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Review of Escapement Goals in 2010 for Salmon Stocks in the Kodiak Management Area, Alaska

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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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ABSTRACT

In May 2010, an interdivisional team of staff from the Alaska Department of Fish and Game reviewed existing Pacific salmon *Oncorhynchus* spp. escapement goals in the Kodiak Management Area (KMA) for the purpose of making recommendations to the directors of the divisions of Commercial and Sport Fisheries. The KMA salmon escapement goals had previously been reviewed in 2007. In 2010, the team reviewed recent data (2007 through 2009) on all 23 escapement goals in existence to determine whether influential new information existed, then further analyzed 18 of these goals. The staff team recommended changing 12 goals, two of which would be split into two new goals each. No goals were eliminated, and none were added for systems currently without escapement goals.

The staff team recommended changes to 5 of the 13 escapement goals for sockeye salmon *O. nerka*. The Ayakulik River sockeye salmon sustainable escapement goal (SEG) of 200,000 to 500,000 fish would be split into two goals, an early-run SEG of 140,000 to 280,000 fish and a late-run SEG of 60,000 to 120,000 fish. The Buskin River SEG of 8,000 to 13,000 fish would change to a biological escapement goal (BEG) of 5,000 to 8,000 fish. The Upper Station early-run SEG of 30,000 to 65,000 fish would change to a BEG of 43,000 to 93,000 fish. The Saltery River BEG of 15,000 to 30,000 fish would change to a BEG of 15,000 to 35,000 fish. The Pasagshak River SEG of 3,000 to 12,000 fish would change to a lower-bound SEG of 3,000 fish. As a result of the staff recommendations, escapement goals for sockeye salmon in the KMA in 2011 would consist of eight BEGS, three SEGs, and three lower-bound SEGs.

The staff team recommended changes to another seven salmon stocks, as follows: reduce the Ayakulik River Chinook salmon *O. tshawytscha* BEG from 4,800 to 9,600 fish to 4,000 to 7,000 fish; reduce the Karluk River Chinook salmon BEG from 3,600 to 7,300 fish to 3,000 to 6,000 fish; change the Mainland District pink salmon *O. gorbuscha* SEG from 250,000 to 750,000 fish to 250,000 to 1,000,000 fish; split the Kodiak Archipelago pink salmon SEG into an even-year SEG of 3,000,000 to 7,000,000 million fish and an odd-year SEG of 2,000,000 to 5,000,000 million fish; and change the SEGs for coho salmon *O. kisutch* from the American, Olds, and Pasagshak rivers to lower-bound SEGs of 400, 1,000, and 1,200 fish, respectively.

In total, these staff recommendations to the directors of the divisions of Commercial and Sport Fisheries result in 25 escapement goals for the KMA in 2011: 14 for sockeye salmon, 2 for Chinook salmon, 4 for coho salmon, 3 for pink salmon, and 2 for chum salmon *O. keta*.

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

INTRODUCTION

This report documents the 2010 review of salmon escapement goals in the Kodiak Management Area (KMA). Recommendations from this review are made to the directors of Commercial and Sport Fisheries of the Alaska Department of Fish and Game (department), and are intended to take effect for salmon stocks returning in 2011. Salmon escapement goals in the KMA were last reviewed in 2007 (Honnold et al. 2007).

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

available. Escapement goals should, therefore, be evaluated on a regular basis to assess the need for revision.

REVIEW PROCESS, DEFINITIONS, AND INITIAL ASSESSMENT

The department adopted a Salmon Escapement Goal Policy in 1992 to help define and instruct the development of escapement goals for salmon stocks in Alaska (e.g., Fried 1994). In 2000 and 2001, the Alaska Board of Fisheries (board) adopted the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP; 5 AAC 39.222) and the *Policy for Statewide Salmon Escapement Goals* (EGP; 5 AAC 39.223) into regulation to ensure that the state's salmon stocks would be conserved, managed, and developed using the sustained yield principle. Section (b)(2) of the EGP states that the board recognizes the responsibility of the department to:

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

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

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

"(3) "biological escapement goal" or "(BEG)" means the escapement that provides the greatest potential for maximum sustained yield; BEG will be the primary management objective for the escapement unless an optimal escapement or inriver run goal has been adopted; BEG will be developed from the best available biological information, and should be scientifically defensible on the basis of available biological information; BEG will be determined by the department and will be expressed as a range based on factors such as salmon stock productivity and data uncertainty; the department will seek to maintain evenly distributed salmon escapements within the bounds of a BEG;" and

"(36) "sustainable escapement goal" or "(SEG)" means a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated due to the absence of a stock specific catch estimate; the SEG is the primary management objective for the escapement, unless an optimal escapement or inriver run goal has been adopted by the board, and will be developed from the best available biological information; the SEG will be determined by the department and will be stated as a range that takes into account data uncertainty; the department will seek to maintain escapements within the bounds of the SEG."

In May 2010, a salmon escapement goal interdivisional review team was formed to evaluate the existing KMA salmon escapement goals. Team members from the Division of Commercial Fisheries were Matt Nemeth, Mark Witteveen, Jeff Wadle, Heather Finkle, M. Birch Foster, Mary Beth Loewen, Eric Volk, Andrew Munro, Doug Eggers, David Barnard, Rob Baer, and James Jackson. Members from the Division of Sport Fish were Jack Erickson, Steve Fleischman, Jim Hasbrouck, Bob Clark, Donn Tracy, Suzanne Schmidt, David Evans, and Matt Miller. The purpose of the team was to (1) determine the appropriate goal type (BEG or SEG) for each KMA salmon stock with an existing goal, based on the quality and quantity of available data, (2) determine the most appropriate methods to evaluate the escapement goal ranges, (3) estimate an appropriate escapement goal for each stock and compare these estimates with the current goal,

(4) determine if a goal could be developed for any stocks or stock-aggregates that currently have no goal, and (5) develop staff recommendations (change, retain, or eliminate) for each goal evaluated and present these recommendations to the directors of Commercial Fisheries and Sport Fish divisions for approval. Formal meetings to discuss and develop such recommendations were held on May 11 and August 25, 2010. The team communicated on a regular basis by telephone and email, and delivered a memorandum of progress to the directors of Commercial Fisheries and Sport Fish divisions on September 28, 2010. This process and timeline was concurrent with a review of escapement goals in the Chignik Management Area (Nemeth et al. 2010).

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

STUDY AREA

The KMA comprises the waters of the western Gulf of Alaska (GOA) 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 from Shuyak Island south to Tugidak Island, distance of approximately 240 km (150 miles). 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. Chirikof Island, located approximately 64 km (40 miles) south southwest of Tugidak Island, is also included in the KMA (Figure 1).

The KMA is divided into seven commercial fishing districts: Afognak, Northwest Kodiak, Southwest Kodiak, Alitak, Eastside Kodiak, Northeast Kodiak, and Mainland districts (Jackson and Dinnocenzo 2010; Figure 1). 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 and sport 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 Dinnocenzo 2010). 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.

BACKGROUND AND METHODS

STOCK STATUS ASSESSMENT: ESCAPEMENT AND HARVEST DATA COLLECTION

The majority of sockeye salmon and all Chinook salmon escapement counts were obtained through the use of fish weirs (Table 1; Tiernan and Caldentey 2010). The remaining sockeye salmon systems were monitored by aerial observation using small fixed-wing aircraft. Most pink and salmon escapement estimates were collected from fixed-wing aircraft surveys of bays and streams. Foot surveys were also conducted on a few streams, primarily for coho salmon in rivers along the Kodiak road system. Aerial and foot survey data were considered an index of escapement. A "peak indexed escapement" estimate was calculated postseason to provide information about the relative level of escapement. Commercial catch data were compiled from department fish ticket information. Estimates of sport harvest were obtained from the Statewide Harvest Survey conducted annually by the Division of Sport Fish (e.g., Jennings et al. 2010a).

Since the last escapement goal review in 2007, escapements to the KMA were above the lower range (or bound) of existing goals for 19 of 23 stocks in 2007, 13 of 23 stocks in 2008, and 15 of 23 stocks in 2009, for a total of 47 of the 69 (68%) of the potential stock years. In this report, escapement estimates of Chinook salmon account for removals of fish harvested in inriver sport fisheries (i.e., these harvested fish are not counted towards the spawning escapement).

ESCAPEMENT GOAL DETERMINATION

Escapement, harvest, and age data associated with each stock or combination of stocks were compiled from research reports, management reports, and unpublished historical databases. Limnological and other habitat data were compiled for each system when available. The team evaluated the type, quality, and amount of data for each stock according to criteria described in Bue and Hasbrouck[1] (*unpublished*). This evaluation was used to initially determine the appropriate type of escapement goal to apply to each stock, as defined in the SSFP and EGP. If a sufficient time series of escapement and total return estimates were available, escapement contrast was sufficiently large, and estimates were sufficiently accurate and precise, then the data were considered sufficient to attempt to develop a BEG for the stock and estimate the escapement level with the greatest potential to provide maximum sustained yield, S_{MSY} (Hilborn and Walters 1992; Chinook Technical Committee 1999; Quinn and Deriso 1999). If return estimates were not available because harvest and age were not consistently measured, then the data were considered insufficient for estimating S_{MSY} and a BEG, and were instead evaluated for an SEG using other methods.

Biological Escapement Goal

In Alaska, most salmon BEGs are developed using Ricker (1954) spawner-recruit models (Munro and Volk 2010). As defined in the SSFP (5AAC 39.222), BEG ranges are estimates of the number of spawners that provide the greatest potential for maximum sustained yield (S_{MSY}). For this review, ranges surrounding S_{MSY} were calculated as the escapement estimates that

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

produced yields of at least 90% of MSY (CTC 1999; Hilborn and Walters 1992). The carrying capacity was estimated by the Ricker model as the escapement level which will provide an equivalent level of return or replacement (Quinn and Deriso 1999). Carrying capacity is defined as S_{EQ} and is the expected annual abundance of spawners when the stock has not been exploited. Estimates of S_{MSY} and S_{EQ} were not used if the model fit the data poorly or if model assumptions were violated. Hilborn and Walters (1992), Quinn and Deriso (1999), and the Chinook Technical Committee (CTC; 1999) provide good descriptions of the Ricker model and diagnostics to assess model fit. All Ricker models assumed a multiplicative error structure and were tested for residual autocorrelation, which was not corrected for if present (in non-Bayesian models) based on the recommendations of Korman et al. (1995) for Alaskan sockeye salmon stocks. When auxiliary data were available (e.g., limnology and/or smolt abundance, age, and size) they were summarized and biological trends were compared to estimates of adult production.

Sustainable Escapement Goal

Sustainable escapement goals (SEGs) were developed using any of several methods, depending on the system, species, and type of data available. For this review, most SEGs were determined using the percentile method (Bue and Hasbrouck *unpublished*), risk analysis (Bernard et al. 2009), or spawner-recruit model (Ricker 1954; described above). Other methods used were the yield analysis (Hilborn and Walters 1992), euphotic volume model (Koenings and Kyle 1997), and zooplankton forage model (Koenings and Kyle 1997). These latter two habitat-based models assess the likely number of fish that can be supported given available habitat or food. Escapement goals were generally not based on results from these models, but results were instead used as a secondary, alternative analysis that was less dependent on 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 followed the methods of Bue and Hasbrouck (*unpublished*), whereby the contrast of the escapement data (i.e., ratio of the highest observed escapement to the lowest observed escapement) and the exploitation rate of the stock were used to select the percentiles of observed annual escapements to be used for estimating the SEG. Low contrast (<4) implies that stock productivity is known for only a limited range of escapements. According to this approach, percentiles of the total range of observed annual escapements that are used to estimate an SEG for a stock with low contrast should be relatively wide, in an attempt to improve future knowledge of stock productivity. In cases where data contrast was less than 4 and the exploitation rate was low, the lower end of the SEG range was the 15^{th} percentile of the escapement data and the upper end of the range was the maximum observed escapement estimate. Alternately, in cases where contrast was larger, the percentiles of observed annual escapements used to estimate an SEG were narrowed. For stocks with high contrast and at least moderate exploitation, the lower end of the SEG range was increased from the 15^{th} to the 25^{th} percentile as a precautionary measure for stock protection. The percentiles used at different levels of contrast were:

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

The risk analysis (Bernard et al. 2009) was used to establish an SEG, in the form of a precautionary reference point (PRP), from a time series of observed escapement estimates using probability distributions. This method is based on estimating the risk of management error and is particularly appropriate in situations where a 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, that is the probability of taking action (e.g., closing a fishery to protect the stock) for three 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).

The yield analysis was similar to that used by Hilborn and Walters (1992), and entailed applying a tabular approach to examine escapement versus yield relationships. Escapements were arranged into 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 (EV) model followed the methods of Koenings and Kyle (1997) and 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 EV 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 EV model, uses the premise that the availability of forage could impact survival of juvenile fish and subsequent adult production. Adult production was calculated using species fecundity and marine survival rates. The zooplankton model assumes zooplankton is the only available forage.

CHINOOK SALMON

Karluk and Ayakulik Rivers

The Karluk and Ayakulik rivers are both located on southwestern Kodiak Island, and support the two largest Chinook salmon stocks in the KMA. The Karluk River drains Karluk Lake, then flows into the Shelikof Strait in the area designated as Inner Karluk Section of Southwest Kodiak District (Dinnocenzo et al. 2007; Figures 1 and 2). The Ayakulik River drains Red Lake, then flows into Shelikof Strait in the area designated as Inner Ayakulik Section of Southwest Kodiak District (Dinnocenzo et al. 2007; Figures 1 and 2).

Biological escapement goals have been developed for Chinook salmon from the Karluk and Ayakulik rivers. Chinook salmon returning to each system are counted using weirs (Tiernan and Caldenty 2010). Annual Chinook salmon escapements for Karluk and Ayakulik Rivers were estimated by subtracting estimates of recreational and subsistence harvest from the inriver run counted at a weir on both systems (Schwarz et al. 2002, Tracy et al. *in prep*). Weir counts were available from 1976 to 2009 for the Karluk River. Although weir counts at the Ayakulik River were available from 1972 to 2009, 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.

Sport harvests for Chinook salmon in both drainages were estimated by the Statewide Harvest Survey. 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, 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. Similarly, all Chinook salmon in the Inner (256-15) and Outer (256-20) Ayakulik sections from June 1 through July 15 were assumed to be of Ayakulik River origin. Harvests occurring from June 1 through July 15 were used to most closely match traditional run timing of both 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 weirs operated on both drainages to estimate age composition of the run. Age composition of the commercial harvest was assumed the same as that observed at the weir. Age data were only available from 1993 to 2009. Age compositions of runs prior to 1993 were estimated using the average age composition of runs in known years.

Brood tables were developed for Karluk River returns beginning in 1976 and for Ayakulik River returns beginning in 1977. A brood table was constructed from returns by year and age composition. Total run by age was estimated by multiplying total run and age composition of Chinook salmon sampled at the weirs. Age-specific returns were summed for each brood year to estimate total return by brood year. Return-per-spawner was then estimated as the total return from each brood year divided by the escapement for that brood year.

Escapement Goal Background and Previous Review

In 1996, a Karluk River Chinook salmon SEG of 4,500 to 8,000 fish was established based on average historical escapements providing harvestable surpluses (Nelson and Lloyd 2001). During the 2001–2002 Board of Fisheries meeting cycle, a BEG of 3,600 to 7,300 spawners was

established based on a spawner-recruit analysis (Hasbrouck and Clark[2] *unpublished*). The BEG was reevaluated 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 three years of data would not substantially change the results of previous analyses (Honnold et al. 2007).

An initial Ayakulik River Chinook salmon SEG of 6,500 to 10,000 fish was established based on average historical escapements providing harvestable surpluses (Nelson and Lloyd 2001). During the 2001–2002 Board of Fisheries meeting cycle, a BEG of 4,800 to 9,600 fish was established based on a spawner-recruit analysis (Hasbrouck and Clark 2002). The BEG was reevaluated 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 the most recent three years of data would not substantially change the results of previous analyses (Honnold et al. 2007).

2010 Review

The most recent escapements from 2007 through 2009 and brood year data from 2000 through 2003 were added to the existing datasets of Chinook salmon from the Karluk (Appendices A2 and A4) and Ayakulik (Appendices B2 and B4) rivers. Datasets were sufficient to conduct a spawner-recruit analysis (Hilborn and Walters 1992; CTC 1999; Quinn and Deriso 1999) and estimate S_{MSY} (Appendices A4 and B4), thus keeping the goals as BEGs. Bayesian statistical methods were used to fit a Ricker (1954) spawner-recruit model to the data. The model included an AR(1) term (Noakes et al. 1987; Pankratz 1991) to incorporate autocorrelation in adult return data. Prior information about Chinook salmon productivity and density dependence was incorporated using the watershed model of Liermann et al. (2010).

SOCKEYE SALMON

The team added escapement data from 2007 through 2009 to the existing data sets for sockeye salmon stocks in the KMA (Table 1). All 13 stocks with escapement goals in the KMA were reevaluated (Table 1). The team identified no other stocks necessitating new goals.

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 (Dinnocenzo et al. 2007; Figures 1 and 2).

Escapement Goal Background and Previous Review

The first published escapement goal for Afognak Lake was developed in 1988 and set at 20,000 to 40,000 sockeye salmon (Nelson and Lloyd 2001). Escapement goal reviews of this system were conducted in 2004 and 2007. All available stock assessment data were analyzed using a spawner-recruit analysis, the percentile method, euphotic volume analysis, and smolt biomass as a function of zooplankton (Nelson et al. 2005). The 2004 review resulted in changing the

[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, Report to the Board of Fisheries 2002, Anchorage.

Afognak Lake SEG to a BEG of 20,000 to 50,000 sockeye salmon. The 2007 review indicated that no changes were warranted to the Afognak Lake BEG (Honnold et al. 2007).

2010 Review

Weir counts were available from 1921 to 1933 and from 1978 to 2009 (Appendices C1 through C3). Aerial surveys were conducted from 1966 through 1977 (except in 1968 and 1972). Stock-specific harvest estimates for Afognak Lake sockeye salmon were estimated by assuming the majority of the Afognak Lake commercial harvest was from the Southeast Afognak Section (252-34) and combined with estimates of subsistence and sport harvest within Afognak Bay.

A spawner-recruit relationship was estimated using the 1982 through 2002 brood years (Appendix C4). Spawning stock and recruitment data were analyzed using a Ricker spawner-recruit model (Ricker 1954) with a multiplicative error structure (Quinn and Deriso 1999). If a Ricker spawner-recruit model was significant, then S_{MSY} was estimated, along with the range of escapements that would produce 90% to 100% of MSY. Residuals were examined for autocorrelation. Afognak Lake limnological data from 2000 to 2009 were also assessed using euphotic volume and zooplankton biomass 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; Figure 1). 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 SEG 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, Ayakulik River sockeye salmon 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 SEG to a range of 200,000 to 500,000 fish (Nelson et al. 2005). With three 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, there was consensus to not reevaluate these goals in 2007 and there was no change to the Ayakulik River sockeye salmon SEG.

2010 Review

Weir counts were available intermittently from 1929 to 1961 and annually from 1962 to 2009 (Appendices D1–D3). Stock-specific harvest estimates were available for the Ayakulik sockeye salmon fisheries from 1970 to 2009. Portions of the Inner and Outer Ayakulik sections (256-10 to 256-20) and the Halibut Bay Section (256-25 to 256-30) commercial sockeye salmon harvest are attributed to the Ayakulik River. In the absence of unique age markers in the escapement, harvest allocations were estimated using historical proportions from tagging and migration studies subject to run timing (Tyler et al. 1981).

A spawner-recruit relationship was estimated using brood year data from 1968 through 2002 (Appendix D4). Spawning stock and recruitment data were analyzed using a Ricker spawner-

recruit model (Ricker 1954) with a multiplicative error structure (Quinn and Deriso 1999). If the Ricker spawner-recruit model was significant, then S_{MSY} was estimated along with the range of escapements that would produce 90% to 100% of MSY. Residuals were examined for autocorrelation.

Red Lake zooplankton and light penetration data from 1990 to 1996 and 2009 were used to assess optimal spawning levels via zooplankton biomass and euphotic volume models.

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 1). Annual escapement of sockeye salmon to the Buskin River watershed has been counted at a weir since 1985 (Schmidt and Evans 2010). Until 1990, the Buskin River weir was located about 2.5 km upstream of the river mouth. In 1990, the weir was relocated to the outlet of Buskin Lake due to numerous washouts caused by high water conditions. 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 (Tiernan and Caldenty 2010).

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 (J. Shaker, Alaska Department of Fish and Game, Kodiak, personal communication), and likely account for most of the annual subsistence harvest.

Stock-specific harvest estimates were available for the Buskin River sockeye salmon fisheries from 1990 through 2009. Sport harvests of Buskin River sockeye salmon are estimated by the Statewide Harvest Survey, while 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 (Schmidt and Evans 2010). 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.

A brood table was developed beginning with 1990 returns. Total run was estimated by summing escapement and harvest by age class from the sport, subsistence, and commercial fisheries each year. Age specific returns were summed for each brood year to estimate total return by brood year. Return-per-spawner was then estimated as the total return of each brood year divided by the escapement for that brood year.

Escapement Goal Background and Previous Review

A Buskin Lake sockeye salmon SEG of 8,000 to 13,000 fish was developed in 1996, based on historical weir counts (Nelson and Lloyd 2001). The SEG was reevaluated 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 range (Nelson et al. 2005). The SEG was reevaluated again in 2007 and left unchanged (Honnold et al. 2007).

2010 Review

The most recent three year escapements (2007 through 2009), including spawner-recruit data, were available for Buskin River sockeye salmon. A Bayesian spawner-recruitment analysis was conducted by Schmidt and Evan (2010) for data collected from 1990 through 2009. This analysis estimated the sockeye salmon spawning escapement for S_{MSY} to be about 6,500 fish. A traditional linear regression analysis yielded similar results.

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 (Dinnocenzo et al. 2007; Wadle 2004). Sockeye salmon were introduced into the previously barren lake from 1951 through 1971 (Blackett 1979). The major donor stocks for Frazer 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 2). 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 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 (Brennan 1998). In 1981, the Frazer Lake escapement goal range was increased 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 and 2007. 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 the department and the new BEG range went into effect in 2005. The 2007 review resulted in changing the BEG to a range of 75,000 to 170,000 fish (Honnold et al. 2007), based on a spawner-recruit analysis.

2010 Review

Sockeye salmon escapements into Frazer Lake have been counted since 1956 (Appendices F1–F3). Stock-specific harvest estimates were available for the Frazer Lake sockeye salmon fisheries from 1974 to 2009.

Spawner-recruit relationships were estimated for the run by analyzing spawning stock and recruitment data from brood years 1966 to 2002 (Appendix F5) using a Ricker spawner-recruit model (Eggers 2001; Hilborn and Walters 1992; Ricker 1954) 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) was used. 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 examined for autocorrelation, temporal trends, and potential bias due to lake fertilization.

Limnology data from 1985 to 1997 and from 2001 to 2009 were analyzed using zooplankton biomass and euphotic volume models to assess optimal escapement levels.

Karluk Lake

Karluk Lake is located on the west side of Kodiak Island and supports the largest sockeye salmon run in the KMA (Dinnocenzo et al. 2007; Wadle 2004). 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 (Dinnocenzo et al. 2007). 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. Karluk Lake was fertilized from 1986 to 1990, and sockeye salmon fry were backstocked into the Upper Thumb River from 1979 to 1987.

Escapement Goal Background and Previous Review

Spawner-recruit analyses were used to develop BEGs of 150,000 to 250,000 fish for the early run and 400,000 to 550,000 fish for the late run of Karluk Lake sockeye salmon in 1992 (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 ranges for the Karluk Lake sockeye salmon stocks to 100,000 to 210,000 fish for the early run and to 170,000 to 380,000 fish for the late run (Nelson et al. 2005). After the next review by Honnold et al. in 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).

2010 Review

Sockeye salmon escapements from Karluk Lake were enumerated by weir counts from 1922 to 2009 (Appendices G1–G5). Escapement assigned to the early run was estimated by including all counts through July 21; escapement assigned to the late run was estimated by including all counts after July 21. Stock-specific harvest estimates were available for the Karluk Lake sockeye salmon fisheries from 1985 to 2009 (Appendices G2 and G3). An age marker analysis (Barrett and Nelson 1995) was used to estimate harvest attributable to Karluk Lake from the Uyak Bay (254-10, 20, 30, 40), Uganik Bay (253-11, 12, 13, 14), Viekoda Bay (253-31, 32, 33, 35), and Inner (255-10) and Outer (255-20) Karluk and Sturgeon (256-40) sections. Harvests through July 15 were attributed to the early run and after July 15 to the late run.

Limnology data from 1985 to 2009, excluding 1998, were analyzed using zooplankton biomass and euphotic volume models to assess optimal escapement levels. Karluk Lake bathymetry data collected in 2009 were applied to the limnology models where applicable.

Spawner-recruit relationships were estimated for the early run and late run using the 1981 through 2002 brood years (Appendices G6 and G7). Spawning stock and recruitment data were analyzed using a spawner-recruit model (Eggers 2001; Hilborn and Walters 1992; Ricker 1954) with a multiplicative error structure (Quinn and Deriso 1999). If a spawner-recruit model was significant, then S_{MSY} was estimated, along with the range of escapements that would produce

90% to 100% of MSY. Residuals were examined for autocorrelation, temporal trends, potential bias from lake fertilization and stocking, and interactions between the early and late runs.

Little River

The Little River is located on the northwest side of Kodiak Island. The river drains Little River Lake, then flows into Shelikof Strait in the Central Section of the Northwest Kodiak District (Jackson and Dinnocenzo 2010; Figures 1 and 2).

Escapement Goal Background and Previous Review

The first published escapement goal for Little River Lake was developed in 1988 and set at 15,000 to 25,000 sockeye salmon (Nelson and Lloyd 2001).

An escapement goal review of this system was conducted in 2004. All available stock assessment data were analyzed using the risk analysis and the percentile methods (Nelson et al. 2005). The review team ultimately recommended eliminating the Little River sockeye salmon SEG due to incomplete escapement data and the inability to actively manage escapements to this system. Both of these limitations were expected to remain in the future. Thus, the SEG was eliminated in 2005.

The 2007 escapement goal review team concluded that an escapement goal on Little River Lake sockeye salmon was warranted because the stock was located within a large commercial fishery section and thus potentially subject to high exploitation. After conducting a risk analysis using aerial survey and weir data, the team recommended a lower-bound SEG of 3,000 sockeye salmon that was then implemented in 2008 (Honnold et al. 2007).

2010 Review

Aerial surveys were used to estimate escapement into Little River from 1968 through 2009 (excluding 1973) and a weir was used from 2001 through 2003 (Appendices H1 and H2). Stock-specific harvest estimates for Little River drainage sockeye salmon were not available. The percentile approach was used, based on aerial survey data from 1968 through 2009.

Malina Creek

Malina Creek is located on the southwest side of Afognak Island in the Kodiak Archipelago. The creek drains two lakes (Upper and Lower Malina lakes), then flows westerly into Malina Bay, in the Southwest Afognak Section of the Afognak District. The system supports a small run of sockeye salmon. To increase the natural production of sockeye salmon into the system, Upper Malina Creek was fertilized from 1991 through 2001, and Lower Malina Creek was fertilized from 1996 through 2001. The lakes were stocked with juvenile sockeye fry from 1992 to 1999 (Schrof and Honnold 2003).

Escapement Goal Background and Previous Review

The first published escapement goal for Malina Creek was developed in 1988 and was set at 5,000 to 10,000 sockeye salmon based on historical aerial survey indexed escapements and, to a lesser extent, cursory spawning habitat evaluations (Nelson and Lloyd 2001). The SEG 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 goal range to an SEG of 1,000 to 10,000 fish; this recommendation was based on the results of the percentile algorithm and zooplankton biomass model. With three 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).

2010 Review

Limnology data were analyzed using zooplankton biomass and euphotic volume models to assess optimal escapement levels. Data from 2000 through 2009 were thought to best reflect recent lake conditions and were thus used for the analysis. The percentile algorithm was employed using available peak aerial survey data from 1977 to 2009 (Appendix I2).

Pasagshak River

The Pasagshak River, which drains Lake Rose Tead, is located on the Kodiak Island road system and supports one of the largest sockeye salmon subsistence fisheries for Kodiak Island residents. Currently, escapement is estimated using aerial and foot surveys of the spawning grounds.

Escapement Goal Background and Previous Review

Pasagshak River sockeye salmon escapements have been indexed by peak aerial surveys since 1968. No stock-specific harvest information is available for commercial fisheries, but annual catch data are available from Commercial Fisheries databases for nearby statistical areas (unpublished data). Since 1993, annual subsistence harvests of Pasagshak River sockeye salmon were estimated from returns of completed permits received by the Division of Commercial Fisheries. The sport fishery harvests of sockeye salmon were estimated by the Statewide Harvest Survey since 1977 (Mills 1979–1994; Howe et al. 1995 and 1996; Howe et al. 2001a–d; Walker et al. 2003; Jennings et al. 2010a, b). No age data were collected from harvests or escapements.

The first Pasagshak River sockeye salmon escapement goal 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).

2010 Review

The current review used the percentile approach to evaluate escapement data from 1968 through 2009, all of which came from peak aerial survey indices (Appendices J1 and J2). Limnology data collected in 2000 were also analyzed using zooplankton biomass and euphotic volume models to assess optimal escapement levels.

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; Dinnocenzo et al. 2007). 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 2). Saltery Lake is the primary brood source for fry stocked into Spiridon Lake by the Kodiak Regional Aquaculture Association (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 2009.

Escapement Goal Background and Previous Review

The first published escapement goal 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 range of 15,000 to 30,000 to an SEG range of 20,000 to 50,000, based on a percentile analysis of 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 in a percentile analysis 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.

2010 Review

Stock-specific harvest estimates for the Saltery Lake sockeye salmon fisheries from 1976 to 2009 were obtained by statistical area from the department's Division of Commercial Fisheries Statewide Harvest Receipt (fish ticket) database (Appendices K1 and K2). It was assumed that the majority of Saltery Lake sockeye salmon were harvested in the Inner Ugak Bay Section (statistical areas 259-41 and 259-42) and commercial, subsistence, and sportfish harvest estimates were summed. A spawner-recruit relationship was estimated for the run by analyzing spawning stock and recruitment data from brood years 1976 to 2003 using a Ricker spawner-recruit model (Ricker 1954; Hilborn and Walters 1992) with a multiplicative error structure (Quinn and Deriso 1999). The brood table was constructed as a continuation and modification of the stock-recruit analysis initiated by Honnold and Sagalkin (2001). If a Ricker spawner-recruit model was significant, then S_{MSY} was estimated, along with the range of escapements that would produce 90% to 100% of MSY. Residuals were examined for autocorrelation and temporal trends. Limnology data collected intermittently from 1994 to 2009 were analyzed using zooplankton biomass and euphotic volume models to assess optimal escapement levels.

Uganik Lake

Uganik Lake is located on the west side of Kodiak Island and is a moderate producer of sockeye salmon (Booth 1993). Uganik River flows from the lake into the East Arm of Uganik Bay, which is part of the Central Section of the Northwest Kodiak District (Dinnocenzo et al. 2007; Figures 1 and 2).

Escapement Goal Background and Previous Review

The first published escapement goal for Uganik Lake was developed in 1988 and set at 40,000 to 60,000 sockeye salmon (Nelson and Lloyd 2001). An escapement goal review of this system conducted during 2004 resulted in eliminating the Uganik Lake sockeye salmon SEG due to incomplete escapement data and the inability to actively manage escapements to this system (Nelson et al. 2005). The SEG was eliminated in 2005.

The 2007 escapement goal review of Uganik Lake sockeye salmon utilized aerial survey and weir count estimates in the percentile algorithm. These analyses lead the review team to recommend establishing a lower-bound SEG threshold of 24,000 sockeye salmon, which was implemented in 2008 (Honnold et al. 2007).

2010 Review

Aerial surveys were used to estimate escapement into Uganik Lake from 1974 through 2009 (excluding 1978) and a weir was used from 1928 through 1932 and again from 1990 through 1992 (Appendices L1 and L2). Stock-specific harvest estimates for Uganik Lake drainage sockeye salmon were not available. The percentile approach was performed using aerial survey data from 1974 to 2009.

Upper Station

The Upper Station system, also referred to as South Olga lakes, is composed of two major lakes located on the southern end of Kodiak Island and supports one of the largest sockeye salmon runs in the Kodiak Archipelago (Jackson and Dinnocenzo 2010). 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 1966 for the late run and 1969 for the early run (Appendices M1–M3); 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, with a range of 100,000 to 180,000 fish that was stratified by month. In 1983, the department increased the escapement goal to 150,000 to 250,000 fish, which remained in place through 1987 (Nelson and Lloyd 2001). In 1988, the goal was split into separate escapement goals 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 by the board in 1999. During the 2004 review, the team recommended changing the current Upper Station early-run sockeye SEG to 30,000 to 65,000 fish based on the escapement percentile assessment and changing the late-run sockeye SEG to a BEG of 120,000 to 265,000 fish (S_{MSY} =186,000) based on a significant Ricker spawner-recruit relationship. With two to three 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, there was consensus to not reevaluate these goals in 2007 and there was no change to the Upper Station sockeye salmon escapement goals (Honnold et al. 2007).

2010 Review

Stock-specific estimates of harvest for Upper Station sockeye salmon were available from 1970 to 2009. Spawner-recruit relationships were estimated for the early, late, and combined runs by analyzing spawning stock and recruitment data from brood years 1975 to 2003 (Appendix M4) using a Ricker spawner-recruit model (Eggers 2001; Hilborn and Walters 1992; Ricker 1954) with a multiplicative error structure (Quinn and Deriso 1999). If a Ricker spawner-recruit model was significant, then S_{MSY} was estimated, along with the range of escapements that would produce 90% to 100% of MSY. Residuals were examined for autocorrelation, temporal trends, and potential bias.

Zooplankton and light penetration data from 1990 to 1993, 1995, 1999, 2000, and 2009 were used to assess optimal escapement levels via zooplankton biomass and euphotic volume models.

COHO SALMON

American, Buskin, Olds, and Pasagshak Rivers

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

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, on which returning coho salmon are counted for a portion of the season with a weir operated at various sites since 1985. Total escapement is estimated based on extrapolations from partial season counts.

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). 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 BEG range was based on updated brood table and spawner-recruit analysis.

In 2007, the review team concluded that the addition of three years of escapement data would not substantially affect the results of previous analysis of any of the four goals, which were thus left unchanged (Honnold et al. 2007).

2010 Review

The team reviewed the most recent escapement data available for KMA coho salmon stocks, which consisted of three years of foot survey data from the American, Olds, and Pasagshak rivers, and three years of weir data from the Buskin River. The team concluded that these data would not substantially affect the results of previous escapement goal analysis, and thus recommended no further analysis of the goal ranges. The team did, however, discuss whether the current goal classification was appropriate on these systems due to the lack of inseason management for the upper ends of the goals.

PINK SALMON

Kodiak Archipelago and Mainland District Aggregates

There are two escapements 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 Dinnocenzo 2010). 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 one or more flights over a standardized subset of streams in the Kodiak Archipelago and across Shelikof Strait in the Mainland District (Figure 1). 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, two years after birth, leading to separate populations in odd and even years that do not interbreed (Heard 1991); because of this, escapement goals have sometimes been established separately for odd- and even-year populations.

Escapement Goal Background and Previous Review

The first KMA district wide pink salmon escapement goals were published in 1978 (Nelson and Lloyd 2001). The peak counts were summed over streams within seven districts: Eastside, Northeast Kodiak, Afognak, Northwest Kodiak, Southwest Kodiak, Alitak Bay, 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, while the other six 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 reevaluated during the 2007 review and left unchanged (Honnold et al. 2007).

2010 Review

Peak aerial survey numbers and weir counts were available from 1968 to 2009 and weir counts from 1976 to 2009 (Appendices R and S). Harvest estimates for wild stock (nonhatchery) KMA pink salmon were available from 1978 to 2009.

Spawner-recruit relationships were estimated for the Kodiak Archipelago and Mainland District pink salmon by analyzing escapement indices and recruitment data from brood years 1976 to 2007, using a spawner-recruit model (Eggers 2001; Hilborn and Walters 1992; Ricker 1954) with a multiplicative error structure (Quinn and Deriso 1999). If a spawner-recruit model was significant, then S_{MSY} was estimated, along with the range of escapements that would produce 90% to 100% of MSY. Residuals were examined for autocorrelation, temporal trends, and potential bias.

CHUM SALMON

Kodiak Archipelago and Mainland District Aggregates

There are two aggregate escapements goals for chum salmon in the KMA, one for the Mainland District and one for the Kodiak Island archipelago. Both escapement goals are SEGs based on aggregates of escapements to multiple streams estimated from aerial surveys of spawning fish from fixed-wing aircraft (Jackson and Dinnocenzo 2010). Peak counts of chum salmon from a single flight are used as the annual index of abundance for that stream.

Chum salmon escapement goals by district were established in 1988 (Nelson and Lloyd 2001), based on historic production. 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 be 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 six 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).

2010 Review

The team reviewed the most recent escapement data available for KMA chum salmon stocks, which consisted of an additional three years of aerial survey data (2007 through 2009). The team concluded that these data would not substantially affect the results of previous escapement goal analyses, and thus recommended no further analysis of the escapement goals.

RESULTS

The team reviewed stock assessment data for two Chinook salmon, 13 sockeye salmon, four coho salmon, two chum salmon aggregate stocks, and two pink salmon aggregate stocks with

existing goals (Table 1). Initial efforts concentrated on reviewing data from 2007 through 2009, determining if previous analyses (from the review in 2007) should be updated or if additional analyses were necessary, and identifying any management concerns with the existing goals. The only goal eliminated in 2007 (Pauls Lake sockeye salmon) was not reevaluated because escapement data have not been collected since 2006.

The team concluded that the three additional years of data would not affect the existing escapement goals for the two chum salmon stock aggregates (Kodiak Archipelago and Mainland District stocks), which were left unchanged and not analyzed further. The team also concluded that three additional years of data would not affect the existing escapement goals for three coho salmon stocks (American, Olds, and Pasagshak rivers), but recommended reclassifying these from SEG ranges to lower-bound SEGs because there is no current inseason management of these stocks. The team elected to formally analyze the 18 remaining stocks, using a combination of new escapement and brood year data available since the last review (Honnold et al. 2007).

The staff team agreed to recommend to the directors of the divisions of Commercial and Sport Fisheries that changes be made to 9 of the 18 goals analyzed (in addition to the three coho salmon goals that were reclassified). For sockeye salmon, the five recommended changes were as follows: split the Ayakulik River sockeye salmon SEG of 200,000 to 500,000 fish into two goals, an early-run SEG of 140,000 to 280,000 fish and a late-run SEG of 60,000 to 120,000 fish; change the Buskin River SEG of 8,000 to 13,000 fish to a BEG of 5,000 to 8,000 fish; change the Upper Station early-run SEG of 30,000 to 65,000 fish to a BEG of 43,000 to 93,000 fish; change the Saltery River BEG of 15,000 to 30,000 fish to a BEG of 15,000 to 35,000 fish; and reclassify the Pasagshak River SEG of 3,000 to 12,000 fish to a lower-bound SEG of 3,000 fish (Table 1).

The staff team recommended reducing both Chinook salmon goals: the Ayakulik River Chinook salmon BEG would change from 4,800 to 9,600 fish to 4,000 to 7,000 fish, and the Karluk River Chinook salmon BEG would change from 3,600 to 7,300 fish to 3,000 to 6,000 fish. The staff team also recommended changing both pink salmon goals: the Mainland District pink salmon SEG would change from 250,000 to 750,000 fish to 250,000 to 1,000,000 fish, and the Kodiak Archipelago pink salmon SEG would be split into an even-year SEG of 3,000,000 to 7,000,000 fish and an odd-year goal of 2,000,000 to 5,000,000 fish (Table 1).

Overall, the staff-recommended changes would result in 25 escapement goals in the Kodiak Management area: 14 for sockeye salmon (eight BEGs, four SEGs, and two lower-bound SEGs); two for Chinook salmon (both BEGs); four for coho salmon (one BEG and three lower-bound SEGs); three for pink salmon (all SEGs), and two for chum salmon (both lower-bound SEGs). Goals for pink salmon and chum salmon would be stock aggregates.

CHINOOK SALMON

Karluk River

Stock Status

Karluk River Chinook salmon escapements averaged 7,700 (range: 750 to 13,750) fish from 1976 through 2009 and 8,750 (range 3,150 to 13,750) fish for brood years 1976 through 2002. Since the current BEG of 3,600 to 7,300 fish was implemented in 2002, escapements have been

below the lower end of the goal range in three years and within the goal range in five years (although not since 2006; Appendix A2).

Evaluation of Recent Data

The spawner-recruit analysis used data from brood years 1976 through 2002 to provide estimates of Ricker model parameters $\ln(\alpha) = 1.28$ (90% credibility interval [CI] of 0.86 to 1.60) and β of 0.00014 (90% CI of 0.00011 to 0.00019). Point estimates derived were posterior medians.

The estimated number of spawners (S_{MSY}) required for maximum sustained yield was 3,975 Chinook salmon (90% CI of 3,170–5,237). The estimated escapement at replacement (S_{EQ}) was 10,070 Chinook salmon (90% CI of 7,752 to 13,810). Considering uncertainty in the estimates, an escapement goal range of 3,000 to 6,000 Chinook salmon would control the maximum risk of overfishing (defined as a loss of >20% of maximum sustained yield) to less than 2%.

Escapement Goal Staff Recommendation to Directors

After reviewing weir and harvest data for the past three years (2007–2009) for Karluk River Chinook salmon, the team concluded that recent low returns from large brood year escapements could improve the current spawner recruit analyses. Bayesian spawner-recruit analyses with AR(1) productivity terms to account for serial correlation between successive years were completed. The team recommended changing the BEG for Karluk River Chinook salmon from its current range of 3,600 to 7,300 fish to a range of 3,000 to 6,000 fish (Table 1).

Ayakulik River

Stock Status

Ayakulik River Chinook salmon escapements averaged 10,200 fish (range: 935 to 24,425) from 1977 through 2009 and 10,725 fish (range: 950 to 20,750) for brood years 1977 through 2003. Since the current BEG of 4,800 to 9,600 fish was implemented in 2002, escapements have been below the lower end of the goal range in three years, within the goal range in two years, and above the goal range in three years (Appendix B2)

Evaluation of Recent Data

The spawner-recruit analysis used data from brood years 1976 through 2003 to provide estimates of Ricker model parameters $\ln(\alpha) = 1.44$ (90% CI of 1.11 to 1.75) and β of 0.00012 (90% CI of 0.00009 to 0.00015). Point estimates derived were posterior medians.

The estimated number of spawners (S_{MSY}) required for maximum sustained yield was 5,165 Chinook salmon (90% CI of 4,297 to 6,474). The estimated escapement at replacement (S_{EQ}) was 13,550 Chinook salmon (90% CI of 11,080 to 17,120). Considering uncertainty in the estimates, a BEG of 4,000 to 7,000 Chinook salmon would control the maximum risk of overfishing (defined as a loss of >20% of maximum sustained yield) to less than 1%.

Escapement Goal Staff Recommendation to Directors

After reviewing weir and harvest data for the past three years (2007 through 2009) for Ayakulik River Chinook salmon, the team concluded that recent low returns from large brood year escapements could improve the current spawner recruit analyses. Bayesian spawner-recruit analyses with AR(1) productivity terms to account for serial correlation between successive years were completed. The team recommended changing the BEG for Ayakulik River Chinook salmon from its current range of 4,800 to 9,600 fish to a range of 4,000 to 7,000 fish (Table 1).

SOCKEYE SALMON

Afognak Lake

Stock Status

Escapements since the current BEG was implemented in 2005 have been within the escapement goal range each year (Appendix C3). The returns for 1999 and 2001 brood years were the lowest in the 1978 to 2002 time series (Appendices C4 and C5), and were possibly reduced by top-down effects from high escapements from 1995 through 1999 (Appendices C2 and C3).

Evaluation of Recent Data

The contrast of the Afognak Lake escapement data was 440 (21 for all weir data and 9 for 1982 through 2009 weir data; Appendix C1), which was above the recommended minimum contrast of 4 (CTC 1999). Returns from escapements that were fully recruited since the last escapement goal review had little effect on the escapement goal range. The spawner-recruit model was significant (P=0.04) and S_{MSY} was estimated to be 39,000 with $S_{90\%MSY}$ range of 29,000 to 56,000 (Table 3; Appendix C5). No autocorrelation was found in the spawner-recruit model residuals.

The euphotic volume model estimated the optimal escapement to Afognak Lake to be 43,000 adult sockeye salmon. The zooplankton biomass model estimated the optimal escapement to Afognak Lake to be 24,000 adult sockeye salmon.

Escapement Goal Staff Recommendation to Directors

The team recommended no change to the Afognak Lake sockeye salmon BEG of 20,000 to 50,000 fish based on the updated Ricker spawner-recruit curve, the corroborating euphotic volume model, and the somewhat different zooplankton biomass model (Table 1).

Ayakulik River

Stock Status

The current Ayakulik River sockeye salmon SEG is 200,000 to 500,000 fish (Table 1; Appendix D1). Sockeye salmon returns have been in decline since brood year 1994, but have recently shown signs of stabilizing or increasing. Department researchers theorize that the decline was likely 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 outmigrants. Escapements have been above the lower end of the range in three of the five years since the current goal was established in 2005 (Appendix D2).

Evaluation of Recent Data

A Ricker spawner-recruit model was fit to the Ayakulik fully recruited brood year spawner-recruit data from 1968 to 2002. The contrast of the escapement data was 22.9 (Appendix D1), which was above the recommended minimum contrast of 4 (CTC 1999). The multiplicative error model was not significant (P=0.4). Other timeframes examined were also not significant. Estimating quality productivity parameters from this model will likely be problematic until more escapement data points are seen between 400,000 and 700,000 fish. The euphotic volume model estimated the optimal escapement to Red Lake, which feeds the Ayakulik River, to be 123,595 adult sockeye salmon. The zooplankton biomass model estimated the optimal escapement to Red Lake to be 211,011 adult sockeye salmon, ranging from 61,000 to 423,000 fish.

Escapement Goal Staff Recommendation to Directors

To protect the different temporal components of this run extending from May to September, the team recommended reinstituting separate early and late-run goals for Ayakulik sockeye salmon. An early-run SEG range of 140,000 to 280,000 fish through July 15 and a late-run SEG range of 60,000 to 120,000 fish after July 15 are recommended based on zooplankton biomass models and historical escapement goals (Table 1). This goal will be reinvestigated in 2013 after completion of run reconstructions and brood tables for the early and late segments.

Buskin River

Stock Status

Since the establishment of the current escapement goal in 1997 (8,000 to 13,000 fish), escapements have been within the current SEG range in three years (but not since 2000), above the upper end of the range in eight years, and below the lower end of the range in two years (the two most recent years, 2008 and 2009; Appendix E2). Recent low returns may have been caused by high escapements in parent years (Appendix E2).

Evaluation of recent data

The spawner-recruit analysis using data from brood years 1990 through 2003 provided Ricker stock-recruitment function estimates of $\ln(\alpha) = 2.16$ (90% bootstrapped confidence intervals [BCI] of 1.63 to 2.75) and β of 0.00012 (90% BCI of 0.00008 to 0.00016).

The estimated number of spawners (S_{MSY}) required for maximum sustained yield was about 6,650 sockeye salmon (90% BCI of 5,350 to 8,300). The estimated exploitation at maximum sustained yield was 0.77 (90% BCI of 0.65 to 0.85). The estimated escapement at replacement (S_{EQ}) was 19,450 sockeye salmon (90% BCI of 17,350 to 22,300). The sustained yield probability calculations suggest that an escapement goal range of 5,000 to 8,000 sockeye salmon would provide a sustained yield that is 90% of MSY.

The Durbin-Watson test detected no serial correlation among the residuals ($P > 0.05$). Plots of the residuals against brood year and of the autocorrelation and partial autocorrelation functions also showed little evidence of autocorrelation (Schmidt and Evans 2010).

From the Bayesian analysis, the median of the posterior distribution of S_{MSY} was 6,550 sockeye salmon. The value of S_{MSY} was between 4,950 fish and 8,700 fish, with 90% certainty.

The Bayesian analysis suggested some positive autocorrelation (ϕ), although the 80% interval extended into the negative range. The spawner-recruit relationship determined by the median values of $\ln(\alpha)$ and β from the Bayesian analysis was not much different than the estimate from the traditional Ricker model fit to the spawner-recruitment data.

Both the traditional regression and Bayesian spawner recruitment analyses estimated that S_{MSY} fell below the current escapement goal range of 8,000 to 13,000 sockeye salmon. Examination of the sustained yield plot suggests a reduction in the upper and lower bounds of the escapement goal may be warranted, and that a BEG range of 5,000 to 8,000 would ensure sustained yield is within 90% of MSY with 90% probability.

Escapement Goal Staff Recommendation to Directors

Results of the updated analysis indicate that the current Buskin River sockeye salmon SEG of 8,000 to 13,000 should be changed to a BEG of 5,000 to 8,000, based on the Bayesian spawner-recruit analysis (Table 1).

Frazer Lake

Stock Status

Sockeye salmon escapements have been within the current BEG range of 75,000 to 170,000 fish since its inception in 2008 (Honnold et al. 2007; Appendices F2 and F3).

Evaluation of Recent Data

A Ricker spawner-recruit model was fit to the Frazer Lake fully recruited brood year spawner-recruit data from 1966 to 2002 (excluding the brood years of 1985 to 1991 where fertilization directly affected production; Appendix F4). The contrast of the Frazer Lake escapement data was 20 (Appendix F1), which was above the recommended minimum contrast of 4 (CTC 1999). The multiplicative error model was significant (P<0.001), S_{MSY} was estimated at 117,000 (90% S_{MSY} range of 75,000 to 168,000), and S_{EQ} was estimated at 321,000 fish (Appendix F5). No autocorrelation was detected in residual plots. Fertilization of Frazer Lake has not occurred for 15 years.

New bathymetry data collected in 2009 were employed in calculating the euphotic volume model for Frazer Lake: the optimal escapement to Frazer Lake was estimated to be 224,497 adult sockeye salmon. The zooplankton biomass model estimated the optimal escapement to Frazer Lake to be 114,982 sockeye salmon.

Escapement Goal Staff Recommendation to Directors

The team recommended no change to the Frazer Lake sockeye salmon BEG range of 75,000 to 170,000 fish (Table 1). The addition of three more years of spawner-recruit data yielded little change in the estimates of productivity; similarly, the zooplankton biomass model corroborated the current BEG.

Karluk Lake

Stock Status – Early Run

Since the establishment of the current escapement goal (110,000 to 250,000 fish) in 2008, escapement of early-run Karluk River sockeye salmon have been above the upper goal range in one year (2007) and below the lower goal range in two years (2008 and 2009; Appendix G4).

Stock Status – Late Run

Since the establishment of the current escapement goal (170,000 to 380,000 fish) in 2005, escapement of late-run Karluk River sockeye salmon has been below the lower goal range in one year, within the range in three years, and above the upper goal range in one year (Appendix G3).

Evaluation of Recent Data – Early Run

Recent low escapements increased the contrast in the escapement to 8.7 (Appendix G1), meeting the minimum recommended level to be used in spawner-recruit analysis (CTC 1999). Returns from escapements that were fully recruited since the last escapement goal review were some of

the largest in the data set, and therefore were of high influence on the spawner-recruit curve (Appendix G6). Using three additional data points over the last review resulted in an estimate of S_{MSY} of 150,000 sockeye salmon, which was lower than the previous estimate of 175,000 fish (Table 1; Appendix G8); however, the new estimate is virtually identical to the estimate made during the 2004 review. No autocorrelation was found in the spawner-recruit model residuals.

Evaluation of Recent Data – Late Run

The recent Karluk Lake late-run escapements were below average and represented returns from very large parent escapements (Appendices G3 and G7). The escapement contrast for the Karluk Lake late run was unchanged with recent escapements, but remains well above the recommended minimum of 4.0 for spawner-recruit analysis (CTC 1999) at 19.9 (Appendix G1). Returns from escapements that were fully recruited since the last escapement goal review were well above average, but were within the range of the rest of the data (Appendix G3). As a result, the addition of recent years' data points did not substantially affect the spawner-recruit curve; the S_{MSY} was estimated at 267,000 sockeye salmon as compared to the S_{MSY} estimated during the last review of 272,000 (Table 1; Honnold et al. 2007). No autocorrelation was found in the spawner-recruit model residuals.

Recent limnological data collected since the last review did not reveal any trends or information to suggest significant changes in Karluk Lake. Escapement estimates from the euphotic volume (593,000 fish) and zooplankton biomass (397,000 fish) models corroborated the combined total of the early- and late-run goals (280,000 to 630,000 fish).

Escapement Goal Staff Recommendation to Directors

The team recommended no change to the current Karluk Lake early-run BEG of 110,000 to 250,000 (S_{MSY} = 175,000) fish, based on the Ricker spawner-recruit curve (Table 1). The spawner-recruit estimate was similar to estimates made during the 2004 review and the team agreed that small changes to this goal should not be made during every review. The team also recommended leaving the Karluk Lake late-run BEG of 170,000 to 380,000 sockeye salmon unchanged (Table 1) because the spawner-recruit analysis was similar to the previous estimate. Limnological analyses also indicated that the current escapement goals were appropriate.

Several events relating to Karluk Lake sockeye salmon complicated analysis of the escapement goals. The estimated harvest assigned to Karluk prior to 1985 (completed brood year 1981) was considered by Barrett and Nelson (1995) to contain substantial errors. In addition, several Karluk Lake rehabilitation activities may have altered the natural state of the spawner-recruit relationship. From 1986 to 1990, Karluk Lake was fertilized to enhance juvenile sockeye salmon survival (Schrof and Honnold 2003). The department 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 data used for the spawner-recruit analysis includes 1981 to 1996 brood years (16 years) and the rehabilitation activities may have had an effect on brood years 1981 to 1995 (15 years).

Recent low runs, largely with very large parent-year escapements, have caused some concern regarding Karluk Lake sockeye salmon. The parent year escapements for recent runs, on average, were well above the escapement goals; however, the returns are not fully recruited at this time and were therefore not used in this analysis.

Little River

Stock Status

The current lower-bound SEG for Little River Lake sockeye salmon is 3,000 fish (Table 1; Appendix H). Since the goal was established in 2007, escapements have fallen below the goal in both 2008 and 2009. Prior to 2008, escapements were above the goal for all but one of the years from 1979 through 2007 (Appendix H2).

Evaluation of Recent Data

Recent escapement estimates via aerial survey have been below the threshold, and qualitative analysis of historical survey timeframes suggest that the current decrease in escapement is likely real and not a function of decreased effort or substandard survey conditions. The contrast of the peak aerial survey data used in the percentile algorithm was 41; the analysis yielded an escapement goal range of 3,000 to 15,000 fish.

Escapement Goal Staff Recommendation to Directors

The team recommended no change to the Little River Lake lower-bound SEG of 3,000 fish, based on the results of the percentile approach (Table 1).

Malina Creek

Stock Status

Escapements have been within the current SEG range (1,000 to 10,000 fish) since it was revised in 2005 (Appendix I2).

Evaluation of Recent Data

The contrast of the peak aerial survey data used in the percentile algorithm was 42.4 (Appendix I1); the analysis yielded an escapement goal range of 1,000 to 7,000 fish. The euphotic volume model estimated the optimal escapement to Malina Creek to be 10,900 adult sockeye salmon. The zooplankton biomass model estimated the optimal escapement to Malina Creek to be 5,900 adult sockeye salmon.

Escapement Goal Staff Recommendation to Directors

The team concluded that the results of percentile algorithm and limnological model analyses corroborated the current Malina Creek SEG, and recommended the SEG remain at 1,000 to 10,000 sockeye salmon (Table 1).

Pasagshak River

Stock Status

The current Pasagshak River sockeye salmon SEG range is 3,000 to 12,000 (Table 1; Appendix J1). Since the SEG was established in 2005, escapements have been within the range one year, above the range in three years, and below the range in one year (Appendix J2).

Evaluation of Recent Data

An SEG for Pasagshak River sockeye salmon was estimated using the percentile approach. High contrast in the aerial survey estimates (128) resulted in an SEG of 2,340 (15th percentile). The euphotic volume model estimated the optimal escapement to Pasagshak River to be 4,500 adult

sockeye salmon. Although zooplankton biomass was relatively low, the strong salmon returns in 2004 and 2005 are an indication of the high potential of this system. After the 1964 earthquake, the level of Lake Rose Tead fell and began receiving increased marine nutrients, creating an unusually productive rearing environment for juvenile salmon (Murray 1986).

Escapement Goal Staff Recommendation to Directors

The team recommended eliminating the upper end of the range, thereby changing the goal to a lower-bound SEG, consistent with other systems for which there is limited ability to manage the stock inseason. The team found no substantial difference between the 15th percentile escapement from the analysis and the existing lower range of 3,000 fish, and therefore recommended leaving the lower bound at 3,000 fish (Table 1).

Saltery Lake

Stock Status

The current Saltery Lake sockeye salmon BEG of 15,000 to 30,000 was adopted in 2001 (Table 1; Appendix K1). Since then, escapements have been within the range three years (all when the weir was not in place), above the upper end of the range in six years (including every year with a weir in place), and have not been below the lower end of the goal (Appendix K2).

Evaluation of Recent Data

A spawner-recruit model was fit to the Saltery Lake fully recruited brood year spawner-recruit data from 1976 to 2003. The contrast of the Saltery Lake escapement data was 7.0 (Appendix K1), which was above the recommended minimum contrast of 4 (CTC 1999). The multiplicative error model was significant (P<0.001). The S_{MSY} was estimated at 23,600 sockeye salmon with a 90% MSY range of 15,300 to 33,400 while S_{EQ} was estimated at 61,000 sockeye salmon (Appendix K4). No autocorrelation was detected in residual plots.

The zooplankton biomass model estimated the optimal escapement to Saltery Lake to be between 23,000 to 35,000 adult sockeye salmon based on the average size sockeye smolt (1997 through 2002) of 2.1 grams. The EV model suggested a lower goal for Saltery Lake (9,000 fish); however, light penetration is limited in the lake due to glacial influence, making the EV model less appropriate.

Escapement Goal Staff Recommendation to Directors

The team recommended changing the Saltery Lake sockeye salmon BEG of 15,000 to 30,000 to a BEG of 15,000 to 35,000 sockeye salmon to more accurately reflect the results of the Ricker spawner-recruit and zooplankton models (Table 1; Appendix K4).

Uganik Lake

Stock Status

The current Uganik Lake sockeye salmon lower-bound SEG is 24,000 fish (Table 1; Appendix L1). Escapements have been above the goal both years (2008 and 2009) since its establishment following the 2007 review (Honnold et al. 2007).

Evaluation of Recent Data

An SEG for Uganik Lake sockeye salmon was estimated according to the percentile method. High contrast in the aerial survey estimates (31) resulted in a SEG of 25,000 (25th percentile).

Escapement Goal Staff Recommendation to Directors

The team recommended no change to the Uganik Lake lower-bound SEG of 24,000 fish, based on the percentile approach (Table 1).

Upper Station

Stock Status – Early Run

The Upper Station early-run sockeye salmon SEG of 30,000 to 65,000 was implemented beginning in the 2005 season. Escapements since 2005 have been within the range four years and below the range one year (Appendices M2 and M4). Management of the fishery is guided by the OEG of 25,000 fish (Table 1; Appendix M1).

Stock Status – Late Run

Since the Upper Station late-run sockeye BEG of 120,000 to 265,000 was implemented in 2005, escapements have been within the range in all five years (Appendices M3 and M5).

Evaluation of Recent Data – Early Run

A Ricker spawner-recruit model was fit to data from fully recruited brood year data from early-run sockeye salmon returning to Upper Station from 1975 through 2003.The contrast of the escapement data was 16.5 (Appendix M1), which was above the recommended minimum contrast of 4 (CTC 1999). The multiplicative error model was significant ($P<0.05$). The S_{MSY} was estimated at 66,000 sockeye salmon with a 90% MSY range of 43,000 to 93,000, while S_{EQ} was estimated at 165,000 sockeye salmon (Appendix M8). The model did not have significant autocorrelation (lag-1).

Evaluation of Recent Data – Late Run

A Ricker spawner-recruit model was fit to data from fully recruited brood year data from early-run sockeye salmon returning to Upper Station from 1975 through 2003. The contrast of the escapement data was 25.9 (Appendix M1), well above the recommended minimum contrast of 4 (CTC 1999). The multiplicative error model was significant ($P<0.05$), but the model had significant autocorrelation (lag-1) and serious nonstationary processes affecting the time series of production. The combined early- and late-run spawner recruit model was not significant ($P>0.05$).

The euphotic volume model estimated the optimal escapement to Upper Station River to be 122,000 adult sockeye salmon. The zooplankton biomass model estimated the optimal escapement to Upper Station River to be 225,000 adult sockeye salmon.

Escapement Goal Staff Recommendation to Directors

The team recommended changing the early-run Upper Station sockeye salmon SEG of 30,000 to 65,000 fish to a BEG range of 43,000 to 93,000 fish, based on the spawner-recruit model (Table 1). The zooplankton biomass model corroborated the new BEG (in combination with the late-run BEG as long as it remains unchanged).

The team recommended no change to the late-run Upper Station sockeye salmon BEG of 120,000–265,000 fish (Table 1). Although the spawner-recruit model was significant, serious nonstationary processes in the time series suggest estimating maximum productivity from this model would be inaccurate.

COHO SALMON

American, Buskin, Olds, and Pasagshak Rivers

Stock Status – All Systems

Since the revision of goals on all four systems in 2005, escapements have been as follows: American River escapements have been below the goal range in two years, within the range in two years, and above the range in one year (Appendix N2); Buskin River escapements have been above the range in all five years (Appendix O2); Olds River escapements have been below the goal range in three years, within the range in one year, and above the range in one year (Appendix P2); and Pasagshak River escapements have been below the range in one year, within the range in two years, and above the range in two years (Appendix Q2).

Evaluation of Recent Data

The escapement goal review team reviewed the most recent data available for KMA coho salmon stocks (Table 1); three additional years of escapement data were available for coho salmon from all four rivers (the Buskin, American, Olds, and Pasagshak rivers), including spawner-recruit data for the Buskin River stock. The team examined stock assessment data from these stocks, concluded that the three additional years of data would not affect the results of the previous analyses in 2007, and declined to evaluate them further. The team also assessed whether classifying the goals as a range was appropriate on these systems due to the lack of inseason management for the upper ends of the goal ranges.

Escapement Goal Staff Recommendation to Directors

The escapement goal team recommended changing the SEGs for the American, Olds, and Pasagshak rivers from ranges to lower-bound SEGs because of the lack of inseason management for the upper bounds of the goals. The lower bounds of the new SEGs would remain the same as the lower end of the prior SEG range: 400 fish for the American River, 1,000 fish for the Olds River, and 1,200 fish for the Pasagshak River. The team recommended no change to the Buskin River BEG of 3,200 to 7,200 coho salmon (Table 1).

PINK SALMON

Kodiak Archipelago and Mainland District Aggregates

Stock Status

Since the Kodiak Archipelago SEG of 2,000,000 to 5,000,000 pink salmon was implemented in 2005, escapements have been within the current SEG range in four years and have exceeded the goal in one year (Appendices R2 and R3).

Since the Kodiak Mainland SEG of 250,000 to 750,000 pink salmon was implemented in 2005, escapements have been below the goal range in one year, within the range in three years, and above the range in one year (Appendix S3).

Evaluation of Recent Data

A Ricker spawner-recruit model was fit to the Kodiak Archipelago pink salmon fully recruited brood year spawner-recruit data from 1976 to 2007. The even- and odd-year pink salmon data were combined in the analysis because there is relatively little production potential between the

two runs, and the combined data increased the statistical power of the analysis. Peak aerial survey indices were expanded by a factor of two (based on findings of Barrett et al. 1990), combined with weir counts at Karluk and Ayakulik rivers, and coupled with harvest estimates. The contrast of the escapement data was 6.3 (Appendix R1), which was above the recommended minimum contrast of 4 (CTC 1999). The multiplicative error model was significant (P<0.001). The S_{MSY} was estimated at 7,870,000 pink salmon with a 90% MSY range of 5,080,000 to 11,200,000 fish, while S_{EQ} was estimated at 20,400,000 pink salmon (Appendix R4). The model did not have significant autocorrelation (lag-1). After correcting for the survey expansion factor and the strong even-year dominance seen in the Karluk and Ayakulik pink salmon runs, S_{MSY} was estimated to be 3,640,000 fish for odd-year returns and 5,240,000 fish for even-year returns.

A Ricker spawner-recruit model was fit to the Kodiak Mainland pink salmon brood years from 1976 to 2007. Kodiak Mainland peak aerial survey indices were expanded by a factor of two (2) and coupled with harvest estimates. The contrast of the escapement data was 31.3 (Appendix S1), which was above the recommended minimum contrast of 4 (CTC 1999). The multiplicative error model was significant (P<0.001). The S_{MSY} was estimated at 1,480,000 pink salmon with a 90% MSY range of 1,000,000 to 2,000,000 fish, while S_{EQ} was estimated at 3,400,000 pink salmon (Appendix S4). The model had borderline significant autocorrelation (lag-1), but was not corrected for. When corrected for the survey expansion factor, S_{MSY} was estimated to be 740,000 fish, which was close to the upper end (750,000 fish) of the current goal.

Escapement Goal Staff Recommendation to Directors

The team recommended changing the Kodiak Archipelago pink salmon SEG range of 2,000,000 to 5,000,000 fish to an odd-year SEG range of 2,000,000 to 5,000,000 and an even-year SEG range of 3,000,000 to 7,000,000 pink salmon (Table 1). The difference in odd- and even-year SEGs is due more to the extreme nature of the odd- and even-year pink salmon runs at Karluk and Ayakulik rivers (where escapement is counted using weirs and not indexed via aerial surveys) than to differences between odd and even years throughout the rest of the KMA.

The team recommended changing the Kodiak Mainland pink salmon SEG range of 250,000 to 750,000 fish to an SEG range of 250,000 to 1,000,000 fish (Table 1). Despite model caveats and some uncertainties, increasing the upper goal to 1,000,000 fish is more likely to result in a range containing S_{MSY}.

CHUM SALMON

Kodiak Archipelago and Mainland District Aggregates

Stock Status

The current lower-bound SEGs for chum salmon in the KMA were both set in 2007, for returns beginning in 2008 (Honnold et al. 2007). The lower bound of 151,000 Kodiak Archipelago chum salmon was exceeded in 2009, but not in 2008; the lower-bound SEG of 104,000 Mainland District chum salmon was exceeded in 2008, but not in 2009 (Table 1).

Evaluation of Recent Data

The escapement goal review team reviewed the most recent data available for KMA chum salmon stocks (Table 1) and concluded that the three additional years of data (2007 through 2009) would not affect the existing goals, and decided not to evaluate them further.

Escapement Goal Staff Recommendation to Directors

The team recommended no change to the existing lower-bound SEGs for the Kodiak Archipelago Mainland District chum salmon stocks (Table 1).

SUMMARY OF STAFF RECOMMENDATIONS TO DIRECTORS

The 2010 review team reviewed data for all 23 salmon escapement goals in the KMA, then analyzed 18 of these goals further. Overall, the team recommended changes to 12 of the 23 existing goals, including the splitting of two goals: Ayakulik River sockeye salmon (into early and late goals) and Kodiak Archipelago pink salmon (into odd- and even-year goals). The new recommendations result in a total of 25 escapement goals in the KMA, as follows: two goals for Chinook salmon (both BEGs); 14 goals for sockeye salmon (eight BEGs, three SEGs, and three lower-bound SEGs); four goals for coho salmon (one BEG and three lower-bound SEGs); three aggregate SEGs for pink salmon; and two aggregate SEGs for chum salmon.

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TABLES AND FIGURES

Table 1.–Existing and recommended salmon escapement goals for the Kodiak Management Area.

Species	System	Escapement data[a]	Current escapement goal				Escapements			Preliminary 2010 recommendation
			Type	Lower	Point	Upper	2007	2008	2009	
Chinook salmon										
	Ayakulik	WC	BEG	4,800	6,638	9,600	6,232	3,071	2,615	Change to 4,000–7,000; S_{MSY} = 5,165
	Karluk	WC	BEG	3,600	4,492	7,300	1,697	752	1,306	Change to 3,000–6,000; S_{MSY} = 3,975
Sockeye salmon										
	Afognak	WC	BEG	20,000	34,000	50,000	21,070	26,874	31,358	No change
	Ayakulik	WC	SEG	200,000		500,000	283,042	162,888	315,184	Change to early-run SEG of 140,000–280,000 and late-run SEG of 60,000–120,000
	Buskin	WC	SEG	8,000		13,000	16,502	5,900	7,757	Change to BEG of 5,000–8,000; S_{MSY} = 6,650
	Frazer	WC	BEG	75,000	105,000	170,000	120,186	105,363	101,845	No change
	Karluk									
	Early run	WC	BEG	110,000	175,000	250,000	294,740	82,191	52,466	No change
	Late run	WC	BEG	170,000	270,000	380,000	267,185	164,419	277,611	No change
	Little River	PAS	Lower-bound SEG	3,000			8,500	2,300	1,500	No change
	Malina	PAS	SEG	1,000		10,000	1,900	3,690	1,400	No change
	Pasagshak	PAS	SEG	3,000		12,000	14,300	14,900	1,400	Change to lower-bound SEG of 3,000
	Saltery	WC or PAS	BEG	15,000		30,000	17,200	49,266	46,591	Change to 15,000–35,000; S_{MSY} = 23,600
	Uganik Lake	PAS	Lower-bound SEG	24,000			35,000	64,700	53,700	No change
	Upper Station									
	Early run[b]	WC	SEG	30,000		65,000	31,895	38,800	34,585	Change to BEG of 43,000–93,000; S_{MSY} = 66,000
	Late run	WC	BEG	120,000	186,000	265,000	149,709	184,856	161,736	No change

-continued-

Table 1.–Page 2 of 2

Species	System	Escapement data[a]	Current escapement goal				Escapements			Preliminary 2010 recommendation
			Type	Lower	Point	Upper	2007	2008	2009	
Coho salmon										
	American	FS	SEG	400		900	307	700	639	Change to lower-bound SEG of 400
	Buskin	WC	BEG	3,200	5,000	7,200	7,697	7,963	9,351	No change
	Olds	FS	SEG	1,000		2,200	868	656	697	Change to lower-bound SEG of 1,000
	Pasagshak	FS	SEG	1,200		3,300	1,896	3,875	2,385	Change to lower-bound SEG of 1,200
Pink salmon										
	Kodiak Archipelago	PAS	SEG	2,000,000		5,000,000	2,208,678	2,924,708	4,707,894	Change to SEGs: even yr 3,000,000–7,000,000; odd yr 2,000,000–5,000,000
	Mainland District	PAS	SEG	250,000		750,000	315,300	236,500	430,100	Change to SEG of 250,000–1,000,000
Chum salmon										
	Kodiak Archipelago	PAS	SEG	151,000			206,983	101,482	202,039	No change
	Mainland District	PAS	SEG	104,000			87,350	122,425	83,106	No change

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

[b] Upper Station early-run sockeye salmon are the only optimal escapement goal (OEG; 25,000) in the KMA, established by the Board of Fisheries in 1999.

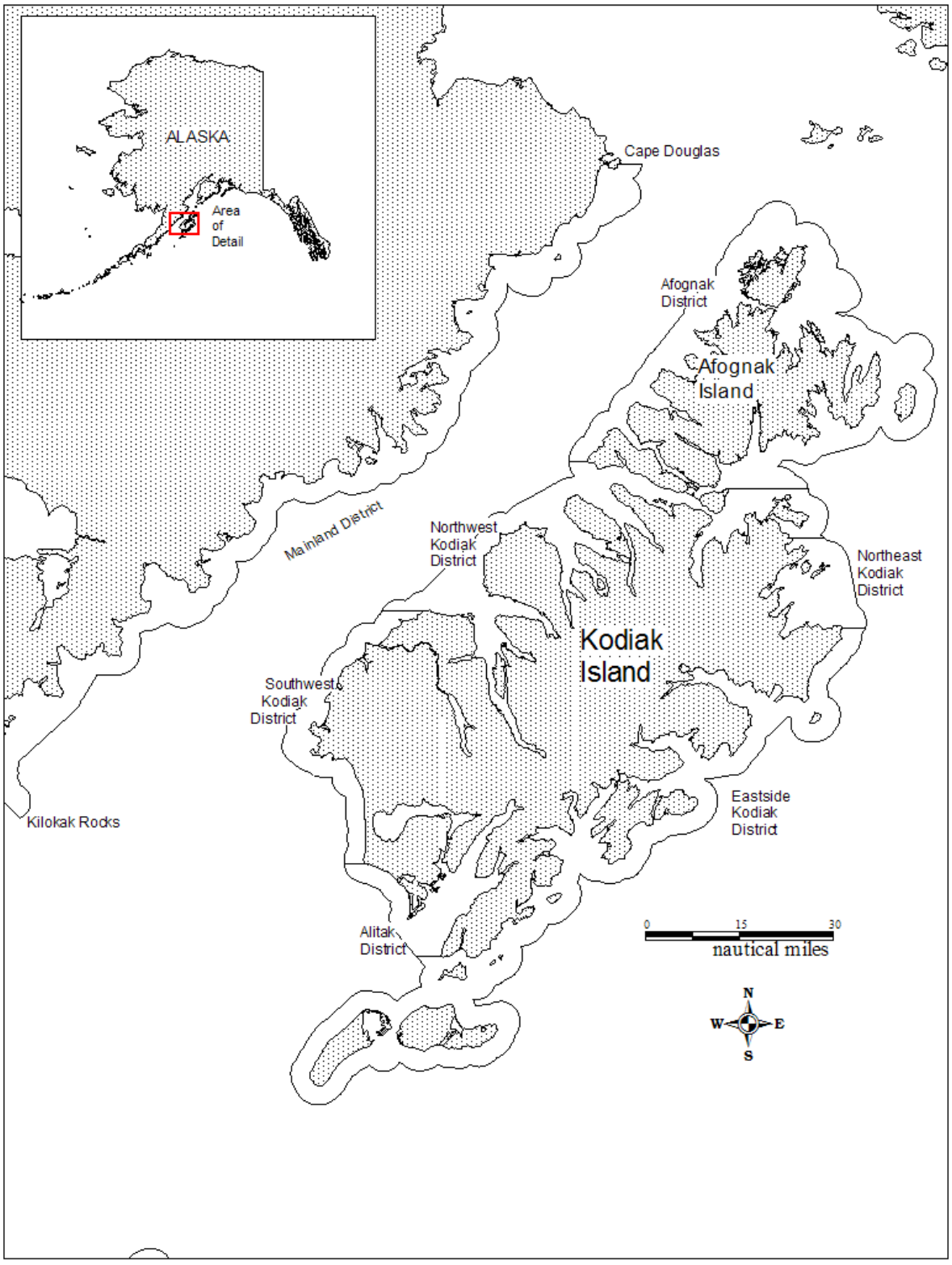


Figure 1.–The Kodiak Management Area, showing the commercial salmon fishing districts.

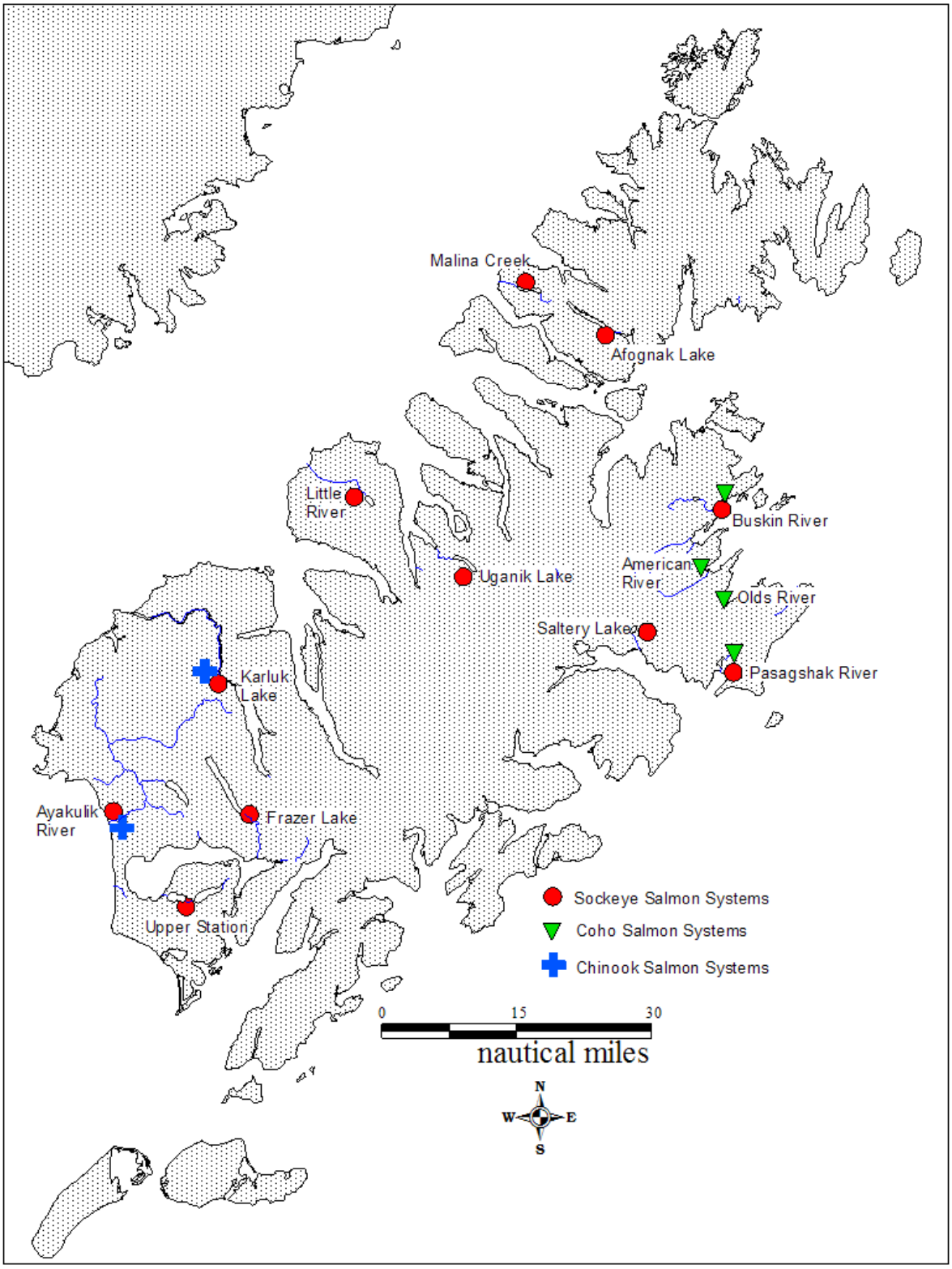


Figure 2.–Locations of Chinook, sockeye, and coho salmon systems with escapement goals in the Kodiak Management Area in 2010.

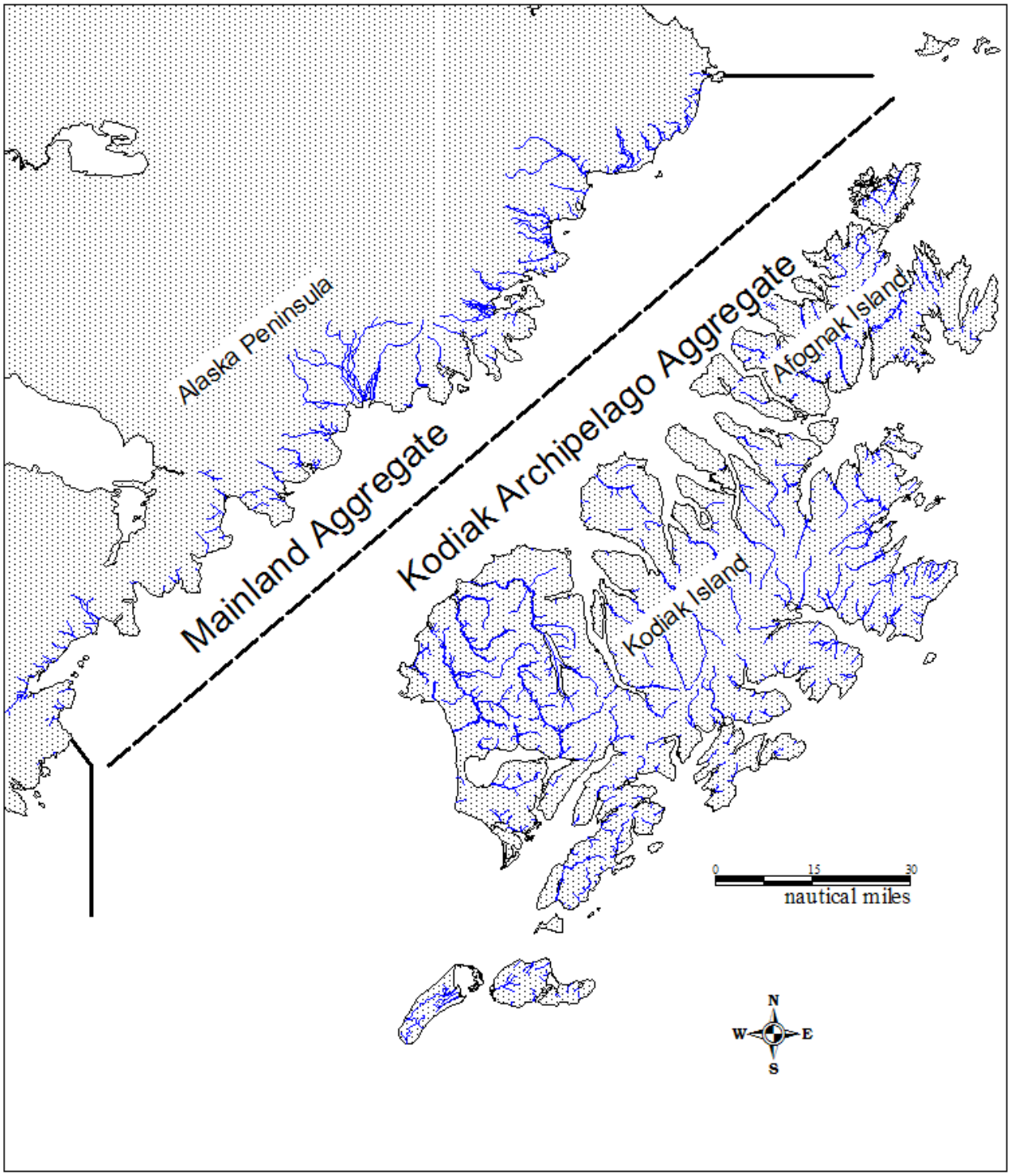


Figure 3.–Geographic boundaries of aggregate escapement goals for chum and pink salmon in the Kodiak Management Area in 2010.

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

Appendix A1.–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, 3,600 –7,300 (2002)
Recommended escapement goal:	BEG, 3,000 –6,000
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1976 to present
Data summary:	
Data quality:	Good escapement and harvest data.
Data type:	Weir estimates, harvest estimates, age composition.
Data contrast:	All survey data 1976 to 2009: 18.27
Methodology:	Bayesian spawner-recruit analysis with an AR(1) productivity term.
Autocorrelation:	Present
Recommendation:	BEG 3,000–6,000.
Comments:	Failed to make escapement each of the last 3 years (2007–2009).

Appendix A2.–Annual harvest, weir count, total return, and escapement estimates for Karluk River Chinook salmon, 1976 through 2009.

System: Karluk River

Species: Chinook salmon

Return Year	Commercial Harvest[a]	Subsistence Harvest[b]	Weir Count	Total Return[c]	Recreational 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 [f]	6,944
2003	1,336	6	7,256	8,891	270 [g]	6,986
2004	2,249	16	7,525	10,183	297 [h]	7,228
2005	349	5	4,798	5,406	114 [i]	4,684
2006	900	17	4,112	5,270	439 [j]	3,673
2007	313	1	1,765	2,217	68 [k]	1,697
2008	13	5	752	770	0	752
2009	0	0	1,306	1,306	0	1,306

-continued-

[a] Source: ADF&G, Division of Commercial Fisheries 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 of ADF&G's Division of Commercial Fisheries; includes all reported harvest in Karluk Section.

[c] Total return is weir count plus commercial and subsistence harvest.

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

[e] Escapement is weir count minus recreational harvest.

[f] Recreational harvest does not include harvest below weir of 485 Chinook.

[g] Recreational harvest does not include harvest below weir of 293 Chinook.

[h] Recreational harvest does not include harvest below weir of 393 Chinook.

[I] Recreational harvest does not include harvest below weir of 254 Chinook.

[j] Recreational harvest does not include harvest below weir of 231 Chinook.

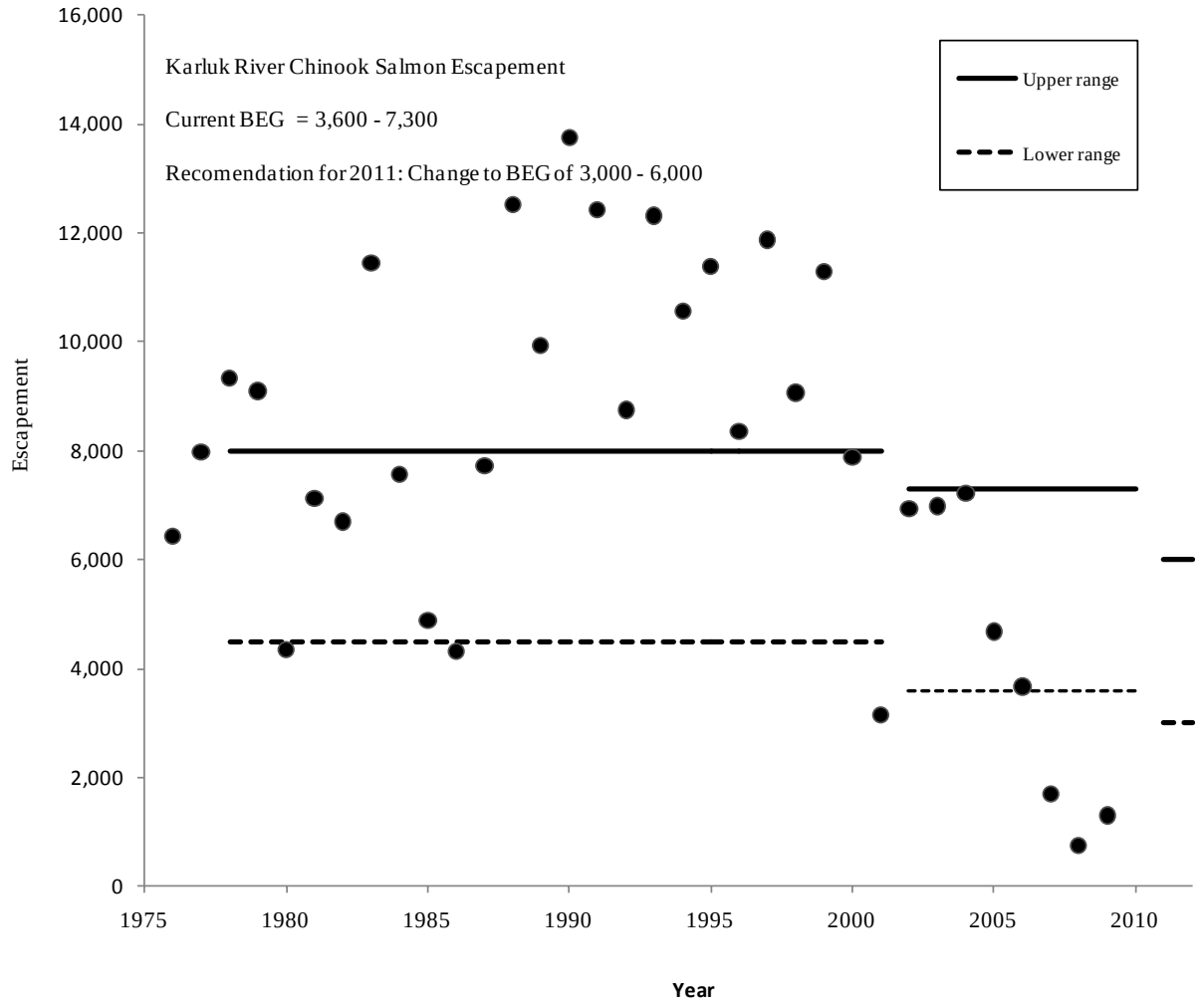
[k] Recreational harvest does not include harvest below weir of 137 Chinook.

Appendix A3.–Karluk River Chinook salmon escapement and escapement goal ranges, 1976 to present.

System: Karluk River

Species: Chinook salmon

Observed escapement by year (weir counts)



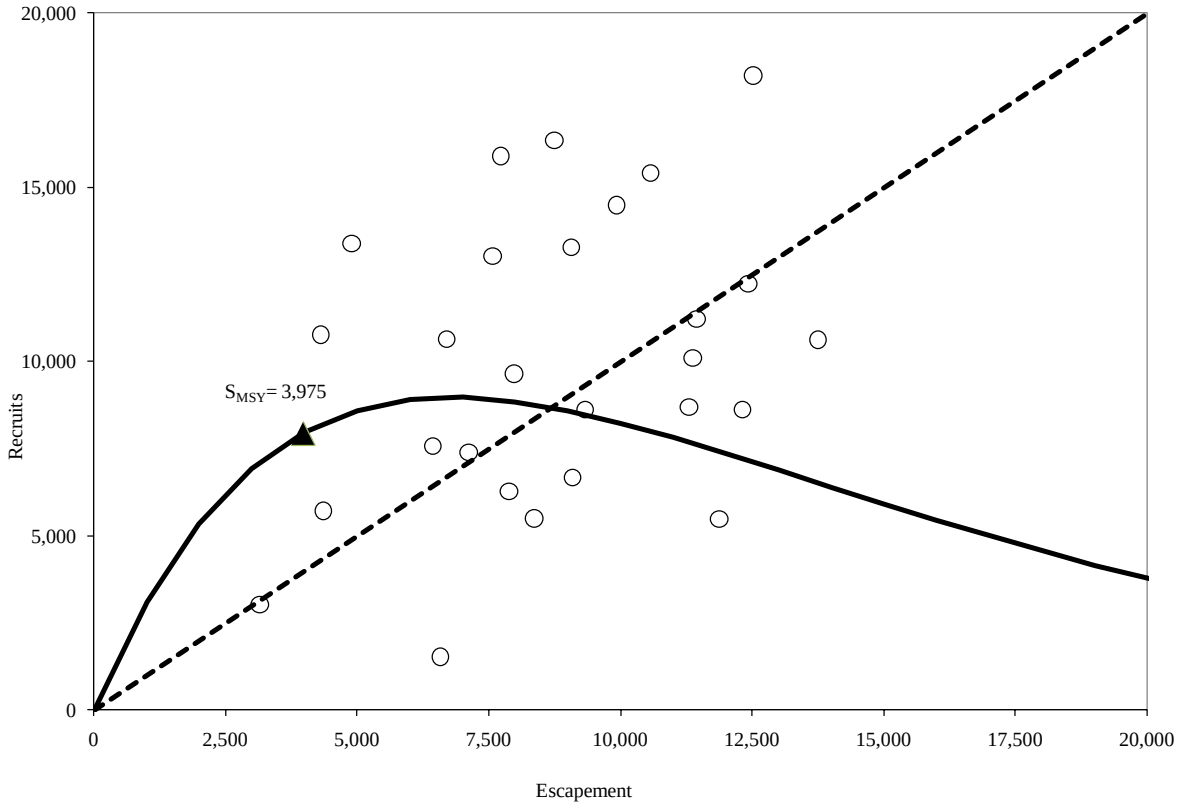
Appendix A4.–Brood table for Karluk River Chinook salmon.

Brood Year	Escapement	Return by age					Total Return	Return/ Spawner
		3	4	5	6	7		
1976	6,436	159	489	2,129	3,879	919	7,575	1.18
1977	7,973	80	771	2,105	6,085	606	9,646	1.21
1978	9,334	126	762	3,301	4,014	420	8,623	0.92
1979	9,094	125	1,195	2,178	2,780	389	6,667	0.73
1980	4,349	196	788	1,508	2,575	645	5,712	1.31
1981	7,114	129	546	1,397	4,270	1,043	7,385	1.04
1982	6,693	89	506	2,317	6,910	820	10,642	1.59
1983	11,442	83	839	3,749	5,431	1,129	11,231	0.98
1984	7,572	137	1,357	2,946	7,481	1,097	13,019	1.72
1985	4,890	222	1,067	4,059	7,264	771	13,383	2.74
1986	4,307	175	1,469	3,941	5,110	77	10,772	2.50
1987	7,731	241	1,427	2,772	10,360	1,098	15,897	2.06
1988	12,518	234	1,004	5,165	10,317	1,484	18,204	1.45
1989	9,925	164	1,352	3,417	8,642	913	14,488	1.46
1990	13,742	77	1,692	2,021	5,950	882	10,621	0.77
1991	12,423	653	1,891	2,751	6,922	0	12,218	0.98
1992	8,745	444	1,921	5,271	7,866	848	16,351	1.87
1993	12,310	115	1,237	1,210	5,938	112	8,612	0.70
1994	10,566	592	1,343	5,938	6,817	707	15,396	1.46
1995	11,373	77	1,272	3,576	4,804	363	10,093	0.89
1996	8,356	141	447	1,554	3,271	89	5,503	0.66
1997	11,869	224	0	2,908	1,778	575	5,485	0.46
1998	9,066	0	2,272	5,246	5,577	178	13,273	1.46
1999	11,297	273	1,689	3,443	2,096	1,203	8,704	0.77
2000	7,879	89	435	2,246	2,840	554	6,264	0.80
2001	3,149	154	680	964	1,109	121	3,028	0.96
2002	6,944	205	263	302	647	119	1,536	0.23
2003	6,986	0	101	81	356			
2004	7,228	0	0	514				
2005	4,684	0	277					
2006	3,673	40						
2007	1,697							
2008	752							
2009	1,306							

Appendix A5.–Fitted Ricker stock-recruitment curves, line of replacement, and actual data for Karluk River Chinook salmon. The solid line represents the Ricker curve and the dashed line represents replacement.

System: Karluk River

Species: Chinook salmon



APPENDIX B. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR AYAKULIK RIVER CHINOOK SALMON.

Appendix B1.–Description of stock and escapement goal 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, 4,800–9,600 (2002)
Recommended escapement goal:	BEG, 4,000–7,000
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1977 to present
Data summary:	
Data quality:	Good escapement and harvest data.
Data type:	Weir estimates, harvest estimates, age composition.
Data contrast:	All survey data 1977 to 2009: 26.12
Methodology:	Bayesian spawner-recruit analysis with an AR(1) productivity term.
Autocorrelation:	Present
Recommendation:	BEG 4,000–7,000.
Comments:	From 2006 through 2009, escapements were within BEG only in 2007

Appendix B2.–Annual harvest, weir count, total return, and escapement estimates for Ayakulik River Chinook salmon, 1977 through 2009.

System: Ayakulik River

Species: Chinook salmon

Return Year	Commercial Harvest[a]	Subsistence Harvest[b]	Weir Count[c]	Total Return	Recreational Harvest[d]	Escapement[e]
1977	361	0	5,163	5,524	0	4,958
1978	615	0	4,739	5,354	0	4,551
1979	70	0	4,833	4,903	0	4,641
1980	0	0	974	974	0	935
1981	473	0	8,018	8,491	0	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	85	37	12,552	12,674	362	12,190
2003	0	14	17,557	17,571	451	17,106
2004	158	16	24,830	25,004	405	24,425
2005	2	8	8,340	8,350	165	8,175
2006	4	37	3,106	3,147	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

-continued-

[a] Source: ADF&G, Division of Commercial Fisheries Statewide Harvest Receipt (fish ticket) database. Commercial harvest is the harvest of Chinook salmon from Inner and Outer Ayakulik statistical areas (256-15 and 256-20) through July 15.

[b] Based on subsistence harvest records maintained by the Westward Region of ADF&G's Division of Commercial Fisheries; includes all reported harvest in Red River Section.

[c] Source ADF&G, Division of Commercial Fisheries Kodiak escapement (weir count) database.

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

[e] Escapement is weir count minus recreational harvest.

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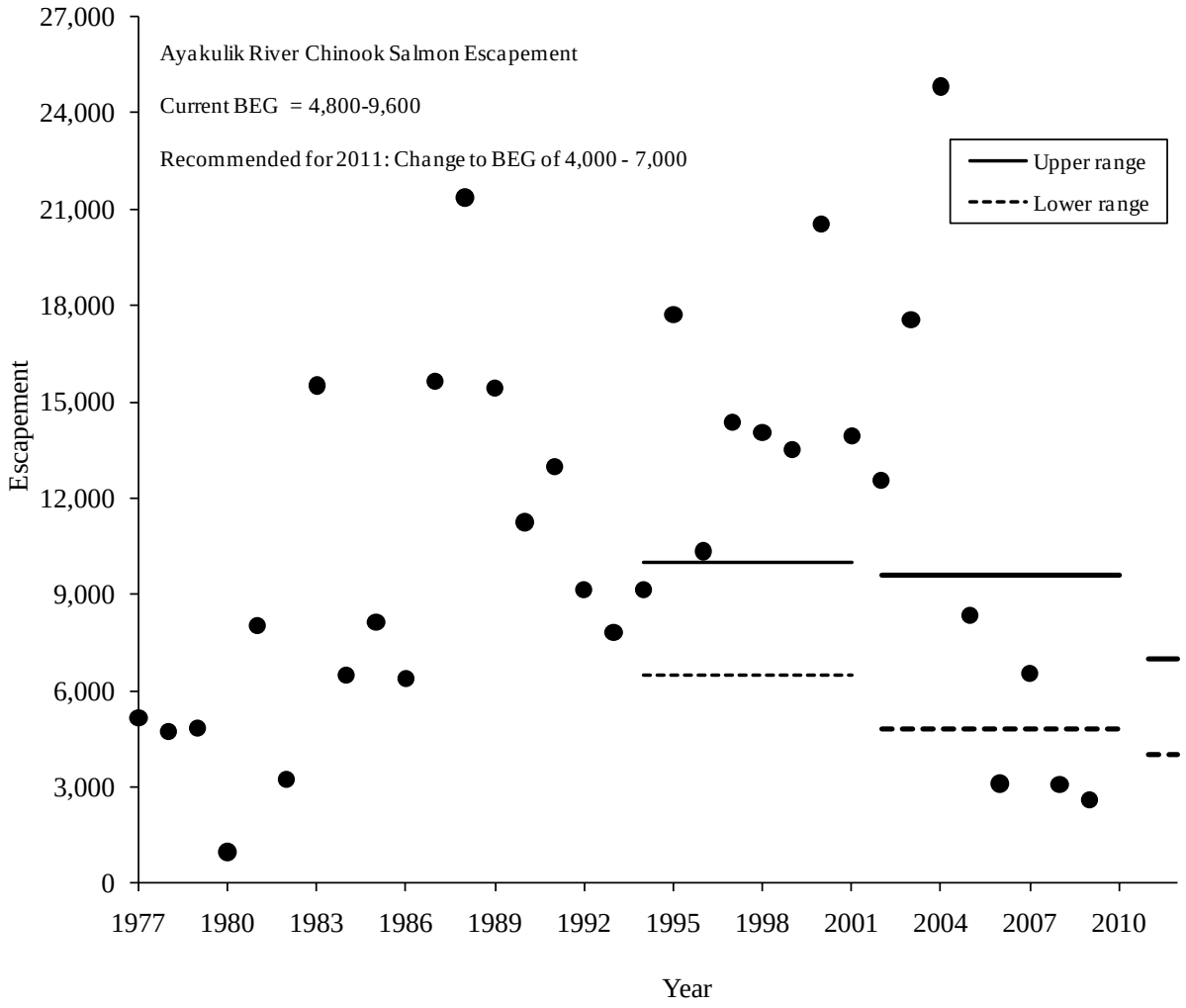
Appendix B3.–Ayakulik River Chinook salmon escapement and escapement goal ranges, 1977 to present.

System: Ayakulik River

Species: Chinook salmon

Observed escapement by year (weir counts)



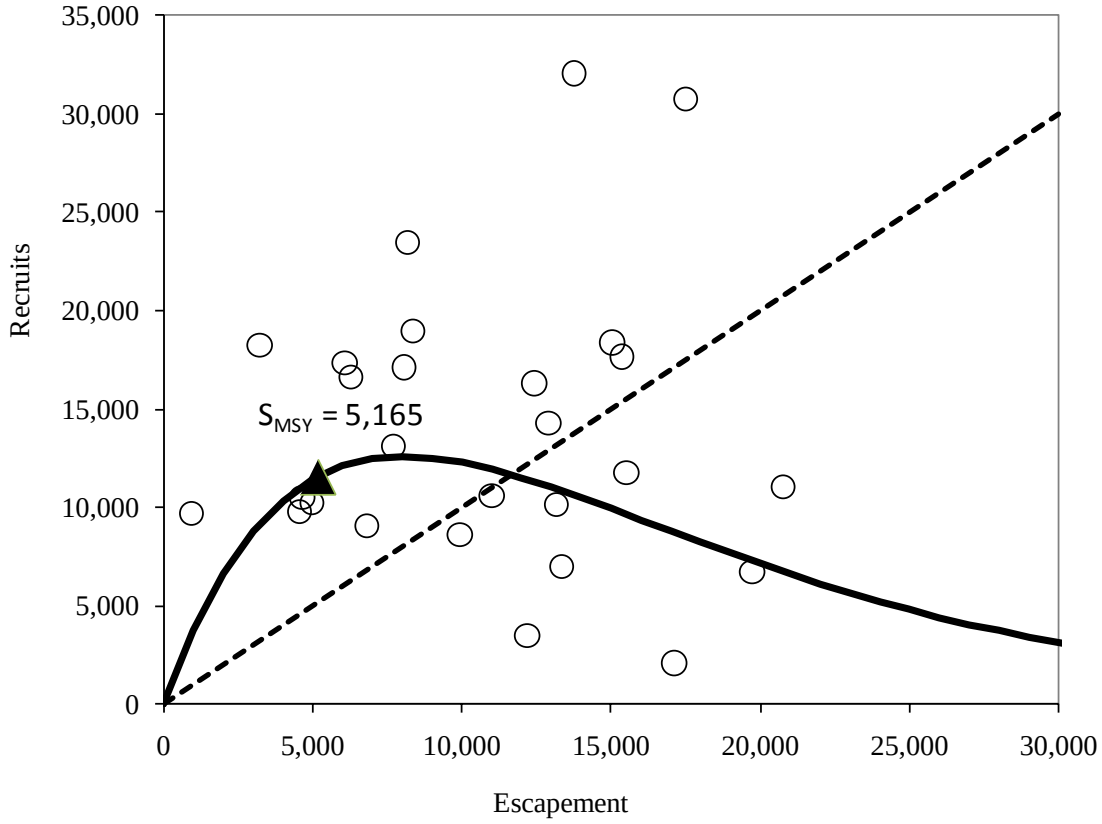
Appendix B4.–Data available for analysis of escapement goal by brood year, Ayakulik River Chinook salmon.

Brood Year	Escapement	Return by age					Total Return	Returns/ Spawner
		3	4	5	6	7		
1977	4,958	44	1,269	963	7,624	333	10,233	2.1
1978	4,551	385	495	4,702	3,729	471	9,783	2.1
1979	4,641	150	2,418	2,300	5,277	343	10,488	2.3
1980	935	733	1,183	3,255	3,845	688	9,703	10.4
1981	7,699	359	1,673	2,371	7,714	993	13,111	1.7
1982	3,230	508	1,219	4,758	11,138	649	18,272	5.7
1983	15,366	370	2,446	6,870	7,275	697	17,658	1.1
1984	6,065	742	3,532	4,487	7,817	743	17,321	2.9
1985	8,075	1,071	2,307	4,822	8,331	590	17,121	2.1
1986	6,295	700	2,479	5,139	6,620	1,695	16,633	2.6
1987	15,510	752	2,642	4,083	4,092	170	11,739	0.8
1988	20,770	801	2,099	1,815	4,769	1,538	11,022	0.5
1989	15,042	637	2,857	2,240	12,084	559	18,376	1.2
1990	10,999	69	974	2,637	6,095	834	10,608	1.0
1991	12,425	988	2,819	3,351	8,732	428	16,318	1.3
1992	8,359	1,040	3,503	2,934	11,288	210	18,975	2.3
1993	6,815	559	1,537	2,140	4,765	58	9,059	1.3
1994	8,190	1,133	2,479	8,439	10,845	567	23,463	2.9
1995	17,501	1,498	3,253	12,315	12,997	702	30,765	1.8
1996	9,925	426	732	3,849	3,519	72	8,599	0.9
1997	13,167	29	1,564	4,244	3,629	705	10,170	0.8
1998	13,779	1,695	3,375	10,300	16,502	192	32,064	2.3
1999	12,894	686	3,504	6,861	3,106	132	14,290	1.1
2000	19,724	67	606	3,666	881	1,506	6,726	0.3
2001	13,361	330	1,035	1,655	3,372	584	6,978	0.5
2002	12,190	359	406	1,382	1,172	146	3,464	0.3
2003	17,106	79	295	880	728	98	2,079	0.1
2004	24,425	0	366	801				
2005	8,175	74	728					
2006	2,937	218						
2007	6,232							
2008	3,071							
2009	2,615							

Appendix B5.–Fitted Ricker stock-recruitment curves, line of replacement, and actual data for Ayakulik River Chinook salmon. The solid line represents the Ricker curve and the dashed line represents replacement.

System: Ayakulik River

Species: Chinook salmon



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:	Commercial Fisheries
Primary fishery:	Commercial purse seine, subsistence, and sport
Current escapement goal:	BEG: 20,000–50,000 (2005)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1921–1933; 1978–2009
	Aerial survey, 1966–1977
Data summary:	
Data quality:	Excellent for weir enumeration 1978–2009; fair for weir counts 1921–1933 and aerial surveys; good for harvest and age data.
Data type:	Weir counts from 1978 to 2009 with escapement age data during weir counts, 1985–2009. Fixed-wing aerial surveys from 1966 to 1977. Commercial, subsistence, sport fish harvest data from Afognak Bay (252–34) from 1978 to 2009.
Data contrast:	Weir and aerial data, all years: 440
	Weir data, all years: 21
	Recent weir data, 1982–2009: 9
	Recent weir data from pre-fertilization years, 1978–1993: 3
Methodology:	Ricker spawner-recruit models, smolt biomass as a function of zooplankton biomass, and euphotic volume models.
Autocorrelation:	None
Criteria for BEG:	Ricker spawner-recruit model.
Recommendation:	Based on the Ricker spawner-recruit analysis and the euphotic volume and zooplankton biomass models, no change to the current of 20,000 to 50,000 sockeye salmon is recommended.

-continued-

Comments:	The BEG estimate was based on a significant relationship from the spawner-recruit data fit to the Ricker model. Limnological data collected from 1989 to 2009 and applied to the zooplankton biomass and euphotic volume models indicates the system is rearing limited. The lake was fertilized from 1990 to 2000 and back-stocked with juvenile sockeye salmon in 1991, 1993, and 1996–1998. Data from post-fertilization years (2001 through 2009) were used in the current analysis because they more accurately reflect current zooplankton production.

Appendix C2.–Afognak Lake sockeye salmon escapement, 1921–2009.

System: Afognak Lake

Species: Sockeye salmon

Data available for analysis of escapement goals

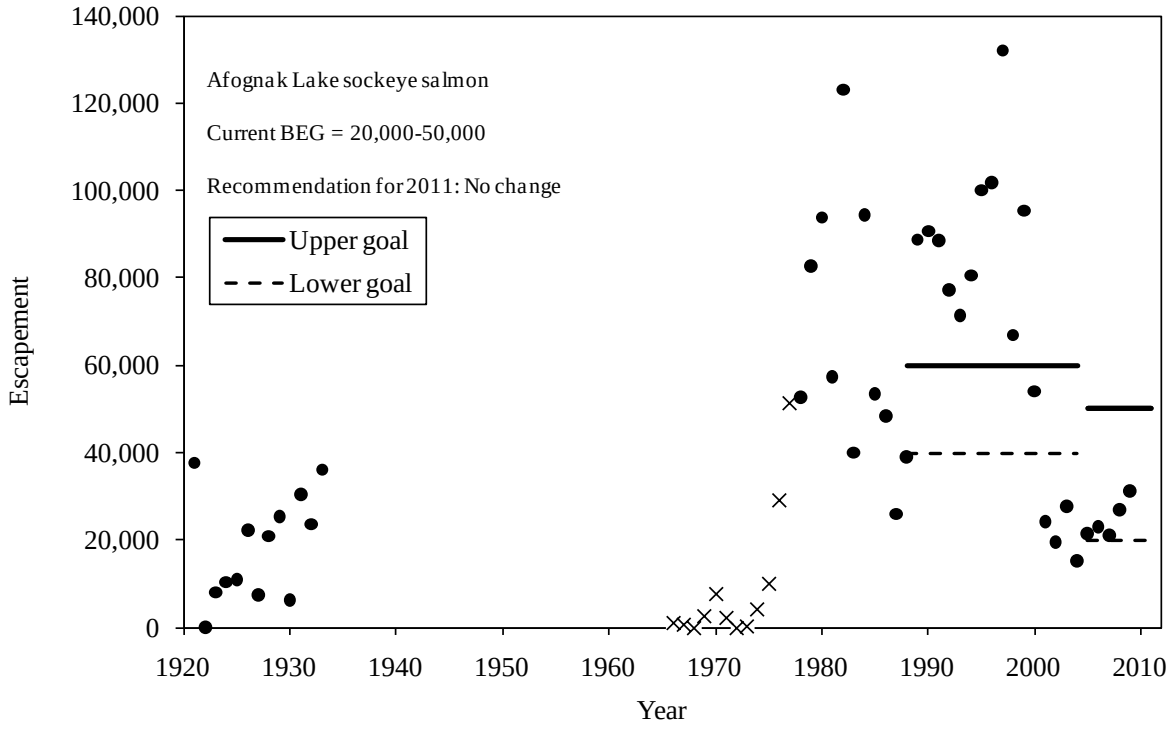
Year	Weir Counts	Peak Aerial Survey	Year	Weir Counts
1921	37,653		1981	57,267
1922	-		1982	123,055
1923	8,025		1983	40,049
1924	10,317		1984	94,463
1925	11,000		1985	53,563
1926	22,250		1986	48,328
1927	7,491		1987	25,994
1928	20,862		1988	39,012
1929	25,428		1989	88,825
1930	6,238		1990	90,666
1931	30,515		1991	88,557
1932	23,574		1992	77,260
1933	36,144		1993	71,460
			1994	80,570
1966		950	1995	100,131
1967		550	1996	101,718
1968		-	1997	132,050
1969		2,600	1998	66,869
1970		7,500	1999	95,361
1971		2,200	2000	54,064
1972		-	2001	24,271
1973		300	2002	19,520
1974		4,300	2003	27,766
1975		10,000	2004	15,181
1976		29,000	2005	21,577
1977		51,300	2006	22,933
1978	52,701		2007	21,070
1979	82,703		2008	26,874
1980	93,861		2009	31,358

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

System: Afognak Lake

Species: Sockeye salmon

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



Appendix C4.–Afognak Lake sockeye salmon brood table.

System: Afognak Lake

Species: Sockeye salmon

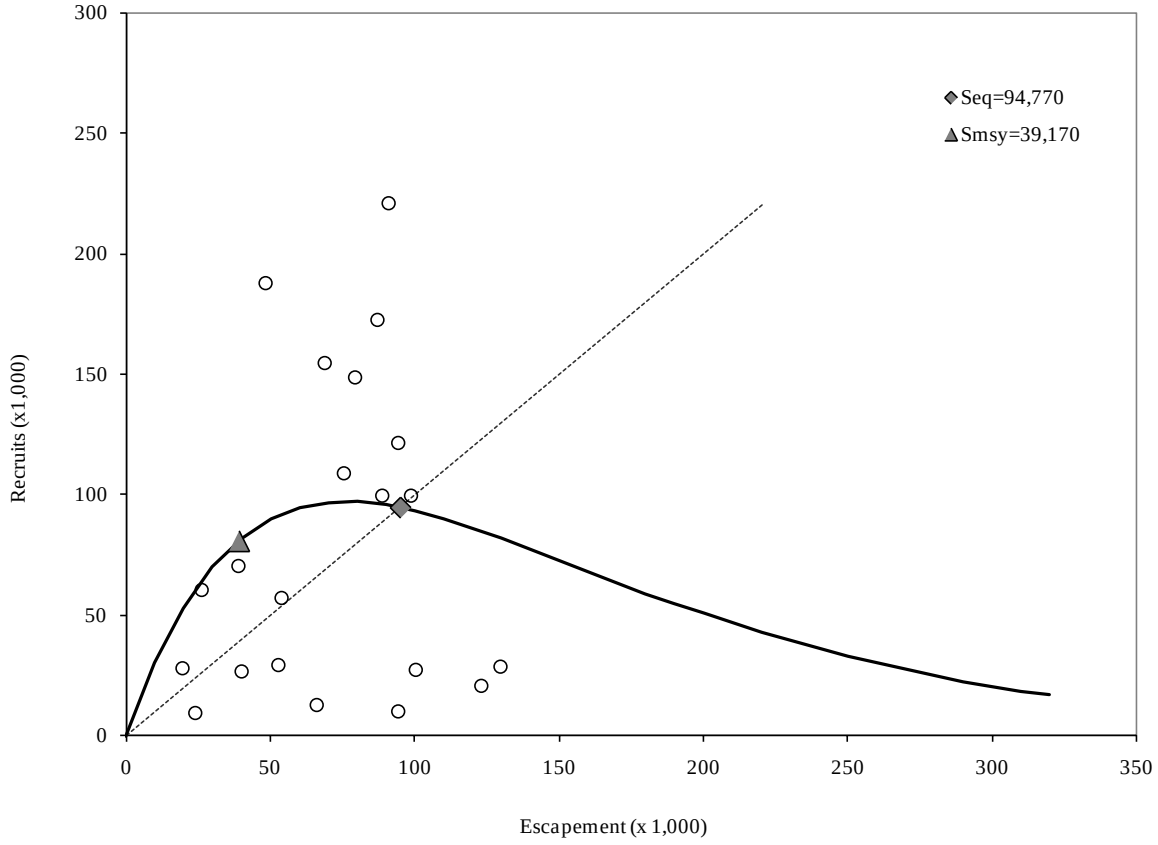
Data available for analysis of escapement goals

Brood		Age Class Returns																Total	
Year	Escapement	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	Return	R/S
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	53,563	36	96	272	0	10,583	2,902	0	26,542	10,030	0	0	6,568	0	0	65	0	57,094	1.07
1986	48,328	0	0	8,022	35	54,737	717	0	108,494	4,958	0	428	10,370	0	0	0	0	187,760	3.89
1987	25,994	0	0	773	0	20,889	313	0	25,139	3,198	99	0	9,772	177	0	0	0	60,359	2.32
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	86,819	0	280	9,681	277	37,463	1,440	0	96,284	4,507	0	48	22,573	0	0	0	0	172,552	1.99
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	68,782	0	0	35,159	0	40,046	10,200	0	47,921	10,364	222	330	8,915	646	0	0	680	154,484	2.25
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	98,609	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	100,266	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	129,481	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	0.20
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	52,648	0	0	1,173	0	6,971	26	0	18,560	495	0	36	2,199	0	0	0	0	29,460	0.56
2001	23,940	0	0	177	164	2,258	142	0	5,176	608	0	8	1,202	0	0	0	0	9,735	0.41
2002	19,334	0	0	716	20	14,769	0	0	11,665	435	0	1	196	0	0	0	0	27,802	1.44
2003	27,448	0	0	580	0	7,074	71	0	14,358	1,054	0	1	890	0	0				
2004	15,181	0	0	1,105	0	11,631	90	0	15,538	710	0								
2005	20,281	0	0	1,238	0	13,151	911												
2006	21,488	0	0	1,492															
2007	20,066	0																	
2008	26,052																		
2009	31,358																		

Appendix C5.–Fitted Ricker spawner-recruitment curves, line of replacement, and actual data Afognak Lake sockeye salmon for brood years 1982 through 2002. The solid line represents the Ricker curve, and the dotted line represents replacement.

System: Afognak Lake

Species: Sockeye salmon



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, sport, and subsistence
Current escapement goal:	SEG: 200,000–500,000 (2005)
Recommended escapement goal:	Early-run SEG: 140,000–280,000
	Late-run SEG: 60,000–120,000
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1929–1961 (variable); 1962–2009
Data summary:	
Data quality:	Excellent for weir enumeration 1962–2009; fair for weir counts 1929–1961; good for harvest and age data.
Data type:	Weir counts from 1962 to 2009 with escapement age data during weir counts. Harvest estimates with age data 1970–2009. Limnology information 1990–1996, 2009.
Data contrast:	Weir data, all years: 40.1
	Weir data, 1970–2009: 22.9
Methodology:	Ricker spawner-recruit models, smolt biomass as a function of zooplankton biomass, and euphotic volume models.
Autocorrelation:	None
Criteria for SEG:	Limnology models and historical escapement
Recommendation:	Reinstitute separate early- (140,000–280,000) and late- run (60,000–120,000) SEGs based on limnology models and historical temporal escapement observations.
Comments:	Estimating quality productivity parameters from the spawner-recruit model will likely be problematic until more escapement data points are seen between 400,000 and 700,000. Separate early- and late-run goals are important to protect the different temporal components of the run.

Appendix D2.–Ayakulik River sockeye salmon escapement and harvest estimates, 1929–2009.

System: Ayakulik River

Species: Sockeye salmon

Data available for analysis of escapement goals

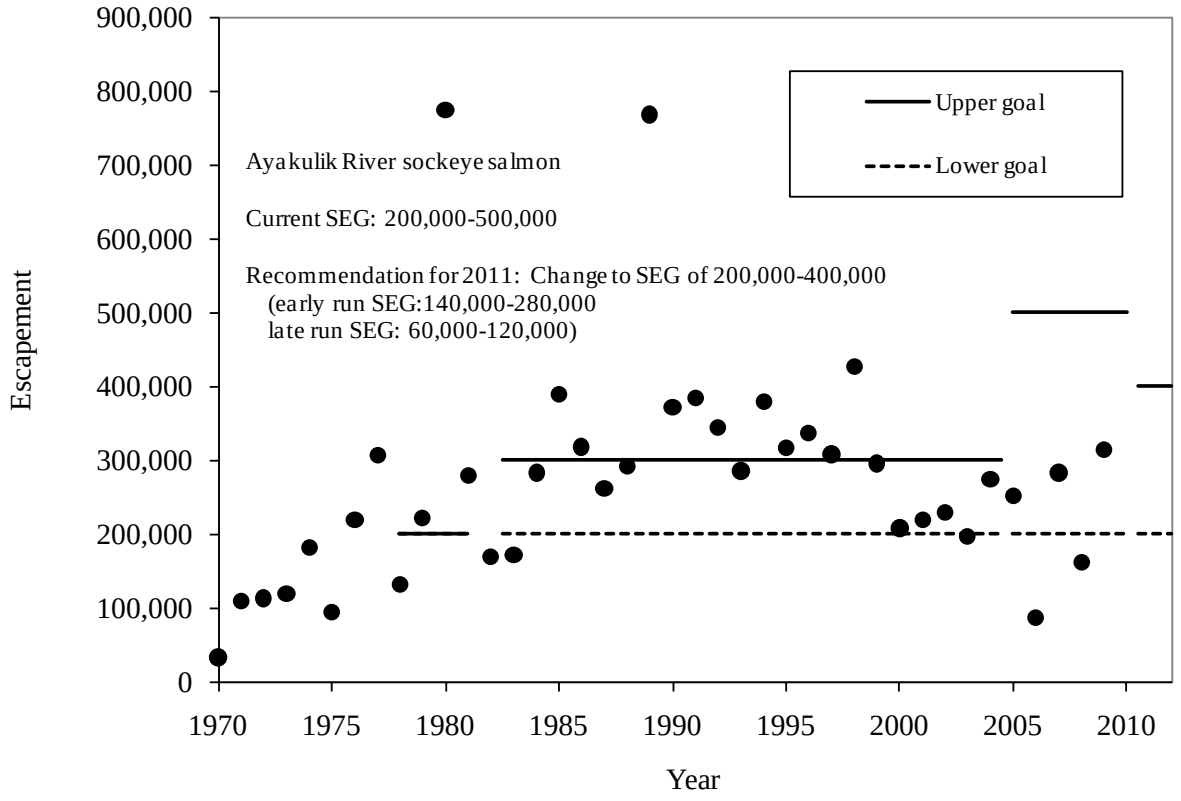
Year	Weir Counts	Commercial Harvest	Year	Weir Counts	Commercial Harvest
1929	28,867		1974	181,631	43,251
1930	133,786		1975	94,517	0
1931	620,993		1976	219,047	132,805
1932	498,523		1977	306,982	165,424
1934	1,160,296		1978	132,864	178,080
1935	514,967		1979	222,270	31,901
1936	491,372		1980	774,328	208,281
1937	253,994		1981	279,200	177,795
1938	186,503		1982	169,678	102,075
1939	184,507		1983	171,415	25,003
1940	284,633		1984	283,215	392,218
1941	280,836		1985	388,759	517,250
1942	285,045		1986	318,135	415,848
1945	429,883		1987	261,913	119,459
1946	170,355		1988	291,774	312,132
1948	218,229		1989	768,101	0
1949	101,625		1990	371,282	1,467,737
1950	176,619		1991	374,859	926,419
1953	121,654		1992	344,184	404,246
1954	107,369		1993	286,170	338,727
1955	85,832		1994	380,181	41,331
1956	71,573		1995	317,832	565,040
1957	154,895		1996	337,155	906,897
1958	94,855		1997	308,214	135,595
1959	75,100		1998	427,208	1,018,898
1960	34,614		1999	295,717	693,912
1962	278,954		2000	208,651	236,190
1963	63,563		2001	218,892	367,522
1964	36,342		2002	229,292	6,505
1965	75,356		2003	197,892	90
1966	71,159		2004	275,238	170,749
1967	224,200		2005	251,906	53,835
1968	220,850		2006	87,780	32,325
1970	33,868	28,306	2007	283,042	99,937
1971	109,199	0	2008	162,888	81,540
1972	113,733	46,733	2009	315,184	70,588

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

System: Ayakulik River

Species: Sockeye salmon

Observed escapement by year (circles).



Appendix D4.–Ayakulik River sockeye salmon brood table.

Brood		Age															Total	
Year	Escap.	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	Return	R/S
1968	220,850	0	0	83	0	4,199	2,825	0	34,463	89,549	0	0	123,053	8,493	0	0	0	262,665	1.2
1969	71,160	0	0	0	0	4,756	3,703	0	3,704	78,972	0	0	13,734	652	0	0	0	105,523	1.5
1970	33,863	0	0	0	0	1,084	6,325	0	2,052	17,543	0	0	9,152	3,274	0	0	0	39,429	1.2
1971	109,174	0	0	3,251	0	35,919	18,925	0	26,505	184,053	0	0	16,736	3,364	0	0	0	288,753	2.6
1972	113,733	0	0	5,080	0	121,160	6,723	0	99,681	260,325	0	0	71,225	0	0	0	0	564,194	5.0
1973	119,993	0	0	986	1,395	79,993	7,548	0	82,532	110,906	0	0	45,469	1,393	0	0	0	330,221	2.8
1974	181,631	0	0	3,364	0	46,281	0	0	45,109	129,000	0	0	221,923	3,892	0	0	0	449,570	2.5
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	0	0	0	0	382,085	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
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	112	1,265,306	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		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					
2004	275,238	0	0	2,445	3,358	24,944	5,073	152	59,544	163,974	0								
2005	251,906	0	67	5,423	694	99,530	13,239												
2006	87,780	0	0	8,645															
2007	283,042	0																	
2008	162,888																		
2009	315,184																		
																	10 year average (1992-2001):	524,009	1.6

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:	SEG, 8,000 –13,000 (1996)
Recommended escapement goal:	Change from SEG to BEG (5,000–8,000)
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 1997 to 2009: 4.05
Methodologies:	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 an escapement range of 5,000–8,000.
Autocorrelation:	Present
Recommendation:	Change to BEG of 5,000 –8,000.
Comments:	Escapements in 2008 and 2009 were within the range of the recommended BEG.

Appendix E2.–Buskin River sockeye salmon estimated escapement and total run, 1997–2009.

System: Buskin River

Species: Sockeye salmon

Data available for analysis of escapement goals

Return Year	Escapement[a]	Commercial Harvest[b]	Subsistence Harvest[c]	Recreational Harvest[d]	Total Return
1997	9,798	0	5,890	1,843	17,531
1998	14,746	0	6,011	1,983	22,740
1999	10,809	0	7,985	1,467	20,261
2000	11,223	0	7,315	2,041	20,579
2001	20,556	0	10,260	827	31,643
2002	17,174	0	13,366	2,204	32,744
2003	23,870	6	10,651	3,017	37,544
2004	22,023	1,098	9,421	1,379	33,921
2005	15,468	0	8,239	1,540	25,247
2006	17,734	6	7,577	1,577	26,894
2007	16,502	30	11,151	1,509	29,192
2008	5,900	0	2,664	1,160	9,724
2009	7,757	0	1,853	695	10,305

[a] Escapement is the estimated count to the weir at Buskin Lake.

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

[c] Subsistence harvest data maintained by Westward Region of ADF&G's Division of Commercial Fisheries

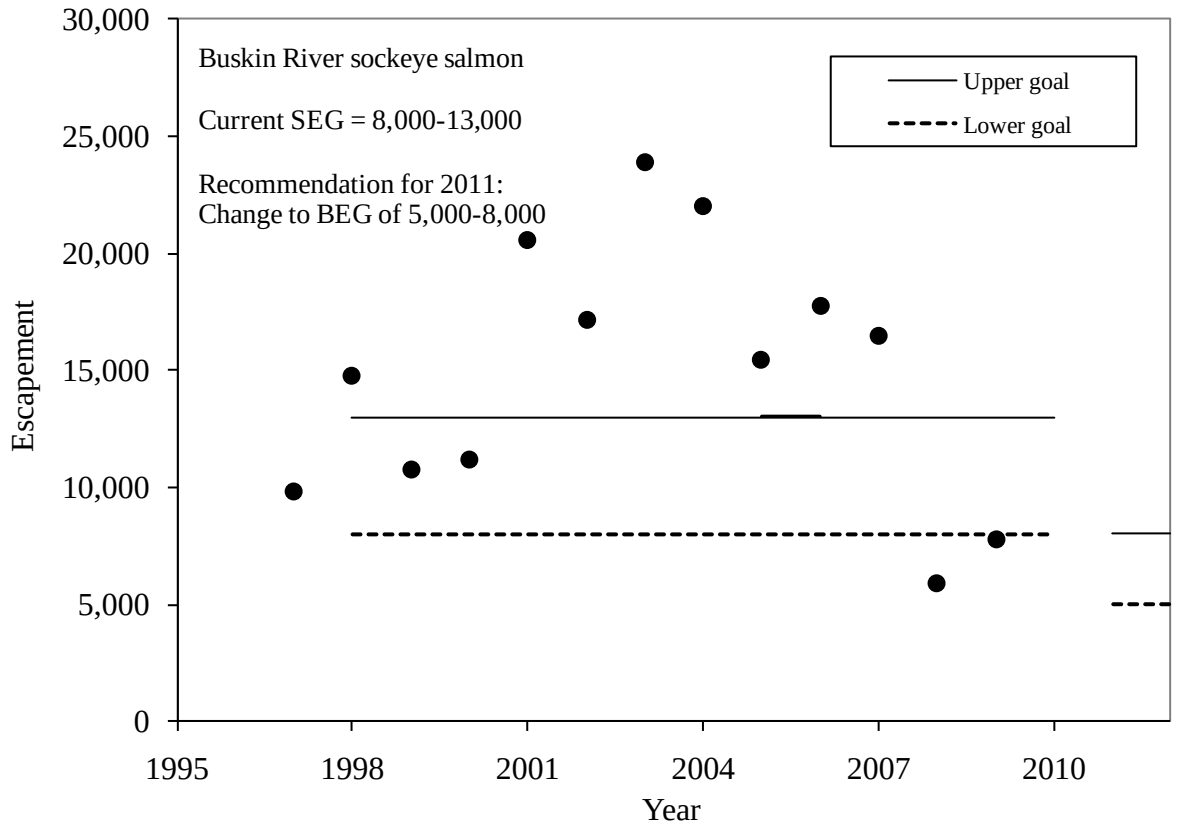
[d] Recreational harvest from SWHS.

Appendix E3.–Buskin River sockeye salmon escapement and escapement goals, 1997 to present.

System: Buskin River

Species: Sockeye salmon

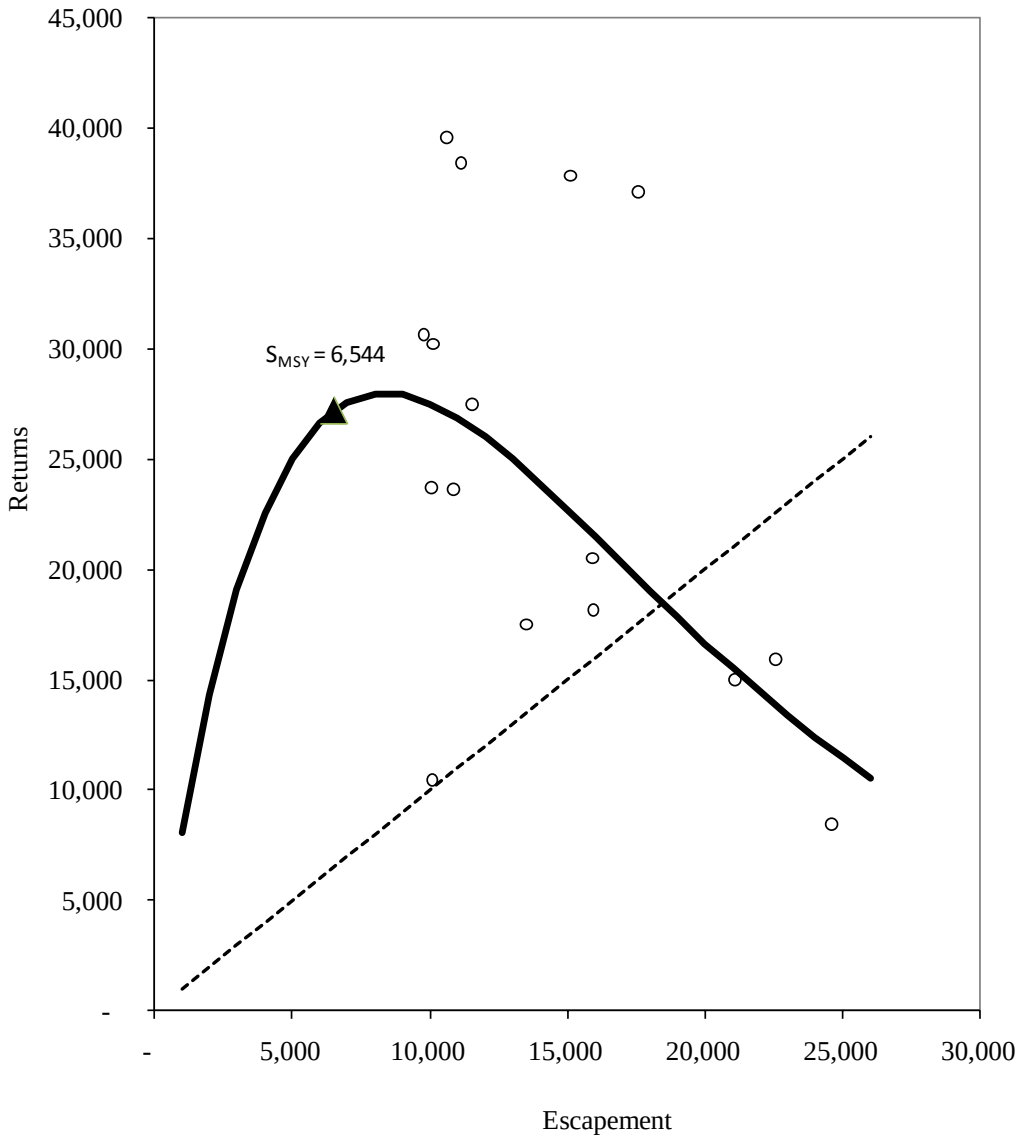
Observed escapement by year (weir counts)



Appendix E4.–Fitted Ricker spawner-recruit curves, line of replacement, and actual data for Buskin Lake sockeye salmon. The solid line represents the Ricker curve, and the dotted line represents replacement.

System: Buskin Lake

Species: Sockeye salmon



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 (2007)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1956–2009
Data summary:	
Data quality:	Excellent for weir counts; good for harvest and age data.
Data type:	Weir counts from 1956 to 2009 with escapement age data during weir counts. Weir counts through Dog Salmon Creek (1985–2009). Total run estimates with age data 1974–2009. Limnology information 1985–1997, and 2001–2009
Data contrast:	30.7 (weir data from 1966 through 2002)
Methodology:	Ricker spawner-recruit models, smolt biomass as a function of zooplankton biomass, and euphotic volume models.
Autocorrelation:	None
Criteria for SEG:	None
Recommendation:	No change to current goals.
Comments:	Significant spawner-recruit model resulted in an estimated S_{MSY} of 117,000 fish, corroborating the current BEG.

Appendix F2.–Frazer Lake sockeye salmon escapement and total run estimates, 1968–2009.

System: Frazer Lake

Species: Sockeye salmon

Data available for analysis of escapement goals

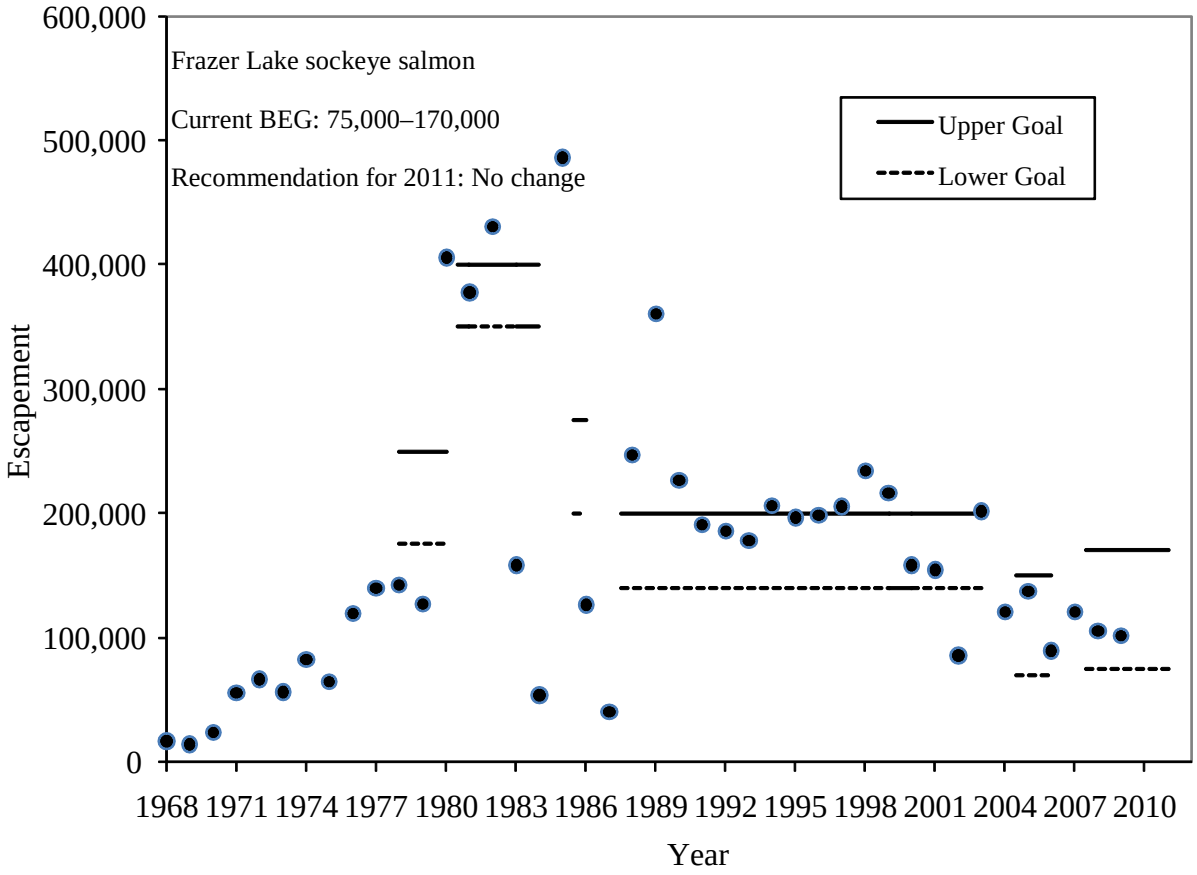
Year	Weir Counts	Total Run
1968	16,738	
1969	14,041	
1970	24,039	
1971	55,366	
1972	66,419	
1973	56,255	
1974	82,609	85,374
1975	64,199	67,499
1976	119,321	128,091
1977	139,548	140,914
1978	141,981	172,317
1979	126,742	153,547
1980	405,535	460,708
1981	377,716	487,926
1982	430,423	506,655
1983	158,340	196,323
1984	53,524	67,377
1985	485,835	637,871
1986	126,529	178,205
1987	40,544	57,582
1988	246,704	458,461
1989	360,373	1,070,871
1990	226,707	979,833
1991	190,358	1,268,145
1992	185,825	418,773
1993	178,391	751,405
1994	206,071	650,045
1995	196,323	952,377
1996	198,695	700,913
1997	205,264	416,419
1998	233,755	606,343
1999	216,565	357,079
2000	158,044	394,705
2001	154,349	403,372
2002	85,317	110,225
2003	201,679	313,914
2004	120,664	712,251
2005	136,948	625,937
2006	89,516	117,900
2007	120,186	168,571
2008	105,363	520,603
2009	101,845	474,976

Appendix F3.–Frazer Lake sockeye salmon escapement and escapement goal ranges, 1968 to present.

System: Frazer Lake

Species: Sockeye salmon

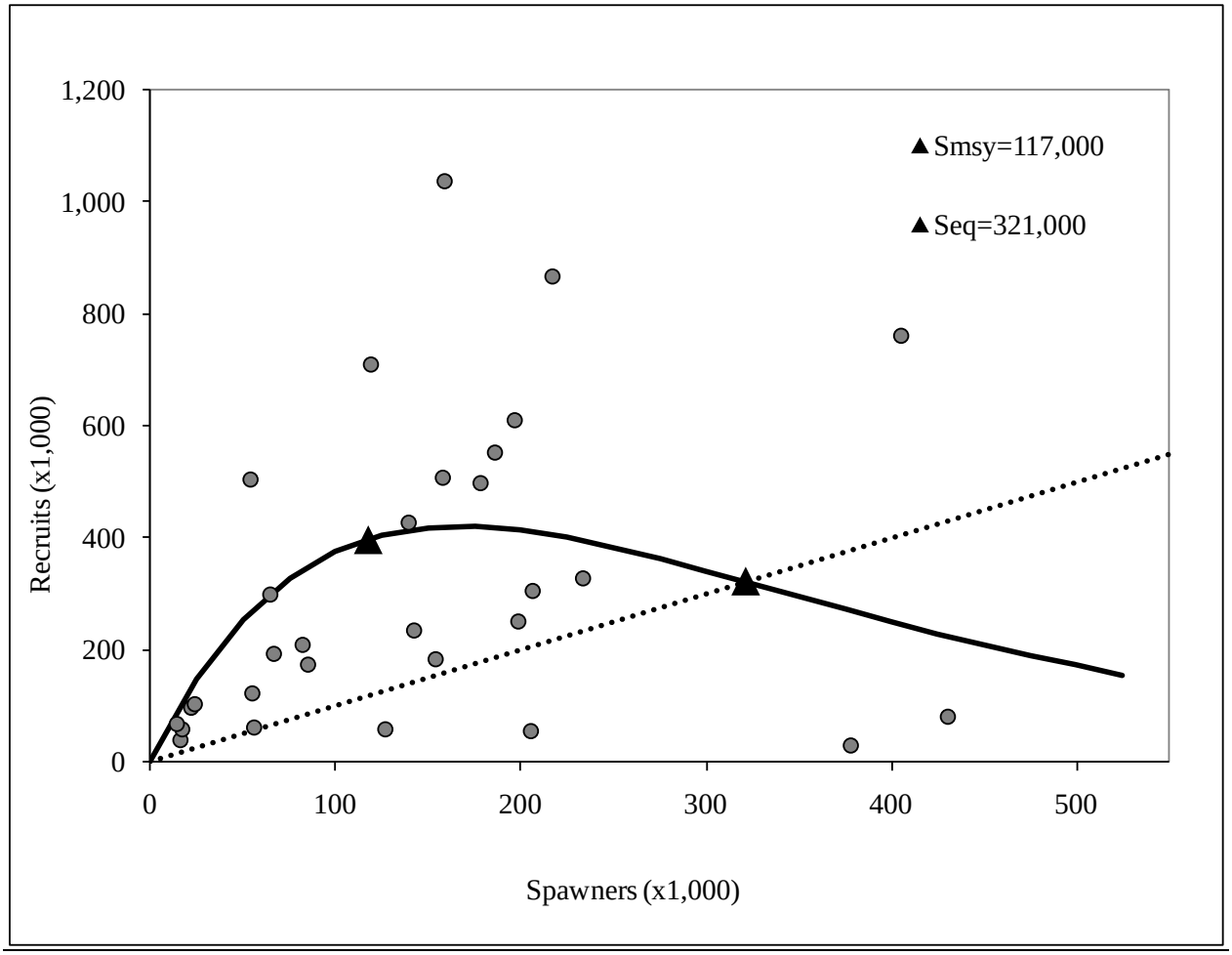
Observed escapement by year (circles).



Appendix F4.–Fitted Ricker stock-recruitment curves, line of replacement, and actual data for Frazer Lake sockeye salmon. The solid line represents the Ricker curve, and the dotted line represents replacement. Data for brood years 1968 through 2002, excluding brood years 1985 through 1991 because they were affected by fertilization.

System: Frazer Lake

Species: Sockeye salmon



Appendix F5.–Frazer Lake sockeye salmon brood table. Escapements taken from Dog Salmon weir to include all fish returning to watershed.

Brood		Age																Total	
Year	Escap.	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	Return	R/S
1966	16,456	0	0	0	11,820	1,732	7,580	16,149	0	0	2,629	0	0	0	0	0	0	39,910	2.4
1967	21,834	0	1,118	0	38,626	395	38,395	11,553	0	0	5,114	0	0	0	0	0	0	95,202	4.4
1968	16,738	0	461	0	15,565	899	15,228	14,998	0	0	10,757	0	0	0	0	0	0	57,910	3.5
1969	14,041	0	138	0	14,654	5,229	9,306	30,137	0	0	6,007	0	0	0	0	512	0	65,984	4.7
1970	24,039	0	2,241	0	17,672	16,989	1,687	51,299	0	0	9,351	3,074	0	0	0	1,691	0	104,005	4.3
1971	55,366	0	512	0	1,417	6,345	769	92,226	0	0	20,151	0	0	0	0	0	0	121,419	2.2
1972	66,419	0	742	0	10,888	11,016	8,032	91,876	0	0	71,167	345	0	0	0	0	0	194,066	2.9
1973	56,255	0	256	0	2,677	5,637	4,825	31,706	345	0	15,969	0	0	0	0	0	0	61,415	1.1
1974	82,609	0	10,850	0	53,591	9,305	28,713	75,084	154	461	30,407	461	0	0	0	0	0	209,026	2.5
1975	64,199	0	1,034	0	22,571	8,906	20,732	173,687	0	0	72,701	0	0	0	0	0	0	299,631	4.7
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	815	0	5,387	0	608,857	3.1
1996	198,695	0	20,062	0	41,983	22,276	81,667	32,786	26	1,641	50,325	101	0	191	0	201	0	251,259	1.3
1997	205,264	0	626	0	8,327	1,639	9,831	14,560	231	630	15,665	2,251	0	0	0	0	77	53,837	0.3
1998	233,755	0	367	0	1,374	24,808	14,710	87,861	16,454	0	57,957	88,617	0	366	0	33,880	0	326,394	1.4
1999	216,565	0	1,152	0	3,507	136,968	77	481,220	0	0	241,075	1,299	0	496	0	2,090	97	867,981	4.0
2000	158,044	0	35,476	0	68,494	15,072	219,630	107,018	0	521	58,178	330	0	547	233	289	521	506,309	3.2
2001	154,349	0	814	0	21,700	557	5,639	3,657	23,842	131	11,476	29,633	293	776	718	81,003	1,501	181,739	1.2
2002	85,317	0	335	0	5,659	14,124	5,844	27,492	11,173	0	44,559	35,868	0	415	0	29,071		174,542	2.0
2003	201,679	0	3,365	0	8,565	58,042	16,372	170,743	2,948	0	81,058	31,271	0						
2004	120,664	0	14,757	0	148,241	16,861	90,953	197,458	0										
2005	136,949	0	1,993	0	34,005	9,131													
2006	89,516	0	113																
2007	120,185																		
2008	105,363																		
2009	147,798																		
																	10-Year Average (1993-2002):	377,357	2.1

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 set gillnet
Current escapement goal:	Early-run BEG: 110,000–250,000 (2007)
	Late-run BEG: 170,000–380,000 (2005)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts: 1922–2009
Data summary:	
Data quality:	Good
Data type:	Weir counts from 1922 to 2009. Age compositions and stock-specific harvest 1985–2009. Rough estimates of harvest attributed to both runs combined, 1922–2009. Smolt outmigration estimates 1961–68, 1980–84, 1991–92, and 1999–2006. Limnology information 1981–2009.
Data contrast:	Weir data 1981–2009: early (8.7), late (19.9)
Methodology:	Ricker spawner-recruit
Recommendations:	No change to current early-run BEG
	No change to current late-run BEG
Comments:	Despite recent low runs, the early-run returns of completed brood years available for this analysis were similar to the recent past. Spawner-recruit analysis yielded results similar to previous analyses. The late-run returns were similar to previous years and the committee recommended leaving the goal unchanged. Brood years 1981–1995 may be affected by fertilization (1986–1990) and egg stocking (1979–1987).

Appendix G2.–Karluk Lake early-run sockeye salmon escapement, 1981–2009.

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	70,750
2009	52,466	16,053

Appendix G3.–Karluk Lake late-run sockeye salmon escapement, 1981–2006.

System: Karluk Lake late run

Species: Sockeye salmon

Data available for analysis of escapement goals

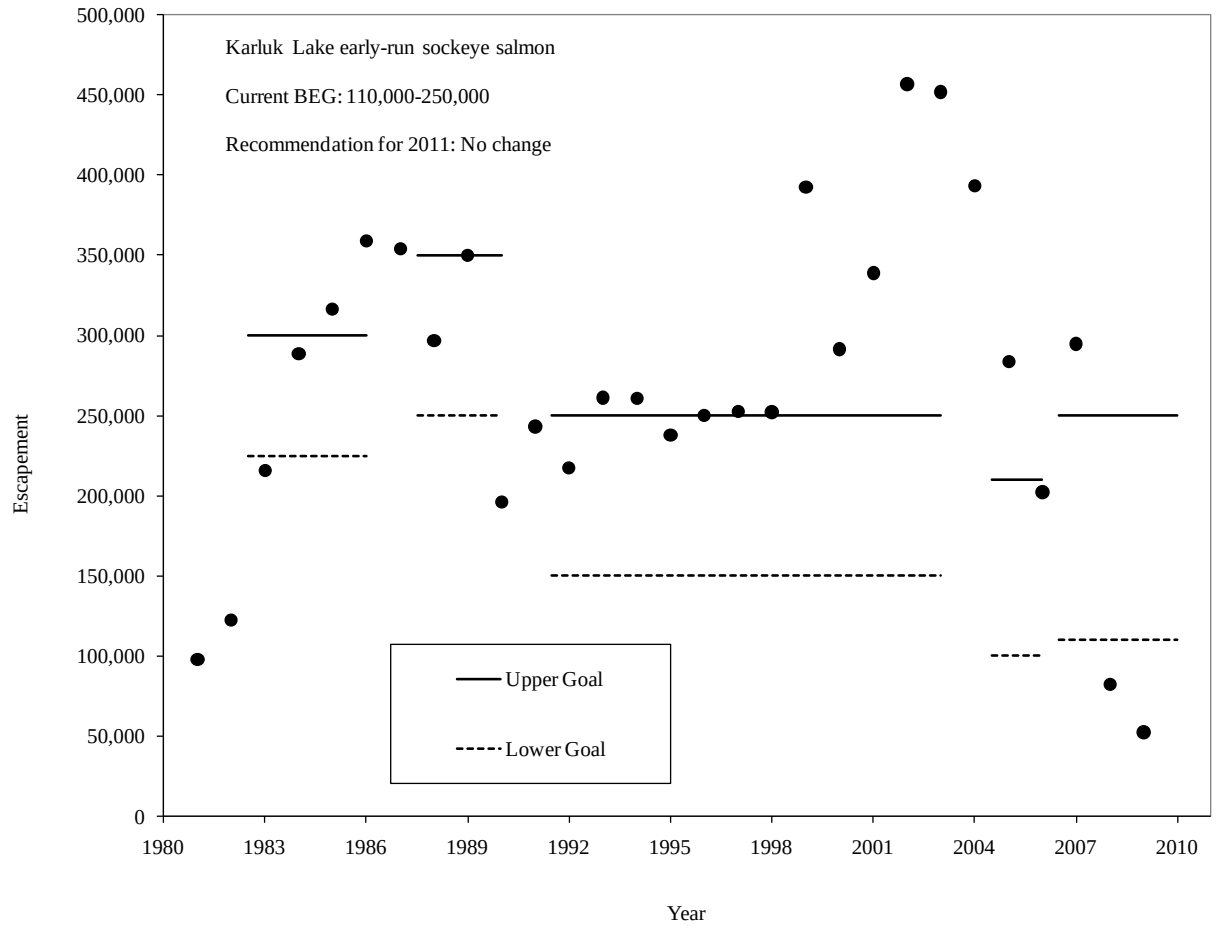
Year	Weir Counts	Commercial Harvest
1981	124,769	
1982	41,702	
1983	220,795	
1984	131,846	
1985	679,260	168,328
1986	528,415	297,042
1987	412,157	170,019
1988	282,306	127,721
1989	758,893	3,476
1990	541,891	990,660
1991	831,970	1,097,830
1992	614,262	442,692
1993	396,288	235,361
1994	587,258	106,325
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	267,185	469,776
2008	164,419	130,588
2009	277,611	52,503

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

System: Karluk Lake early run

Species: Sockeye salmon

Observed escapement by year (circles).

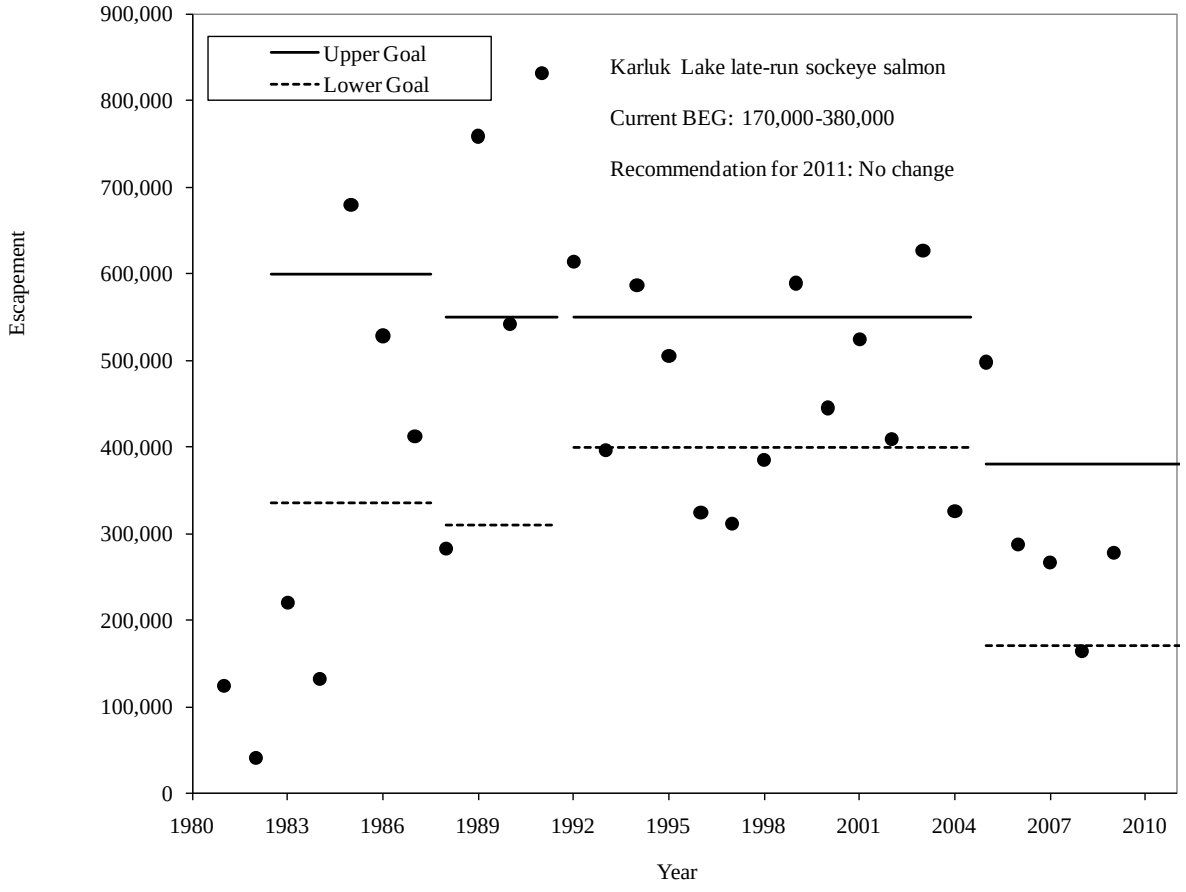


Appendix G5.–Karluk Lake late-run sockeye salmon escapement and escapement goals, 1981 to present.

System: Karluk Lake late run

Species: Sockeye salmon

Observed escapement by year (circles).



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

Brood		Ages																			Total	Return/
Year	Escap.	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	Return	Spawner
1976	204,037																				0		
1977	185,312																	0	0	0	0		
1978	248,741														0	10,989	0	0	0	0	0		
1979	212,872										0	50,484	45,654	0	641	14,673	0	0	0	0	0		
1980	132,396						0	11,635	193,760	4,085	0	103,899	60,395	0	0	37,689	0	0	0	0	0		
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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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			
2002	456,842	0	78	0	4,894	11,188	0	7,592	69,773	1,251	99	59,363	12,086	0	698	4,882	0						
2003	451,856	0	0	286	2,237	9,403	0	1,150	30,926	638	49	15,852	15,878	621									
2004	393,468	760	0	99	196	390	0	946	17,044	4,700													
2005	283,860	0	279	0	6,029	1,257																	
2006	202,366	0	0																				
2007	294,740																						
2008	82,191																						
2009	52,466																						

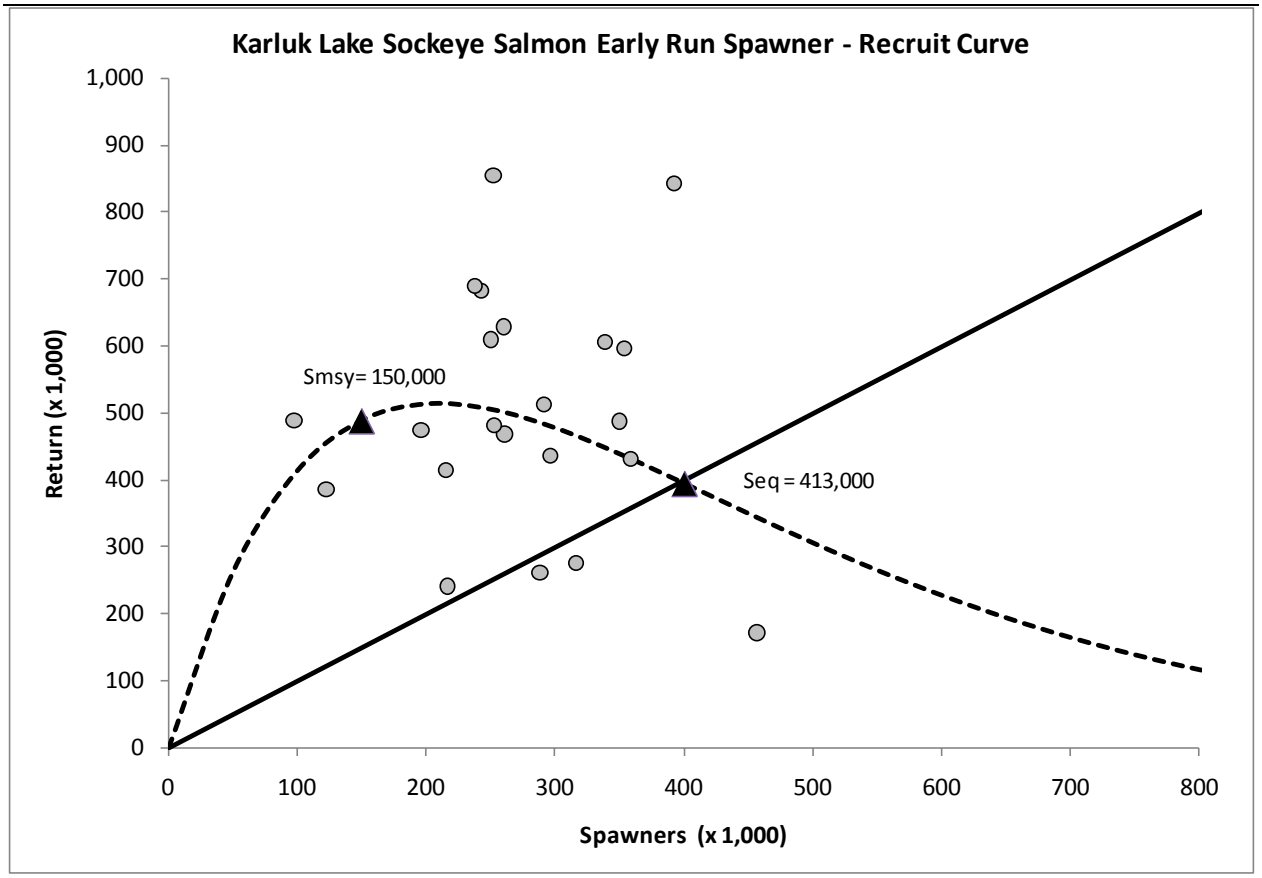
Appendix G7.–Karluk Lake late-run sockeye salmon brood table.

Brood		Ages																				Total	Return/
Year	Escap.	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	Return	Spawner
1976	319,459																					0		
1977	366,936																		0	0	0	0		
1978	112,194															0	6,728	0	0	0	0	0		
1979	248,908											0	54,171	167,426	0	0	85,143	0	0	0	0	0		
1980	14,227							0	446	596,053	4,476	0	156,074	177,587	0	1,190	25,537	0	0	0	0	0		
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	5.4
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	11.1
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	2.6
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	8.4
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	2.7
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	3.4
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	1.6
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	1.8
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	1.0
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	1.3
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	0.8
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	0.5
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	1.9
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	1.7
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	1.9
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	2.1
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	3.4
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	3.1
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	1.5
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	2.3
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			
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						
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									
2004	326,466	0	277	5	301	1,998	510	0	543	15,162	10,973													
2005	498,102	0	3,532	63	0	423	2,022																	
2006	288,007	0	0	15																				
2007	267,185	0																						
2008	164,419																							
2009	277,611																							

Appendix G8.–Fitted Ricker spawner-recruit curve, line of replacement, and actual data for Karluk Lake early-run sockeye salmon, brood years 1981 through 2002. The dashed line represents the Ricker curve, and the solid straight line represents replacement.

System: Karluk Lake early run

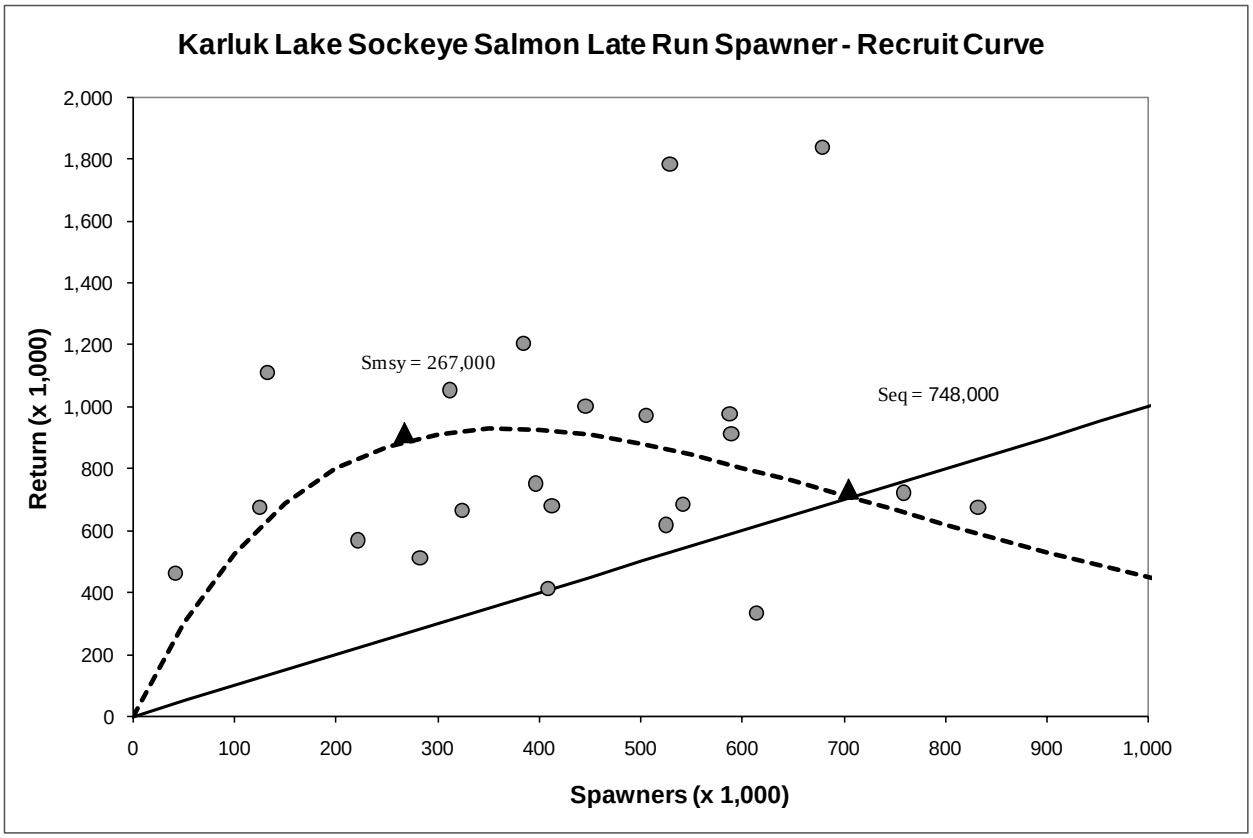
Species: Sockeye salmon



Appendix G9.–Fitted Ricker spawner-recruit curve, line of replacement, and actual data for Karluk Lake late-run sockeye salmon. The dashed line represents the Ricker curve, and the solid straight line represents replacement.

System: Karluk Lake late run

Species: Sockeye salmon



APPENDIX H. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR LITTLE RIVER SOCKEYE SALMON

Appendix H1.–Description of stock and escapement goal for Little River sockeye salmon.

System: Little 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 and gillnet
Current escapement goal:	Lower-bound SEG: 3,000 (2007)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Aerial surveys: 1968–1972, 1974–2009, weir counts 2001–2003
Data summary:	
Data quality:	Fair for aerial surveys, good for weir counts
Data type:	Fixed-wing aerial surveys with peak surveys from 1968 to 2009, and weir counts 2001 to 2003. No stock-specific harvest information is available.
Data contrast:	All survey data 1968 to 2009: 41.0
Methodology:	Percentile method
Autocorrelation:	None
Recommendation:	No change to lower-bound SEG of 3,000 fish.
Comments:	Examination of aerial survey intensity and timeframes suggested the current perceived downturn in productivity is real and not merely a function of decreased effort or conditions.

Appendix H2.–Little River sockeye salmon aerial survey and weir count estimates, 1968–2009.

System: Little River

Species: Sockeye salmon

Data available for analysis of escapement goals

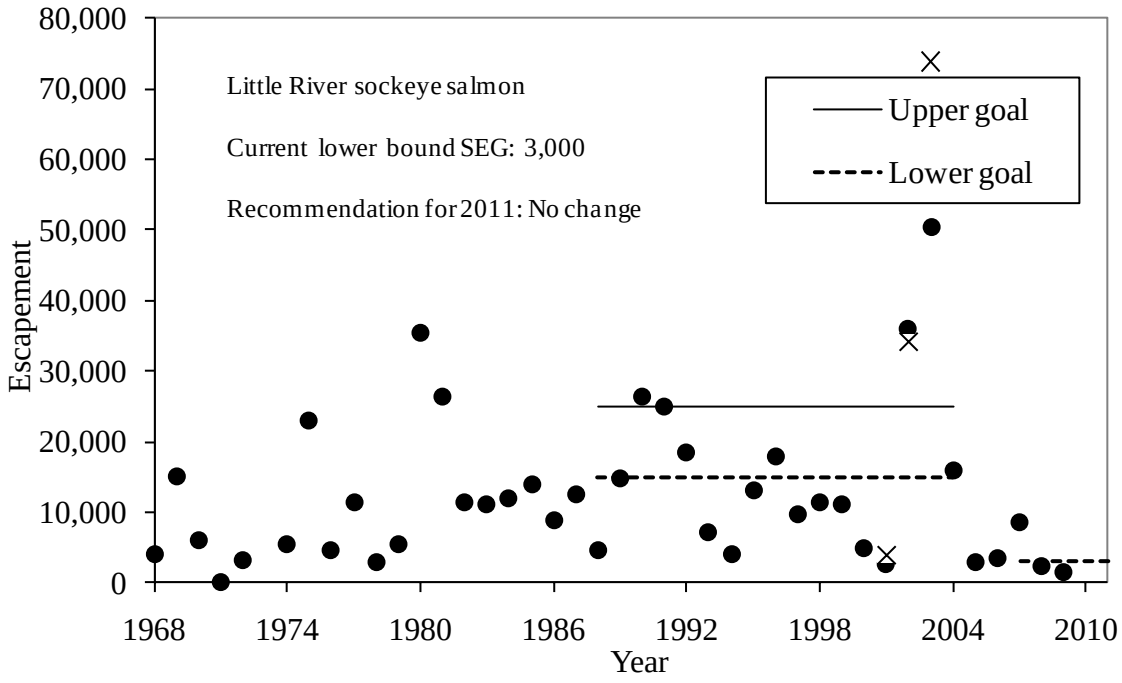
Year	Peak survey	Weir counts	Year	Peak survey	Weir counts
1968	4,000		1989	14,700	
1969	15,000		1990	26,300	
1970	6,000		1991	24,960	
1971	230		1992	18,500	
1972	3,289		1993	7,200	
1973			1994	4,200	
1974	5,500		1995	13,000	
1975	23,000		1996	18,000	
1976	4,500		1997	9,800	
1977	11,500		1998	11,500	
1978	2,800		1999	11,000	
1979	5,500		2000	5,000	
1980	35,500		2001	2,700	3,994
1981	26,500		2002	36,000	34,064
1982	11,500		2003	50,500	73,856
1983	11,000		2004	16,000	
1984	12,000		2005	3,000	
1985	14,000		2006	3,500	
1986	9,000		2007	8,500	
1987	12,500		2008	2,300	
1988	4,500		2009	1,500	

Appendix H3.–Little River sockeye salmon escapement and escapement goal ranges, 1968 to present.

System: Little River

Species: Sockeye salmon

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



APPENDIX I. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR MALINA CREEK SOCKEYE SALMON

Appendix I1.–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 recommended
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Aerial counts, 1968–1991, 2003–2009 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 2006, 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, 2003–2009: 42.4 Weir data 1992–2002, 2004, 2005: 10.1 All available weir and survey data 1968–2009: 64.4
Methodology:	Percentile, euphotic volume analysis, spawning habitat, smolt biomass as a function of zooplankton biomass
Percentiles:	15^{th} to 75^{th} (all available data and aerial survey data) 15^{th} to 85^{th} (weir data only)
Recommendation:	Euphotic volume and zooplankton biomass models corroborate the current SEG. The escapement percentiles (all data) also suggest maintaining the current goal of 1,000 to 10,000 sockeye salmon.
Comments:	Lake was stocked with indigenous juvenile sockeye salmon from 1992 to 1999 and fertilized from 1991 to 2001.

Appendix I2.–Malina Creek sockeye salmon escapement, 1968–2009.

System: Malina Creek

Species: Sockeye salmon

Data available for analysis of escapement goals

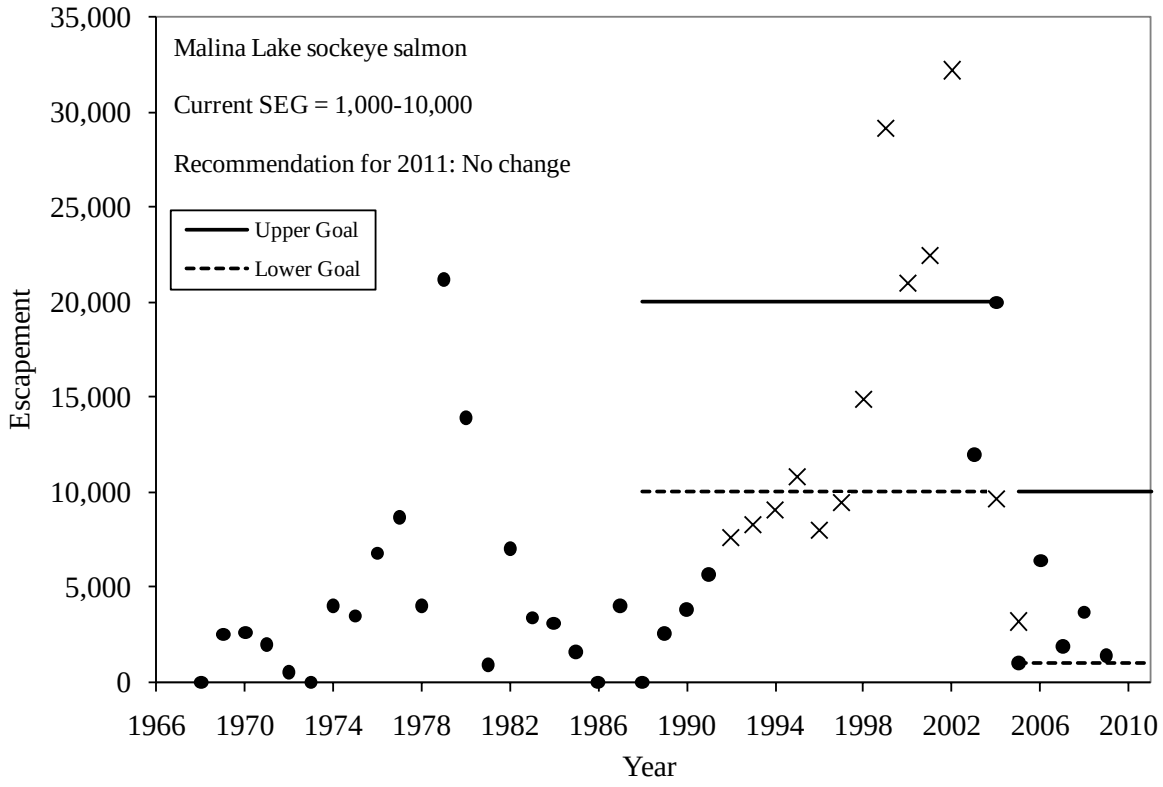
Year	Peak Aerial Survey	Weir Counts
1968	0	
1969	2,500	
1970	2,600	
1971	2,000	
1972	500	
1973	0	
1974	4,000	
1975	3,500	
1976	6,800	
1977	8,667	
1978	4,000	
1979	21,200	
1980	13,900	
1981	900	
1982	7,000	
1983	3,400	
1984	3,100	
1985	1,600	
1986	0	
1987	4,000	
1988	0	
1989	2,570	
1990	3,800	
1991	5,650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

Appendix I3.–Malina Creek sockeye salmon escapement and escapement goals, 1968 to present.

System: Malina Creek

Species: Sockeye salmon

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



APPENDIX J. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR PASAGSHAK RIVER SOCKEYE SALMON

Appendix J1.–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:	SEG Range: 3,000–12,000 (2005)
Recommended escapement goal:	Lower-bound SEG: 3,000
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Survey counts, 1968–1969, 1971–1976, 1978–2009.
Data summary:	
Data quality:	Good. Small lake and limited tributaries represent a small area to survey.
Data type:	Fixed-wing peak aerial survey escapement index counts for 1968–2009. 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:	All survey data 1968 to 2009: 128.0
Methodology:	Percentile
Autocorrelation:	None
Recommendation:	Change SEG range to lower-bound SEG of 3,000 fish.
Comments:	Change to lower-bound SEG is consistent with other minor system escapement goals.

Appendix J2.–Pasagshak River sockeye salmon aerial survey and harvest estimates, 1968–2009.

System: Pasagshak River

Species: Sockeye salmon

	Peak	Harvest		
Year	Survey	Recreational[a]	Subsistence[b]	Commercial[c]
1968	3,000			
1969	6,000			
1970				582
1971	700			2,782
1972	2,000			1,448
1973	400			27
1974	4,025			387
1975	1,000			3
1976	4,500			193
1977		176		0
1978	7,570	85		386
1979	12,000	236		1,017
1980	3,484	284		66
1981	2,859	205		856
1982	5,400	199		326
1983	3,458	192		401
1984	6,200	374		68
1985	1,580	182		1
1986	3,200	428	64	2,514
1987	15,500	417	82	1
1988	20,000	819	84	217
1989	21,500	1,244	166	0
1990	5,280	1,018	598	1,219
1991	39,530	815	1,664	5,649
1992	6,890	427	1,752	62,060
1993	32,000	543	2,253	33,919
1994	2,400	861	1,554	4,828
1995	13,700	571	2,099	14,021
1996	22,093	723	2,854	369
1997	33,765	1,009	2,759	5,632
1998	4,450	614	1,089	841
1999	11,000	1,241	2,996	6,150
2000	10,000	2,721	4,520	8,429
2001	3,800	701	6,650	1,356
2002	4,750	1,062	4,577	2,908
2003	8,000	492	5,910	8,505
2004	46,400		10,023	1,171
2005	22,000		7,416	17,972
2006	6,300		7,616	831
2007	14,300		7,550	1,817
2008	14,900		8,826	1,705
2009	1,400			2,940

[a] Recreational harvests from the Statewide Harvest Survey.

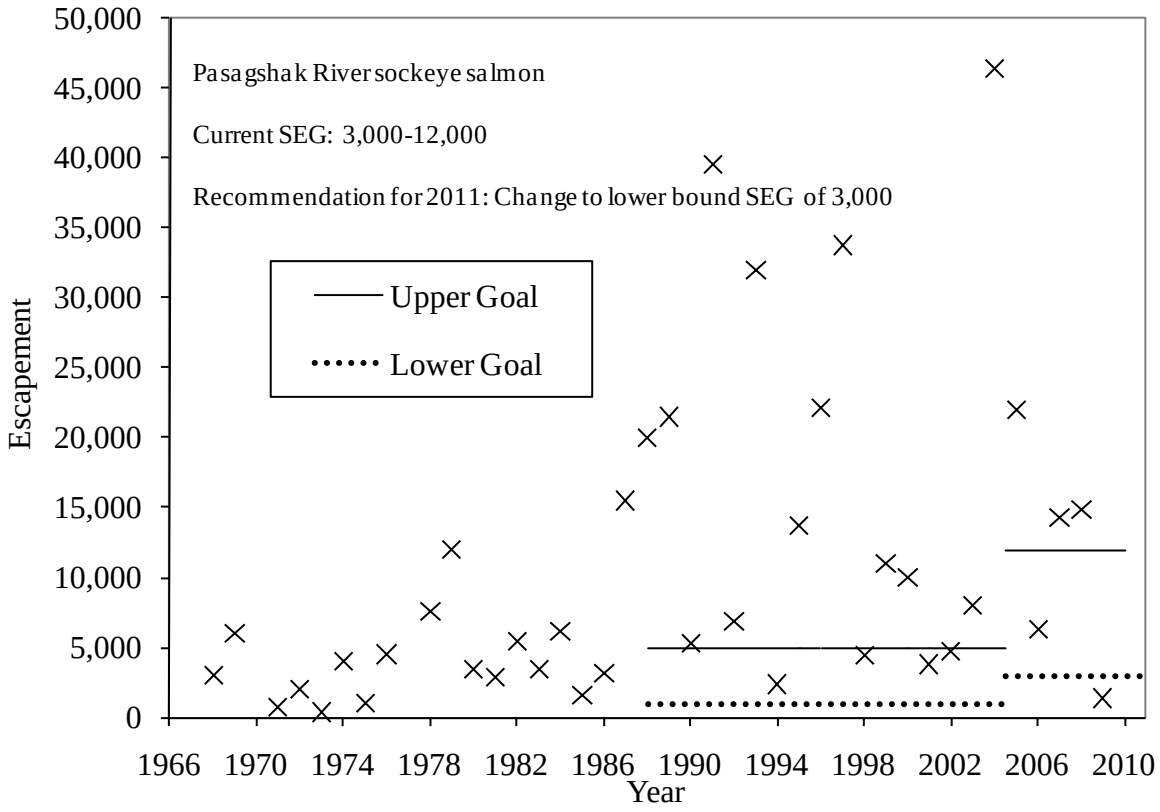
[b] Subsistence harvests from the ADF&G Division of Commercial Fisheries database, Westward Region.

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

Appendix J3.–Pasagshak River sockeye salmon escapement and escapement goals, 1968 to present.

System: Pasagshak River

Species: Sockeye salmon



APPENDIX K. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR SALTERY LAKE SOCKEYE SALMON

Appendix K1.–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: 15,000–30,000 (2001)
Recommended escapement goal:	BEG: 15,000–35,000
Optimal escapement goal:	None
In Lake goal:	None
Action points:	None
Escapement enumeration:	Aerial surveys: 1976–1986, 1992, 2004–2007 Weir counts: 1986–1991, 1993–2003, 2008–2009
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 2008–2009. Harvest data are available from 1976–2009. Limnology data from 1994 to 2009
Data contrast:	All data 1976 to 2009: 7.0
Methodology:	S-R model, zooplankton model
Autocorrelation:	None
Criteria for BEG:	S-R model, zooplankton model
Recommendation:	Change BEG range of 15,000–30,000 fish to a BEG range of 15,000–35,000 fish.
Comments:	Saltery Lake sockeye salmon escapement has been estimated via weir since 2008 and current plans by KRAA are continue the project on an annual basis.

Appendix K2.–Saltery Lake sockeye salmon aerial survey and weir count estimates, 1976–2009.

System: Saltery Lake

Species: Sockeye salmon

Data available for analysis of escapement goals

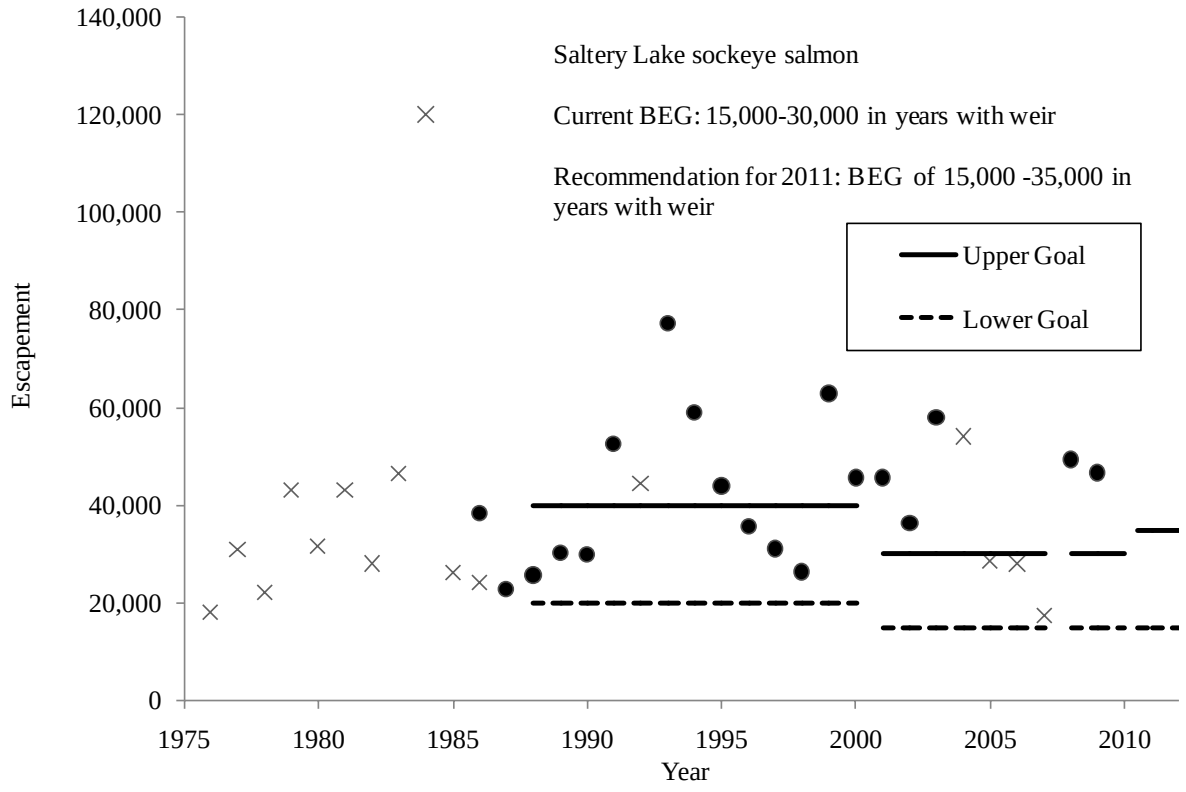
Year	Peak Survey	Weir Counts	Year	Peak Survey	Weir Counts
1976	18,000		1993		77,186
1977	30,800		1994		58,975
1978	22,000		1995		43,859
1979	43,000		1996		35,488
1980	31,600		1997		31,016
1981	43,000		1998		26,263
1982	28,000		1999		62,821
1983	46,400		2000		45,604
1984	120,000		2001		45,608
1985	26,000		2002		36,336
1986	24,000	38,314	2003		57,993
1987		22,705	2004	54,000	
1988		25,654	2005	28,500	
1989		30,237	2006	28,000	
1990		29,767	2007	17,200	
1991		52,592	2008		49,266
1992	44,450		2009		46,591

Appendix K3.–Saltery Lake sockeye salmon escapement and escapement goals, 1976 to present.

System: Saltery Lake

Species: Sockeye salmon

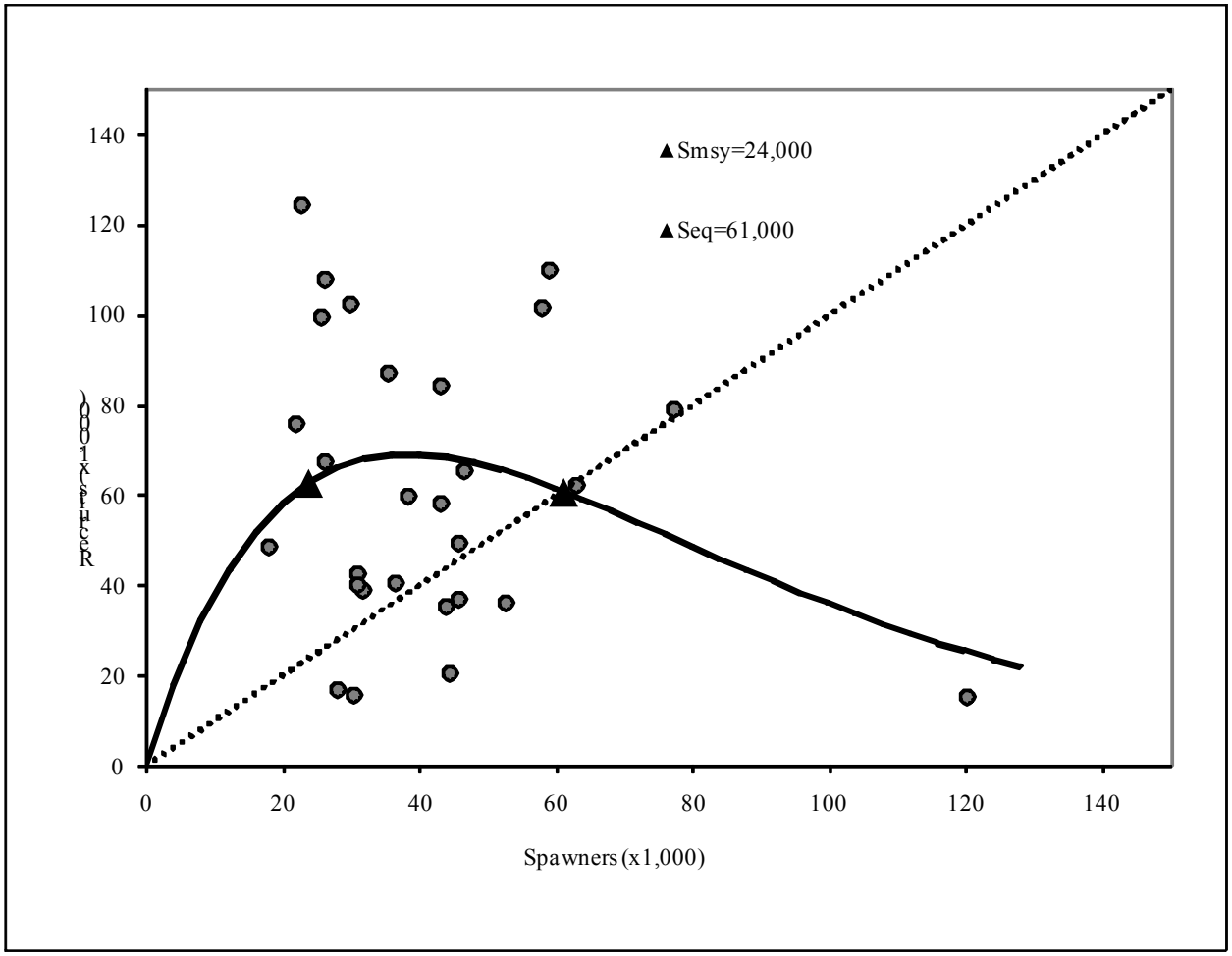
Observed escapement by year (circles are weir counts, Xs are aerial surveys)



Appendix K4.–Fitted Ricker stock-recruitment curves, line of replacement, and actual data for Saltery Lake sockeye salmon brood years 1976–2003. The solid line represents the Ricker curve, and the dotted line represents replacement.

System: Saltery Lake

Species: Sockeye salmon



Appendix K5.–Saltery Lake sockeye salmon brood table.

Brood		Age[b]														Total	
Year	Escapement[a]	0.2	1.1	2.1	0.3	1.2	1.3	2.2	3.1	1.4	2.3	3.2	2.4	3.3	3.4	return	R/S
1976	18,000	42	84	113	174	4,234	25,223	8,418	91	59	9,465	395	74	148	0	48,520	2.70
1977	30,800	23	45	228	352	8,569	12,112	4,042	44	100	15,915	664	195	391	0	42,680	1.39
1978	22,000	46	91	110	169	4,115	20,367	6,798	74	264	42,156	1,759	0	0	0	75,949	3.45
1979	43,000	22	44	184	284	6,919	53,948	18,005	195	0	4,622	0	0	0	0	84,223	1.96
1980	31,600	37	74	488	752	18,328	14,155	2,311	0	0	2,747	0	0	0	0	38,892	1.23
1981	43,000	98	195	0	0	7,800	49,450	0	0	0	784	0	0	0	0	58,326	1.36
1982	28,000	0	0	0	1,099	1,648	9,670	1,045	0	0	3,481	0	0	0	0	16,944	0.61
1983	46,400	0	0	0	261	14,113	31,329	3,094	0	0	16,420	310	0	0	0	65,527	1.41
1984	120,000	0	261	0	0	774	7,435	3,718	0	0	2,492	0	608	0	0	15,288	0.13
1985	26,000	0	0	0	0	3,098	19,519	9,967	0	0	34,679	0	112	223	0	67,597	2.60
1986	38,314	0	0	0	1,246	8,306	22,511	2,434	0	151	24,082	0	0	1,267	0	59,997	1.57
1987	22,705	0	0	0	0	608	30,819	10,286	112	0	81,119	0	716	716	0	124,377	5.48
1988	25,654	0	0	279	430	10,470	13,942	29,152	0	0	45,134	0	0	0	0	99,407	3.87
1989	30,237	56	112	0	0	1,267	4,298	4,298	0	471	5,049	0	0	0	0	15,553	0.51
1990	29,767	0	0	0	716	15,761	55,340	4,915	0	398	24,658	0	0	368	0	102,156	3.43
1991	52,592	0	0	0	471	1,077	11,931	1,591	0	368	20,237	368	0	291	0	36,335	0.69
1992	44,450	0	0	0	0	1,193	8,095	5,887	0	0	5,242	0	0	0		20,418	0.46
1993	77,186	0	0	368	0	1,104	5,242	5,825	582	0	13,514	16,632	615	35,145	525	79,028	1.02
1994	58,975	0	0	1,165	0	10,194	18,712	49,897	0	0	29,484	0	686	0	0	110,138	1.87
1995	43,859	291	291	0	0	5,198	6,276	11,454	0	0	11,982	0	0	0	0	35,492	0.81
1996	35,488	0	0	0	0	5,531	32,734	11,251	0	193	35,650	1,042	492	283	106	87,176	2.46
1997	31,016	0	0	0	729	1,740	4,998	8,674	0	0	23,566	195	195	32	93	40,129	1.29
1998	26,263	0	403	1,166	0	20,546	54,320	16,290	0	90	14,807	197	171	28	59	108,017	4.11
1999	62,821	0	193	298	0	11,042	27,422	9,952	0	79	13,039	173	108	18	63	62,323	0.99
2000	45,604	390	0	315	952	6,403	24,148	8,764	0	50	8,242	109	116	19	0	49,508	1.09
2001	45,608	102	114	278	838	5,639	15,264	5,539	0	54	8,851	118	0	0	0	36,796	0.81
2002	36,336	90	100	176	530	3,564	16,392	5,949	0	0	13,986	0	0	0		40,786	1.12
2003	57,993	57	63	189	569	3,828	68,334	15,079	0	346	13,100	0				101,564	1.75
2004	54,000	61	68	370	4,678	5,442	37,024	16,214									
2005	28,500	109	0	271	1,684	4,503											
2006	28,000	277	0														
2007	17,200																
2008	49,266																
2009	46,591																
												10-yr average (1994-2003)				67,193	1.63

[a] Escapement counts prior to 1986, in 1992 and from 2004–2007 were from aerial surveys (peak counts).

[b] Age composition of the catch was assigned based on the escapement samples. Samples were not taken prior to 1985 and in 1992; thus, age assignments for these years were based on the average age composition from samples taken 1985–1999 (excluding 1992). Samples were also not taken from 2004 to 2007; thus, age assignments for these years were based on the average age composition from samples taken from 2003 and 2008–2009.

APPENDIX L. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR UGANIK LAKE SOCKEYE SALMON

Appendix L1.–Description of stock and escapement goal for Uganik Lake sockeye salmon.

System: Uganik 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:	Lower-bound SEG: 24,000 (2007)
Recommended escapement goal:	No change
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1928–1932, 1990–1992.
	Aerial surveys, 1974, 1976–1977, 1979–2009.
Data summary:	
Data quality:	Fair for aerial surveys (glacially fed lake has variable water visibility); good for weir enumeration.
Data type:	Fixed-wing aerial surveys, weir escapement estimates from 1990 to 1992 include some escapement age data. No stock-specific harvest information is available. Limnology data from 1990, 1991, 1996 and 2009.
Data contrast:	All survey data 1974 to 2009: 31.4
Methodology:	Percentile Method
Autocorrelation:	None
Recommendation:	No change to lower-bound SEG of 24,000 fish.
Comments:	Examination of aerial survey intensity and timeframes suggested the current perceived upturn in productivity is real and not merely a function of increased effort or conditions.

Appendix L2.–Uganik Lake sockeye salmon aerial survey and weir count estimates, 1928–2009.

System: Uganik Lake

Species: Sockeye salmon

Data available for analysis of escapement goals

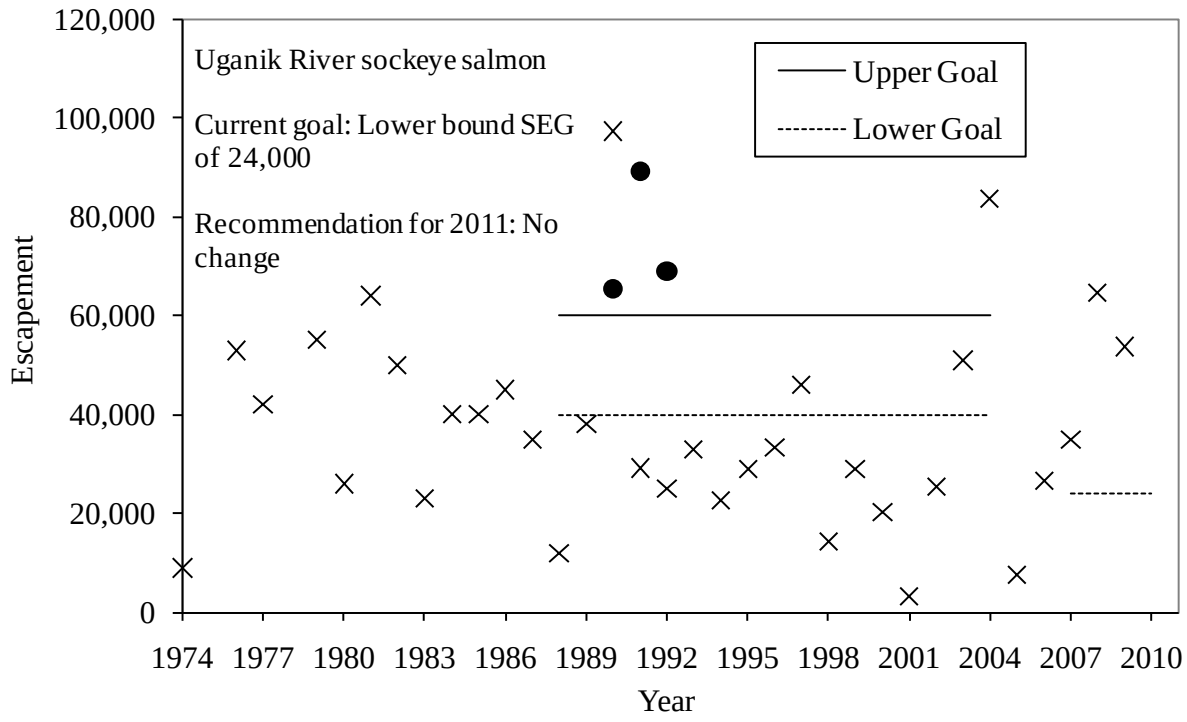
Year	Peak survey	Weir counts
1928		15,282
1929		24,913
1930		9,814
1931		6,777
1932		25,808
1974	9,000	
1976	53,000	
1977	42,000	
1978		
1979	55,000	
1980	26,000	
1981	64,000	
1982	50,000	
1983	23,000	
1984	40,000	
1985	40,000	
1986	45,000	
1987	35,000	
1988	12,000	
1989	38,000	
1990	97,300	65,551
1991	29,100	89,304
1992	25,000	69,015
1993	33,000	
1994	22,600	
1995	29,000	
1996	33,200	
1997	45,900	
1998	14,250	
1999	29,000	
2000	20,310	
2001	3,100	
2002	25,400	
2003	51,000	
2004	83,600	
2005	7,500	
2006	26,700	
2007	35,000	
2008	64,700	
2009	53,700	

Appendix L3.–Uganik Lake sockeye salmon escapement and escapement goals, 1974 to present.

System: Uganik Lake

Species: Sockeye salmon

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



APPENDIX M. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR UPPER STATION RIVER SOCKEYE SALMON

Appendix M1.–Description of stock and escapement goal for Upper Station River sockeye salmon.

System: Upper Station 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 and gillnet
Current escapement goal:	Early-run SEG: 30,000–65,000 (2005)
	Late-run BEG: 120,000–265,000 (2005)
Recommended escapement goal:	Early-run BEG: 43,000–93,000
	Late run: No change
Optimal escapement goal:	Early run: 25,000 (1999)
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1969–2009 (early run) and 1966–2009 (late run)
Data summary:	
Data quality:	Excellent for weir counts 1966–2009; good for harvest and age data.
Data type:	Weir counts from 1966 to 2009 with escapement age data during weir counts. Harvest estimates with age data 1970–2009. Limnology information 1990–1993, 1995, 1999, 2000, and 2009.
Data contrast:	Weir data, all years: 16.5 (early run), 25.9 (late run)
Methodology:	Ricker spawner-recruit models, smolt biomass as a function of zooplankton biomass, and euphotic volume models.
Autocorrelation:	Significant in late run (lag-1)
Recommendation:	Change early-run SEG to BEG: 43,000–93,000 based on a significant Ricker spawner-recruit model and S_{MSY}=66,000.
Comments:	While spawner recruit models are significant for both the early and late run, the late-run model has a strong nonstationary process occurring in addition to significant autocorrelation (lag-1).

Appendix M2.–Upper Station River early-run sockeye salmon escapement and harvest estimates, 1966–2009.

System: Upper Station River

Species: Sockeye salmon

Data available for analysis of escapement goals

Year	Weir counts	Commercial harvest
1966		
1967		
1968		
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

Appendix M3.–Upper Station River late-run sockeye salmon escapement and harvest estimates, 1966–2009.

System: Upper Station River

Species: Sockeye salmon

Data available for analysis of escapement goals

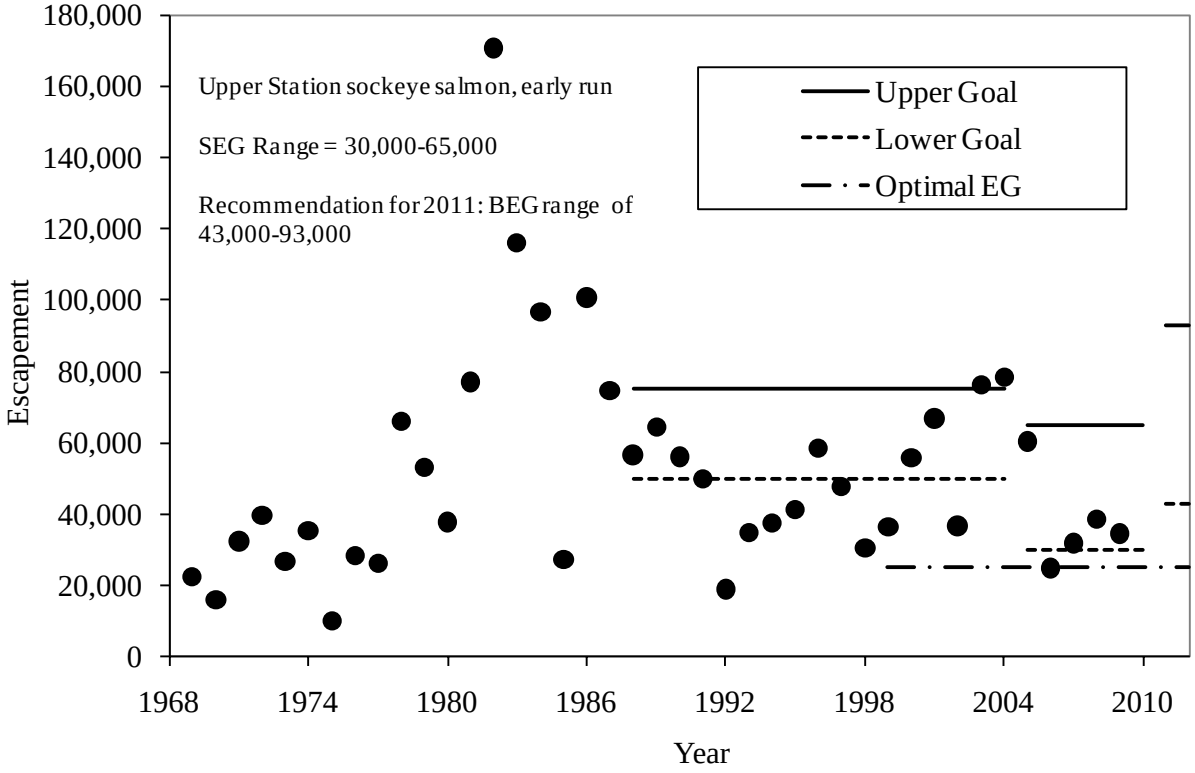
Year	Weir counts	Commercial harvest
1966	36,154	
1967	66,999	
1968	15,743	
1969	74,150	
1970	36,833	
1971	95,150	
1972	68,351	
1973	67,826	
1974	251,234	
1975	74,456	
1976	48,650	
1977	49,001	
1978	38,126	
1979	134,579	
1980	77,718	
1981	118,900	
1982	306,161	345,943
1983	179,741	361,991
1984	239,608	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

Appendix M4.–Upper Station River early-run sockeye salmon escapement and escapement goals, 1969 to present.

System: Upper Station River

Species: Sockeye salmon

Observed escapement by year (circles).

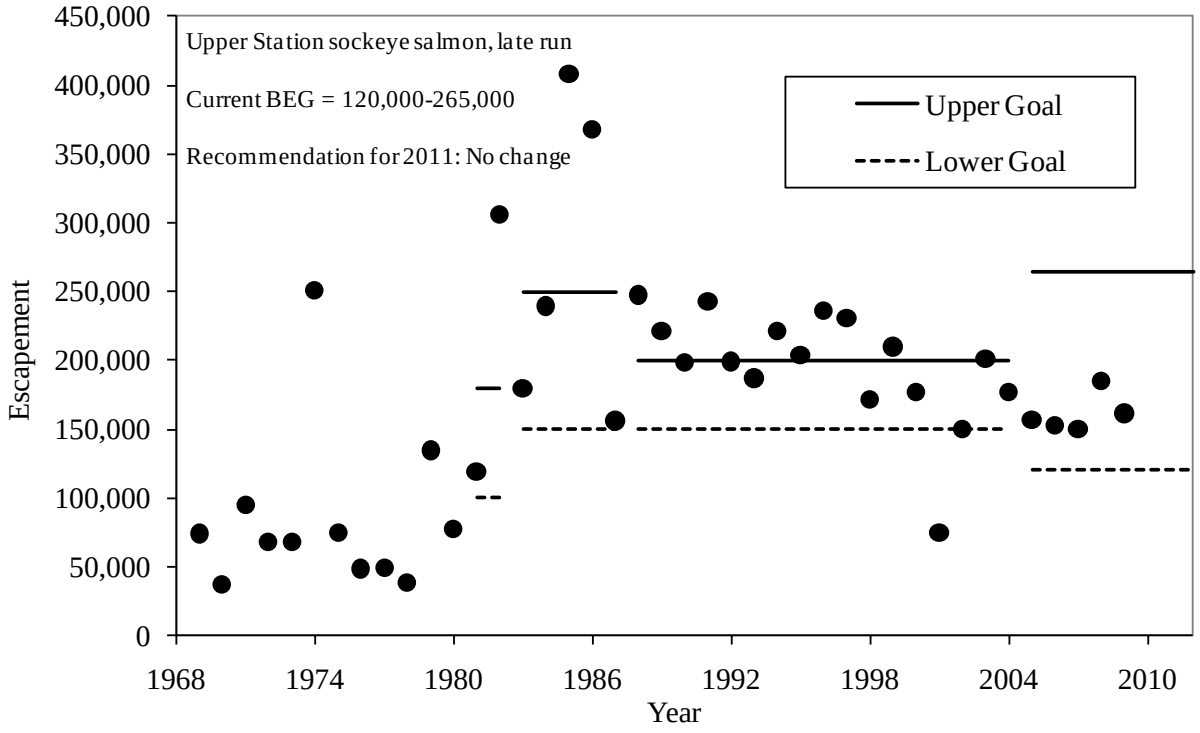


Appendix M5.–Upper Station River late-run sockeye salmon escapement and escapement goals, 1969 to present.

System: Upper Station River

Species: Sockeye salmon

Observed escapement by year (circles)



Appendix M6.–Upper Station River early-run sockeye salmon brood table.

Brood		Age															Total	
Year	Escap.	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	Return	R/S
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	119,018	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	186,763	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
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				
2004	78,487	0	191	1,553	6,398	36,836	3,258	0	25,750	32,372	0							
2005	60,349	0	233	281	0	5,884	3,446											
2006	24,997	0	0	269														
2007	31,895	0																
2008	38,800																	
2009	34,585																	
																	10-Year Average (1993-2002):	113,345	2.6

Appendix M7.–Upper Station River late-run sockeye salmon brood table.

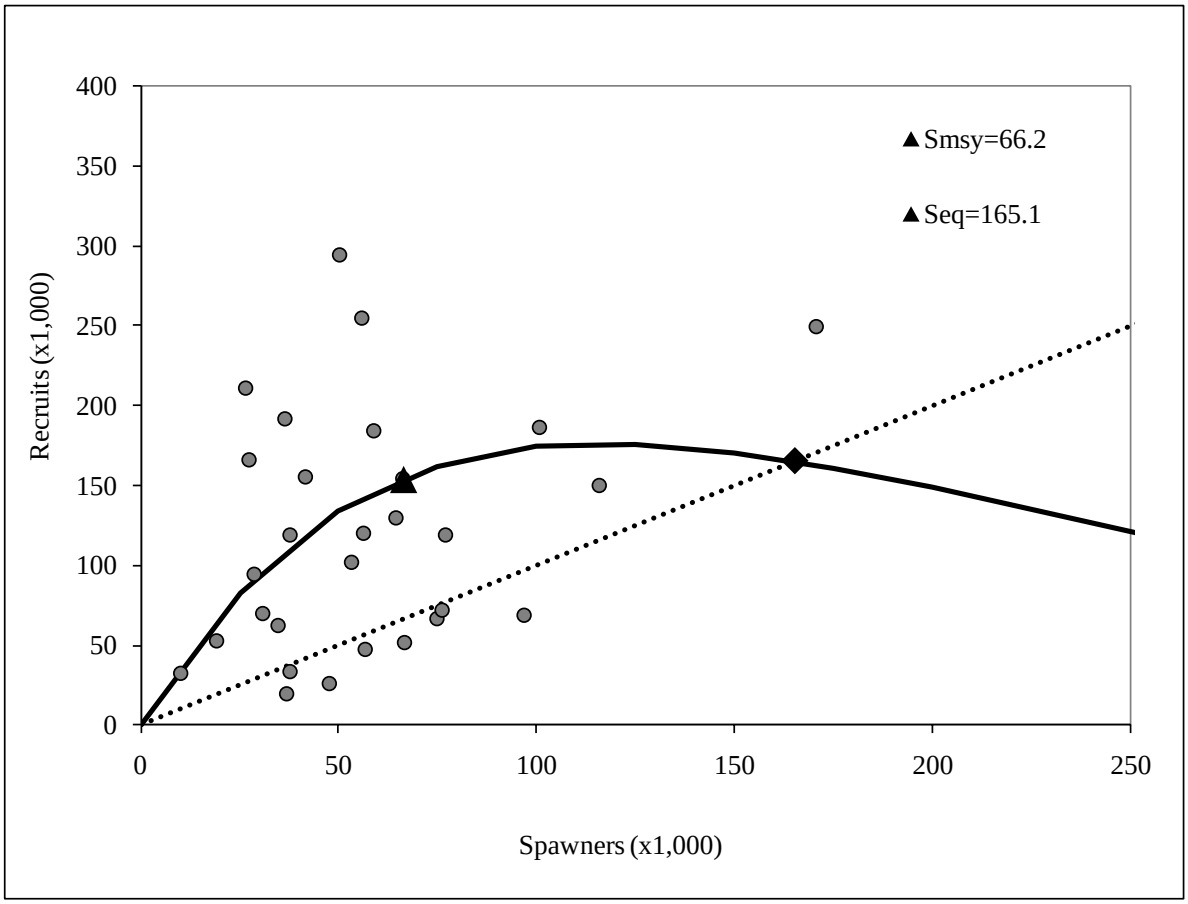
Brood		Age															Total	
Year	Escap.	0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	3.1	1.4	2.3	3.2	3.3	2.4	Return	R/S
1975	74,456	901	3,021	0	0	61,142	1,132	0	36,479	76,157	0	0	5,228	0	0	0	184,060	2.5
1976	48,650	0	10,190	0	36,479	38,399	2,560	0	11,501	141,154	0	0	10,336	940	0	0	251,559	5.2
1977	49,001	0	640	0	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	1,701	5,696	8,310	0	7,078	77,172	0	78	9,900	300	0	0	110,971	1.5
2002	150,349	411	2,421	3,965	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	337	51,307	7,446	0	16,131	256,511	0	357	15,308	548				
2004	177,108	669	5,264	1,535	24,845	99,160	7,094	0	29,761	255,957	181							
2005	156,401	139	2,828	2,423	3,067	20,933	20,082											
2006	153,153	0	931	1,561														
2007	149,709	218																
2008	184,856																	
2009	161,736																	
																	335,758	1.8

10-Year Average (1993-2002):

Appendix M8.–Fitted Ricker stock-recruitment curves, line of replacement, and actual data for Upper Station early-run sockeye salmon from brood years 1975 through 2003. The solid line represents the Ricker curve, and the dotted line represents replacement..

System: Upper Station early run

Species: Sockeye salmon



APPENDIX N. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR AMERICAN RIVER COHO SALMON

Appendix N1.–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:	SEG 400–900 (2005)
Recommended escapement goal:	Change to lower-bound SEG of 400 fish
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Foot surveys, 1980–present with no surveys in 1988, 1989 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 62% to 108% 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 259-23).
Data contrast:	All survey data 1980 to 2009: 50.8
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 range 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:	No significant autocorrelation of foot survey counts.
Recommendation:	Change to lower-bound SEG of 400 fish
Comments:	SEG has been achieved two of the past three years (2007–2009).

Appendix N2.–Annual escapement index and harvest of American River coho salmon, 1980–2009.

System: American River

Species: Coho salmon

Data available for analysis of escapement goals

	Foot	Harvest		
Year	Survey	Recreational[a]	Subsistence[b]	Commercial[c]
1980	903		8	433
1981	627		1	30
1982	266		95	121
1983	114	378	43	73
1984	277	486	0	2
1985	439	349	15	298
1986	221	826	2	71
1987	555	435	33	359
1988		1,710	0	89
1989	296	1,500	0	0
1990	419	849	14	1
1991		722	60	4
1992	167	583	0	0
1993	412	2,340	3	73
1994	194	642	0	0
1995	169	794	2	1,303
1996	69	549	15	0
1997	2,204	1,749	6	31
1998	1,360	700	0	129
1999	284	1,090	0	29
2000		480	0	0
2001	233	860	18	0
2002	1,034	1,195	5	0
2003	511	1,051	42	4
2004	753	1,283	4	0
2005	339	1,636	41	0
2006	2,033	835	0	8
2007	307	980	0	0
2008	700	799	1	28
2009	639	405	0	2,422

[a] Recreational harvests from the Statewide Harvest Survey.

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

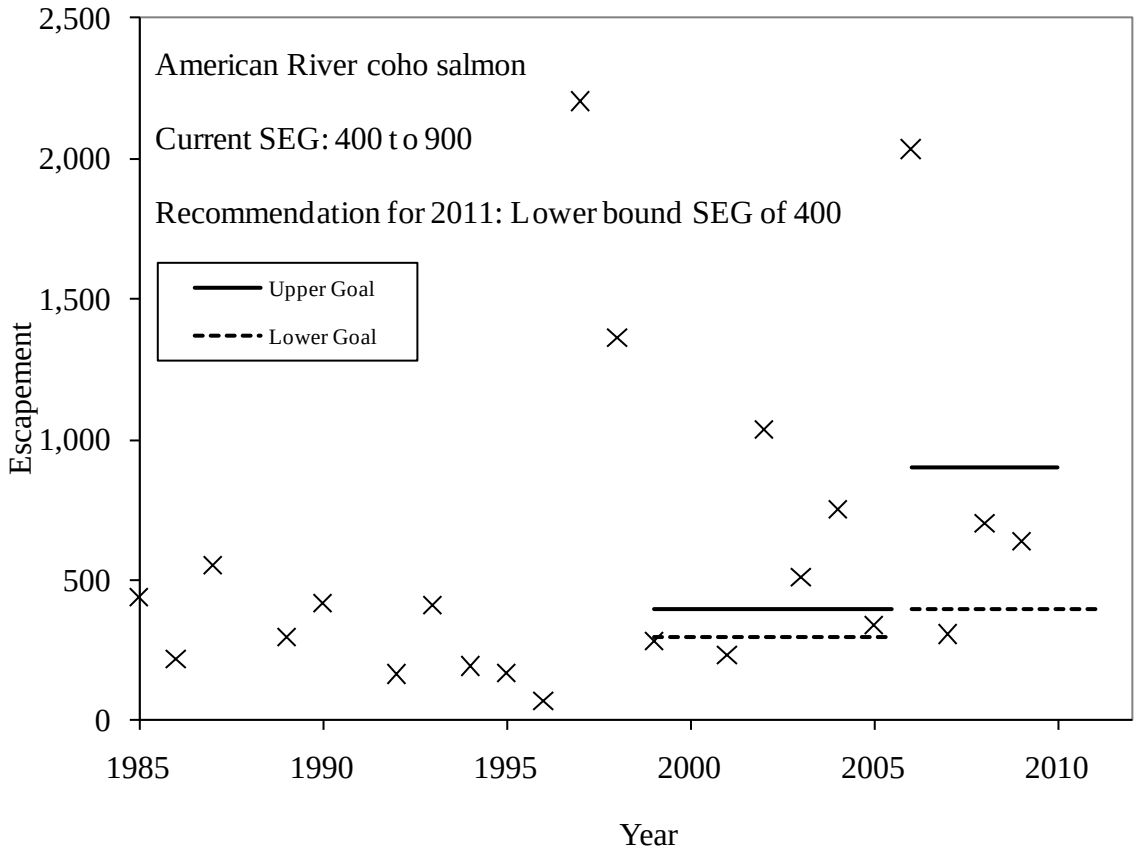
[c] Commercial harvests from the ADF&G Division of Commercial Fisheries database.

Appendix N3.–American River coho salmon escapement and escapement goals, 1985 to present.

System: American River

Species: Coho salmon

Observed escapement by year (foot surveys)



APPENDIX O. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR BUSKIN RIVER COHO SALMON

Appendix O1.–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, and subsistence
Current escapement goal:	BEG: 3,200–7,200 fish (2005)
Recommended escapement goal:	No change to BEG (3,200–7,200 fish)
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Weir counts, 1985 to present
Data summary:	
Data quality:	Good escapement and harvest data.
Data type:	Weir estimates, harvest estimates, age composition.
Data contrast:	All survey data 1985 to 2009: 2.67
Methodology:	A Ricker stock-recruit analysis was conducted on brood table information from escapements in 1990–1999 and returns in 1993–2003. Also a theoretical stock-recruit analysis with average foot survey and average harvest (recreational, commercial and subsistence) from 1985 to 2003 was done to specify the BEG range that potentially maximizes yield give uncertainty in the productivity of this stock. Alpha-parameter values used in the stock recruit analysis ranged from 4 to 8.
Autocorrelation:	No significant autocorrelation of residuals of the Ricker stock-recruit analysis. Significant autocorrelation of escapements at lag 2 (0.50)
Recommendation:	No change to BEG of 3,200–7,200.
Comments:	BEG has been exceeded each of the past three years (2007–2009).

Appendix O2.–Annual escapement and harvest of Buskin River coho salmon, 1980–2009.

System: Buskin River

Species: Coho salmon

Data available for analysis of escapement goals

Year	Estimated Escapement	Weir Count	Harvest			Total Return
			Recreational[a]	Subsistence[b]	Commercial[c]	
1980			2,643			
1981			2,269			
1982			2,431			
1983			2,307			
1984			1,871			
1985	8,930	9,474	2,178	2,554	666	14,872
1986	8,915	9,939	4,098	2,618	1,065	17,720
1987	10,320	11,103	3,133	1,747	2,334	18,317
1988	5,914	6,782	3,474	1,556	254	12,066
1989	8,735	9,930	4,782	1,301	0	16,013
1990	5,842	6,222	1,521	1,821	1	9,565
1991	7,892	8,929	4,149	1,473	15	14,566
1992	6,167	6,535	1,474	1,563	0	9,572
1993	5,782	6,813	4,125	1,723	7	12,668
1994	7,539	8,146	2,429	2,193	15	12,783
1995	8,161	8,694	2,132	1,309	224	12,359
1996	7,819	8,439	2,481	1,372	0	12,292
1997	10,210	10,926	2,864	1,445	0	15,235
1998	8,395	9,062	2,669	1,555	9	13,295
1999	8,939	9,794	3,422	1,467	3	14,686
2000	7,390	8,048	2,631	2,011	0	12,690
2001	12,911	13,494	2,332	1,430	0	17,256
2002	10,022	10,646	2,497	1,514	0	14,657
2003	12,325	13,150	3,302	1,247	6	17,705
2004	8,384	9,599	4,860	1,496	95	16,050
2005	15,844	16,596	3,010	2,437	0	22,043
2006	11,706	13,348	6,567	1,567	763	22,245
2007	7,697	9,001	5,215	1,193	757	25,870
2008	7,963	9,028	4,259	1,165	0	24,423
2009	9,351	10,624	5,092	874	138	28,088

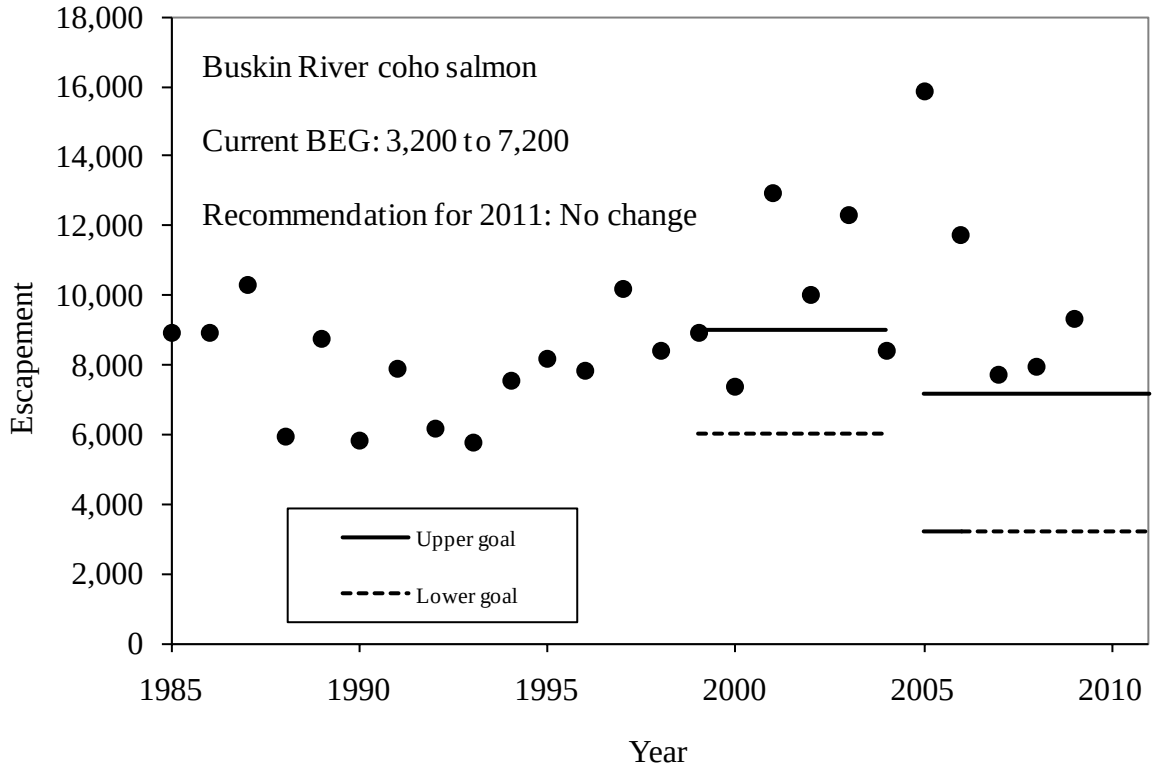
[a] Recreational harvests from the Statewide Harvest Survey.

[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 O3.–Buskin River coho salmon escapement and escapement goals, 1985 to present.

System: Buskin River
Species: coho salmon
Observed escapement by year (weir counts)



APPENDIX P. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR OLDS RIVER COHO SALMON

Appendix P1.–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, and subsistence
Current escapement goal:	SEG, 1,000 – 2,200 fish (2005)
Recommended escapement goal:	Change to lower-bound SEG of 1,000 fish
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 2009: 12.50
Methodology:	Theoretical stock-recruit analysis with average foot surveys and average harvest (recreational, commercial and subsistence) from 1980 to 2003 was used to specify the SEG range 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:	No significant autocorrelation of soot survey counts.
Recommendation:	Change to lower-bound SEG of 1,000 fish.
Comments:	SEG has not been achieved during the past three years (2007–2009).

Appendix P2.–Annual escapement index and harvest of Olds River coho salmon, 1980–2009.

System: Olds River

Species: Coho salmon

	Foot	Harvest		
Year	Survey	Recreational[a]	Subsistence[b]	Commercial[c]
1980	780		0	6,069
1981			152	1,366
1982	1,375		279	1,839
1983		31	64	766
1984	325	611	445	4,252
1985	1,648	304	337	332
1986	1,849	1,651	312	447
1987	842	307	379	3,310
1988		1,273	209	1,773
1989	743	2,571	143	0
1990	1,706	948	379	7
1991		1,778	247	178
1992	308	1,085	276	0
1993	525	1,876	82	40
1994	395	1,083	225	2
1995	2,642	833	116	3,988
1996	2,200	864	305	0
1997	4,064	1,519	363	3,011
1998	2,296	951	269	10
1999	1,382	1,349	258	320
2000	1,097	1,712	383	0
2001	3,454	1,268	295	4,948
2002	790	1,346	215	0
2003	1,534	1,233	595	9
2004	1,860	2,082	342	446
2005	2,495	1,993	347	0
2006	1,912	1,617	366	4,491
2007	868	1,401	183	1,811
2008	656	696	179	48
2009	697	1,889	95	2,468

[a] Recreational harvests from the Statewide Harvest Survey.

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

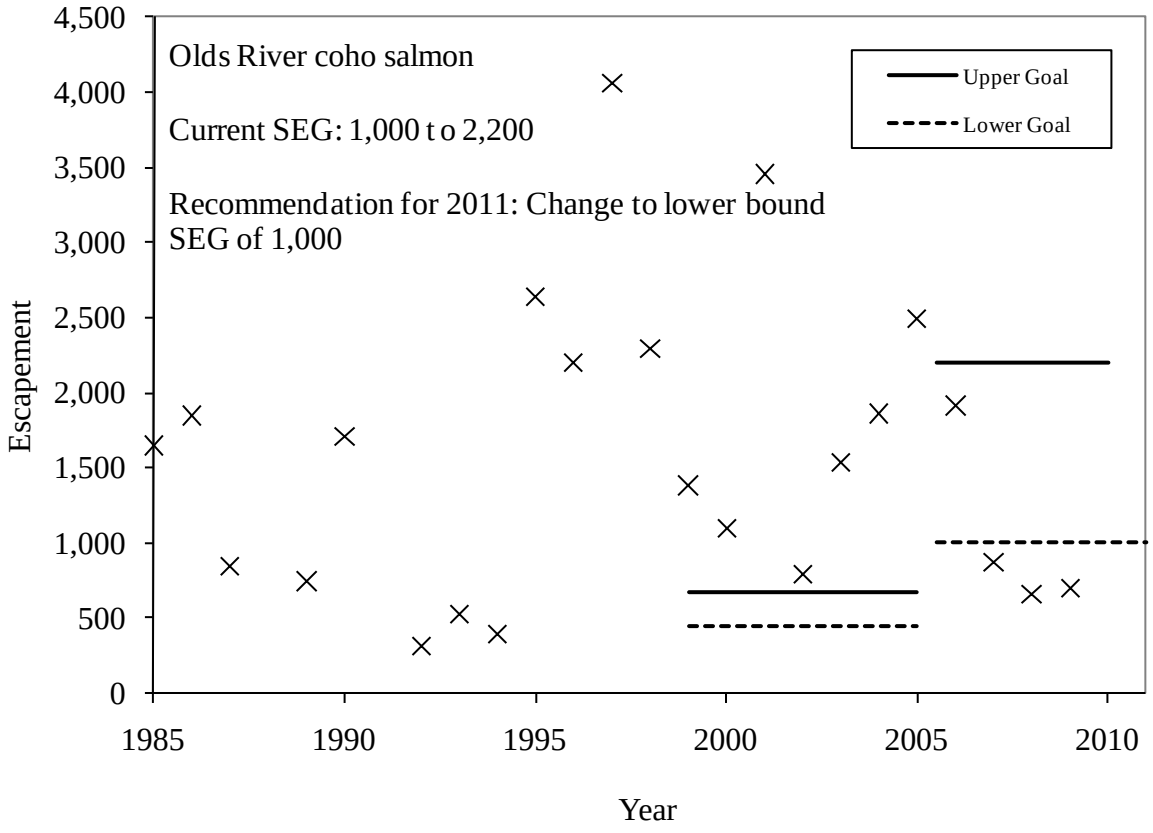
[c] Commercial harvests from the ADF&G Division of Commercial Fisheries database.

Appendix P3.–Olds River coho salmon escapement and escapement goals, 1985 to present.

System: Olds River

Species: Coho salmon

Observed escapement by year (foot surveys)



APPENDIX Q. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR PASAGSHAK RIVER COHO SALMON

Appendix Q1.–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:	SEG, 1,200–3,300 fish (2005)
Recommended escapement goal:	Change to lower-bound SEG of 1,200 fish
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:	All survey data 1980 to 2009: 9.48
Methodology:	Theoretical stock-recruit analysis with average foot surveys and average harvest (recreational, commercial and subsistence) from 1980 to 2003 was used to specify the SEG range 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:	Significant autocorrelation of foot survey counts at lag 1 (0.55).
Recommendation:	Change to lower-bound SEG of 1,200 fish.
Comments:	SEG has been achieved two of the past three years (2007–2009).

Appendix Q2.–Annual escapement index and harvest of Pasagshak River coho salmon, 1980–2009.

System: Pasagshak River

Species: Coho salmon

Data available for analysis of escapement goals

	Foot	Harvest		
Year	Survey	Recreational[a]	Subsistence[b]	Commercial[c]
1980	2,664	2,480	18	1,832
1981	2,621	1,015	16	1,048
1982	175	1,100	17	2,787
1983	1,920	1,322	20	2,316
1984	1,540	1,870	76	1,485
1985		2,292	117	1,691
1986	3,571	2,951	35	1,184
1987	2,519	3,459	0	9,425
1988		2,601	0	778
1989		2,065	28	0
1990	2,173	2,105	60	46
1991		1,296	216	94
1992		1,765	118	222
1993	1,337	2,274	276	714
1994		994	112	106
1995		1,215	65	927
1996	2,248	1,458	196	0
1997	2,813	1,468	88	41
1998	1,906	969	140	48
1999	3,409	1,195	75	226
2000	4,526	2,691	348	374
2001	6,209	804	181	44
2002	5,825	945	112	81
2003	8,886	2,547	353	143
2004	3,402	2,441	261	12
2005	3,773	3,655	334	6,622
2006	937	1,121	320	8,294
2007	1,896	2,095	149	0
2008	3,875	2,836	315	0
2009	2,385	2,044	232	53

[a] Recreational harvests from the Statewide Harvest Survey.

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

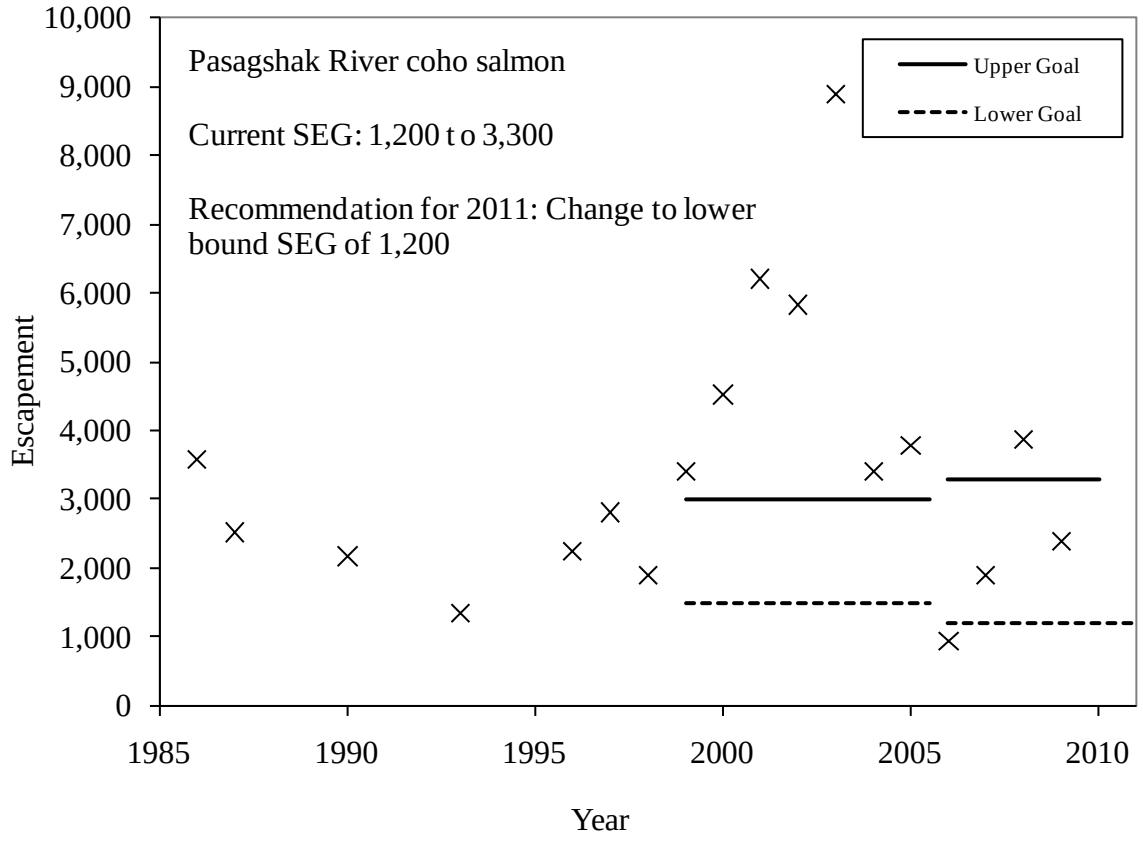
[c] Commercial harvests from the ADF&G Division of Commercial Fisheries database.

Appendix Q3.–Pasagshak River coho salmon escapement and escapement goals, 1985 to present.

System: Pasagshak River

Species: Coho salmon

Observed escapement by year (foot surveys)



APPENDIX R. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR KODIAK ARCHIPELAGO PINK SALMON

Appendix R1.–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
Previous escapement goal:	SEG: 2,000,000–5,000,000 (2005)
Recommended escapement goal:	SEG Odd Years: 2,000,000–5,000,000
	SEG Even Years: 3,000,000–7,000,000
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Aerial Survey, 1968–2009
	Weir counts, 1976–2009
Data summary:	
Data quality:	Fair
Data type:	Fixed-wing aerial surveys from 1968 to 2009 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 1976–2009: 6.3
Methodology:	Ricker Model
Autocorrelation:	None
Recommendation:	Reinstitute separate odd- and even-year SEGs: 2,000,000–5,000,000 during odd years and 3,000,000–7,000,000 during even years.
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=3.9x10-5). The resultant S_{MSY} estimate was corrected for Karluk and Ayakulik weir counts and weighted peak aerial survey data.

Appendix R2.–Kodiak Archipelago pink salmon aggregate escapement and harvest estimates, 1976–2009.

System: Kodiak Archipelago

Species: Pink salmon

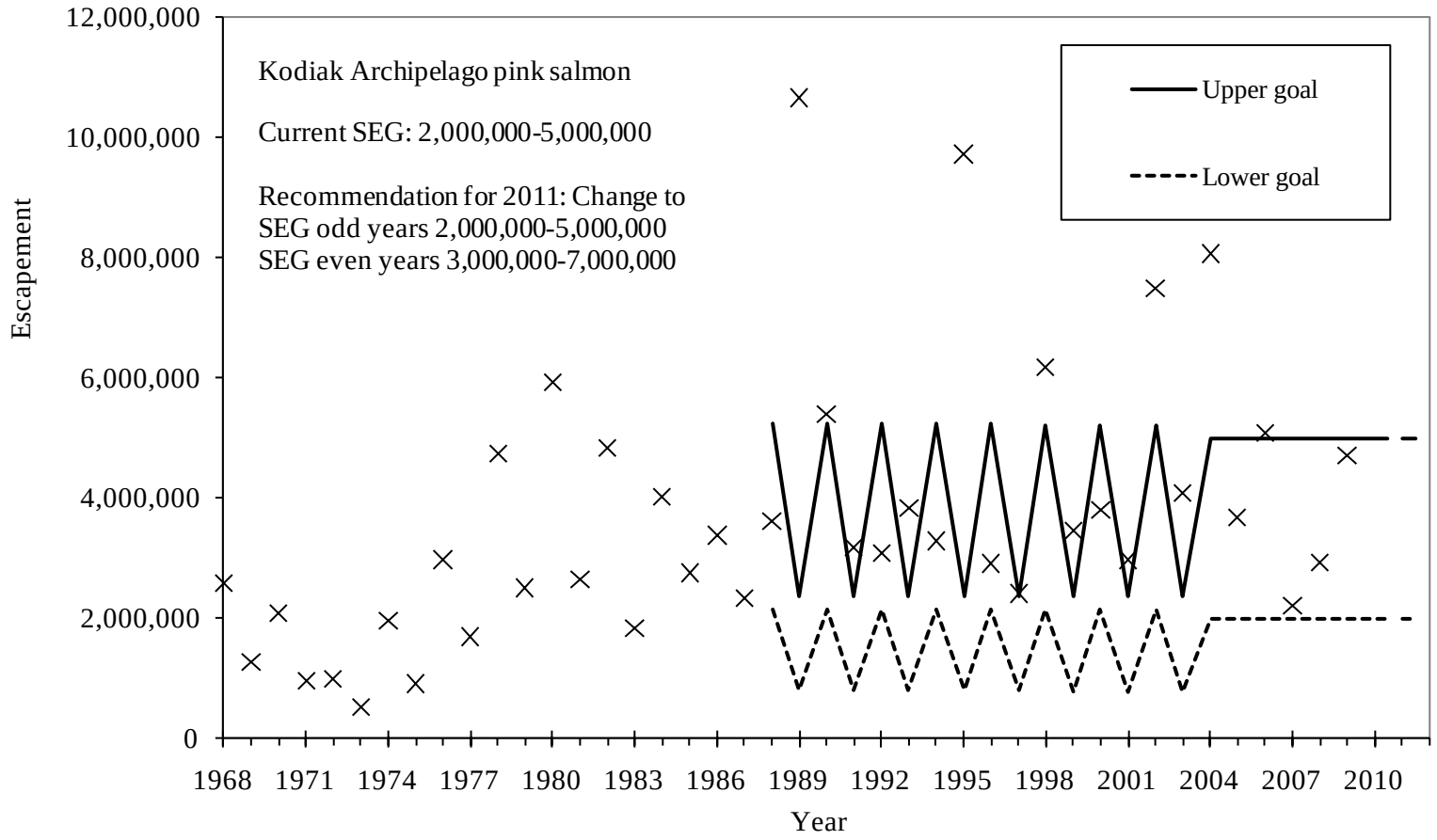
Data available for analysis of escapement goals

Year	Peak survey	Karluk escapement	Ayakulik escapement	Total aggregate	Harvest
1976	1,896,172	708,575	373,439	2,978,186	
1977	1,645,405	3,716	52,319	1,701,440	
1978	2,390,421	981,351	1,380,792	4,752,564	14,767,000
1979	2,421,546	10,278	81,473	2,513,297	10,445,000
1980	2,722,850	857,627	2,359,160	5,939,637	16,726,000
1981	2,598,263	6,358	51,248	2,655,869	9,362,000
1982	1,797,618	721,462	2,326,674	4,845,754	7,318,000
1983	1,789,979	17,702	38,902	1,846,583	4,289,000
1984	1,721,696	631,060	1,672,408	4,025,164	10,228,000
1985	2,721,921	3,788	41,232	2,766,941	3,607,000
1986	2,155,011	560,210	668,297	3,383,518	10,356,000
1987	2,299,180	7,819	24,222	2,331,221	3,898,000
1988	2,505,168	397,409	711,676	3,614,253	12,207,000
1989	10,513,032	45,655	109,880	10,668,567	182,000
1990	1,280,253	708,372	3,423,969	5,412,594	4,569,000
1991	3,043,228	16,053	116,329	3,175,610	14,136,000
1992	2,026,048	665,883	401,083	3,093,014	2,415,000
1993	3,700,902	29,597	101,672	3,832,171	20,577,000
1994	2,656,350	195,449	438,991	3,290,790	5,917,000
1995	9,590,435	29,005	111,066	9,730,506	37,636,000
1996	1,531,891	532,870	855,783	2,920,544	2,458,000
1997	2,292,204	13,594	114,881	2,420,679	9,096,000
1998	4,482,336	576,150	1,135,439	6,193,925	15,225,000
1999	3,367,358	4,468	89,160	3,460,986	7,459,000
2000	2,401,072	315,926	1,096,916	3,813,914	6,139,000
2001	2,907,916	10,374	66,554	2,984,844	6,042,000
2002	5,447,111	352,853	1,694,513	7,494,477	11,308,000
2003	3,939,804	7,814	140,794	4,088,412	8,360,000
2004	5,493,059	1,059,229	1,522,675	8,074,963	17,171,100
2005	3,412,280	41,597	234,281	3,688,158	16,061,700
2006	3,527,274	539,815	1,019,283	5,086,372	26,636,025
2007	1,926,926	32,048	249,704	2,208,678	16,307,004
2008	1,558,371	741,797	624,540	2,924,708	7,624,518
2009	4,520,874	27,923	159,097	4,707,894	18,050,323

Appendix R3.–Kodiak Archipelago pink salmon indexed escapement and escapement goal ranges, 1968 to present.

System: Kodiak Archipelago

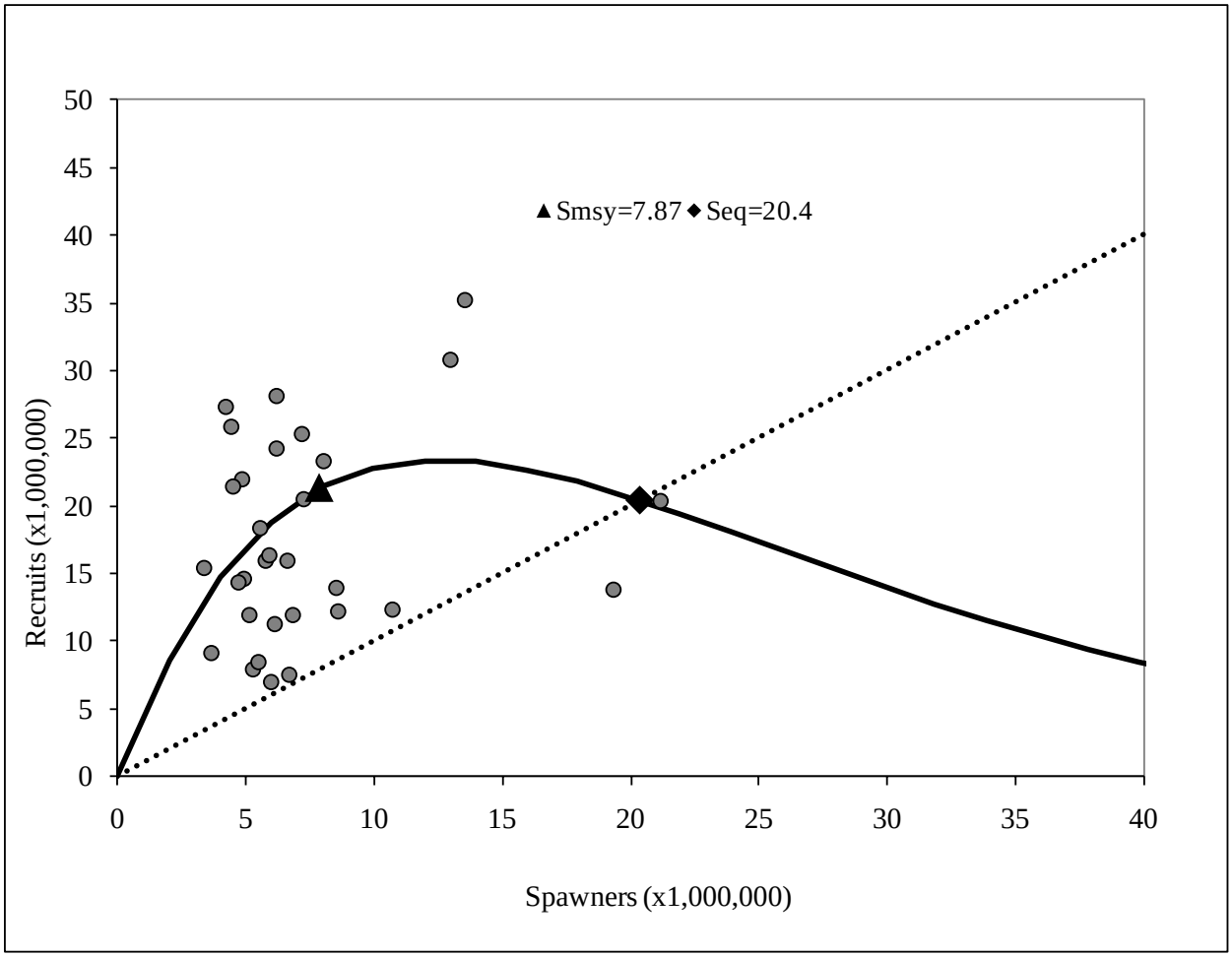
Species: Pink salmon



Appendix R4.–Fitted Ricker spawner-recruit curve, line of replacement, and data for Kodiak Archipelago pink salmon from brood years 1976 through 2007 (odd and even years combined). The solid line represents the Ricker curve, and the dotted line represents replacement. Aerial survey data is expanded by a factor of two (2).

System: Kodiak Archipelago

Species: Pink salmon



APPENDIX S. SUPPORTING INFORMATION FOR ESCAPEMENT GOALS FOR KODIAK MAINLAND PINK SALMON

Appendix S1.–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: 250,000–750,000 (2005)
Recommended escapement goal:	SEG: 250,000–1,000,000
Optimal escapement goal:	None
Inriver goal:	None
Action points:	None
Escapement enumeration:	Aerial Survey, 1968–2009
Data summary:	
Data quality:	Fair
Data type:	Fixed-wing aerial surveys from 1968 to 2009 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 1976–2009: 31.3
Methodology:	Ricker Model
Autocorrelation:	Present (lag-1), but borderline significant
Recommendation:	Change the SEG to a range of 250,000 to 1,000,000 fish from unexpanded survey counts.
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 ($P=6.3x10^{-5}$). The resultant S_{MSY} estimate was corrected for expanded aerial survey information.

Appendix S2.–Kodiak Mainland pink salmon aggregate escapement and harvest estimates, 1976–2009.

System: Kodiak Mainland

Species: Pink salmon

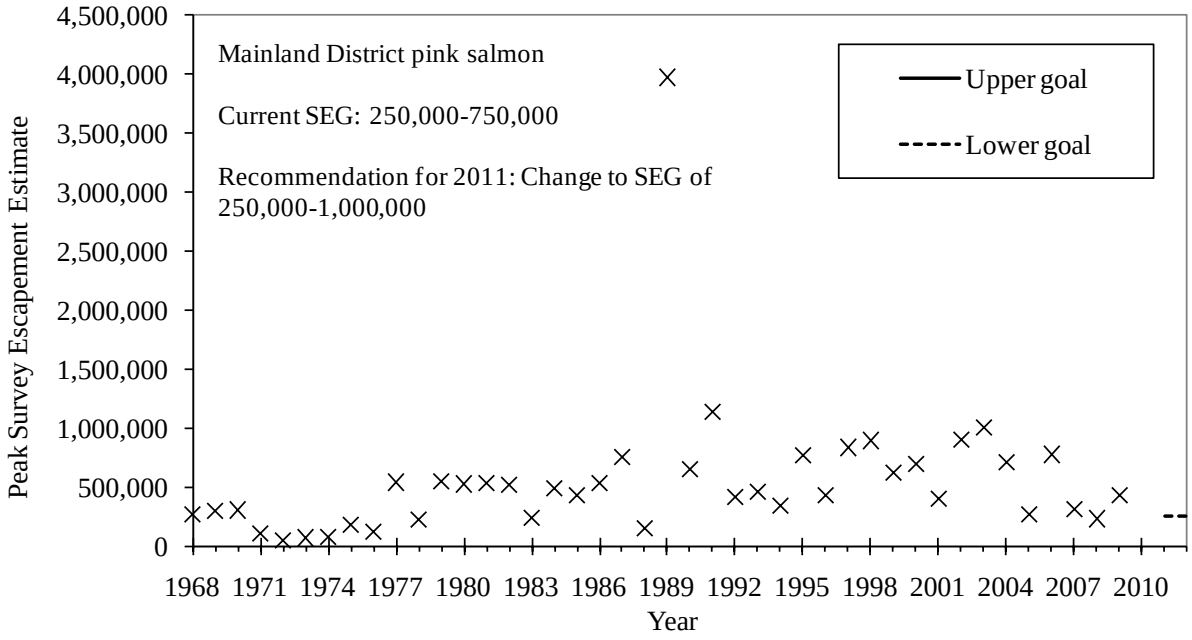
Data available for analysis of escapement goals

Year	Peak survey	Harvest
1976	127,185	
1977	542,380	
1978	225,390	237,000
1979	549,300	623,000
1980	529,885	287,000
1981	533,000	271,000
1982	524,495	582,000
1983	243,521	184,000
1984	494,780	345,000
1985	437,375	261,000
1986	537,850	806,000
1987	758,300	226,000
1988	157,000	1,748,000
1989	3,977,020	0
1990	649,506	876,000
1991	1,142,000	1,166,000
1992	419,060	190,000
1993	459,410	1,366,000
1994	344,930	194,000
1995	767,726	696,000
1996	430,450	50,000
1997	839,350	728,000
1998	895,050	559,000
1999	620,700	384,000
2000	693,900	117,000
2001	407,000	398,000
2002	901,925	323,000
2003	1,008,550	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

Appendix S3.–Kodiak Mainland pink salmon indexed escapement and escapement goals ranges, 1968 to present.

System: Kodiak Mainland

Species: Pink salmon



Appendix S4.–Fitted Ricker spawner-recruit curve, line of replacement, and data for Kodiak Mainland pink salmon from brood years 1976 through 2009 (odd and even years combined). The solid line represents the Ricker curve, and the dotted line represents replacement. Aerial survey data is expanded by a factor of two (2).

System: Kodiak Mainland

Species: Pink salmon