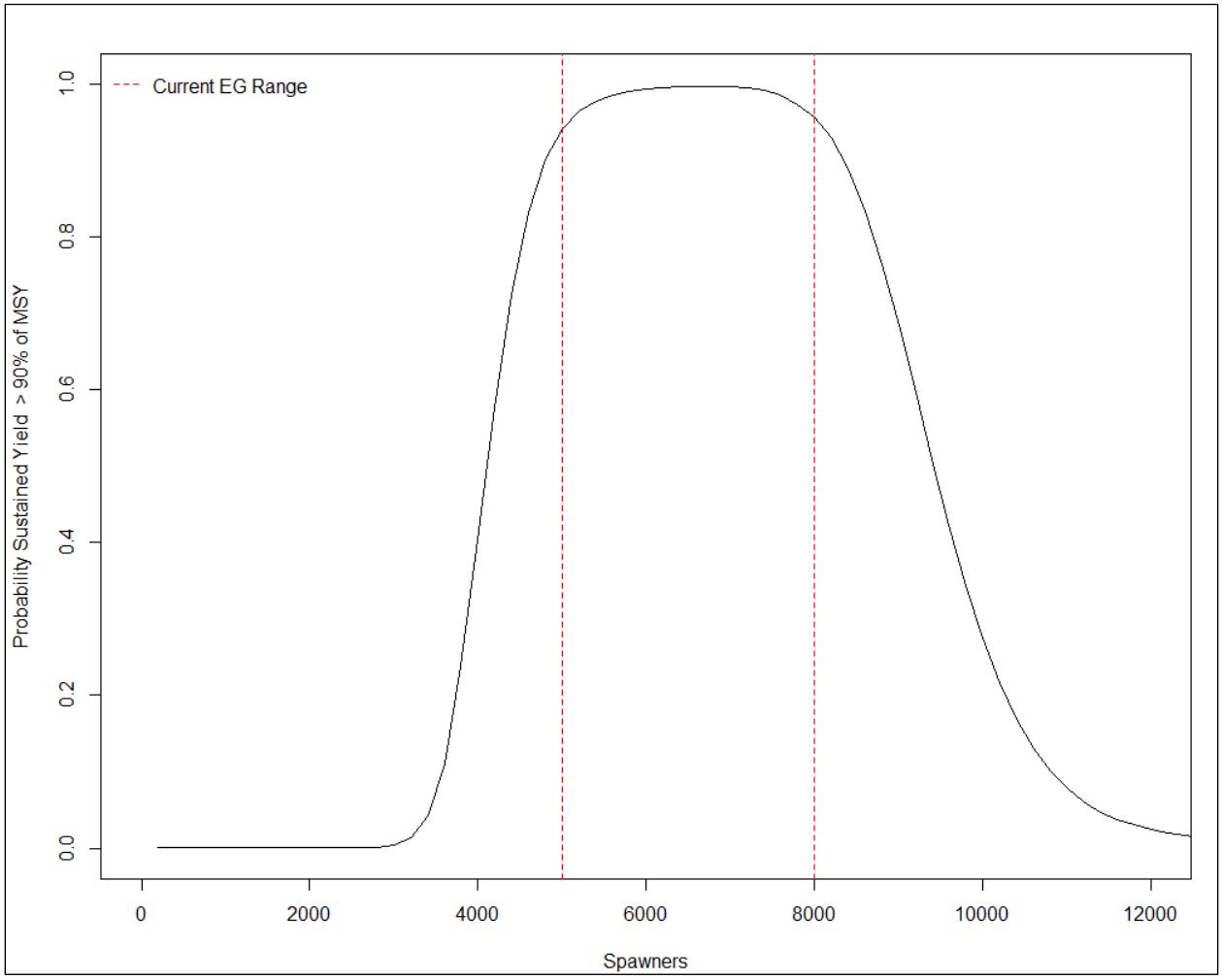
Observed escapement by year (weir counts)



Appendix E4.–Ricker spawner-recruit function fitted to Buskin River sockeye salmon data, 1990–2011 brood years. Parameter estimates are posterior medians.



Appendix E5.–Optimal yield profile obtained by fitting an age-structured spawner-recruit model to Buskin River sockeye salmon data, 1990–2015. Probability of achieving at least 90% of maximum sustained yield is plotted. Vertical lines show recommended escapement goal.



APPENDIX F: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR FRAZER LAKE SOCKEYE SALMON

Appendix F1.–Description of stock and escapement goal for Frazer Lake sockeye salmon.

System: Frazer Lake
Species: Sockeye salmon
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine and gillnet
Current escapement goal:	BEG: 75,000–170,000 (2008)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1956–2018
Data summary:	
Data quality:	Excellent for weir counts; good for harvest and age data.
Data type:	Weir counts from 1956 to 2018 with escapement age data during weir counts. Weir counts through Dog Salmon Creek (1985–2018). Total run estimates with age data 1974–2018. Limnology information 1985–1997 and 2001–2018.
Data contrast:	Weir data from 1989 through 2018: 4.2
Methodology:	Ricker spawner-recruit models (1966-2008; excluding 1985-1991), smolt biomass as a function of zooplankton biomass, and euphotic volume models.
Autocorrelation:	None
Comments:	None

Appendix F2.–Frazer Lake sockeye salmon escapement and total run estimates, 1956–2018.

System: **Frazer Lake**

Species: **Sockeye salmon**

Data available for analysis of escapement goals

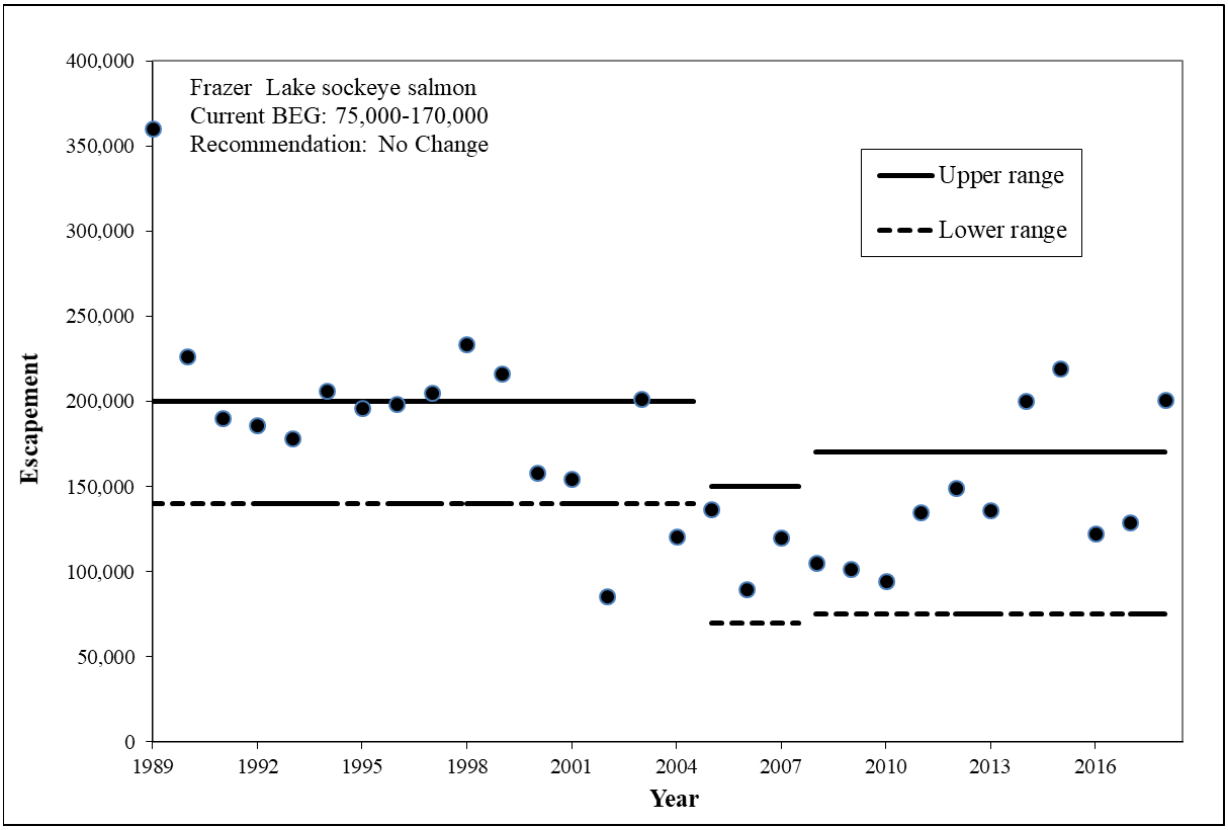
Year	Weir Counts	Run Size	Year	Weir Counts	Run Size
1956	6	–	1988	246,704	458,461
1957	165	–	1989	360,373	1,070,871
1958	71	–	1990	226,707	979,833
1959	62	–	1991	190,358	1,268,145
1960	440	–	1992	185,825	418,773
1961	873	–	1993	178,391	751,405
1962	3,090	–	1994	206,071	650,045
1963	11,857	–	1995	196,323	952,377
1964	9,966	–	1996	198,695	700,913
1965	9,074	–	1997	205,264	416,419
1966	16,456	–	1998	233,755	606,343
1967	21,834	–	1999	216,565	357,079
1968	16,738	–	2000	158,044	394,705
1969	14,041	–	2001	154,349	403,372
1970	24,039	–	2002	85,317	110,225
1971	55,366	–	2003	201,679	313,914
1972	66,419	–	2004	120,664	712,251
1973	56,255	–	2005	136,948	625,937
1974	82,609	85,374	2006	89,516	117,900
1975	64,199	67,499	2007	120,186	168,571
1976	119,321	128,091	2008	105,363	520,603
1977	139,548	140,914	2009	101,845	474,976
1978	141,981	172,317	2010	94,680	165,112
1979	126,742	153,547	2011	134,642	372,422
1980	405,535	460,708	2012	148,884	372,047
1981	377,716	487,926	2013	136,059	271,230
1982	430,423	506,655	2014	200,296	426,265
1983	158,340	196,323	2015	219,093	437,169
1984	53,524	67,377	2016	122,585	244,327
1985	485,835	637,871	2017	129,227	216,401
1986	126,529	178,205	2018	201,161	321,832
1987	40,544	57,582			

Appendix F3.–Frazer Lake sockeye salmon escapement and escapement goal ranges, 1989–2018.

System: **Frazer Lake**

Species: **Sockeye salmon**

Observed escapement by year (circles)



Appendix F4.–Frazer Lake sockeye salmon brood table.

Brood year	Escap.	Age 0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	4.1	2.4	4.2	3.3	8yo	Total return	R/S[a]
1976	119,321	0	2,150	0	223,444	8,753	73,677	257,625	0	0	143,383	0	0	0	0	393	0	709,424	5.9
1977	139,548	0	2,764	0	73,189	2,928	92,211	107,917	0	0	146,064	393	0	0	0	0	0	425,466	3.0
1978	141,981	0	7,807	0	162,130	507	24,148	22,970	0	0	16,844	0	0	0	0	638	0	235,043	1.7
1979	126,742	0	507	0	1,374	982	2,965	24,323	0	0	26,791	0	0	0	0	2,165	0	59,106	0.5
1980	405,535	0	0	0	6,064	16,305	7,654	589,393	0	0	141,065	684	0	46	0	52	0	761,264	1.9
1981	377,716	0	876	0	12,120	0	2,455	7,748	0	172	5,239	0	0	0	0	862	0	29,471	0.1
1982	430,423	0	1,276	0	23,647	431	28,624	3,735	24	754	10,870	10,812	0	0	0	0	0	80,172	0.2
1983	158,340	0	10	26	8,935	9,729	13,438	380,531	1,604	0	586,833	0	0	0	0	36,986	0	1,038,092	6.6
1984	53,524	0	1,001	0	5,771	33,628	7,437	386,832	0	0	67,142	2,046	0	0	0	0	0	503,856	9.4
1985	485,835	0	192	0	16,502	4,399	49,290	53,978	151	0	22,578	9,032	0	1,595	0	2,694	0	160,412	0.3
1986	126,529	1,393	67,475	0	727,658	40,794	230,893	972,290	0	0	168,815	9,129	0	0	0	8,584	0	2,227,031	17.6
1987	40,544	0	1,787	1,851	3,019	26,596	3,902	187,581	0	0	159,822	104	0	156	0	882	0	385,701	9.5
1988	246,704	0	1,886	0	21,073	7,793	30,096	210,586	133	0	64,565	20,510	0	16	0	7,994	0	364,652	1.5
1989	360,373	0	16,191	208	327,929	12,847	153,078	373,277	5,752	0	300,182	145,325	0	0	0	40,754	0	1,375,543	3.8
1990	226,707	0	1,096	0	18,217	12,986	33,393	400,750	1,678	0	210,744	15,341	0	455	0	9,340	0	704,000	3.1
1991	190,358	0	621	0	2,031	57,463	1,728	330,834	302	0	105,361	630	0	0	0	0	0	498,970	2.6
1992	185,825	0	3,545	0	20,513	78,168	27,471	211,959	4,666	0	185,148	18,141	0	0	0	2,209	0	551,819	3.0
1993	178,391	0	2,529	45	12,677	41,759	56,178	291,218	4,831	0	64,155	17,867	0	256	0	5,830	0	497,344	2.8
1994	206,071	0	2,056	0	23,034	17,688	39,741	112,849	1,048	0	77,546	15,427	0	187	0	15,733	0	305,309	1.5
1995	196,323	0	10,106	0	59,574	39,574	77,223	152,287	1,251	0	251,356	11,284	0	878	0	5,794	0	609,328	3.1
1996	198,695	0	20,062	0	41,983	22,276	81,667	32,786	26	1,670	54,175	109	92	211	0	201	0	255,258	1.3
1997	205,264	0	626	0	8,327	1,639	10,462	15,598	176	833	19,673	2,251	0	0	0	0	77	59,662	0.3
1998	233,755	0	367	0	1,450	18,943	14,884	128,297	12,803	0	58,315	89,184	0	362	0	33,767	0	358,372	1.5
1999	216,565	0	879	0	3,754	104,150	79	484,554	0	0	239,961	1,297	0	649	0	2,576	97	837,997	3.9
2000	158,044	0	26,856	0	69,457	10,097	218,891	105,837	0	721	79,631	435	0	678	316	309	514	513,742	3.3
2001	154,349	0	565	0	21,563	2,508	7,110	5,096	8,508	145	14,177	38,040	223	774	706	80,473	1,502	181,390	1.2
2002	85,317	0	1,675	0	6,801	5,173	6,216	34,309	8,528	0	44,275	35,650	0	416	0	29,093	198	172,334	2.0

-continued-

Appendix F4.–Page 2 of 2.

Brood year	Escap.	Age 0.2	1.1	0.3	1.2	2.1	1.3	2.2	3.1	1.4	2.3	3.2	4.1	2.4	4.2	3.3	8yo	Total return	R/S[a]
2003	201,679	0	1,201	0	9,899	44,359	16,348	169,365	3,430	0	81,123	31,296	0	184	0	1,236	0	358,440	1.8
2004	120,664	0	11,274	0	147,145	19,606	91,014	197,567	0	298	25,918	243	0	175	0	0	0	493,239	4.1
2005	136,948	0	2,318	0	34,034	8,824	43,136	36,815	5,935	435	36,735	3,222	89	339	0	500	0	172,382	1.3
2006	89,516	0	107	246	6,723	40,388	21,539	217,026	7,498	0	116,935	5,777	0	687	0	2,649	0	419,575	4.7
2007	120,186	0	3,793	661	13,301	67,117	21,050	171,111	0	0	87,987	576	0	454	0	0	0	366,050	3.0
2008	105,363	0	4,623	0	45,645	10,103	48,444	100,680	0	151	44,642	0	0	0	0	277	0	254,565	2.4
2009	101,845	495	93	0	10,784	17,550	16,452	322,752	860	0	174,311	12,255	0	108	0	2,143	0	557,803	5.5
2010	94,680	0	1,873	0	13,154	26,967	23,316	160,354	2,047	0	80,454	5,076	0	0	0	2,782	0	316,023	3.3
2011	134,642	0	832	0	8,207	55,889	6,723	142,675	161	0	121,157	843	0	648	0	0	0	337,135	2.5
2012	148,884	513	388	0	1,296	3,255	1,089	38,025	475	0	6,228	2,775	0	0	0	0		54,044	0.4
2013	136,059	0	2,435	0	19,533	28,978	7,887	193,903	2,901	0	82,015	5,280	0						
2014	200,296	0	3,520	0	41,048	33,946	28,337	158,548	0										
2015	219,093	0	32,496	0	66,627	13,720													
2016	122,585	0	62,078																
2017	129,227																		
2018	201,161																		
2019	169,627																		

Note: Shaded years (1985–1995), were not included in spawner-recruit analysis due to influence from fertilization.

[a] R/S = return/spawner.

APPENDIX G: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR KARLUK LAKE SOCKEYE SALMON

Appendix G1.–Description of stock and escapement goals for Karluk Lake sockeye salmon.

System: Karluk Lake
Species: Sockeye salmon
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine and gillnet
Current escapement goal:	Early-run BEG: 150,000–250,000 (2017) Late-run BEG: 200,000–450,000 (2017)
Recommended escapement goal:	No Change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts: 1922–2018
Data summary:	
Data quality:	Good
Data type:	Weir counts from 1922 to 2018. Age compositions and stock-specific harvest 1985–2018. Rough estimates of harvest attributed to both runs combined, 1922–2018. Smolt outmigration estimates 1961–68, 1980–84, 1991–92, 1999–2006, and 2011–2014. Limnology information 1981–2018.
Data contrast:	Weir data 1981–2018: early (8.6), late (19.9).
Methodology:	Ricker spawner-recruit
Autocorrelation:	Yes
Comments:	None

Appendix G2.–Karluk Lake early-run sockeye salmon escapement, 1981–2018.

System: Karluk Lake early run

Species: Sockeye salmon

Data available for analysis of escapement goals

Year	Weir counts	Commercial harvest
1981	97,937	–
1982	122,705	–
1983	215,620	–
1984	288,422	–
1985	316,688	28,326
1986	358,756	116,191
1987	354,094	77,156
1988	296,510	35,236
1989	349,753	2
1990	196,197	32,021
1991	243,069	28,135
1992	217,152	245,012
1993	261,169	308,579
1994	260,771	188,452
1995	238,079	283,333
1996	250,357	509,874
1997	252,859	134,480
1998	252,298	116,473
1999	392,419	182,577
2000	291,351	266,485
2001	338,799	303,664
2002	456,842	167,038
2003	451,856	372,761
2004	393,468	396,088
2005	283,860	245,800
2006	202,366	272,537
2007	294,740	198,354
2008	82,191	70,751
2009	52,798	16,054
2010	71,453	9,908
2011	87,049	6,805
2012	188,085	47,801
2013	234,880	210,699
2014	252,097	176,323
2015	260,758	124,983
2016	173,874	41,884
2017	242,599	189,056
2018	205,054	42,474

Appendix G3.–Karluk Lake late-run sockeye salmon escapement, 1981–2018.

System: **Karluk Lake late run**

Species: **Sockeye salmon**

Data available for analysis of escapement goals

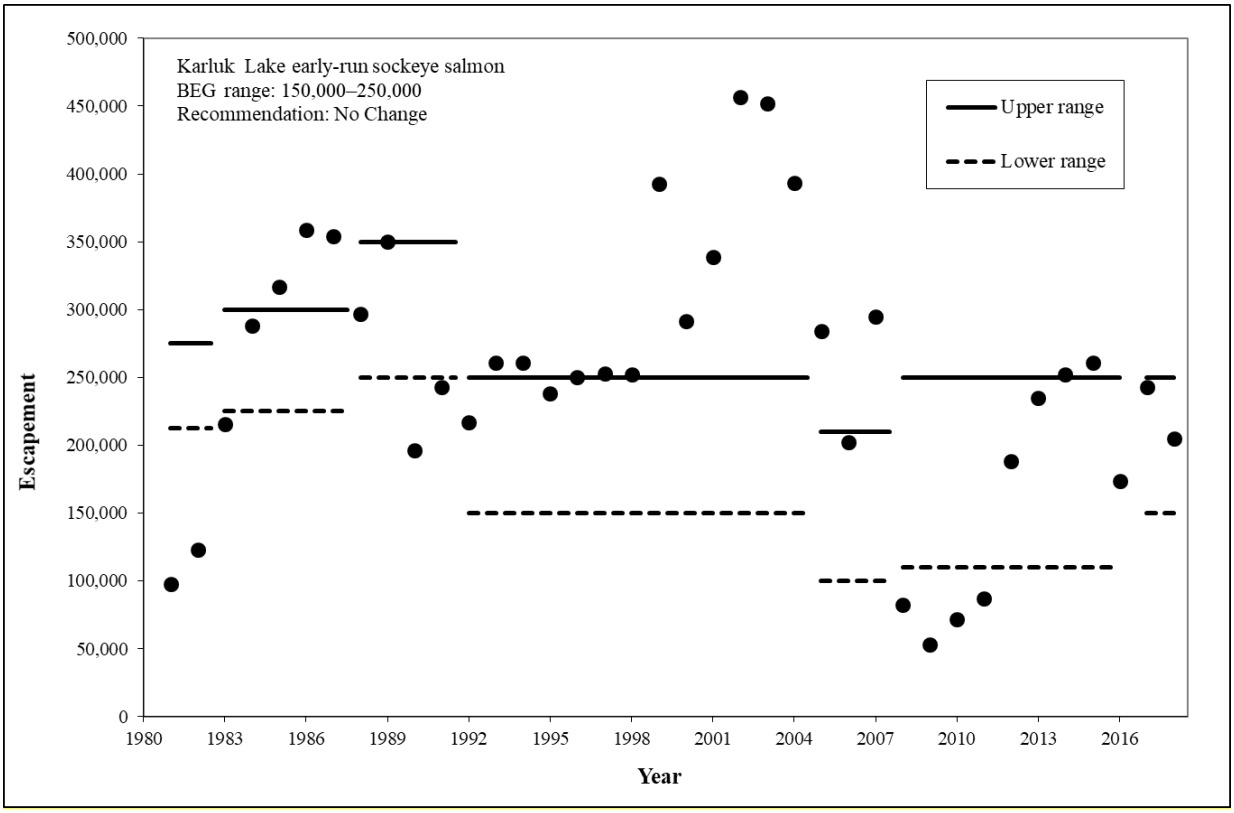
Year	Weir counts	Commercial harvest
1981	124,769	–
1982	41,702	–
1983	220,795	–
1984	131,846	–
1985	679,260	168,328
1986	528,415	297,042
1987	412,157	170,019
1988	282,306	127,721
1989	758,893	3,476
1990	541,891	990,660
1991	831,970	1,097,830
1992	614,262	442,692
1993	396,288	235,361
1994	587,258	106,325
1995	504,977	361,535
1996	323,969	187,717
1997	311,902	127,114
1998	384,848	302,166
1999	589,119	414,885
2000	445,393	211,546
2001	524,739	347,790
2002	408,734	457,285
2003	626,854	965,484
2004	326,466	332,464
2005	498,102	423,573
2006	288,007	282,441
2007	251,835	469,775
2008	164,299	130,587
2009	277,280	52,503
2010	276,649	39,348
2011	230,273	34,995
2012	314,605	275,192
2013	336,479	416,935
2014	543,469	744,893
2015	368,896	472,761
2016	314,935	461,650
2017	385,896	643,431
2018	428,225	658,372

Appendix G4.–Karluk Lake early-run sockeye salmon escapement and escapement goal ranges, 1981–2018.

System: **Karluk Lake early run**

Species: **Sockeye salmon**

Observed escapement by year (circles)

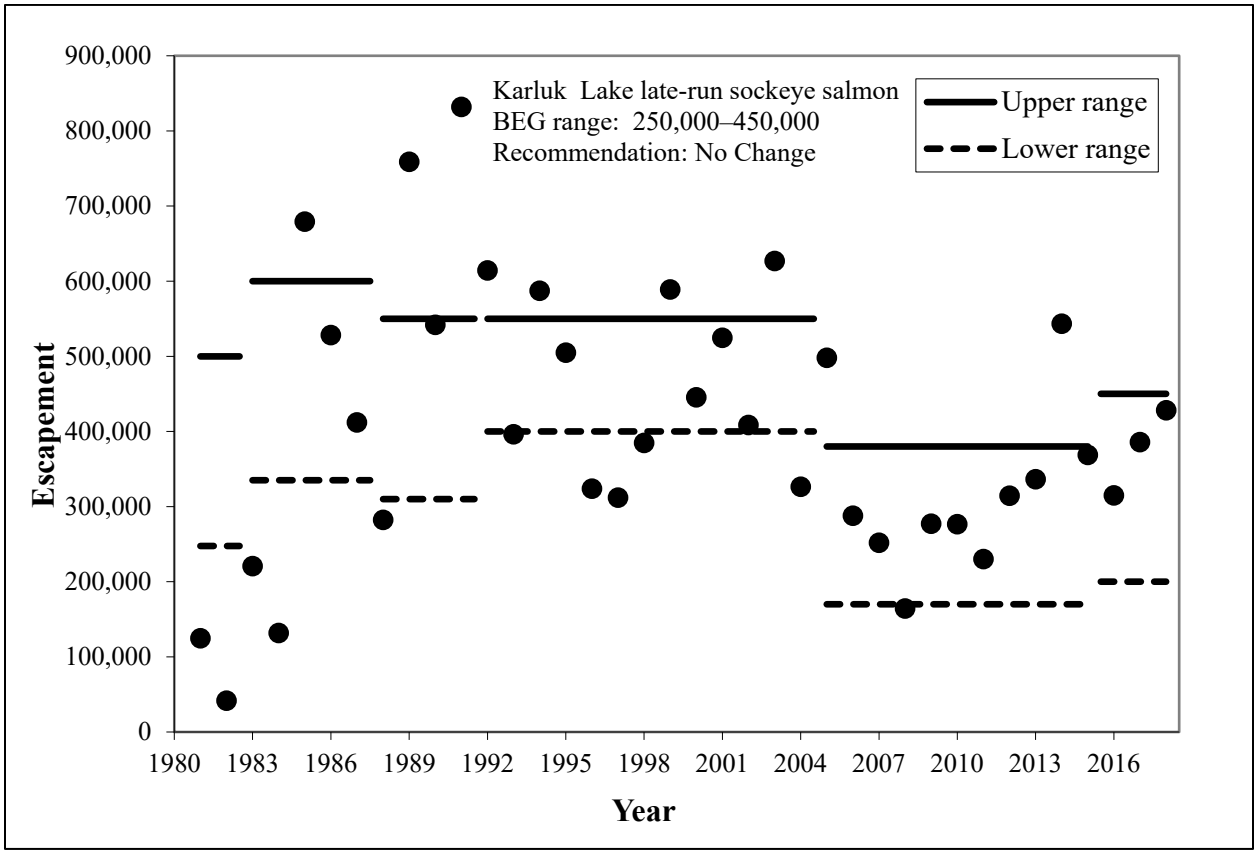


Appendix G5.–Karluk Lake late-run sockeye salmon escapement and escapement goals, 1981–2018.

System: **Karluk Lake late run**

Species: **Sockeye salmon**

Observed escapement by year (circles)



Appendix G6.–Karluk Lake early-run sockeye salmon brood table.

Brood Year	Escap.	Ages 0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	4.1	2.4	3.3	4.2	2.5	3.4	4.3	4.4	Total Return	R/S[a]
1976	204,037																					0		
1977	185,312																		0	0	0	0		
1978	248,741															0	10,989	0	0	0	0	0	10,989	
1979	212,872											0	50,484	45,654	0	641	14,673	0	0	0	0	0	111,453	
1980	132,396							0	11,635	193,760	4,085	0	103,899	60,395	0	0	37,689	0	0	0	0	0	411,464	
1981	97,937				0	8,558	18,604	0	3,735	278,831	1,672	0	117,158	38,129	0	272	22,433	0	0	0	0	0	489,391	5.0
1982	122,705	0	0	1,244	841	4,650	5,466	0	21,058	197,293	4,169	0	93,560	37,079	0	0	20,728	0	0	0	0	320	386,408	3.1
1983	215,620	0	0	143	564	8,159	7,032	0	14,244	149,947	1,728	0	183,829	33,945	0	337	14,082	0	0	0	0	0	414,009	1.9
1984	288,422	0	0	0	0	4,090	8,393	0	5,830	97,537	738	0	94,258	30,589	0	908	19,634	0	0	0	0	0	261,977	0.9
1985	316,688	0	0	0	24	4,258	2,842	0	3,969	72,857	3,010	0	88,599	57,934	0	1,955	40,331	0	0	38	30	0	275,847	0.9
1986	358,756	0	24	0	337	6,152	2,201	346	6,443	87,691	4,031	94	129,381	131,218	0	479	61,223	1,508	0	235	113	0	431,475	1.2
1987	354,094	0	427	0	1,456	958	2,884	0	8,503	114,504	19,876	416	44,051	337,905	0	285	60,244	2,309	0	690	1,969	0	596,477	1.7
1988	296,510	0	0	0	0	8,383	6,297	0	9,708	84,322	13,770	0	37,096	202,729	0	320	70,357	231	0	39	2,906	0	436,159	1.5
1989	349,753	0	0	1,621	0	8,492	7,624	0	13,979	104,564	5,517	0	167,751	101,296	0	1	69,709	5,362	0	0	1,713	0	487,630	1.4
1990	196,197	0	0	181	0	18,149	2,780	0	50,649	79,156	6,586	652	146,751	97,063	0	269	70,863	760	0	0	0	0	473,858	2.4
1991	243,069	0	0	1,224	1,062	26,661	12,015	0	83,430	326,422	7,087	0	127,809	81,364	809	107	12,113	2,476	0	0	247	0	682,826	2.8
1992	217,152	0	0	2,669	4	9,627	9,642	0	13,159	52,730	14,935	0	42,891	58,375	0	769	36,603	0	0	79	0	0	241,483	1.1
1993	261,169	0	2	1,534	350	3,309	18,252	0	7,718	226,377	2,275	0	128,158	35,029	0	1,752	42,563	437	0	288	0	0	468,044	1.8
1994	260,771	0	0	1,017	0	8,956	7,266	0	41,179	294,780	1,857	427	182,133	54,148	0	587	33,887	1,781	0	1,042	0	0	629,059	2.4
1995	238,079	0	0	218	0	23,268	13,106	0	33,004	231,809	3,463	0	245,934	83,559	0	1,405	52,470	835	0	492	0	0	689,562	2.9
1996	250,357	0	0	0	0	2,063	5,959	0	2,217	253,847	2,326	0	215,129	84,029	0	61	42,035	0	0	1,461	114	0	609,241	2.4
1997	252,859	0	0	0	1,838	3,930	11,696	0	6,691	233,964	3,274	0	131,879	63,748	0	0	24,066	0	0	0	0	0	481,086	1.9
1998	252,298	0	0	574	0	4,258	19,885	0	5,410	531,206	4,517	532	168,024	104,530	715	0	14,578	0	0	0	0	0	854,229	3.4
1999	392,419	0	0	898	0	15,382	28,948	0	33,620	432,204	10,393	76	192,314	80,270	0	0	48,461	0	0	116	0	0	842,682	2.1
2000	291,351	0	0	939	0	9,611	4,286	0	3,393	223,141	6,013	129	109,252	78,082	0	483	74,506	523	0	1,561	0	0	511,919	1.8
2001	338,799	0	0	0	0	3,223	6,573	0	1,102	216,151	5,644	0	274,770	51,394	0	3,144	42,585	425	59	771	65	0	605,906	1.8
2002	456,842	0	0	78	0	4,894	11,188	0	7,592	69,773	1,251	99	59,363	12,086	0	698	4,882	0	0	0	0	0	171,904	0.4
2003	451,856	0	0	0	286	2,237	9,403	0	1,150	30,926	638	49	15,852	15,878	621	1	1,494	686	0	0	128	0	79,349	0.2

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Appendix G6.–Page 2 of 2.

Brood Year	Escap.	Ages																				Total Return	R/S[a]
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	4.1	2.4	3.3	4.2	2.5	3.4	4.3	4.4	
2004	393,468	0	760	0	99	196	390	0	946	17,044	4,700	0	5,120	32,065	0	0	10,449	101	0	21	0	0	71,891	0.2
2005	283,860	0	0	279	0	6,029	1,257	0	2,506	14,088	4,245	0	7,754	16,806	176	0	871	0	0	0	0	0	54,010	0.2
2006	202,366	0	0	0	23	15,167	5,207	0	4,056	27,614	6,532	0	13,395	8,786	0	0	1,027	0	0	0	0	0	81,807	0.4
2007	294,740	0	0	759	20	3,832	16,049	0	10,030	175,426	1,589	21	158,348	9,584	0	700	5,643	0	0	0	0	0	382,002	1.3
2008	82,191	0	0	338	0	15,219	10,309	102	44,996	184,375	2,182	137	145,950	9,675	0	63	1,599	0	0	0	0	0	414,946	5.0
2009	52,798	0	0	240	8	20,084	22,414	0	7,071	186,660	978	0	27,530	2,048	0.0	0	1	0	0	0	0	0	267,035	5.1
2010	71,453	0	0	2,288	0	28,315	41,549	0	23,538	276,983	1,242	0	18,647	3,700	0	33	447	0	0	0	0	0	396,743	5.6
2011	87,049	148	184	1,556	0	23,576	28,230	0	9,274	129,421	1,155	494	46,345	805	0	49	251	0	0	0	0		241,489	2.8
2012	188,085	0	0	932	0	28,938	23,415	280	58,091	266,861	2,089	49	29,594	1,714	0	0	410	0					412,374	2.2
2013	234,880	0	0	1,208	2,883	30,722	21,558	0	6,425	187,432	1,984	0	96,895	8,259	0								357,366	1.5
2014	252,097	0	362	605	49	8,380	8,919	0	3,382	87,320	492													
2015	260,758	80	1,165	1,516	3,042	20,572	22,131																	
2016	173,874	0	136	110																				
2017	242,599	0																						
2018	205,054																							
2019	190,168																							

[a] R/S = return/spawner.

Appendix G7.–Karluk Lake late-run sockeye salmon brood table.

Brood Year	Escap.	Ages																					Total Return	Total Run
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	4.1	2.4	3.3	4.2	2.5	3.4	4.3	4.4		
1976	319,459																					0		
1977	366,936																		0	0	0	0	0	847,588
1978	112,194															0	6,728	0	0	0	0	0	6,728	825,457
1979	248,908											0	54,171	167,426	0	0	85,143	0	0	0	0	0	306,739	582,176
1980	14,227							0	446	596,053	4,476	0	156,074	177,587	0	1,190	25,537	0	0	0	0	0	961,363	410,027
1981	124,769				0	5,158	13,129	0	0	402,872	2,521	0	187,293	49,557	0	0	14,077	0	0	0	0	0	674,607	762,369
1982	41,702		0	0	0	0	1,261	0	5,239	290,631	606	0	110,997	34,711	0	0	19,631	0	0	0	0	0	463,075	1,532,551
1983	220,795	0	0	0	4,079	4,160	12,830	0	480	241,803	1,268	31	213,452	42,156	0	2,070	47,370	0	0	0	0	0	569,699	1,929,800
1984	131,846	0	885	0	0	445	6,246	0	30,516	424,123	0	937	303,542	271,018	0	471	71,764	651	0	0	0	0	1,110,598	1,056,954
1985	679,260	169	0	0	1,084	30,165	212	189	60,235	784,914	494	595	493,743	421,972	0	462	43,998	0	0	42	0	0	1,838,274	631,649
1986	528,415	0	893	0	15,519	39,109	978	105	57,974	835,214	1,162	0	114,862	655,219	0	563	60,240	325	0	147	1,623	0	1,783,933	693,583
1987	412,157	106	5,976	201	17,067	24,703	1,737	0	550	226,552	2,373	0	23,389	320,723	0	79	54,451	1,600	0	0	0	0	679,507	866,512
1988	282,306	0	2,531	111	2,424	4,649	1,512	0	3,127	189,196	7,249	0	71,078	212,649	0	0	16,740	0	0	0	9	0	511,274	511,686
1989	758,893	0	3,555	799	3,717	5,909	12,607	0	3,302	308,439	6,233	0	151,212	214,110	0	0	12,030	950	0	0	0	0	722,863	439,016
1990	541,891	0	3,591	971	6,292	16,995	3,241	0	10,310	447,371	1,085	18	52,479	80,226	0	591	62,392	1,095	0	0	64	0	686,721	687,014
1991	831,970	0	7,113	340	2,879	16,292	3,023	0	8,568	340,535	4,731	52	191,311	85,334	0	952	13,107	659	0	111	0	0	675,007	1,004,004
1992	614,262	0	1,567	1,923	0	3,880	6,759	0	12,234	57,188	5,043	0	76,196	138,987	0	513	28,379	0	0	0	0	0	332,669	656,939
1993	396,288	0	0	1,501	2,860	3,550	17,168	0	11,541	412,758	1,362	36	202,913	75,591	0	0	23,523	0	0	0	0	0	752,802	872,529
1994	587,258	0	0	198	1,192	24,718	4,323	0	17,261	616,350	1,008	0	159,094	109,890	0	551	41,274	821	0	128	0	0	976,808	866,019
1995	504,977	0	1,156	0	3,219	48,766	8,685	0	1,839	353,857	5,252	0	390,880	129,216	0	424	28,253	405	0	284	1,384	0	973,619	1,592,338
1996	323,969	0	540	633	0	2,970	108	0	469	283,071	2,817	0	149,445	139,820	0	0	83,431	0	0	0	934	0	664,238	658,930
1997	311,902	0	0	407	0	1,473	21,821	0	291	494,043	18,682	0	268,631	235,707	0	0	12,330	0	0	421	0	0	1,053,807	921,673
1998	384,848	0	0	136	0	586	33,787	1,399	2,716	923,141	8,407	0	78,063	143,454	0	0	12,558	0	0	0	284	0	1,204,530	570,448
1999	589,119	0	0	0	0	25,117	41,401	0	7,645	403,399	3,410	85	154,603	210,642	0	0	65,446	0	0	208	94	0	912,050	721,611
2000	445,393	155	669	51	3,376	6,049	270	0	1,126	531,303	2,955	0	292,380	55,025	0	2,875	100,967	1,046	0	4,014	0	10	1,002,271	294,887
2001	524,739	0	0	0	0	2,543	5,375	0	2,611	132,216	3,786	0	305,575	113,907	0	13,374	38,224	0	21	231	10	0	617,873	329,783
2002	408,734	0	0	62	2,790	3,319	12,383	0	6,844	183,353	672	361	161,086	25,895	0	9	14,881	99	0	0	528	0	412,282	315,995
2003	626,854	0	0	208	1,750	2,494	1,544	0	1,887	41,395	2,247	0	15,635	269,401	348	0	5,707	10,460	0	0	1,746	0	354,822	267,014
2004	326,466	0	277	5	301	1,998	510	0	543	15,162	10,973	0	7,084	223,546	0	0	8,868	2,084	0	0	0	0	271,352	589,797
2005	498,102	0	3,532	63	0	423	2,022	0	544	63,514	768	0	20,543	72,929	0	0	3,929	0	0	0	0	0	168,266	753,414

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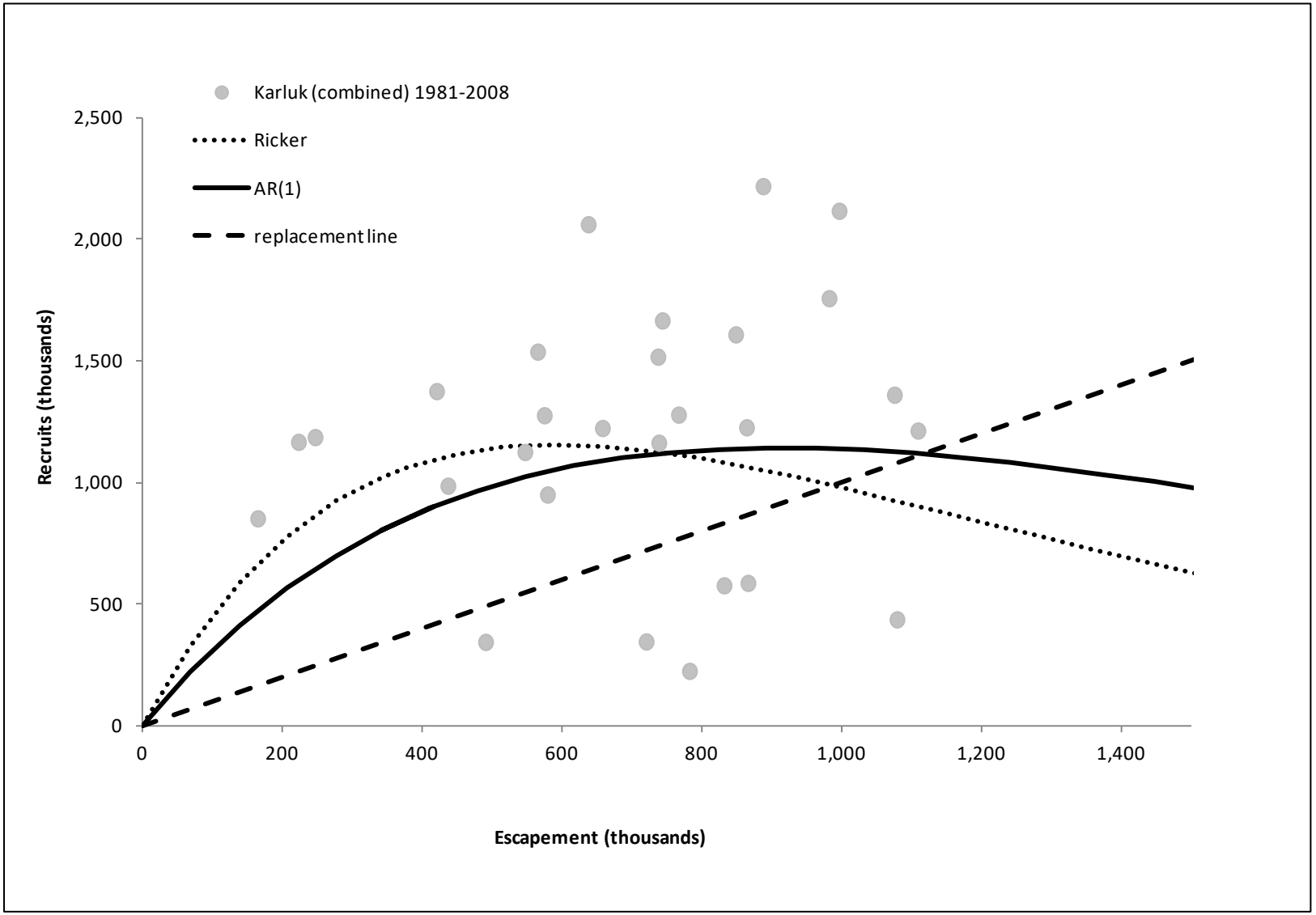
Appendix G7.–Page 2 of 2.

Brood Year	Escap.	Ages																				Total Return	Total Run
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	4.1	2.4	3.3	4.2	2.5	3.4	4.3	4.4	
2006	288,007	0	0	15	0	1,734	2,029	0	1,553	123,394	11,965	34	38,311	73,030	0	59	7,613	0	0	0	0	0	259,736	1,288,362
2007	251,835	0	0	81	2,235	3,207	18,490	0	6,173	452,112	217	0	183,111	64,437	0	901	9,435	0	0	0	0	0	740,399	841,657
2008	164,299	0	0	0	34	8,620	6,489	0	5,738	464,655	508	159	215,642	60,733	0	154	5,958	0	0	0	0.0	0	768,690	776,585
2009	277,280	0	501	349	7	14,742	11,322	0	7,407	921,554	6,778	0	51,167	74,985	0	0	1,009	0	0	0	0	0	1,089,820	1,029,327
2010	276,649	0	203	1,020	0	34,359	28,966	0	44,158	578,076	2,578	0	29,006	22,456	0	0	8,443	0	0	0	0	0	749,264	1,086,597
2011	230,273	0	0	2,428	0	35,700	48,035	0	17,984	645,806	1,551	1,276	259,900	19,783	0	223	687	0	0	0	0		1,033,374	735,869
2012	314,605	0	0	846	77	35,769	21,225	0	67,635	555,033	2,524	619	48,225	55,909	0	0	6,460	0					794,321	
2013	336,479	0	129	1,571	7,261	53,487	47,821	0	13,851	889,228	3,421	0	152,684	58,259	0								1,227,712	
2014	543,469	0	3,217	2,948	47	59,007	9,674	0	13,073	410,979	0													
2015	368,896	0	3,889	1,818	19,742	53,185	18,902																	
2016	314,935	0	848	1,738																				
2017	385,896	0																						
2018	428,225																							
2019	317,380																							

Appendix G8.–Karluk Lake sockeye salmon stock-recruitment models expected relationship for brood years, 1981–2008 (combined runs). The dotted line represents the Ricker model, solid line represents Ricker AR(1), and the dashed lined represents the replacement line.



Appendix G9.–Parameter estimates and key quantities from the analysis of Karluk Lake sockeye salmon Ricker models for brood years, 1981–2008.

System	Model		Parameter				Durbin-Watson test statistic	Key quantities in thousands of fish			R^2
			ln α	β	ϕ	σ		S_{MSY}	S_{EQ}	MSY	
Karluk Early	Ricker	Estimate	2.07	0.0063		0.74	0.68	124	369	461	0.40
		Standard error	0.44	0.0015							
	Ricker AR(1)	Estimate	1.33	0.0038	0.731	0.54		168	436	293	0.67
		Standard error	0.76	0.0015	0.142						
Karluk Late	Ricker	Estimate	1.75	0.0027		0.62	0.82	259	713	633	0.44
		Standard error	0.28	0.0006							
	Ricker AR(1)	Estimate	1.52	0.0022	0.613	0.51		294	777	568	0.62
		Standard error	0.47	0.0005	0.162						
Karluk Combined (Early and Late)	Ricker	Estimate	1.67	0.0017		0.61	0.62	406	1,098	904	0.34
		Standard error	0.34	0.0005							
	Ricker AR(1)	Estimate	1.23	0.0011	0.729	0.44		520	1,301	710	0.66
		Standard error	0.35	0.0004	0.139						

APPENDIX H: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR MALINA CREEK SOCKEYE SALMON

Appendix H1.–Description of stock and escapement goal for Malina Creek sockeye salmon.

System: Malina Creek
Species: Sockeye salmon
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine
Current escapement goal:	SEG: 1,000 to 10,000 (2005)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Aerial counts, 1968–1991, 2003–2018 Weir counts, 1992–2002, 2004–2005
Data summary:	
Data quality:	Fair to poor for aerial counts, excellent for weir counts.
Data type:	Aerial counts from 1968 through 1991 and 2003 through 2018, weir counts from 1992 through 2002 and 2004 through 2005 include escapement age data. Limnology data from 1989 to 2009. No stock-specific harvest information is available.
Data contrast:	Peak aerial surveys 1968–1991, 2003–2018: 42.4 Weir data 1992–2002, 2004, 2005: 10.1
Methodology:	Percentile (15th–75th), euphotic volume analysis, spawning habitat, smolt biomass as a function of zooplankton biomass.
Comments:	Lake was stocked with indigenous juvenile sockeye salmon from 1992 to 1999 and fertilized from 1991 to 2001.

Appendix H2.–Malina Creek sockeye salmon escapement, 1968–2018.

System: Malina Creek

Species: Sockeye salmon

Data available for analysis of escapement goals

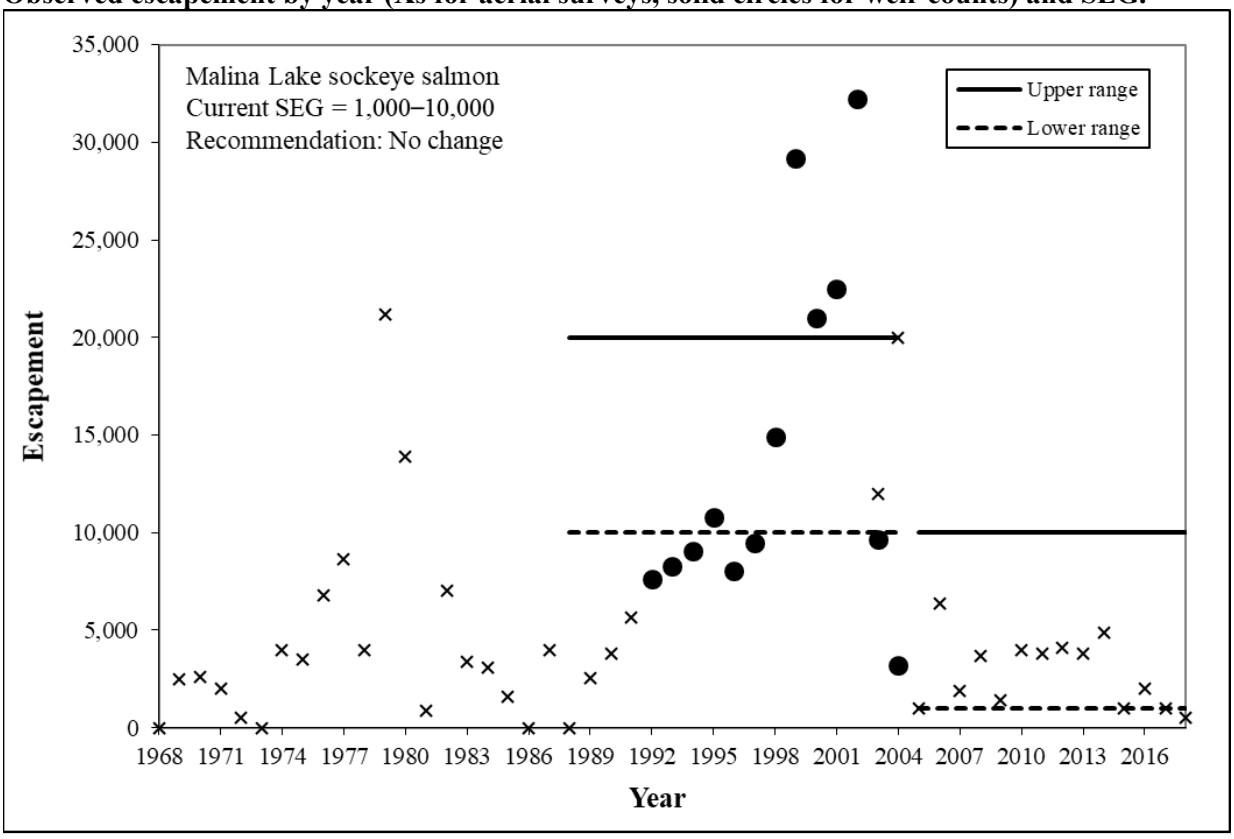
Year	Peak aerial survey	Weir counts	Year	Peak aerial survey	Weir counts
1968	0	–	1994	–	9,042
1969	2,500	–	1995	–	10,803
1970	2,600	–	1996	–	8,030
1971	2,000	–	1997	–	9,455
1972	500	–	1998	–	14,917
1973	0	–	1999	–	29,171
1974	4,000	–	2000	–	21,006
1975	3,500	–	2001	–	22,490
1976	6,800	–	2002	–	32,214
1977	8,667	–	2003	12,000	9,636
1978	4,000	–	2004	20,000	3,180
1979	21,200	–	2005	1,000	–
1980	13,900	–	2006	6,400	–
1981	900	–	2007	1,900	–
1982	7,000	–	2008	3,690	–
1983	3,400	–	2009	1,400	–
1984	3,100	–	2010	4,000	–
1985	1,600	–	2011	3,800	–
1986	0	–	2012	4,100	–
1987	4,000	–	2013	3,800	–
1988	0	–	2014	4,900	–
1989	2,570	–	2015	1,000	–
1990	3,800	–	2016	2,000	–
1991	5,650	–	2017	1,000	–
1992	–	7,610	2018	500	–
1993	–	8,273			

Appendix H3.–Malina Creek sockeye salmon escapement and escapement goals, 1968–2018.

System: **Malina Creek**

Species: **Sockeye salmon**

Observed escapement by year (Xs for aerial surveys, solid circles for weir counts) and SEG.



APPENDIX I: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR PASAGSHAK RIVER SOCKEYE SALMON

Appendix I1.–Description of stock and escapement goal for Pasagshak River sockeye salmon.

System: Pasagshak River
Species: Sockeye salmon
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Subsistence gillnet, commercial purse seine, and sport.
Current escapement goal:	Lower-bound SEG: 3,000 (2011)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Survey counts, 1968–1969, 1971–1976, 1978–2018. Weir counts, 2011–2018.
Data summary:	
Data quality:	Good
Data type:	Fixed-wing peak aerial survey escapement index counts for 1968–2018; weir installed in 2011–2018. Subsistence harvest estimated annually since 1993 from permit returns. Inriver sport harvests estimated annually since 1977 through the Statewide Harvest Survey. No stock-specific harvest information for commercial fisheries, though total annual catch data are available from Pasagshak Bay (statistical area 259-43). Commercial harvests include sockeye salmon from the Pasagshak River and other nearby systems. No age data collected from the escapements or harvests. Limnology data collected in 2000.
Data contrast:	Aerial survey data 1968 to 2018: 232
Methodology:	Percentile
Comments:	None

Appendix I2.–Pasagshak River sockeye salmon aerial survey and harvest estimates, 1968–2018.

System: Pasagshak River
Species: Sockeye salmon

Year	Peak survey	Weir	Harvest		
			Sport[a]	Subsistence[b]	Commercial[c]
1968	3,000				
1969	4,500				
1970					
1971	700				
1972	2,000				
1973	200				
1974	4,000				
1975	1,000				
1976	4,500				
1977			176		
1978	5,470		85		
1979	12,000		236		
1980	3,484		284		
1981	2,759		205		
1982	5,400		199		
1983	3,458		192		
1984	3,700		374		
1985	1,500		182		
1986	3,200		428	64	
1987	14,000		417	82	
1988	20,000		819	84	
1989	14,300		1,244	166	
1990	4,680		1,018	598	
1991	25,000		815	1,664	
1992	3,590		427	1,752	
1993	16,000		543	2,253	
1994	2,400		861	1,554	
1995	12,500		571	2,099	
1996	21,500		723	2,846	
1997	13,200		1,009	2,746	
1998	1,850		614	1,011	
1999	9,800		1,241	2,589	
2000	6,000		2,721	4,088	
2001	3,800		701	6,471	
2002	4,750		1,062	4,492	
2003	8,000		492	5,910	
2004	46,400		3,192	9,820	8,612
2005	22,000		3,751	7,396	1,861
2006	6,300		2,074	7,616	612
2007	14,300		1,721	7,525	0
2008	14,900		4,527	8,760	0
2009	1,400		1,021	7,121	0
2010	4,800		1,027	4,494	0
2011	8,100	13,402	1,592	6,021	11
2012	2,600	4,585	2,080	4,981	0
2013	9,750	11,421	1,685	6,796	15
2014	350	522	2,077	828	0
2015	600	2,077	31	155	0
2016	3,200	7,053	572	593	
2017	4,800	11,021	2,084	5,724	
2018	1,100	2,019			

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[a] Sport harvests from the Statewide Harvest Survey.

[b] Subsistence harvests from the ADF&G Division of Commercial Fisheries database, Westward Region.

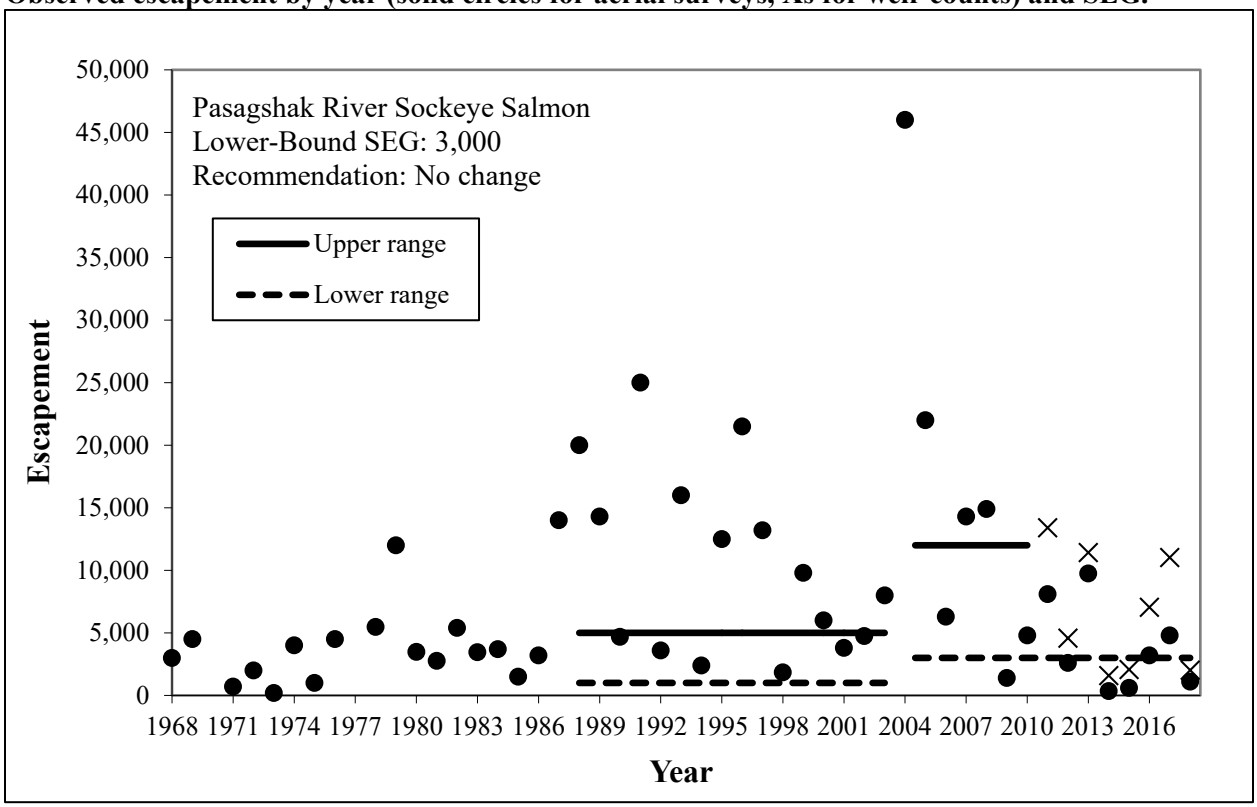
[c] Commercial harvests from the ADF&G Division of Commercial Fisheries database statistical area 259-43. Prior to 2004, statistical areas were not split out, and it is impossible to separate harvest among systems.

Appendix I3.–Pasagshak River sockeye salmon escapement and escapement goals, 1968–2018.

System: **Pasagshak River**

Species: **Sockeye salmon**

Observed escapement by year (solid circles for aerial surveys, Xs for weir counts) and SEG.



APPENDIX J: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR SALTERY LAKE SOCKEYE SALMON

Appendix J1.–Description of stock and escapement goal for Saltery Lake sockeye salmon.

System:	**Saltery Lake**
Species:	**Sockeye salmon**
Description of stock and escapement goals	
Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine, sport, and subsistence
Current escapement goal:	BEG: 15,000–35,000 (2011)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Aerial surveys: 1976–1986, 1992, 2004–2007 Weir counts: 1986–1991, 1993–2003, 2008–2018
Data summary:	
Data quality:	Fair for aerial surveys, good for weir counts
Data type:	Aerial surveys from 1976–1986, 1992, 2004–2007, weir counts from 1986–1991, 1993–2003, and 2008–2018. Harvest data are available from 1976–2009. Limnology data from 1994 to 2009.
Data contrast:	Weir data: 3.4
Methodology:	Ricker spawner-recruit, zooplankton model
Autocorrelation:	None
Comments:	None

Appendix J2.–Saltery Lake sockeye salmon aerial survey and weir count estimates, 1976–2018.

System: **Saltery Lake**

Species: **Sockeye salmon**

Data available for analysis of escapement goals

Year	Peak survey	Weir counts
1976	18,000	–
1977	30,800	–
1978	22,000	–
1979	43,000	–
1980	31,600	–
1981	43,000	–
1982	28,000	–
1983	46,400	–
1984	120,000	–
1985	26,000	–
1986	24,000	38,314
1987	–	22,705
1988	–	25,654
1989	–	30,237
1990	–	29,767
1991	–	52,592
1992	44,450	–
1993	–	77,186
1994	–	58,975
1995	–	43,859
1996	–	35,488
1997	–	31,016
1998	–	26,263
1999	–	62,821
2000	–	45,604
2001	–	45,608
2002	–	36,336
2003	–	57,993
2004	50,721	–
2005	23,078	–
2006	24,631	–
2007	15,382	–
2008	–	47,467
2009	–	43,468
2010	–	24,102
2011	–	27,803
2012	–	25,155
2013	–	35,939
2014	–	29,047
2015	–	39,920
2016	–	54,377
2017	–	35,218
2018	–	19,299

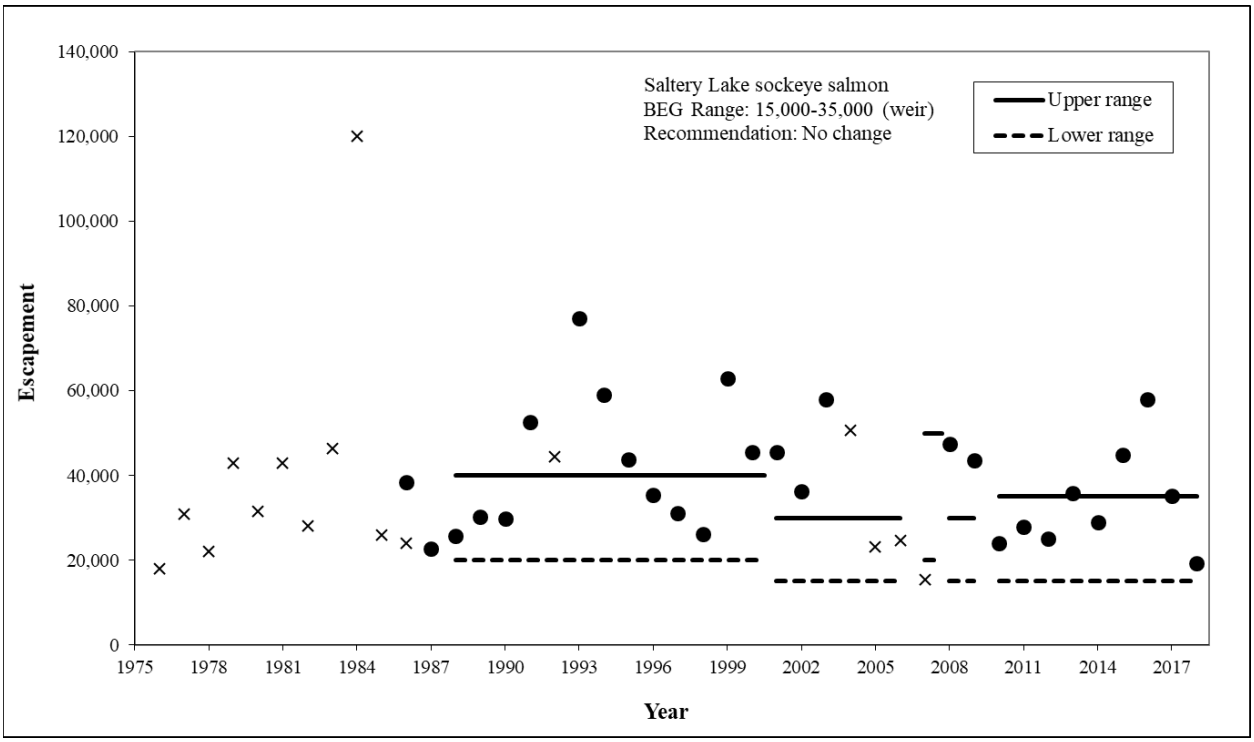
Note: Escapement numbers since 2004 have number of fish removed for egg-take subtracted from total escapement.

Appendix J3.–Saltery Lake sockeye salmon escapement and escapement goals, 1976–2018.

System: **Saltery Lake**

Species: **Sockeye salmon**

Observed escapement by year (circles are weir counts, Xs are aerial surveys)



APPENDIX K: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR UPPER STATION RIVER SOCKEYE SALMON

Appendix K1.–Description of stock and escapement goal for Upper Station River sockeye salmon.

System: **Upper Station**
Species: **Sockeye salmon**
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine and gillnet
Current escapement goal:	Early-run SEG: 43,000–93,000 (2010: data range 1975-2003, AR(1))
	Late-run BEG: 120,000–265,000 (2005; 2010 analysis used data from 1975-2003, stationarity and AR(1))
Recommended escapement goal:	Late-run: SEG 120,000–265,000
Optimal escapement goal:	Early run: 25,000 (1999-2014), 30,000 (2015-2016)
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1969–2018 (early run) and 1966–2018 (late run)
Data summary:	
Data quality:	Excellent for weir counts 1966–2018; fair for harvest and age data.
Data type:	Weir counts from 1966 to 2018 with escapement age data during weir counts. Harvest estimates with age data 1970–2018. Limnology information 1990–1993, 1995, 1999, 2000, and 2009 through 2018.
Data contrast:	Weir data, all years: early (16.5), late (25.9) Brood table years: early (16.5), late (11.1), both (9.0)
Methodology:	Ricker spawner-recruit models, percentile approach, yield analysis, smolt biomass as a function of zooplankton biomass, and euphotic volume models.
Autocorrelation:	Significant in late run (lag-1)
Comments:	Spawner recruit models are not significant for both the early and late run and have strong nonstationary processes occurring in addition to significant autocorrelation (lag-1) for the late run.

Appendix K2.–Upper Station River early-run sockeye salmon escapement and harvest estimates, 1969–2018.

System: Upper Station River early-run

Species: Sockeye salmon

Data available for analysis of escapement goals

Year	Weir counts	Commercial harvest
1969	22,509	–
1970	16,168	–
1971	32,529	–
1972	39,613	–
1973	26,892	–
1974	35,319	–
1975	10,325	–
1976	28,567	–
1977	26,380	–
1978	66,157	–
1979	53,115	–
1980	37,866	–
1981	77,042	–
1982	170,610	30,217
1983	115,890	27,800
1984	96,798	19,994
1985	27,408	6,364
1986	100,812	113,562
1987	74,747	70,072
1988	56,724	67,896
1989	64,582	59,389
1990	56,159	106,647
1991	50,026	119,764
1992	19,076	22,622
1993	34,852	51,996
1994	37,645	57,727
1995	41,492	170,502
1996	58,686	154,617
1997	47,655	18,735
1998	30,713	82,582
1999	36,521	51,457
2000	55,761	87,265
2001	66,795	91,895
2002	36,802	0
2003	76,175	24,215
2004	78,487	190,627
2005	60,349	95,717
2006	24,997	7,432
2007	31,895	5,877
2008	38,800	60,392
2009	34,585	46,623
2010	42,060	13,105
2011	28,759	22,874
2012	25,487	34,700
2013	27,712	29,502
2014	36,823	10,517
2015	54,473	11,631
2016	48,047	14,466
2017	83,614	17,922
2018	61,732	9,021

Appendix K3.–Upper Station River late-run sockeye salmon escapement and harvest estimates, 1966–2018.

System: Upper Station River late-run

Species: Sockeye salmon

Data available for analysis of escapement goals

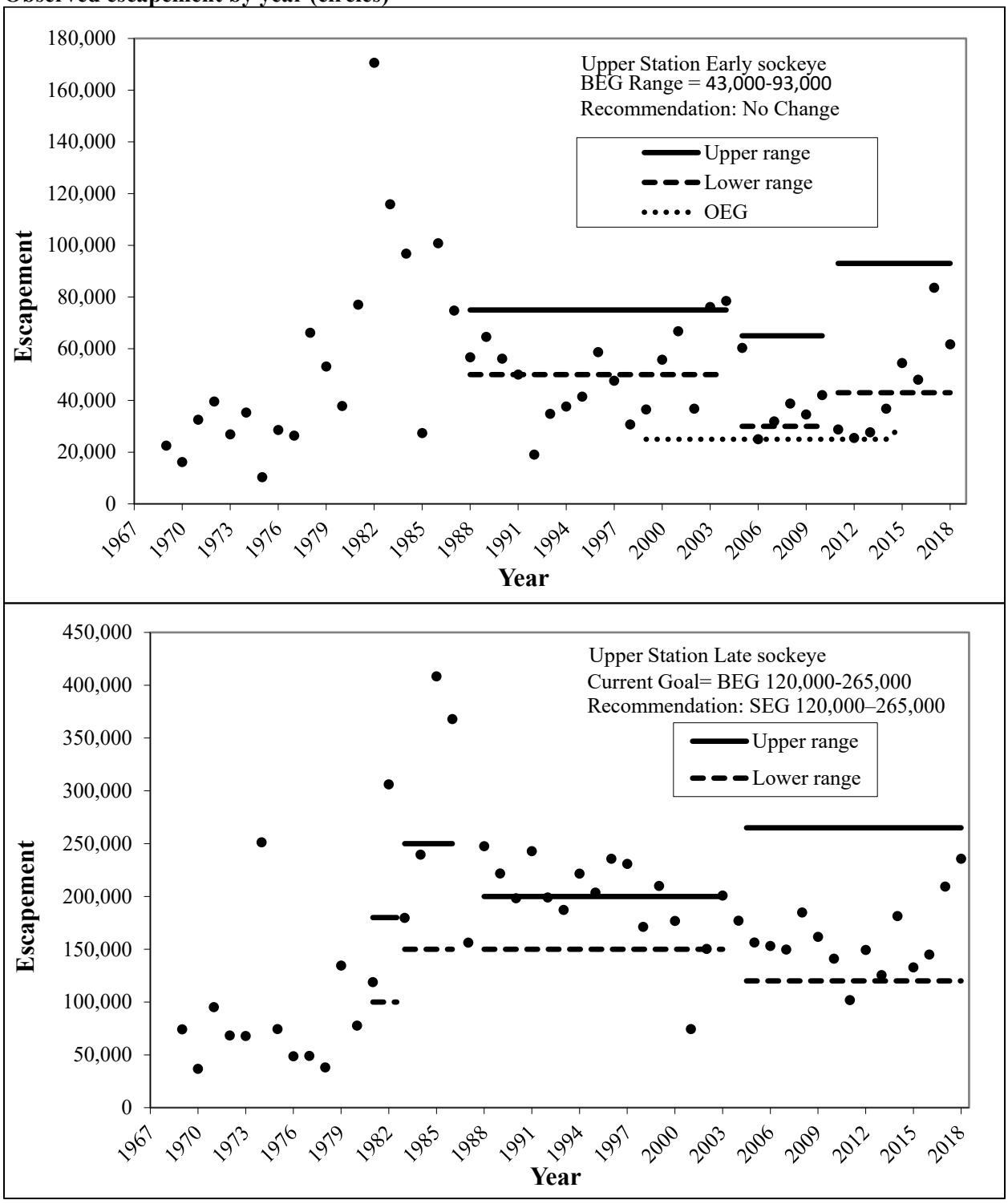
Year	Weir counts	Commercial harvest
1966	36,154	–
1967	66,999	–
1968	15,743	–
1969	74,150	–
1970	36,833	–
1971	95,150	–
1972	68,351	–
1973	67,826	–
1974	251,234	–
1975	74,456	–
1976	48,650	–
1977	49,001	–
1978	38,126	–
1979	134,579	–
1980	77,718	–
1981	118,900	–
1982	306,161	345,943
1983	179,741	361,991
1984	239,608	328,309
1985	408,409	522,561
1986	367,922	1,025,016
1987	156,274	384,337
1988	247,647	754,836
1989	221,706	485,347
1990	198,287	512,468
1991	242,860	514,467
1992	199,067	219,371
1993	187,229	258,283
1994	221,675	235,186
1995	203,659	383,973
1996	235,727	666,349
1997	230,793	288,226
1998	171,214	185,086
1999	210,016	358,673
2000	176,783	136,471
2001	74,408	60,620
2002	150,349	9,367
2003	200,894	211,844
2004	177,108	336,745
2005	156,401	124,324
2006	153,153	62,296
2007	149,709	44,032
2008	184,856	237,865
2009	161,736	187,403
2010	141,139	63,319
2011	101,893	68,875
2012	149,325	64,332
2013	125,573	33,656
2014	181,411	12,893
2015	132,864	53,803
2016	145,013	45,036
2017	209,298	97,120
2018	235,669	148,355

Appendix K4.–Upper Station River early-run sockeye salmon escapement and escapement goals, 1969–2018.

System: **Upper Station River**

Species: **Sockeye salmon**

Observed escapement by year (circles)



Appendix K5.–Upper Station River early-run sockeye salmon brood table.

Brood year	Escap.	Age 0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	3.3	2.4	Total return	return/ spawner
1975	10,325	0	0	0	0	1,458	208	0	6,393	14,783	0	0	8,738	485	0	0	32,065	3.1
1976	28,567	0	0	0	133	9,722	0	0	10,438	47,090	0	0	27,139	0	0	0	94,522	3.3
1977	26,380	0	0	0	0	32,041	243	0	48,850	94,081	0	0	35,526	634	0	0	211,375	8.0
1978	66,157	0	243	243	1,809	28,948	0	0	32,354	70,735	0	0	19,660	0	37	0	154,029	2.3
1979	53,115	0	0	0	0	4,124	0	0	17,554	65,300	0	46	14,870	38	142	0	102,074	1.9
1980	37,866	0	317	0	2,341	11,937	0	0	4,000	7,165	38	0	7,259	0	25	0	33,082	0.9
1981	77,042	0	0	0	542	2,832	1,498	0	4,370	85,872	0	43	23,861	0	0	0	119,082	1.5
1982	170,610	0	2,472	234	1,006	113,439	781	0	75,684	37,220	0	360	18,131	70	0	0	249,398	1.5
1983	115,890	0	285	1,220	1,181	5,491	1,205	0	11,396	87,555	0	0	41,723	217	0	0	150,273	1.3
1984	96,798	0	109	0	3,443	2,118	66	0	1,792	46,879	0	0	14,103	113	60	0	68,683	0.7
1985	27,408	0	1,476	4	2,865	2,314	22,466	0	6,714	86,949	0	0	42,895	633	64	0	166,380	6.1
1986	100,812	0	35	5,680	449	51,361	936	0	36,048	83,179	60	18	8,248	340	408	0	186,783	1.9
1987	74,747	0	2,134	46	1,022	2,027	3,849	0	726	30,417	27	0	25,242	779	57	0	66,326	0.9
1988	56,724	0	17	0	71	82	852	0	1,607	35,640	210	206	7,282	1,072	0	0	47,038	0.8
1989	64,582	0	450	404	5,823	8,751	6,313	0	5,539	67,810	0	0	34,127	0	0	0	129,217	2.0
1990	56,159	0	1,497	578	0	6,275	3,414	0	19,145	82,269	0	0	6,839	361	6	0	120,384	2.1
1991	50,026	0	407	3,258	20,467	46,391	6,815	0	57,478	131,931	0	0	27,274	0	0	0	294,021	5.9
1992	19,076	52	2,338	223	5,878	5,959	3,583	0	3,435	24,099	0	0	7,268	0	0	0	52,835	2.8
1993	34,852	219	669	605	2,423	5,189	2,741	0	11,812	31,749	0	0	5,168	1,229	0	62	61,866	1.8
1994	37,645	0	229	994	4,887	53,607	1,320	0	7,176	33,104	0	0	17,361	570	0	0	119,248	3.2
1995	41,492	0	185	2,467	5,857	33,691	1,497	360	44,415	44,608	0	492	20,938	689	92	0	155,291	3.7
1996	58,686	0	79	177	2,723	30,487	1,973	0	81,164	51,987	4	25	15,238	281	0	0	184,138	3.1
1997	47,655	0	422	45	0	972	2,438	0	558	11,566	34	0	7,233	795	2,006	0	26,069	0.5
1998	30,713	0	0	6	0	145	6,264	0	418	45,950	0	0	16,490	8	0	0	69,281	2.3
1999	36,521	0	0	2,598	328	27,894	6,080	0	34,497	81,382	0	360	38,405	626	28	0	192,198	5.3
2000	55,761	0	780	10,912	7,338	122,434	2,623	69	59,315	40,862	69	121	9,843	139	235	28	254,768	4.6
2001	66,795	0	1,131	1,123	3,856	6,472	5,116	0	4,335	15,475	0	24	13,764	0	0	0	51,298	0.8

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Appendix K5.–Page 2 of 2.

Brood year	Escap.	Age 0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	3.3	2.4	Total return	return/ spawner
2002	36,802	82	532	382	574	1,295	42	36	4,890	2,815	0	0	8,604	0	0	36	19,289	0.5
2003	76,175	0	75	502	88	10,903	3,245	0	9,334	34,250	0	106	13,258	86	0	0	71,846	0.9
2004	78,487	0	191	1,553	6,398	36,836	3,258	0	25,750	32,372	0	0	4,211	0	0	0	110,570	1.4
2005	60,349	0	233	281	0	5,884	3,446	0	3,904	42,706	64	0	9,733	130	0	2	66,385	1.1
2006	24,997	0	0	269	0	1,815	2,367	0	4,513	24,439	5	28	14,943	620	0	4	49,002	2.0
2007	31,895	0	71	26	136	3,578	4,849	0	3,112	28,723	0	16	16,845	0	0	0	57,358	1.8
2008	38,800	0	0	978	52	10,317	2,056	0	10,744	21,686	5	0	2,534	0	0	0	48,373	1.2
2009	34,585	0	108	226	2,346	2,774	2,782	0	2,354	30,938	4	0	7,963	0	0	0	49,495	1.4
2010	42,060	0	0	228	0	1,784	6,735	0	2,353	45,458	89	0	5,892	76	0	0	62,615	1.5
2011	28,759	0	80	132	0	1,376	7,241	0	696	27,850	26	0	16,886	0	0	0	54,286	1.9
2012	25,487	0	0	1,625	438	15,567	4,505	0	14,248	31,792	0	0	2,681	0	0	0	70,856	2.8
2013	27,712	0	319	7,144	976	31,053	2,719	0	8,118	28,517	0	0	4,704	99				
2014	36,823	0	79	3,240	0	26,729	1,373	0	8,904	16,940	0							
2015	54,473	0	148	3,289	0	18,840	2,582											
2016	48,047	0	39	12,490														
2017	83,614	0																
2018	61,732																	
2019	49,517																	

Appendix K6.–Upper Station River late-run sockeye salmon brood table.

Brood year	Escap.	Age 0.1	0.2	1.1	2.0	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	3.3	2.4	Total return	R/S[a]
1975	74,456	901	3,021	0	0	0	61,142	1,132	0	36,479	76,157	0	0	5,228	0	0	0	184,060	2.5
1976	48,650	0	10,190	0	0	36,479	38,399	2,560	0	11,501	141,154	0	0	10,336	940	0	0	251,559	5.2
1977	49,001	0	640	0	0	3,137	52,279	1,046	0	66,714	312,897	0	0	9,732	0	0	0	446,444	9.1
1978	38,126	0	82,601	1,046	0	90,205	134,367	4,698	0	55,146	217,342	0	0	26,755	2,638	0	0	614,798	16.1
1979	134,579	0	31,947	0	0	63,256	71,366	0	0	103,020	339,950	0	736	10,850	360	280	0	621,765	4.6
1980	77,718	0	124,890	0	0	56,178	35,951	2,131	0	21,758	55,472	399	0	16,555	965	223	0	314,522	4.0
1981	118,900	0	1,294	0	0	17,853	157,249	12,280	1,007	149,158	345,506	0	0	14,809	0	0	879	700,035	5.9
1982	306,161	0	644,017	5,129	0	324,600	364,312	5,029	117	92,824	231,963	0	0	5,168	2,042	0	0	1,675,201	5.5
1983	179,741	4,867	182,514	0	0	135,177	23,242	1,682	0	53,195	92,799	0	0	30,036	0	1,488	0	525,000	2.9
1984	239,608	3,012	37,733	528	0	89,721	187,451	5,064	0	21,543	224,033	0	0	23,712	4,642	0	0	597,438	2.5
1985	408,409	2,313	562,757	1,958	0	309,775	34,924	12,374	0	40,759	179,839	0	578	45,289	6,140	0	0	1,196,706	2.9
1986	367,922	1,449	72,415	1,953	0	94,380	291,815	5,610	678	116,039	451,917	0	0	17,721	1,579	1,289	6	1,056,851	2.9
1987	156,274	0	68,016	495	0	113,821	12,899	127	0	17,053	104,995	0	225	27,470	15,072	39	0	360,212	2.3
1988	247,647	0	9,222	216	0	27,793	76,583	1,000	0	71,330	80,102	177	133	4,037	1,244	0	0	271,836	1.1
1989	221,706	401	169,158	1,125	0	85,530	83,807	12,864	142	53,928	184,067	308	0	21,693	0	0	0	613,023	2.8
1990	198,287	1,432	56,992	3,904	0	115,907	27,747	7,728	444	17,591	237,284	0	0	4,315	0	67	0	473,411	2.4
1991	242,860	6,744	51,810	4,858	0	163,283	73,541	6,484	160	44,507	712,676	31	0	20,546	0	0	0	1,084,640	4.5
1992	199,067	4,913	61,018	1,108	0	15,733	58,923	12,611	79	6,302	279,349	0	0	7,189	156	192	26	447,599	2.2
1993	187,229	5,186	46,015	5,688	0	114,817	35,842	45,256	444	10,769	199,820	191	278	27,883	5,350	0	0	497,539	2.7
1994	221,675	1,417	10,206	6,322	0	23,167	90,488	17,439	44	25,603	293,322	80	0	6,069	968	0	0	475,125	2.1
1995	203,659	233	3,020	3,340	0	3,349	179,562	24,492	0	13,017	251,855	0	254	14,264	307	247	20	493,960	2.4
1996	235,727	277	1,972	6,536	0	1,335	35,606	4,057	0	15,478	88,856	121	1	4,856	2,282	0	1,500	162,877	0.7
1997	230,793	0	347	0	0	916	2,842	11,901	0	1,932	129,206	1,984	130	8,502	17,554	1,942	0	177,256	0.8
1998	171,214	0	0	89	0	0	2,511	13,979	0	3,281	219,890	25,325	0	13,190	890	0	0	279,155	1.6
1999	210,016	0	279	2,323	0	672	80,315	15,939	0	20,091	313,886	19	346	40,906	5,360	465	9	480,610	2.3
2000	176,783	96	34,433	5,197	0	36,394	122,248	4,045	98	30,388	181,491	0	31	16,677	986	187	165	432,436	2.4
2001	74,408	0	522	215	0	1,701	5,696	8,310	0	7,078	77,172	0	78	9,900	300	0	0	110,971	1.5

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Appendix K6.–Page 2 of 2.

Brood year	Escap.	Age 0.1	0.2	1.1	2.0	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	3.3	2.4	Total return	R/S[a]
2002	150,349	411	2,421	3,965	0	7,179	94,543	8,085	0	21,609	95,473	0	0	13,730	0	0	235	247,650	1.6
2003	200,894	43	888	1,667	0	337	51,307	7,446	0	16,131	256,511	0	357	15,308	548	0	0	350,545	1.7
2004	177,108	669	5,264	1,535	0	24,845	99,160	7,094	0	29,761	255,957	181	0	5,577	1,457	185	0	431,685	2.4
2005	156,401	139	2,828	2,423	0	3,067	20,933	20,082	0	6,256	171,458	153	0	8,694	3,150	0	4	239,187	1.5
2006	153,153	0	931	1,561	0	177	10,327	8,207	0	5,267	126,317	182	74	3,988	6,115	531	0	163,678	1.1
2007	149,709	218	59	787	0	287	12,235	11,858	0	10,286	140,872	46	277	8,838	241	0	0	186,005	1.2
2008	184,856	0	0	2,217	0	349	40,340	7,761	0	10,196	105,047	943	0	5,639	0	0	0	172,492	0.9
2009	161,736	376	2,236	1,527	0	5,796	8,546	16,773	0	3,942	171,268	0	0	23,034	250	0	0	233,747	1.4
2010	141,139	58	149	2,066	0	38	9,380	3,245	0	4,197	115,614	24	0	1,408	1,764	0	0	137,943	1.0
2011	101,893	0	7	533	0	5,790	26,119	7,436	0	7,460	101,503	8	0	7,343	704	0	0	156,902	1.5
2012	149,325	0	1,699	1,927	0	3,637	56,890	5,748	0	45,927	141,560	0	0	9,326	373	0	0	267,087	1.8
2013	125,573	579	7,762	3,278	0	13,373	66,103	14,350	0	9,025	178,257	0	0	3,425	0				
2014	181,411	593	10,842	2,993	0	4,676	147,013	2,289	0	9,829	113,308	0							
2015	132,864	3,765	29,948	3,107	0	11,163	32,156	6,652											
2016	145,013	0	3,090	8,891	252														
2017	209,298	1,809																	
2018	235,669																		
2019	165,146																		

[a] R/S = return/spawner.

APPENDIX L: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR AMERICAN RIVER COHO SALMON

Appendix L1.–Description of stock and escapement goal for American River coho salmon.

System: American River
Species: Coho salmon
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Sport and Commercial
Primary fishery:	Sport, commercial, and subsistence
Current escapement goal:	Lower-bound SEG: 400 (2011)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Foot surveys, 1980–present with no surveys in 1986, 1988, and 1991.
Data summary:	
Data quality:	All survey data are good.
Data type:	Foot surveys are conducted annually and inriver harvest of the recreational fishery are estimated annually through the Statewide Harvest Survey. Although there is no stock-specific harvest information available for subsistence and commercial fisheries, annual catch data are available for Kalsin Bay (statistical area 259-23).
Data contrast:	All survey data 1980 to 2018: 68.9
Methodology:	Theoretical stock-recruit analysis with average foot surveys and average harvest (recreational, commercial and subsistence) from 1980–2003 was used to specify the SEG that potentially maximizes yield give uncertainty in the productivity of this stock. Alpha-parameter values in the stock-recruit analysis ranged from 4 to 8.
Autocorrelation:	None
Comments:	None

Appendix L2.–Annual escapement index and harvest of American River coho salmon, 1980–2018.

System: **American River**

Species: **Coho salmon**

Data available for analysis of escapement goals

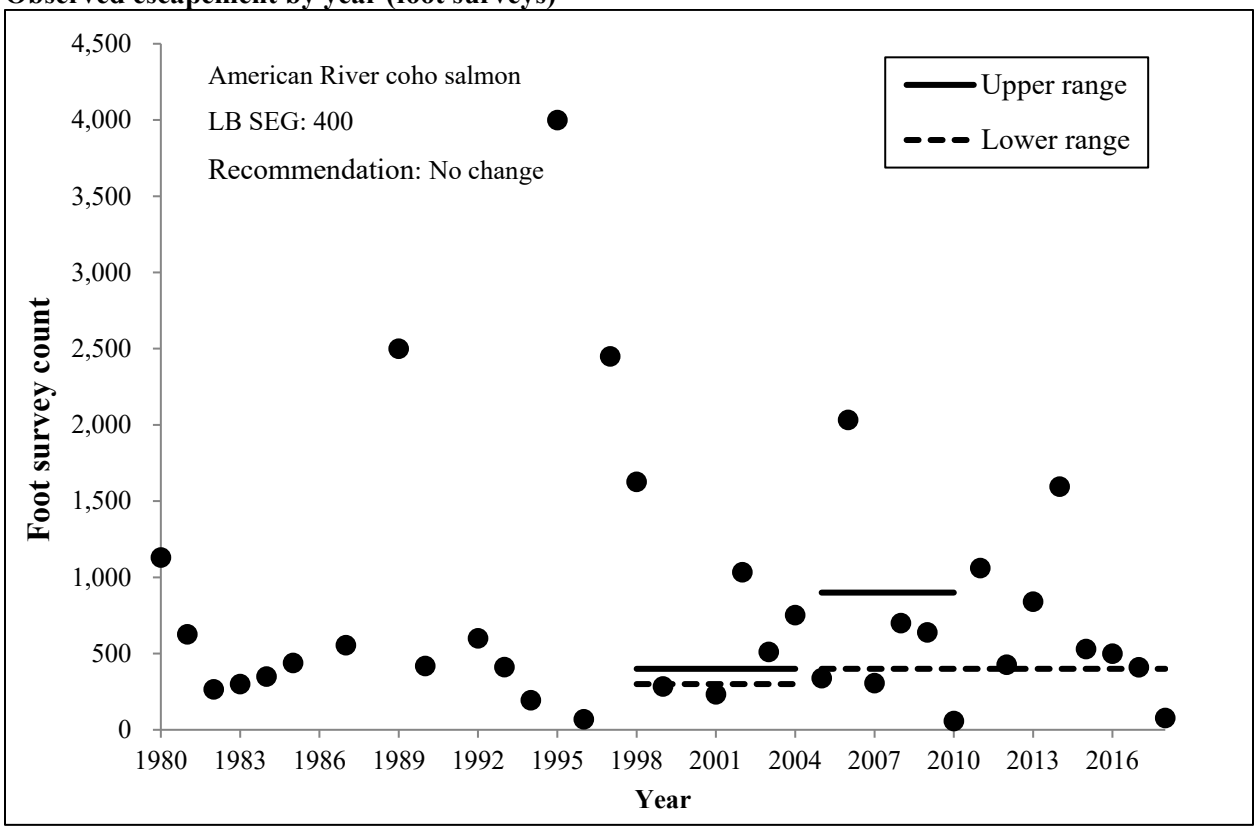
Year	Foot survey
1980	1,130
1981	627
1982	266
1983	300
1984	350
1985	439
1986	–
1987	555
1988	–
1989	2,500
1990	419
1991	–
1992	600
1993	412
1994	194
1995	4,000
1996	69
1997	8,200
1998	1,627
1999	284
2000	–
2001	233
2002	1,034
2003	511
2004	753
2005	339
2006	2,033
2007	307
2008	700
2009	639
2010	58
2011	1,061
2012	427
2013	841
2014	1,595
2015	530
2016	500
2017	410
2018	78

Appendix L3.–American River coho salmon escapement and escapement goals, 1980–2018.

System: **American River**

Species: **Coho salmon**

Observed escapement by year (foot surveys)



APPENDIX M: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR BUSKIN RIVER COHO SALMON

Appendix M1.–Description of stock and escapement goal for Buskin River coho salmon.

System: **Buskin River**
Species: **Coho salmon**
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Sport and commercial
Primary fishery:	Sport, commercial, subsistence
Current escapement goal:	BEG: 4,700–9,600 fish (2014)
Recommended escapement goal:	Change to SEG of 4,700 to 9,600
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1985 to present
Data summary:	
Data quality:	Escapement data with significant estimation and harvest data.
Data type:	Weir estimates, harvest estimates, age composition.
Data contrast:	All survey data 1989 to 2018: 3.3
Methodology:	Percentile Method
Autocorrelation:	None
Comments:	None

Appendix M2.–Annual escapement and harvest of Buskin River coho salmon, 1980–2018.

System: Buskin River

Species: Coho salmon

Data available for analysis of escapement goals

			Harvest			
Year	Escapement	Weir count	Sport[a]	Subsistence[b]	Commercial[c]	Total run
1980	–	–	2,643	–	–	–
1981	–	–	2,269	–	–	–
1982	–	–	2,431	–	–	–
1983	–	–	2,307	–	–	–
1984	–	–	1,871	–	–	–
1985	9,213	9,474	2,178	2,554	666	14,611
1986	9,477	9,939	4,098	2,541	1,065	17,151
1987	10,727	11,103	3,133	1,742	2,334	17,936
1988	6,365	6,782	3,474	1,586	254	11,679
1989	9,356	9,930	4,782	1,302	0	15,440
1990	6,039	6,222	1,521	1,774	1	9,335
1991	8,434	8,929	4,121	1,481	15	14,051
1992	6,358	6,535	1,474	1,907	0	9,739
1993	6,318	6,813	4,125	1,720	7	12,170
1994	7,855	8,146	2,429	2,167	15	12,466
1995	8,438	8,694	2,132	1,285	224	12,079
1996	8,141	8,439	2,481	1,263	0	11,885
1997	10,582	10,926	2,864	1,383	0	14,829
1998	8,742	9,062	2,669	1,394	9	12,814
1999	9,383	9,794	3,422	1,320	3	14,128
2000	7,737	8,048	2,589	1,717	0	12,043
2001	13,214	13,494	2,332	1,421	0	16,967
2002	10,349	10,649	2,497	1,517	0	14,363
2003	12,754	13,150	3,302	1,242	6	17,304
2004	9,016	9,599	4,860	1,481	95	15,452
2005	16,235	16,596	3,010	2,414	0	21,659
2006	12,560	13,348	6,567	1,567	763	21,457
2007	8,375	9,001	5,215	1,193	757	15,540
2008	8,176	9,028	4,259	1,165	0	13,600
2009	9,583	10,624	5,207	874	138	15,802
2010	6,239	6,808	2,847	679	0	9,765
2011	5,298	6,026	3,640	287	197	9,422
2012	4,906	5,291	1,926	984	10	7,826
2013	4,974	5,959	4,926	611	40	10,551
2014	7,335	8,413	5,388	1,537	1	14,261
2015	NA	4,341	NA	824	13	NA
2016	2,134	2,513	1,895	496	0	4,525
2017	5,162	5,559	2,337	300	0	7,799
2018	4,218	4,523	1,793	1,146	0	7,157

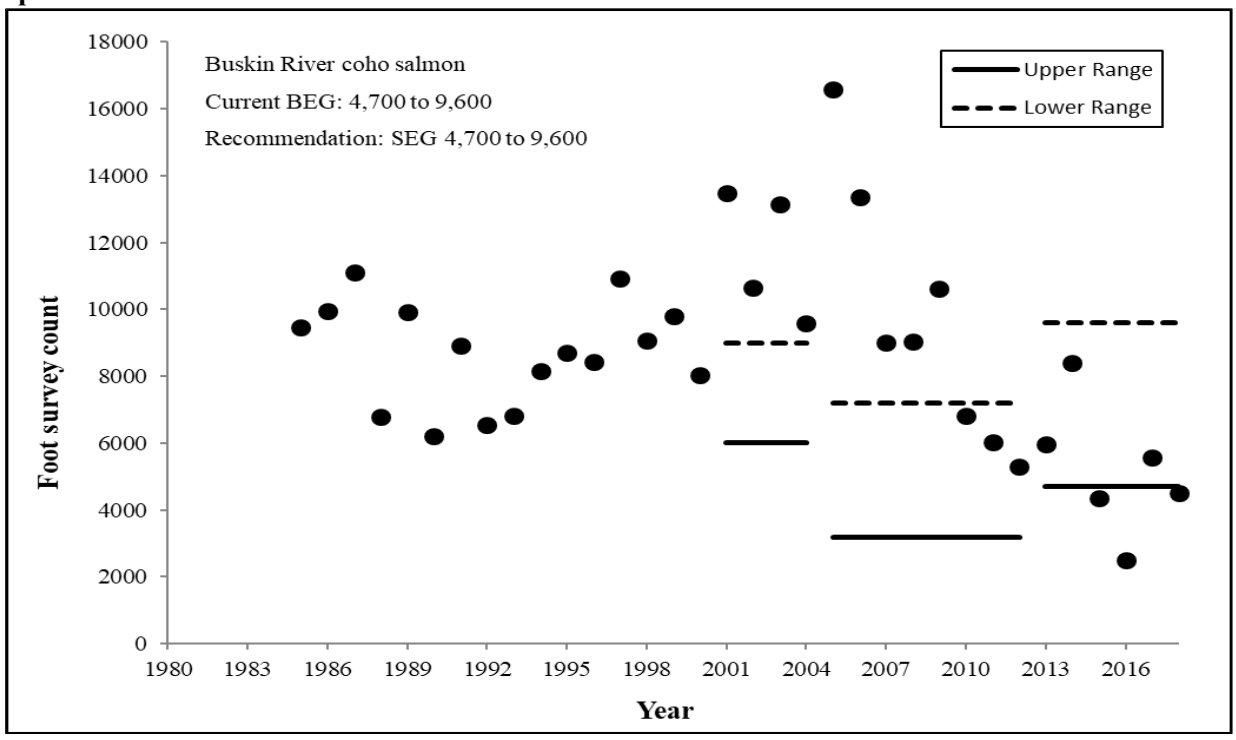
[a] Sport harvests from the Statewide Harvest Survey.

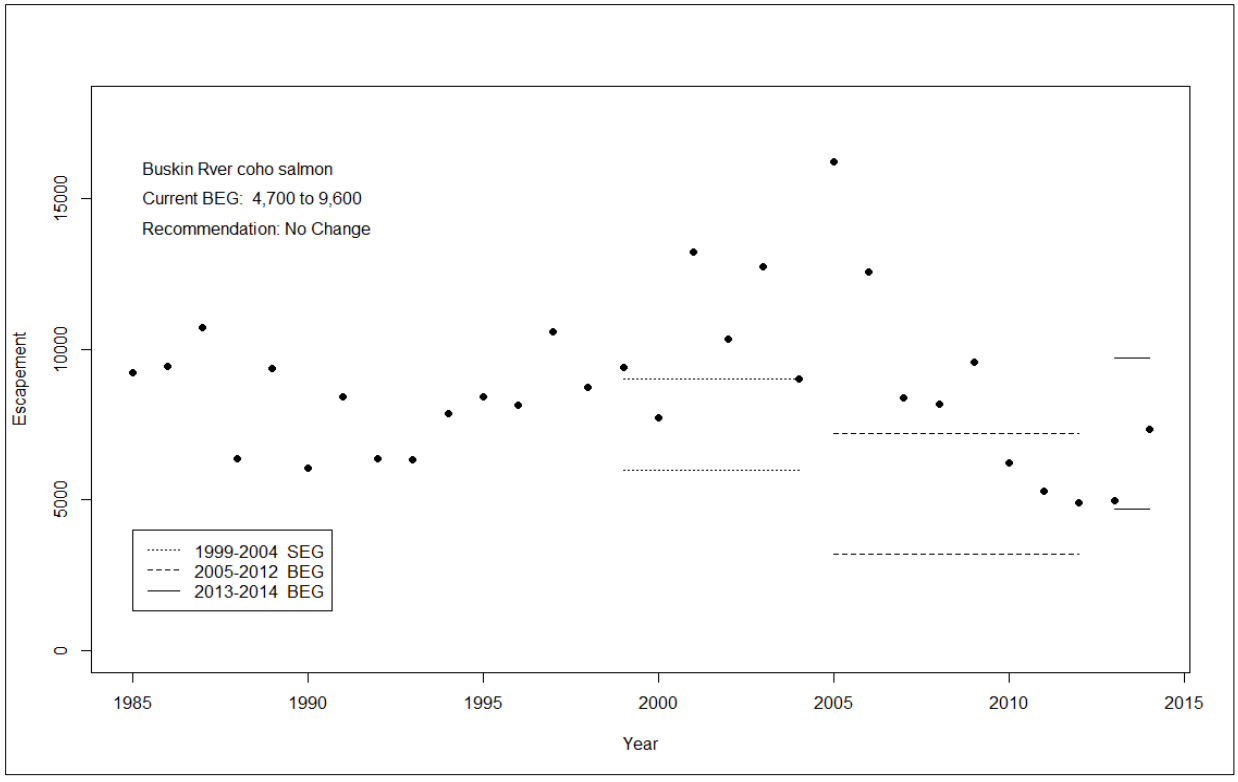
[b] Subsistence harvests from the ADF&G Division of Commercial Fisheries database, Westward Region.

[c] Commercial harvests from the ADF&G Division of Commercial Fisheries database.

Appendix M3.–Buskin River coho salmon escapement and escapement goals, 1985–2018.

System: **Buskin River**
Species: **Coho salmon**





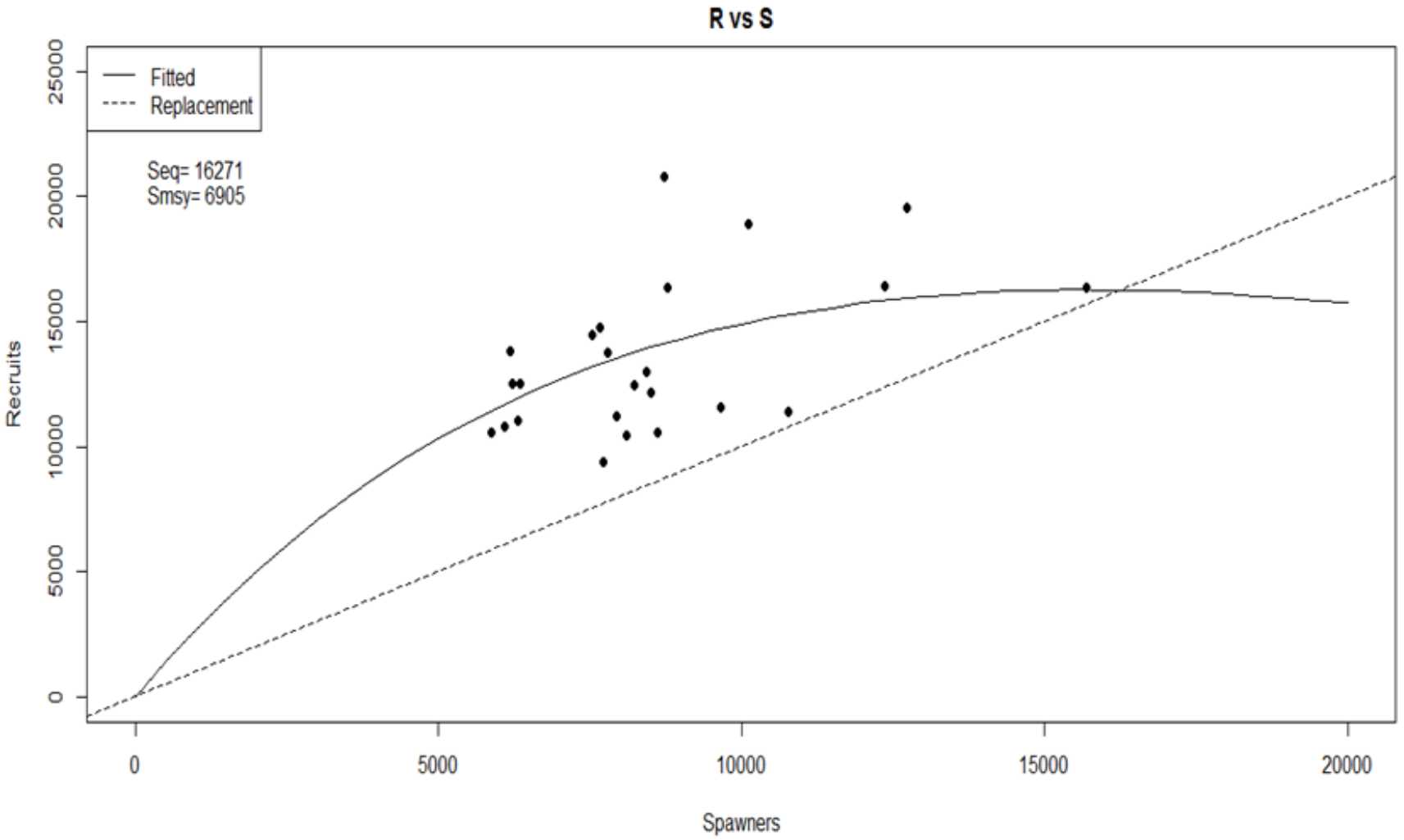
Appendix M4.–Buskin River coho salmon brood table, 1989–2014.

System: Buskin River
Species: Coho salmon

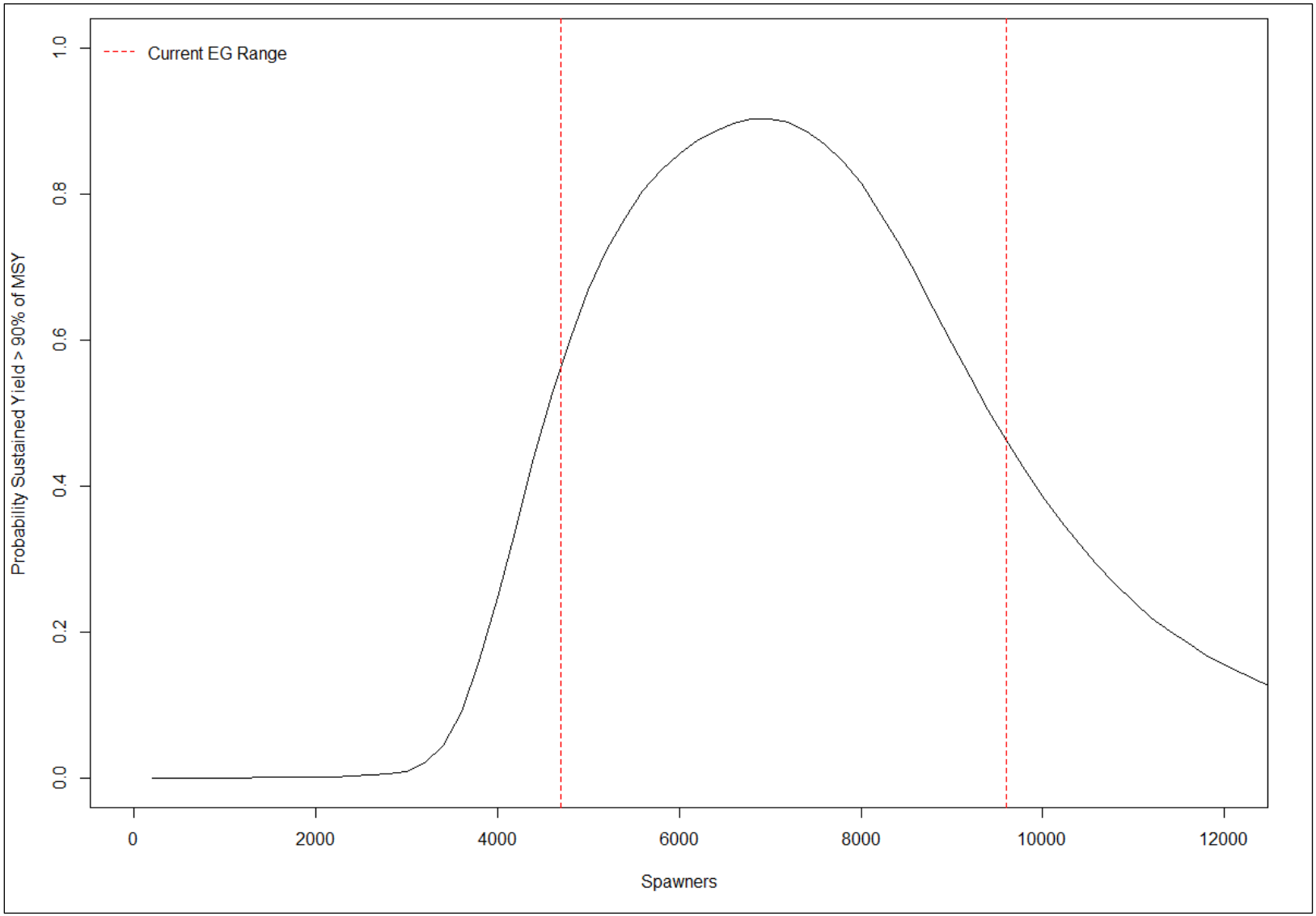
Brood Year	Escap.	Age class										Return	Return/ spawner
		1.0	1.1	1.2	2.0	2.1	2.2	3.0	3.1	3.2	4.1		
1989	9,356	0	2,275	0	213	8,774	0	0	648	0	0	11,910	1.3
1990	6,039	0	2,143	38	40	8,082	37	38	262	0	0	10,640	1.8
1991	8,434	0	3,431	0	229	8,938	44	0	1,049	0	69	13,759	1.6
1992	6,358	0	2,767	0	37	8,215	0	0	1,517	0	0	12,537	2.0
1993	6,318	37	2,578	0	0	10,139	55	69	1,265	44	44	14,232	2.3
1994	7,855	0	2,897	0	138	9,074	177	110	2,392	0	0	14,788	1.9
1995	8,438	0	2,310	0	0	9,079	160	44	917	0	0	12,510	1.5
1996	8,141	0	2,303	0	44	8,733	42	40	42	0	0	11,205	1.4
1997	10,582	0	2,153	0	40	8,526	0	42	422	0	0	11,183	1.1
1998	8,742	0	8,106	0	210	11,641	0	47	1,375	0	0	21,379	2.4
1999	9,383	0	2,159	0	94	11,846	0	89	2,137	0	0	16,325	1.7
2000	7,737	0	3,683	0	311	9,653	0	0	1,325	0	0	14,970	1.9
2001	13,214	0	3,624	0	0	14,969	0	0	1,135	0	0	19,729	1.5
2002	10,349	38	5,233	0	66	15,200	0	28	141	0	0	20,705	2.0
2003	12,754	66	5,039	0	55	11,954	0	0	258	0	0	17,372	1.4
2004	9,016	0	2,883	0	492	9,153	0	64	705	0	0	13,297	1.5
2005	16,235	70	4,061	0	64	12,782	0	0	185	0	0	17,163	1.1
2006	12,560	0	2,013	0	302	7,602	0	124	1,047	0	0	11,087	0.9
2007	8,375	0	1,483	0	371	6,805	95	0	95	0	91	8,941	1.1
2008	8,176	0	1,570	0	0	7,158	0	95	273	0	0	9,097	1.1
2009	9,583	0	191	0	191	8,931	0	0	223	0	0	9,536	1.0
2010	6,239	0	1,185	0	365	11,810	0	0	960	0	0	14,320	2.3
2011	5,298	0	1,671	NA	0	NA		NA					
2012	4,906	0	NA		NA								
2013	4,974												
2014	7,335												
2015	NA												

Note: NA means data not available yet.

Appendix M5.–Ricker spawner-recruit function fitted to Buskin River coho salmon data, 1989 to 2015 brood years. Parameter estimates are posterior medians.



Appendix M6.–Optimal yield profile obtained by fitting an age-structured spawner-recruit model to Buskin River coho salmon data, 1989–2015. Probability of achieving at least 90% of maximum sustained yield is plotted. Vertical lines show recommended escapement goal.



APPENDIX N: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR OLDS RIVER COHO SALMON

Appendix N1.–Description of stock and escapement goal for Olds River coho salmon.

System: Olds River
Species: Coho salmon
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Sport and commercial
Primary fishery:	Sport, commercial, subsistence
Current escapement goal:	Lower-bound SEG of 1,000 fish (2010)
Recommended escapement goal:	LB SEG 500
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Foot surveys, 1980 to present with no surveys in 1981, 1983, 1988, and 1991.
Data summary:	
Data quality:	Mark-recapture work conducted in 1997 and 1998 (Begich et al. 2000) indicated foot surveys in the Olds River represent 69% to 104% of point estimates of abundance and were within the 95% confidence interval of estimated abundance in 1998.
Data type:	Foot surveys are conducted annually and inriver harvest of the recreational fishery are estimated annually through the Statewide Harvest Survey. Although there is no stock-specific harvest information available for subsistence and commercial fisheries, annual catch data are available for Kalsin Bay (statistical area 259-24).
Data contrast:	All survey data 1980 to 2018: 81.3
Methodology:	Percentile Approach
Autocorrelation:	None
Comments:	None

Appendix N2.–Annual escapement index of Olds River coho salmon, 1980–2018.

System: **Olds River**

Species: **Coho salmon**

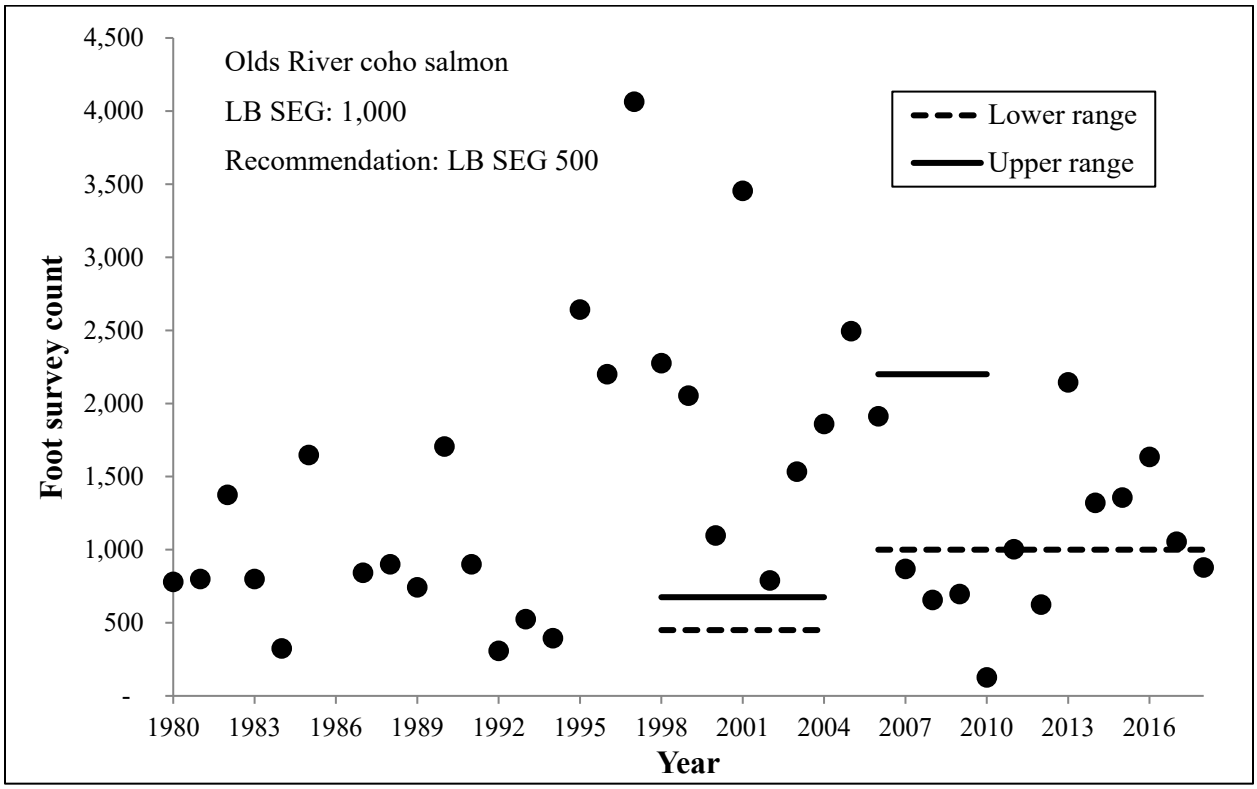
Year	Foot survey
1980	780
1981	800
1982	1,375
1983	800
1984	325
1985	1,648
1986	–
1987	842
1988	900
1989	743
1990	1,706
1991	900
1992	308
1993	525
1994	395
1995	2,642
1996	2,200
1997	4,064
1998	2,276
1999	2,054
2000	1,097
2001	3,454
2002	790
2003	1,534
2004	1,860
2005	2,495
2006	1,912
2007	868
2008	656
2009	697
2010	127
2011	1,003
2012	624
2013	2,145
2014	1,320
2015	1,357
2016	1,634
2017	1,054
2018	878

Appendix N3.–Olds River coho salmon escapement and escapement goals, 1980–2018.

System: **Olds River**

Species: **Coho salmon**

Observed escapement by year (foot surveys)



APPENDIX O: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR PASAGSHAK RIVER COHO SALMON

Appendix O1.–Description of stock and escapement goal for Pasagshak River coho salmon.

System: Pasagshak River
Species: Coho salmon
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area – Westward Region
Management division:	Sport and commercial
Primary fishery:	Sport, commercial, and subsistence
Current escapement goal:	Lower-bound SEG: 1,200 fish (2010)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Foot surveys, 1980–present with no surveys in 1985, 1988, 1989, 1991, 1992, 1994, and 1995.
Data summary:	
Data quality:	Fishery managers have indicated that foot surveys in the Pasagshak River since 1996 likely represent most of the actual escapement to the system.
Data type:	Foot surveys are conducted annually and inriver harvest of the recreational fishery are estimated annually through the Statewide Harvest Survey. Although there is no stock-specific harvest information available for subsistence and commercial fisheries, annual catch data are available for statistical area 259-41.
Data contrast:	1980 to 2018 (excluding 1992; considered incomplete): 99.3
Methodology:	Theoretical stock-recruit analysis
Autocorrelation:	Significant autocorrelation of foot survey counts at lag 1
Comments:	None

Appendix O2.–Annual escapement index of Pasagshak River coho salmon, 1980–2018.

System: Pasagshak River

Species: Coho salmon

Data available for analysis of escapement goals

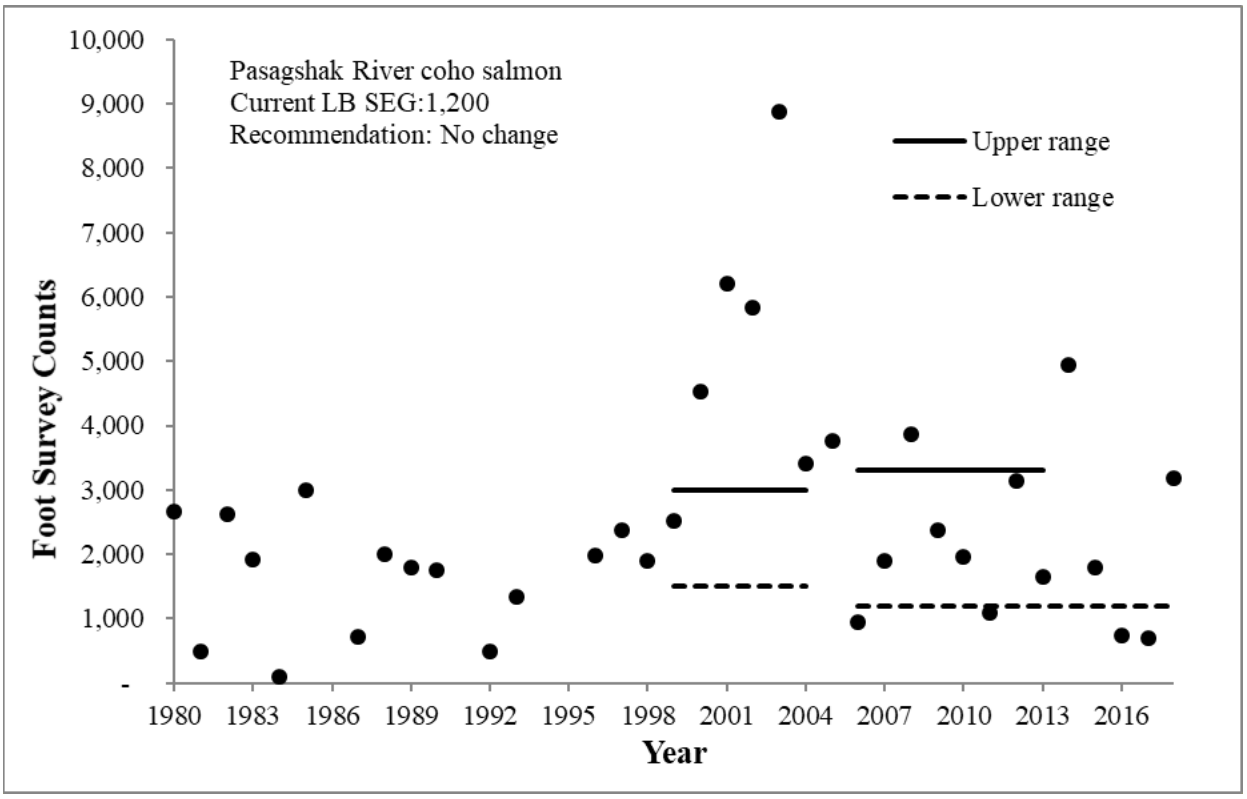
Year	Foot survey
1980	2,664
1981	500
1982	2,621
1983	1,920
1984	90
1985	3,000
1986	–
1987	714
1988	2,000
1989	1,800
1990	1,757
1991	–
1992	500
1993	1,337
1994	–
1995	–
1996	1,973
1997	2,371
1998	1,906
1999	2,525
2000	4,526
2001	6,209
2002	5,825
2003	8,886
2004	3,402
2005	3,773
2006	937
2007	1,896
2008	3,875
2009	2,385
2010	1,971
2011	1,083
2012	3,132
2013	1,648
2014	4,934
2015	1,790
2016	737
2017	701
2018	3,186

Appendix O3.–Pasagshak River coho salmon escapement and escapement goals, 1980–2018.

System: **Pasagshak River**

Species: **Coho salmon**

Observed escapement by year (foot surveys)



APPENDIX P: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR KODIAK ARCHIPELAGO PINK SALMON

Appendix P1.–Description of stock and escapement goal for Kodiak Archipelago pink salmon.

System: **Kodiak Archipelago**
Species: **Pink salmon**
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area – Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine and gillnet
Current escapement goal:	SEG Odd Years: 2,000,000–5,000,000 (2011) SEG Even Years: 3,000,000–7,000,000 (2011)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Aerial Survey, 1968–2018 Weir counts, 1976–2018
Data summary:	
Data quality:	Fair
Data type:	Fixed-wing aerial surveys from 1968 to 2018 with peak counts used as an index of spawning escapement. Index streams are flown annually with peak counts from streams summed annually to produce a single index for the archipelago after combination with weir counts.
Data contrast:	Peak aerial surveys, all years 1976–2018:
Methodology:	Ricker Model
Autocorrelation:	None
Comments:	An expansion factor of two (2) was used on pink salmon escapement aerial survey data and combined with Karluk and Ayakulik escapement data. The resultant Ricker model was significant (P = 3.9 x 10-5). The resultant S_{MSY} estimate was corrected for Karluk and Ayakulik weir counts and weighted peak aerial survey data.

Appendix P2.–Kodiak Archipelago pink salmon peak escapement and harvest estimates, 1978–2018.

System: Kodiak Archipelago

Species: Pink salmon

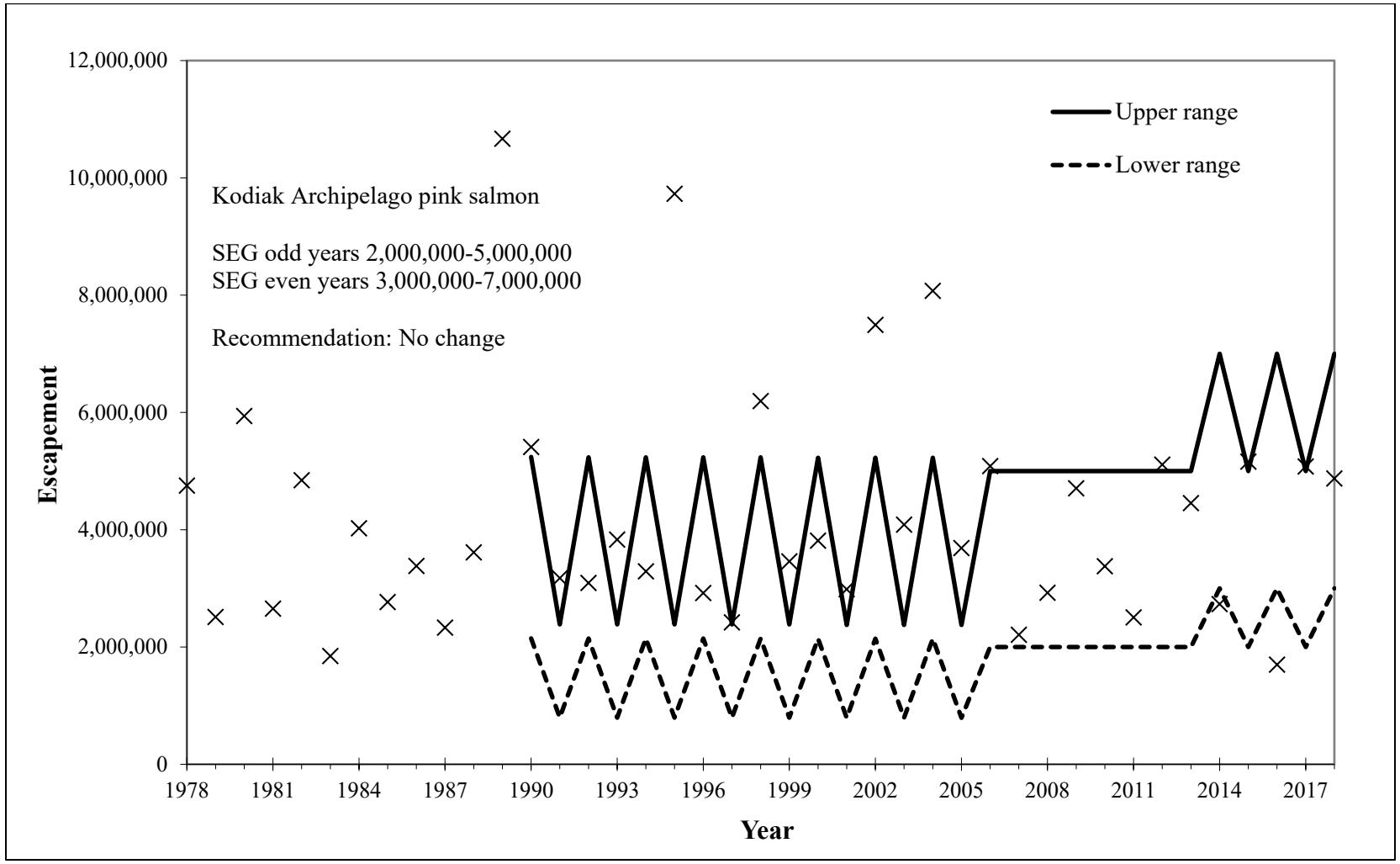
Data available for analysis of escapement goals

Year	Peak survey	Harvest
1978	4,752,564	14,767,000
1979	2,513,297	10,445,000
1980	5,939,637	16,726,000
1981	2,655,869	9,362,000
1982	4,845,754	7,318,000
1983	1,846,583	4,289,000
1984	4,025,164	10,228,000
1985	2,766,941	3,607,000
1986	3,383,518	10,356,000
1987	2,331,221	3,898,000
1988	3,614,253	12,207,000
1989	10,668,567	182,000
1990	5,412,594	4,569,000
1991	3,175,610	14,136,000
1992	3,093,014	2,415,000
1993	3,832,171	20,577,000
1994	3,290,790	5,917,000
1995	9,730,506	37,636,000
1996	2,920,544	2,458,000
1997	2,420,679	9,096,000
1998	6,193,925	15,225,000
1999	3,460,986	7,459,000
2000	3,813,914	6,139,000
2001	2,984,844	6,042,000
2002	7,494,477	11,308,000
2003	4,088,412	8,360,000
2004	8,074,963	17,171,100
2005	3,688,158	16,061,700
2006	5,086,372	26,636,025
2007	2,208,678	16,307,004
2008	2,924,708	6,018,025
2009	4,707,894	18,077,949
2010	3,378,483	5,473,019
2011	2,506,714	14,221,904
2012	5,111,049	13,807,487
2013	4,450,711	16,229,772
2014	2,733,282	4,743,500
2015	5,614,531	27,284,122
2016	1,699,281	
2017	5,079,016	
2018	4,874,342	

Appendix P3.–Kodiak Archipelago pink salmon indexed escapement and escapement goal ranges, 1978–2018.

System: **Kodiak Archipelago**

Species: **Pink salmon**



APPENDIX Q: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR KODIAK MAINLAND PINK SALMON

Appendix Q1.–Description of stock and escapement goal for Kodiak Mainland pink salmon.

System: Kodiak Mainland
Species: Pink salmon
Description of stock and escapement goals

Regulatory area:	Kodiak Management Area – Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine
Current escapement goal:	SEG: 250,000–1,000,000 (2011)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Aerial Survey, 1968–2018
Data summary:	
Data quality:	Fair
Data type:	Fixed-wing aerial surveys from 1968 to 2018 with peak counts used as an index of spawning escapement. 16 streams are flown annually with peak counts from streams summed annually to produce a single index for the district.
Data contrast:	Peak aerial surveys, all years 1978–2018: 17.7
Methodology:	Ricker Model
Autocorrelation:	Present (lag-1), but borderline significant
Comments:	An expansion factor of two (2) was used on pink salmon escapement aerial survey data and coupled with harvest estimates. The resultant Ricker model was significant ($P = 6.3 \times 10^{-5}$). The resultant S_{MSY} estimate was corrected for expanded aerial survey information.

Appendix Q2.–Kodiak Mainland pink salmon aggregate escapement and harvest estimates, 1978–2018.

System: Kodiak Mainland

Species: Pink salmon

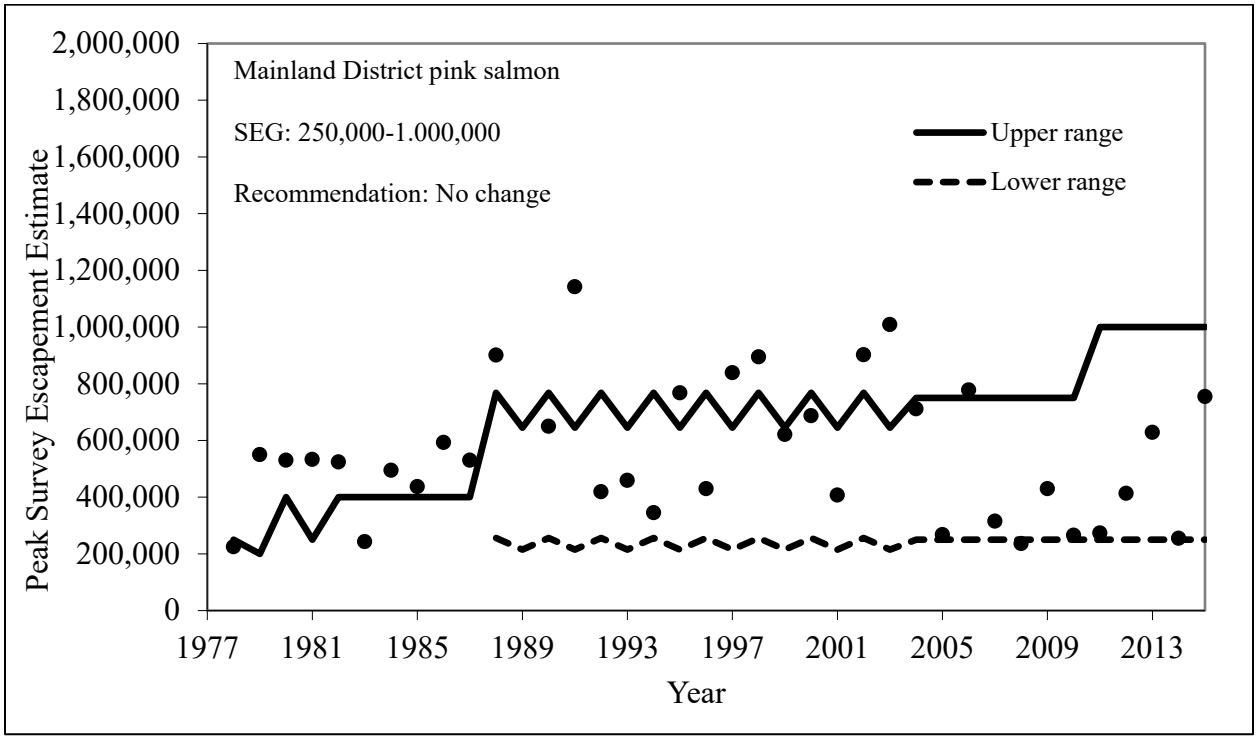
Data available for analysis of escapement goals

Year	Peak survey	Harvest
1978	225,000	237,000
1979	550,000	623,000
1980	530,000	287,000
1981	533,000	271,000
1982	524,000	582,000
1983	243,000	184,000
1984	495,000	345,000
1985	437,000	261,000
1986	593,000	806,000
1987	530,000	226,000
1988	901,000	1,748,000
1989	3,977,000	0
1990	650,000	876,000
1991	1,142,000	1,166,000
1992	419,000	190,000
1993	459,000	1,366,000
1994	345,000	194,000
1995	768,000	696,000
1996	430,000	50,000
1997	839,000	728,000
1998	895,000	559,000
1999	621,000	384,000
2000	687,000	117,000
2001	407,000	398,000
2002	902,000	323,000
2003	1,009,000	173,000
2004	711,555	283,600
2005	268,050	473,812
2006	778,200	899,213
2007	315,300	617,342
2008	236,500	652,238
2009	430,100	631,800
2010	265,650	141,308
2011	273,500	249,245
2012	413,325	97,687
2013	620,680	204,611
2014	254,650	154,841
2015	754,600	787,280
2016	65,305	
2017	1,010,100	
2018	280,400	

Appendix Q3.–Kodiak Mainland pink salmon indexed escapement and escapement goals ranges, 1978–2018.

System: **Kodiak Mainland**

Species: **Pink salmon**



APPENDIX R: SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR KODIAK CHUM SALMON

Appendix R1.–Description of stock and escapement goal for Kodiak chum salmon.

System: **Kodiak Archipelago**

Species: **Chum salmon**

Description of stock and escapement goals

Regulatory area:	Kodiak Management Area–Westward Region
Management division:	Commercial Fisheries
Primary fishery:	Commercial purse seine
Current escapement goal:	Lower-bound SEG: 101,000 (2017)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Aerial Survey, 1967–2018
Data summary:	
Data quality:	Fair
Data type:	Fixed-wing aerial surveys available from 1967 to 2018. Data used in analysis represents indicator streams and years with a complete survey dataset from 1978 to present. No stock-specific harvest information is available.
Data contrast:	Aerial surveys, 1978–2018: 7.2
Methodology:	15th to 75th percentile (Bue and Hasbrouck unpublished)
Criteria for SEG:	High contrast, low exploitation
Comments:	Seventeen area-wide systems were chosen to represent an indexed escapement goal: Uganik River 253-122, Terror River 253-331, Uyak River 254-202, Zachar River 254-301, Spiridon River 254-401, Sturgeon River 256-401, Deadman River 257-502, Sulua Creek 257-603, N. Kiliuda Creek 258-206, W. Kiliuda Creek 258-207, Midway Creek 258-521, Barling Creek 258-522, American River 259-231, Olds River 259-242, Kizhuyak River 259-365, Saltery River 259-415, and Eagle Harbor 259-424.

Appendix R2.–Kodiak Archipelago chum salmon aggregate escapement indices, 1967–2018.

System: Kodiak Archipelago

Species: Chum salmon

Data available for analysis of escapement goals

Year	Kodiak Archipelago Index
1967	
1968	
1969	
1970	
1971	
1972	
1973	
1974	
1975	
1976	
1977	
1978	134,000
1979	
1980	
1981	247,500
1982	305,300
1983	344,420
1984	233,400
1985	
1986	
1987	
1988	
1989	424,100
1990	164,895
1991	388,653
1992	
1993	
1994	106,300
1995	181,303
1996	115,635
1997	97,600
1998	
1999	
2000	223,531
2001	149,800
2002	143,100
2003	
2004	
2005	
2006	
2007	85,050
2008	59,080
2009	105,750
2010	119,000
2011	143,550
2012	94,900
2013	
2014	84,700
2015	171,800
2016	89,700
2017	184,500
2018	115,100

Appendix R3.–Kodiak Archipelago chum salmon peak aerial survey counts, in selected indicator streams, 1978–2018.

System: Kodiak Archipelago

Species: Chum salmon

Year	253-122 Uganik River	253-331 Terror River	254-202 Uyak River	254-301 Zachar River	254-401 Spiridon River	256-401 Sturgeon River	257-502 Deadman River	257-603 Sulua Chum Creek	258-206 N. Kiliuda Creek	258-207 W. Kiliuda Creek	258-521 Midway Creek	258-522 Barling Creek	259-231 American River	259-242 Sid Olds	259-365 Kizhuyak River	259-415 Saltery River	259-424 Eagle Harbor	**Total Index**
1978	4,000	3,000	8,000	6,000	8,000	57,300	10,000	6,000	3,500	3,000	2,700	1,500	4,000	6,000	4,000	5,000	2,000	134,000
1979	2,000	5,000	[redacted]	2,500	21,000	97,000	2,000	2,900	300	11,000	1,000	3,000	5,000	6,000	31,000	3,200	6,900	–
1980	[redacted]			10,000	11,000	44,000	75	24,000	3,500	20,000	20,000	2,000	4,000	8,500	21,000	1,200	[redacted]	–
1981	8,000	5,000	1,500	18,000	7,000	72,000	15,000	9,000	4,400	32,000	20,000	3,000	2,500	500	35,000	7,000	7,600	247,500
1982	30,000	12,900	3,000	40,000	38,000	55,000	8,000	8,000	7,200	8,200	10,000	12,000	3,000	42,000	12,000	8,000	8,000	305,300
1983	25,000	10,050	40,000	20,000	40,000	74,000	40,000	31,000	3,000	2,200	12,000	9,000	10,000	11,000	3,170	5,000	9,000	344,420
1984	10,000	10,000	10,000	12,000	21,000	80,000	10,000	12,000	4,000	9,000	5,000	5,000	8,400	15,000	9,000	10,000	3,000	233,400
1985	5,000	3,000	10,000	24,600	[redacted]	1,500	10,000	20,000	13,000	11,300	16,000	3,000	10,400	8,000	7,000	6,000	7,000	–
1986	250	10,000	[redacted]	15,600	67,000	92,000	1,100	600	1,800	1,400	12,000	5,000	4,000	8,000	55,000	189	4,500	–
1987	15,000	15,000	10,000	5,000	[redacted]	12,200	16,000	8,700	2,400	3,160	1,100	5,800	800	4,500	8,500	250	12,000	–
1988	20,000	15,000	25,000	75,000	15,000	53,200	10,000	50	5,000	20,000	[redacted]	500	8,000	15,000	27,500	[redacted]	500	–
1989	53,000	23,000	57,600	80,000	32,000	5,000	22,000	5,500	1,800	34,000	2,300	10,000	11,000	1,400	55,500	15,000	15,000	424,100
1990	8,000	5,000	6,000	12,800	5,000	90,000	1,500	1,800	25	4,400	7,350	6,350	8,000	4,000	2,300	270	2,100	164,895
1991	11,823	2,200	60,000	11,400	22,100	47,500	52,500	20,250	200	19,500	63,900	21,800	12,000	10,000	1,480	17,000	15,000	388,653
1992	30,000	15,000	15,000	30,000	16,900	41,000	8,000	3,800	[redacted]	1,500	1,000	5,000	4,500	3,000	6,400	250	4,100	–
1993	10,000	6,100	2,500	20,000	5,000	1,300	[redacted]	4,500	5,000	3,500	3,000	2,800	2,000	7,000	500	3,000	11,000	–
1994	10,000	5,000	8,000	12,800	10,300	10,000	7,500	9,000	3,500	2,000	1,750	5,500	3,250	5,000	4,200	500	8,000	106,300
1995	14,000	16,000	13,000	23,000	22,000	32,000	17,000	20,000	200	1,500	3,500	500	8,000	1,500	8,000	103	1,000	181,303
1996	35,000	15,000	3,100	15,000	8,000	6,820	5,100	2,500	10	900	5,600	7,500	2,500	100	3,900	5	4,600	115,635
1997	20,000	15,000	3,500	20,000	3,400	3,200	3,000	800	500	500	3,500	2,500	6,000	1,500	5,000	6,000	3,200	97,600

-continued-

Appendix R3.–Page 2 of 2.

Year	253-122 Uganik River	253-331 Terror River	254-202 Uyak River	254-301 Zachar River	254-401 Spiridon River	256-401 Sturgeon River	257-502 Deadman River	257-603 Sulua Chum Creek	258-206 N. Kiliuda Creek	258-207 W. Kiliuda Creek	258-521 Midway Creek	258-522 Barling Creek	259-231 American River	259-242 Sid Olds	259-365 Kizhuyak River	259-415 Saltery River	259-424 Eagle Harbor	**Total Index**
1998		5,000	5,000	10,000	3,650	24,093	1,000	4,000		100	3,000	5,200	800	1,000	1,800	1,500	1,600	–
1999	7,000	15,000	2,000	20,000	8,500	71,610		7,500	6,500	5,200	7,700	12,600		2,000	300	2,500	7,100	–
2000	40,000	10,000	15,000	28,000	16,500	14,331	33,800	4,800	3,800	11,000	3,000	9,000	1,500	1,500	10,800	2,500	18,000	223,531
2001	18,000	15,000	17,650	20,700	3,000	500	10,500	5,000	50	400	4,500	5,000	8,000	5,500	23,900	1,000	11,100	149,800
2002	8,000	2,000	10,000	11,500	6,500	55,700	2,000	700	6,000	9,000	5,600	6,000	5,000	2,000	1,400	6,900	4,800	143,100
2003	6,000	13,600	3,000	9,200	4,500	12,900	8,300	24,000	3,000	5,100	15,000	5,600	500	1,700	23,000		2,600	–
2004	4,000	15,600	5,000	2,100		10,100	5,000		20,000	5,000	8,000	10,000			4,000		250	–
2005	5,000	1,700	8,000	5,600	13,400	2,000	6,700	35,000		15,000		1,000		7,000	1,500	6,000	6,000	–
2006		6,600	2,600	17,000	5,000	14,500			60,000	35,000	12,000	27,000	3,300	5,500	10,100	14,000	12,000	–
2007	1,800	8,400	4,500	5,000	7,900	300	5,900	6,600	1,400	4,900	3,400	14,600	8,200	8,550	200	1,500	1,900	85,050
2008	9,000	4,500	6,000	2,500	11,200	4,000	2,500	1,400	500	200	2,800	6,900	700	980	1,000	700	4,200	59,080
2009	1,600	4,800	4,500	9,400	23,500	750	14,000	6,700	3,200	3,500	4,000	3,500	5,400	3,100	12,400	600	4,800	105,750
2010	9,200	3,600	2,000	2,200	10,700	8,400	4,200	5,000	2,200	4,200	7,500	29,000	4,300	6,200	8,700	2,400	9,200	119,000
2011	15,000	3,700	9,850	34,300	8,300	8,400	8,200	6,300	7,000	6,900	9,600	4,500	4,800	2,300	3,600	2,500	8,300	143,550
2012	5,100	7,000	8,800	3,600	5,100	9,100	9,600	700	3,400	9,700	6,000	8,000	3,500	3,200	7,200	1,900	3,000	94,900
2013	3,800	5,000	3,800	16,600	300		8,800	10,500	8,000	10,600	17,000	19,600	400	2,300	6,600	3,900	1,900	–
2014	1,600	7,000	8,500	8,500	6,600	1,200	12,100	3,000	2,500	6,000	7,500	8,500	400	1,900	3,800	1,600	4,000	84,700
2015	10,000	10,800	11,800	28,000	15,000	1,100	19,000	9,600	4,500	2,500	13,400	8,000	10,500	3,200	5,300	6,200	12,900	171,800
2016	8,300	5,100	4,400	9,000	5,800	5,900	8,000	2,300	4,300	5,200	15,400	5,800	600	1,300	4,600	2,800	900	89,700
2017	13,000	10,000	18,000	17,800	8,300	15,000	22,000	15,000	10,000	11,000	13,500	8,500	5,200	3,000	4,000	6,000	4,200	184,500
2018	8,500	10,000	7,000	15,000	6,300	10,000	15,000	6,000	3,400	8,000	3,600	10,000	1,000	1,600	100	2,200	7,400	115,100

Note: Systems not successfully surveyed in a survey year are blacked out. If 1 or more system in a survey year was not successfully surveyed, the Total Index was not calculated and is noted with an en dash.

Appendix R4.–Kodiak Archipelago chum salmon escapement and escapement goals ranges, 1967–2018.

System: **Kodiak Archipelago**

Species: **Chum salmon**