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# **Escapement Goal Recommendations for Select Arctic-Yukon-Kuskokwim Region Salmon Stocks, 2010**

by

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and

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December 2009

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Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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<b>Weights and measures (metric)</b>		<b>General</b>		<b>Measures (fisheries)</b>	
centimeter	cm	Alaska Administrative Code	AAC	fork length	FL
deciliter	dL	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	mid-eye to fork	MEF
gram	g	all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.	mid-eye to tail fork	METF
hectare	ha	at	@	standard length	SL
kilogram	kg	compass directions:		total length	TL
kilometer	km	east	E		
liter	L	north	N	<b>Mathematics, statistics</b>	
meter	m	south	S	<i>all standard mathematical signs, symbols and abbreviations</i>	
milliliter	mL	west	W	alternate hypothesis	H <sub>A</sub>
millimeter	mm	copyright	©	base of natural logarithm	<i>e</i>
		corporate suffixes:		catch per unit effort	CPUE
<b>Weights and measures (English)</b>		Company	Co.	coefficient of variation	CV
cubic feet per second	ft <sup>3</sup> /s	Corporation	Corp.	common test statistics	(F, t, $\chi^2$ , etc.)
foot	ft	Incorporated	Inc.	confidence interval	CI
gallon	gal	Limited	Ltd.	correlation coefficient (multiple)	R
inch	in	District of Columbia	D.C.	correlation coefficient (simple)	r
mile	mi	et alii (and others)	et al.	covariance	cov
nautical mile	nmi	et cetera (and so forth)	etc.	degree (angular)	°
ounce	oz	exempli gratia (for example)	e.g.	degrees of freedom	df
pound	lb	Federal Information Code	FIC	expected value	<i>E</i>
quart	qt	id est (that is)	i.e.	greater than	>
yard	yd	latitude or longitude	lat. or long.	greater than or equal to	≥
		monetary symbols (U.S.)	\$, ¢	harvest per unit effort	HPUE
<b>Time and temperature</b>		months (tables and figures): first three letters	Jan, ..., Dec	less than	<
day	d	registered trademark	®	less than or equal to	≤
degrees Celsius	°C	trademark	™	logarithm (natural)	ln
degrees Fahrenheit	°F	United States (adjective)	U.S.	logarithm (base 10)	log
degrees kelvin	K	United States of America (noun)	USA	logarithm (specify base)	log <sub>2</sub> , etc.
hour	h	U.S.C.	United States Code	minute (angular)	'
hour	h	U.S. state	use two-letter abbreviations (e.g., AK, WA)	not significant	NS
minute	min			null hypothesis	H <sub>0</sub>
second	s			percent	%
<b>Physics and chemistry</b>				probability	P
all atomic symbols				probability of a type I error (rejection of the null hypothesis when true)	$\alpha$
alternating current	AC			probability of a type II error (acceptance of the null hypothesis when false)	$\beta$
ampere	A			second (angular)	"
calorie	cal			standard deviation	SD
direct current	DC			standard error	SE
hertz	Hz			variance	
horsepower	hp			population	Var
hydrogen ion activity (negative log of)	pH			sample	var
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

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YUKON-KUSKOKWIM REGION SALMON STOCKS, 2010**

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December 2009

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## ABSTRACT

An Alaska Department of Fish and Game Escapement Goal Review Team (review team) was convened to review salmon escapement goals for Arctic-Yukon-Kuskokwim (AYK) Region in preparation for the January 2010 meeting of the Alaska Board of Fisheries. The review team makes recommendations for sustainable escapement goals (SEGs) and biological escapement goals (BEGs) to the directors of the two divisions who ultimately establish the final goals. This report documents the review team's recommendations for escapement goals in three management areas of AYK Region.

In Kuskokwim Management Area, which includes Kuskokwim River and Kuskokwim Bay drainages, there are currently 23 established escapement goals for 14 Chinook salmon, 4 chum salmon, 2 coho salmon, and 3 sockeye salmon stocks. The review team is recommending one new coho salmon goal based on weir and tower counts at Kwethluk River and one new sockeye salmon escapement goal based on weir counts at Kogrukuk River (a tributary of Holitna River).

In Yukon River Management Area, there are currently 17 established escapement goals for 7 Chinook salmon, 2 summer chum salmon, 7 fall chum salmon, and 1 coho salmon stocks. The review team is recommending revision of the Chinook salmon SEG for East Fork Andreafsky River from an aerial survey-based goal to a weir-based goal. For East Fork Andreafsky summer chum salmon, the team is recommending that the weir-based BEG be changed to an SEG threshold. The review team is also recommending that the drainagewide BEG for fall chum salmon be changed to an SEG because the current goal range does not provide for a high probability of achieving MSY; however, no change is recommended for the specific numerical goal range. Lastly, the review team is recommending that Toklat River fall chum salmon BEG and Gisasa River Chinook aerial survey goal be eliminated.

For Norton Sound/Port Clarence and Kotzebue Management Areas, a total of 33 escapement goals exist for 5 Chinook salmon, 18 chum salmon, 3 coho salmon, 5 pink salmon, and 2 sockeye salmon stocks. The review team is recommending elimination of aerial survey SEGs for chum salmon on Flambeau, Sinuk, Solomon, and Bonanza rivers. The team also recommends revision of Niukluk River chum salmon SEG range to an SEG threshold and revision of the SEG range for Niukluk River coho salmon.

Keywords: Pacific salmon, *Oncorhynchus*, escapement goal, Arctic-Yukon-Kuskokwim, stock status, Kuskokwim Management Area, Yukon Management Area, Norton Sound/Port Clarence Management Area, Kotzebue Management Area.

## INTRODUCTION

This report makes escapement goal recommendations for salmon stocks of Kuskokwim (Kuskokwim River and Kuskokwim Bay), Yukon River, Norton Sound/Port Clarence, and Kotzebue Sound Management Areas (Figure 1). In the process of coming to these recommendations, detailed analyses were performed for some stocks. Those analyses will be published in separate reports or included in this report as appendices. Escapement goals were evaluated and recommended based on policies adopted into regulation by the Alaska Board of Fisheries (board): the *Policy for the Management of Sustainable Salmon Fisheries* (Sustainable Salmon Policy: 5 AAC 39.222) and the *Policy for Statewide Salmon Escapement Goals* (Escapement Goal Policy: 5 AAC 39.223). These policies call for review of salmon escapement goals every three years in concert with the regulatory cycle for each management area and provide process and criteria to be followed.

Escapement goals recommended in this report are the products of several collaborative meetings of Arctic-Yukon-Kuskokwim (AYK) Region Escapement Goal Review Team (review team), department staff, guests from federal agencies, and various non-governmental organizations. The review team was comprised of regional research coordinators and fishery scientists from divisions of Commercial Fisheries and Sport Fish. The review team helped direct the work of other staff and reviewed that work in the process of making escapement goal recommendations.



Figure 1.—Arctic-Yukon-Kuskokwim Region salmon management areas for the Division of Commercial Fisheries, ADF&G.

The review team collaborated closely with regional and area staff to review escapement and other data and make escapement goal recommendations in preparation for the AYK Region regulatory meeting scheduled for January 2010. Public meetings were conducted on October 14, 2008 and December 18, 2008 to develop assignments and recommendations. Participation in these meetings and review of analyses by representatives of non-governmental organizations, federal agencies, and the public was greatly appreciated. These recommendations, however, are only those of the ADF&G review team.

The Sustainable Salmon Policy defines three types of escapement goals that are set by the department:

*Biological Escapement Goal (BEG):* 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.



*Sustainable Escapement Goal (SEG):* a level of escapement, indicated by an index or an escapement estimate that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated due to the absence of a stock specific catch estimate; 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.

*Sustained Escapement Threshold (SET):* a threshold level of escapement, below which the ability of the salmon stock to sustain itself is jeopardized; in practice, SET can be estimated based on lower ranges of historical escapement levels, for which the salmon stock has consistently demonstrated the ability to sustain itself; the SET is lower than the lower bound of the BEG and lower than the lower bound of the SEG; the SET is established by the department in consultation with the board, as needed, for salmon stocks of management or conservation concern.

The majority of salmon stocks in AYK Region do not have sufficient quantity or quality of data to develop BEG recommendations. For those stocks that have sufficient escapement information, but lack the data to estimate total returns, sustainable escapement goals (SEG) may be developed. Bue and Hasbrouck (*Unpublished*) suggested the following criteria for categorizing data needed to develop BEGs and SEGs depending on the accuracy and amount of data available:

**Excellent:** Escapement, harvest and age all estimated with relatively good accuracy and precision (e.g., escapement estimated by a weir or hydroacoustics, harvest estimated by Statewide Harvest Survey of Fish Tickets); escapement and return estimates can be derived for a sufficient time series to construct a brood table and estimate MSY.

**Good:** Escapement, harvest and age all estimated with reasonably good accuracy and/or precision (e.g., escapement estimated by capture-recapture experiment or multiple foot/aerial surveys); no age data or data are of questionable accuracy and/or precision; *data may allow construction of brood table; data time series relatively short to accurately estimate MSY* (emphasis added).

**Fair:** Escapement estimated or indexed and harvest estimated with reasonably good accuracy, but precision lacking for one if not both; no age data; data insufficient to estimate total return and construct brood table.

**Poor:** Escapement indexed (e.g., single foot/aerial survey) such that the index provides a fairly reliable measure of escapement; no harvest and age data.

Biological Escapement Goals (BEGs) are established to provide levels of escapement that will on average produce large harvestable surpluses. Escapements above or below these levels may be sustainable, but will on average provide for a smaller harvestable surplus. Few stocks in AYK region have data that are considered to be “good” or “excellent” according to the Bue and Hasbrouck criteria above, which are needed in order to establish BEGs.

Sustainable Escapement Goals (SEGs) are set to provide levels of escapement that will produce runs and harvests similar to what has occurred in the past. Most escapement goals in AYK Region are SEGs because the data fall into the fair and poor categories or because the time series

of good and excellent quality data is too short to perform a reliable spawner-recruit analysis. Usually, inadequate data exists to determine total escapement or total return for a given stock.

Great advances in stock assessment have been made in AYK Region in recent years. More stocks have escapement assessed by weirs, towers, or mark-recapture studies. Sonar projects provide total abundance estimates for several stocks, and radiotelemetry provides valuable information on the distribution of salmon. Many of these projects have operated less than 10 years and sufficient data do not yet exist to develop escapement goals. As these assessment projects continue, data should significantly improve the ability to set additional scientifically defensible escapement goals in AYK Region where it makes sense to establish goals.

During its regulatory process, the board reviews BEGs, SEGs, and SETs, and with the assistance of the department, determines the appropriateness of establishing an optimal escapement goal:

*Optimal Escapement Goal (OEG):* a specific management objective for salmon escapement that considers biological and allocative factors and may differ from the SEG or BEG; an OEG will be sustainable and may be expressed as a range with the lower bound above the level of SET and will be adopted as a regulation by the board; the department will seek to maintain evenly distributed escapements within the bounds of the OEG. The board will provide an explanation of the reasons for establishing an OEG and, to the extent practicable with the assistance of the department, an estimate of expected differences in yield of any salmon stock, relative to maximum sustained yield, resulting from implementation of an OEG.

No formal policy existed for setting escapement goals until 1992 when the first escapement goal policy was put into effect by the commissioner. This policy required that escapement goals be documented in written reports, which was first done for AYK Region by Buklis (1993). A review of Norton Sound escapement goals and recommendations for revisions was completed by Fair et al. (*Unpublished*), but these revisions were never officially adopted.

Prior to adoption of the regulatory Escapement Goal Policy in 2001, all escapement goals established by the department for stocks in these areas were termed biological escapement goals. However, most of these goals did not meet the criteria for a BEG under the new policy definition. At the 2001 board meeting, only select stocks were reviewed and biological escapement goals were established consistent with the Sustainable Salmon Policy definitions and the Escapement Goal Policy process (Clark 2001a-c; Clark and Sandone 2001; Eggers 2001; Evenson 2002).

In 2004, a review team reviewed all stocks with escapement goals and provided recommendations for continuing a goal, establishing a new goal consistent with the Sustainable Salmon Policy, or discontinuing a goal (ADF&G 2004). Under the new policy, escapement goals must be approved by the directors of the divisions of Commercial Fisheries and Sport Fish. Goals recommended at the January 2004 board meeting were officially adopted by the department in May 2005. At least two escapement goal recommendations were changed by the review team just prior to, or during, the 2004 board meeting. Therefore, the recommendations contained in the 2004 escapement goal report (ADF&G 2004) do not accurately reflect the goals adopted by the division directors.

In 2007, the escapement goal review team extensively reviewed escapement and harvest data for 57 Kuskokwim Area stocks, 39 Yukon Area stocks, and 54 Norton Sound/Port Clarence Area and Kotzebue Area stocks. Of these 150 stocks, 72 had existing escapement goals that were

reviewed, revised, or established in 2004/2005. Since only three additional years of data existed for those stocks since they were last reviewed, the review team focused its efforts on stocks for which there was sufficient additional data or a new analytical technique to warrant a thorough review and analysis.

In preparation for the 2010 board meeting, the escapement goal review team reviewed escapement and harvest data for 31 Kuskokwim Area stocks, 18 Yukon Area stocks, and 35 Norton Sound/Port Clarence Area and Kotzebue Area stocks. In view of the comprehensive review of AYK Region stocks conducted during the 2007 process, the review team considered a smaller set of stocks for review.

In order to provide adequate time for public review, the review team provided draft recommendations three weeks prior to the AYK Region Board of Fisheries meeting proposal deadline of April 10, 2009. In order to accomplish this, the review team focused on escapement goals for river systems that had accumulated sufficient data or for which a more detailed review could be done because of the quantity, quality, and type of data available.

Two public meetings were held to discuss stocks that would be reviewed and assignments were made among area and regional staff for those analyses. These meetings occurred in Anchorage, AK on October 14, 2008 and December 18, 2008.

## **METHODS**

The escapement goal team evaluated the type, quality, and amount of data for each stock to determine the appropriate type of escapement goal as defined in the Sustainable Salmon Policy. Available data on escapement, harvest, and age composition for each stock were compiled from research reports, management reports, and unpublished historical databases. The following methods were used to set BEGs and SEGs.

### **METHODS FOR SETTING BIOLOGICAL ESCAPEMENT GOALS**

The analyses used to develop the BEGs during this review used various methods for reconstructing runs, but all used Ricker two parameter spawner-recruit models to estimate the escapement that produces maximum sustained yield (MSY). A range of escapements that produce 90% or more of MSY or represent the 90% credible bounds for spawners at MSY was used as the range for the BEG. For the remainder of stocks in the region, data were of insufficient quality or quantity to develop a BEG. In general, a relatively long series of escapement and total return estimates are needed. Optimal length of a data set can vary, but ideally, it would include several generations of fish, and variability, or contrast, in the numbers of spawners and the subsequent returns. Secondly, stock specific age composition and harvest data are necessary in order to develop a complete picture of the total returns from each brood year. Because many of the salmon fisheries in the region are mixed stock fisheries, it is rare that accurate estimates of the contribution of a specific stock to subsistence, commercial, or sport harvests are available.

## METHODS FOR SETTING SUSTAINABLE ESCAPEMENT GOALS

Bue and Hasbrouck (Unpublished) suggested an algorithm to estimate sustainable escapement goals (SEGs) for Upper Cook Inlet salmon stocks (hereafter referred to as the “percentile method”):

Spawning Contrast <sup>a</sup>	SEG Range
Low (<4)	15 <sup>th</sup> percentile – Maximum
Medium (4 – 8)	15 <sup>th</sup> and 85 <sup>th</sup> percentile
High (>8) and at most low exploitation	15 <sup>th</sup> and 75 <sup>th</sup> percentile
High (>8) and at least moderate exploitation	25 <sup>th</sup> and 75 <sup>th</sup> percentile

<sup>a</sup> Relative range of the entire time series of escapement data calculated by dividing the maximum observed escapement by the minimum observed escapement.

These criteria were used to assess the available salmon escapement data for all areas of the AYK Region and make recommendations for SEGs for many of those stocks where the data were not suitable for establishing BEGs. For a few stocks, a minimum SEG point threshold was recommended rather than a range. Threshold SEG goals were only considered in situations where a stock is managed incidentally to a targeted stock, fishing power is low, or there is no apparent relationship between spawners and recruits (e.g., some Norton Sound pink salmon stocks).

Goals were established from percentiles according to the following conventions for rounding off numbers. To be precautionary, all numbers were rounded up to establish goal ranges. Numbers in the 100s were rounded up to the nearest 10; numbers in the 1,000s were rounded up to the nearest 100; numbers in the 10,000s were rounded up to the nearest 1,000; numbers in the 100,000s were rounded up to the nearest 10,000. For example, a goal number of 5,826 would be rounded to 5,900; and a goal number of 105,500 would be rounded up to 110,000.

There is still considerable debate within the department and public as to methodologies for setting SEGs and what constitutes adequate justification for setting an SEG. The review team agreed that while the percentile method has a high probability of replicating the returns historically observed for a stock, it is a descriptive method which is not based on a determination of the relationship between spawners and recruitment. The escapement goal and sustainable fisheries policies state that SEGs should be expressed as a range. However, increasingly, throughout Alaska, SEGs are being established that only have a lower bound or threshold (Bernard et al. 2009). Many agree that this is a logical approach where insufficient fishing power exists to harvest potential yields from targeted stocks or to sustain current yields from non-targeted stocks.

In order to help validate the results of the percentile method with regard to Chinook salmon, the department also employed in its 2007 review the habitat-based model developed by Parken et al. (2004). This method uses the relationship between the escapement that produces MSY ( $S_{MSY}$ ) and the area of the watershed ( $km^2$ ) to predict  $S_{MSY}$ . This model is based on 13 stream-type (age-1 smolt and older) Chinook salmon stocks of varying drainage areas from California to Alaska for which spawner-recruit analysis was used to estimate  $S_{MSY}$ . The Parken method was not used to make recommendations, but rather to help validate recommendations made based on the percentile method.

The remainder of this report presents the review team’s recommendations for escapement goals in each of the areas in the AYK Region. These recommendations will be discussed and considered at length up to and during the 2010 board meeting. Final approval of escapement goals will be made by directors of divisions of Commercial Fisheries and Sport Fish following the 2010 board meeting.

## KUSKOKWIM MANAGEMENT AREA

In Kuskokwim Management Area, which includes Kuskokwim River and Kuskokwim Bay drainages, there are currently 23 established escapement goals for 14 Chinook salmon, 4 chum salmon, 2 coho salmon, and 3 sockeye salmon stocks (Table 1). A comprehensive review of escapement data for most Kuskokwim Management Area stocks was conducted for the 2007 board cycle (Molyneaux and Brannian 2006). During this cycle, efforts were focused on reviewing those stocks with weir enumeration projects that did not have sufficient data to establish a goal in 2007. This included 4 chum salmon stocks, 4 coho salmon stocks, and one sockeye salmon stock.

Table 1.–Escapement goal review summary for the Kuskokwim Management Area for 2010.

	Salmon Species			
	Chinook	Chum	Coho	Sockeye
Current Escapement Goals (2007)	14	4	2	3
Escapement Goals revised	0	0	0	0
Escapement Goals discontinued	0	0	0	0
Escapement Goals recommended	0	0	1	1
Total Escapement Goals (2010)	1 BEG 13 SEG	0 BEG 4 SEG	0 BEG 3 SEG	1 BEG 3 SEG

The review team is recommending one new coho salmon goal based on weir and tower counts at Kwethluk River. Nine years of escapement estimates are available from recent years and all were realized under a light to moderate harvest regime. The recommended goal is a sustainable escapement goal (SEG) threshold of >19,000 coho salmon, which corresponds to the minimum observed escapement. It was the consensus of the review team that escapements exceeding this threshold would be sustainable and would provide for moderate yields (Appendix A1).

The team is also recommending one new sockeye salmon escapement goal based on weir counts at Kogruklu River. There is an active sockeye salmon fishery with a guideline harvest level of 50,000 fish, yet there is no escapement goal in the Kuskokwim River drainage. Recent radiotelemetry studies suggest that up to 70% of Kuskokwim River drainage sockeye spawn in the Holitna drainage and 12%–13% of these fish spawn in Kogruklu River (Gilk et al. *In prep*). The recommended SEG is 4,400–17,000 sockeye salmon and was derived using the percentile method (Appendix A2).

All other existing goals are recommended to continue without revision (Table 2). Escapement data from twenty-eight additional stocks in Kuskokwim Management Area were reviewed (Table 3), but no goals were recommended. Reasons for not recommending a goal were generally because there was a lack of sufficient data or because a particular enumeration method was changed.

Table 2.–Summary of escapement goal recommendations for Kuskokwim Management Area salmon stocks for 2010.

Stock Unit	Enumeration Method	Current Escapement Goal			Escapement Goal Recommendation		
		Goal	Type	Year Established	Action	New or Revised Goal	Type
<b>Chinook Salmon</b>							
Aniak River	Aerial Survey	1,200–2,300	SEG	2005	No Revision		
Cheneetuk River	Aerial Survey	340–1,300	SEG	2005	No Revision		
Gagaraya River	Aerial Survey	300–830	SEG	2005	No Revision		
George River	Weir	3,100–7,900	SEG	2007	No Revision		
Goodnews River (Main Fork)	Aerial Survey	640–3,300	SEG	2005	No Revision		
Holitna River	Aerial Survey	970–2,100	SEG	2005	No Revision		
Kanektok River	Aerial Survey	3,500–8,000	SEG	2005	No Revision		
Kisaralik River	Aerial Survey	400–1,200	SEG	2005	No Revision		
Kogruklu River	Weir	5,300–14,000	SEG	2005	No Revision		
Kwethluk River	Weir	6,000–11,000	SEG	2007	No Revision		
Middle Fork Goodnews River	Weir	1,500–2,900	BEG	2005	No Revision		
Pitka Fork Salmon River	Aerial Survey	470–1,600	SEG	2005	No Revision		
Salmon River (Aniak Drainage)	Aerial Survey	330–1,200	SEG	2005	No Revision		
Tuluksak River	Weir	1,000–2,100	SEG	2007	No Revision		
<b>Chum Salmon</b>							
Aniak River	Sonar	220,000–480,000	SEG	2007	No Revision		
Kanektok River	Aerial Survey	>5,200	SEG	2005	No Revision		
Kogruklu River	Weir	15,000–49,000	SEG	2005	No Revision		
Middle Fork Goodnews River	Weir	>12,000	SEG	2005	No Revision		
<b>Coho Salmon</b>							
Kogruklu River	Weir	13,000–28,000	SEG	2005	No Revision		
Middle Fork Goodnews River	Weir	>12,000	SEG	2005	No Revision		
Kwethluk	Weir	None			Establish	>19,000	SEG
<b>Sockeye Salmon</b>							
Goodnews River (Main Fork)	Aerial Survey	5,500–19,500	SEG	2005	No Revision		
Kanektok River	Aerial Survey	14,000–34,000	SEG	2005	No Revision		
Middle Fk. Goodnews River	Weir	18,000–40,000	BEG	2007	No Revision		
Kogruklu River	Weir	None			Establish	4,400–17,000	SEG

Table 3.–Kuskokwim Management Area salmon stocks for which escapement goals were not established because of insufficient data or because new enumeration methods were developed.

Stock (enumeration method)	Rationale for not Establishing an Escapement Goal
<b>Chinook Salmon</b>	
Arolik River (aerial survey)	Lacks sufficient historical escapement and stock contribution data.
Bear Creek (aerial survey)	Lacks sufficient historical escapement and stock contribution data.
Eek River (aerial survey)	Lacks sufficient historical escapement and stock contribution data.
Hoholitna River (aerial survey)	Lacks sufficient historical escapement and stock contribution data.
Holokuk River (aerial survey)	Existing middle river escapement goals were considered adequate.
Kanektok River (weir)	Insufficient number of escapement estimates.
Kipchuk River (aerial survey)	Existing middle river escapement goals were considered adequate.
Oskawalik River (aerial survey)	Existing middle river escapement goals were considered adequate.
Pitka Fork (aerial survey)	Lacks sufficient historical escapement and stock contribution data.
Salmon River (aerial survey)	Lacks sufficient historical escapement and stock contribution data.
Takotna River (weir)	Lacks sufficient historical escapement, stock contribution data, and lack of corroboration by habitat-based model.
Tatlawiksuk River (aerial survey)	Lacks sufficient historical escapement, stock contribution data, and lack of corroboration by habitat-based model.
Tatlawiksuk River (weir)	Lacks sufficient historical escapement, stock contribution data, and lack of corroboration by habitat-based model.
Tuluksak River (aerial survey)	Favored weir goal because of better precision and accuracy.
<b>Chum Salmon</b>	
George River (weir)	Lacks sufficient historical escapement and stock contribution data.
Kanektok River (weir)	Insufficient number of escapement estimates.
Kuskokwim R. (run reconstruction)	Lacks sufficient historical escapement data; requires extensive additional field work and analysis.
Kwethluk River (tower and weir)	Lacks sufficient historical escapement and stock contribution data.
Takotna River (weir)	Lacks sufficient historical escapement and stock contribution data.
Tatlawiksuk River (weir)	Lacks sufficient historical escapement and stock contribution data.
Tuluksak River (weir)	Lacks sufficient historical escapement and stock contribution data.
<b>Coho Salmon</b>	
George River (weir)	Lacks sufficient historical escapement and stock contribution data.
Kanektok River (weir)	Insufficient number of escapement estimates.
Takotna River (weir)	Lacks sufficient historical escapement and stock contribution data.
Tatlawiksuk River (weir)	Lacks sufficient historical escapement and stock contribution data.
Tuluksak River (weir)	Lacks sufficient historical escapement and stock contribution data.
<b>Sockeye Salmon</b>	
Arolik River (aerial survey)	Lacks sufficient historical escapement and stock contribution data.
Kanektok River (weir)	Insufficient number of escapement estimates.

## YUKON RIVER MANAGEMENT AREA

In Yukon River Management Area, which includes the entire Yukon River drainage, there are currently 17 established escapement goals for 7 Chinook salmon, 2 summer chum salmon, 7 fall chum salmon, and 1 coho salmon stocks (Table 4). Eleven of these goals are biological escapement goals based on spawner-recruit analyses. Six are sustainable escapement goals based on the percentile method. In addition, there are three goals for Canadian stocks, not listed here, that are established in the *Yukon River Salmon Agreement* as part of the Pacific Salmon Treaty between the United States and Canada. Annual escapement targets for these Canadian stocks (mainstem Yukon River Chinook salmon, mainstem Yukon River fall chum salmon, and Fishing Branch River fall chum salmon) are set annually by the Yukon River Panel, a bilateral group of stakeholders established under the treaty.

Table 4.–Escapement goal review summary for Yukon River Management area for 2010.

	Salmon Species			
	Chinook	Summer Chum	Fall Chum	Coho
Current Escapement Goals (2007)	7	2	7	1
Escapement Goals Revised	1	1	1	0
Escapement Goals Discontinued	1	0	1	0
Escapement Goals Recommended	0	0	0	0
Total Escapement Goals (2010)	2 BEG 4 SEG	1 BEG 1 SEG	5 BEG 1 SEG	0 BEG 1 SEG

The review team is recommending revision of the Chinook salmon SEG for East Fork Andreafsky River from an aerial survey-based goal to a weir-based goal. The recommended new SEG range is 2,100–4,900 Chinook salmon past the weir (Appendix B1). The team is also recommending elimination of the Gisasa River aerial survey goal for Chinook salmon because aerial surveys do not appear to track true abundance based on recent weir counts. Currently, there are insufficient data for a weir-based goal, but we expect that in future years a weir-based goal for Gisasa River will be evaluated.

For East Fork Andreafsky summer chum salmon, the team is recommending that the weir-based BEG of 65,000–130,000 chum salmon be changed to an SEG threshold of >40,000. This recommendation is based on a stock-recruit analysis using a Bayesian approach that accommodates data uncertainty associated with measurement error and missing data. Despite little to no harvest of this stock in recent years, the existing escapement goal has rarely been met. The stock-recruit analysis indicates that meeting or exceeding this threshold should provide a >90% probability of providing at least 70% of maximum sustained yield (MSY). A detailed account of this analysis is provided in a separate report (Fleischman and Evenson *In prep*).

Spawner-recruit analyses for Chena River and Salcha River Chinook salmon stocks were conducted to evaluate the current BEGs for those stocks. These analyses are presented in a separate report (Evenson and Reed *In prep*), but the analyses revealed no changes to the current BEGs were warranted.

The review team is recommending that the drainagewide BEG for fall chum salmon be changed to an SEG since the current goal range does not effectively encompass MSY. No change is recommended for the specific numerical goal range. The drainagewide SEG of 300,000–600,000 includes all Alaskan and Canadian stocks. A detailed account of this analysis is provided in a separate report (Fleischman and Borba *In prep*).

The team is also recommending that the Toklat River fall chum salmon BEG be eliminated. Environmental changes have altered the relationship between surveys and peak spawning dates, and channel breaches have altered the flow of the mainstem through some of the more productive habitat, obscuring fish and making counts impossible. These changes have rendered the Toklat River survey unreliable (Brannian et al. 2006) and foot surveys have been discontinued. With no assessment to evaluate performance of the goal, it should be eliminated.

All other existing goals are recommended to continue without revision (Table 5). Eighteen additional stocks in Yukon Management Area were reviewed (Table 6), but no goals were recommended. Reasons for not recommending a goal were generally because there was insufficient data or because a particular enumeration method was changed.



Table 5.–Summary of escapement goal recommendations for Yukon River Management Area for 2010.

Stock Unit	Enumeration Method	Current Escapement Goal			Escapement Goal Recommendation		
		Goal	Type	Year Established	Action	New or Revised Goal	Type
<b>Chinook Salmon<sup>a</sup></b>							
Andreafsky River (East Fork)	Aerial Survey	960–1,700	SEG	2005	Revise	2,100-4,900 (weir)	SEG
Andreafsky River (West Fork)	Aerial Survey	640–1,600	SEG	2005	No Revision		
Anvik River	Aerial Survey	1,100–1,700	SEG	2005	No Revision		
Chena River	Tower/Mark–Recapture	2,800–5,700	BEG	2001	No Revision		
Gisasa River	Aerial Survey	420–1,100	SEG	2005	Eliminate		
Nulato River (forks combined)	Aerial Survey	940–1,900	SEG	2005	No Revision		
Salcha River	Tower/Mark–Recapture	3,300–6,500	BEG	2001	No Revision		
<b>Chum Salmon (Summer)</b>							
East Fork Andreafsky River	Weir	65,000–130,000	BEG	2001	Revise	>40,000	SEG
Anvik River	Sonar	350,000–700,000	BEG	2005	No Revision		
<b>Chum Salmon (Fall)<sup>b</sup></b>							
Yukon R Drainage <sup>c</sup>	Multiple <sup>d</sup>	300,000–600,000	BEG	2001	Revise	300,000–600,000	SEG
Tanana River	Mark–Recapture	61,000–136,000	BEG	2001	No Revision		
Delta River	Foot Survey	6,000–13,000	BEG	2001	No Revision		
Toklat River	Foot Survey	15,000–33,000	BEG	2001	Eliminate		
Upper Yukon R. Tributaries <sup>e</sup>	Multiple <sup>f</sup>	152,000–312,000	BEG	2001	No Revision		
Chandalar River	Sonar	74,000–152,000	BEG	2001	No Revision		
Sheenjek River	Sonar	50,000–104,000	BEG	2001	No Revision		
<b>Coho Salmon</b>							
Delta Clearwater River	Boat Survey	5,200–17,000	SEG	2005	No Revision		

<sup>a</sup> The Canadian Chinook salmon border escapement goal, which is under the Yukon River Salmon Agreement and reviewed annually by the Yukon River Panel is not included as part of this summary.

<sup>b</sup> The Canadian fall chum salmon border escapement goal or Fishing Branch River goal, which are under the Yukon River Salmon Agreement and reviewed annually by the Yukon River Panel are not included in this summary.

<sup>c</sup> This goal includes all Alaskan and Canadian stocks.

<sup>d</sup> Includes foot survey, weir, sonar, aerial survey counts, and mark–recapture.

<sup>e</sup> Includes Chandalar, Sheenjek, and Fishing Branch Rivers. Per footnote above, Fishing Branch River is not listed as an individual goal.

<sup>f</sup> Includes sonar, weir, and aerial survey counts.

Table 6.–Yukon River area salmon stocks for which escapement goals were not established because of insufficient data or because new enumeration methods were developed.

Stock (enumeration method)	Rationale for not Establishing an Escapement Goal
<b>Chinook Salmon</b>	
Gisasa River (weir)	Aerial surveys are not reflective of Chinook salmon abundance based on comparison with weir counts. Insufficient range of escapement estimates to develop a weir-based escapement goal.
<b>Chum Salmon (Summer)</b>	
Chena River (aerial survey)	Aerial surveys are not reflective of summer chum salmon abundance and are no longer conducted.
Chena River (tower)	Counts are incomplete; no stock apportionment.
Gisasa River (weir)	Insufficient number of escapement estimates.
Gisasa River (aerial survey)	Aerial surveys are not reflective of summer chum salmon abundance and are no longer conducted.
Clear/Caribou Creek (aerial survey)	Aerial surveys are not reflective of summer chum salmon abundance and are no longer conducted.
Clear Creek (tower)	Insufficient number of escapement estimates.
Kaltag River (aerial survey)	Aerial surveys are not reflective of summer chum salmon abundance and are no longer conducted.
Nulato River (mainstem, tower/weir)	Project no longer operates.
Nulato River (North Fork, aerial survey)	Aerial surveys are not reflective of summer chum salmon abundance and are no longer conducted.
Nulato River (South Fork, aerial survey)	Aerial surveys are not reflective of summer chum salmon abundance and are no longer conducted.
Salcha River (aerial survey)	Aerial surveys are not reflective of summer chum salmon abundance and are no longer conducted.
Salcha River (tower)	Counts are incomplete and lack stock contribution data.
Tozitna River (aerial survey)	Aerial surveys are not reflective of summer chum salmon abundance and are no longer conducted.
Yukon River (mainstem, Pilot Station sonar)	Requires extensive reanalysis due to change in historical relationship (2 times) with Anvik River escapement.
<b>Coho Salmon</b>	
Andreafsky River (East Fork, weir)	Insufficient number of escapement estimates.
Nenana River (aerial survey)	Insufficient number of escapement estimates for entire system.
Yukon River (mainstem, Pilot Station sonar)	Incomplete run assessment would require extensive analysis to determine feasibility.

## **NORTON SOUND/PORT CLARENCE AND KOTZEBUE MANAGEMENT AREAS**

A total of 32 escapement goals exist in Norton Sound/Port Clarence and Kotzebue Management areas for 5 Chinook salmon, 18 chum salmon, 3 coho salmon, 5 pink salmon, and 2 sockeye salmon stocks (Table 7). Biological escapement goals exist for 4 stocks including Norton Sound Subdistrict 1 (Nome) chum salmon, Kwiniuk and Tubutulik rivers chum salmon, and Kotzebue (all areas) chum salmon (Table 8). The Nome area BEGs were established in 2001 and 2007

based on extensive spawner-recruit analyses (Clark 2001b, c; Eggers and Clark 2006). In 2004, data for Nome-area stocks were reanalyzed using updated data sets and no changes were recommended in the ranges (ADF&G 2004), although the goals for individual Subdistrict One (Nome) rivers were clarified as being SEGs rather than BEGs. Addition of two years' data available since 2004 did not warrant reanalysis in 2007. All other goals are sustainable escapement goals (Table 8).

Table 7.–Norton Sound/Port Clarence and Kotzebue Management Areas escapement goal review summary for 2010.

	Salmon Species				
	Chinook	Chum	Coho	Pink	Sockeye
Current Escapement Goals (2007)	5	18	3	5	2
Escapement Goals Revised	0	1	1	0	0
Escapement Goals Discontinued	0	4	0	0	0
Escapement Goals Recommended	0	0	0	0	0
Total Escapement Goals (2007)	0 BEG 5 SEG	4 BEG 14 SEG	0 BEG 3 SEG	0 BEG 5 SEG	0 BEG 2 SEG

The review team is recommending elimination of aerial survey escapement goals for chum salmon on Flambeau, Sinuk, Solomon and Bonanza Rivers. Due to weather, uncertainty of the relationship of the survey to peak spawning time and availability of aircraft, these counts are unreliable for evaluating goals on these specific systems. However, the aerial surveys will continue as part of the overall subdistrict one chum salmon goal. The team recommends changing the Niukluk River chum salmon goal to an SEG threshold of >23,000 (Appendix C1) based on a risk analysis (Bernard et al. 2009). Escapements exceeding this threshold result in 6.6% estimated risk of a management concern (four consecutive years of escapements below the threshold), and a 6.4% estimated risk of experiencing a 75% drop in mean escapement.

The review team is also recommending a modification to the range of the SEG for Niukluk coho salmon. The previous goal (2,400–5,800 coho salmon) assumed that tower counts were true escapements, without recognizing subsistence and sport harvest occurring upstream from the counting tower. Subsistence permits and the sport fishing statewide harvest survey now specifically enumerate harvest above the tower. The revised SEG of 2,400–7,200 coho salmon was derived using the percentile method, with escapement numbers calculated by subtracting harvest from counts at the tower (Appendix C2).

Escapement data from 23 additional stocks were evaluated during the 2010 review, but no goals were recommended (Table 9). Reasons for not recommending a goal were generally either because there was insufficient data or because a particular enumeration method was changed. For Pilgrim River sockeye salmon, excellent data on escapement and age composition are being collected (Burkhart and Dunmall *In prep*; Dunmall 2004, 2005), but the weir has operated only since 2003 and complete numbers are available for only the 1998 and 1999 brood years. We expect that a weir-based escapement goal may be developed for this stock for the 2013 review cycle.

Table 8.—Summary of escapement goal recommendations for Norton Sound/Port Clarence and Kotzebue Management Areas for 2010.

Stock Unit	Enumeration Method	Current Escapement Goal			Escapement Goal Recommendation		
		Goal	Type	Year Established	Action	New or Revised Goal	Type
<b>Norton Sound/Port Clarence Management Area</b>							
Chinook Salmon							
Fish R./Boston Cr.	Aerial Survey	>100	SEG	2005	No Revision		
Kwiniuk River	Tower	300–550	SEG	2005	No Revision		
North River (Unalakleet R.)	Tower	1,200–2,600	SEG	2005	No Revision		
Old Woman R. (Unalakleet R.)	Aerial Survey	550–1,100	SEG	2005	No Revision		
Shaktoolik River	Aerial Survey	400–800	SEG	2005	No Revision		
Chum Salmon							
Bonanza River	Expanded Aerial Survey	2,300–3,400	SEG	2001	Eliminate		
Eldorado River	Expanded Aerial Survey	6,000–9,200	SEG	2001	No Revision		
Flambeau River	Expanded Aerial Survey	4,100–6,300	SEG	2001	Eliminate		
Kwiniuk River	Tower	10,000–20,000	BEG	2001	No Revision		
Niukluk River (Fish R.)	Tower	>30,000	SEG	2005	Revise	>23,000	SEG
Nome River	Weir	2,900–4,300	SEG	2001	No Revision		
Old Woman R. (Unalakleet R.)	Aerial Survey	2,400–4,800	SEG	2005	No Revision		
Sinuk River	Expanded Aerial Survey	4,000–6,200	SEG	2001	Eliminate		
Snake River	Tower/weir	1,600–2,500	SEG	2001	No Revision		
Solomon River	Expanded Aerial Survey	1,100–1,600	SEG	2001	Eliminate		
Subdistrict One (Nome, all systems)	Multiple	23,000–35,000	BEG	2001	No Revision		
Tubutulik River	Expanded Aerial Survey	8,000–16,000	BEG	2001	No Revision		
Coho Salmon							
Kwiniuk River	Aerial Survey	650–1,300	SEG	2005	No Revision		
Niukluk River	Tower	2,400–6,100	SEG	2007	Revise	2,400–7,200	SEG
North River (Unalakleet R.)	Aerial Survey	550–1,100	SEG	2005	No Revision		

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Table 8.–Page 2 of 2.

Stock Unit	Enumeration Method	Current Escapement Goal			Escapement Goal Recommendation		
		Goal	Type	Year Established	Action	New or Revised Goal	Type
<b>Norton Sound/Port Clarence Management Area (Continued)</b>							
Pink Salmon							
Kwiniuk River (all years)	Tower	>8,400	SEG	2005	No Revision		
Niukluk River (all years)	Tower	>10,500	SEG	2005	No Revision		
Nome River (even year)	Weir	>13,000	SEG	2005	No Revision		
Nome River (odd year)	Weir	>3,200	SEG	2005	No Revision		
North River (Unalakleet. R. all years)	Tower	>25,000	SEG	2005	No Revision		
Sockeye Salmon							
Salmon Lake	Aerial Survey	4,000–8,000	SEG	2005	No Revision		
Glacial Lake	Aerial Survey	800–1,600	SEG	2005	No Revision		
<b>Kotzebue Management Area</b>							
Chum Salmon							
Kotzebue (all areas)	Expanded Aerial Survey	196,000–421,000	BEG	2007	No Revision		
Noatak/Eli Rivers	Aerial Survey	42,000–91,000	SEG	2007	No Revision		
Salmon River (Kobuk R. drainage)	Aerial Survey	3,300–7,200	SEG	2007	No Revision		
Squirrel River (Kobuk R. drainage)	Aerial Survey	4,900–10,500	SEG	2007	No Revision		
Tutuksuk River (Kobuk R. drainage)	Aerial Survey	1,400–3,000	SEG	2007	No Revision		
Upper Kobuk and Selby Rivers	Aerial Survey	9,700–21,000	SEG	2007	No Revision		

Table 9.—Norton Sound/Port Clarence and Kotzebue Management areas salmon stocks for which escapement goals were not established because of insufficient data or because new enumeration methods were developed.

Stock (Enumeration method)	Rationale for not Establishing an Escapement Goal
<b>Chinook Salmon</b>	
Niukluk River (aerial)	Small Chinook salmon system; not representative of Fish River drainage
Niukluk River (tower)	Small Chinook salmon system; not representative of Fish River drainage
Unalakleet River (run reconstruction)	Lacks sufficient historical escapement data
<b>Chum Salmon</b>	
None	
<b>Coho Salmon</b>	
Bonanza River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Eldorado River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Eldorado River (tower/weir)	Project no longer operates during the coho salmon migration
Flambeau River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Kwiniuk River (tower)	Insufficient number of escapement estimates
Nome River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Nome River (weir)	Insufficient number of escapement estimates
North River (tower)	Lacks sufficient historical escapement and stock contribution data
Sinuk River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Snake River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Solomon River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Tubutulik River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
<b>Pink Salmon</b>	
Bonanza River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Eldorado River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Sinuk River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Snake River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Solomon River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
Tubutulik River (aerial survey)	Lacks sufficient historical escapement and stock contribution data
<b>Sockeye Salmon</b>	
Glacial Lake (weir)	Insufficient number of escapement estimates
Pilgrim River (weir)	Insufficient number of escapement estimates

## **EFFECT OF 2010 ESCAPEMENT GOAL RECOMMENDATIONS ON STOCKS OF CONCERN**

The department will develop its recommendations for stocks of concern designations after the 2009 fishing season and prior to adoption of goals recommended in this report. Stocks of concern definitions are given in the Sustainable Salmon Policy and currently there are four stocks listed as stocks of concern (Table 10). Stocks of concern will not be evaluated with the goals recommended in this report; however, for most of the stocks currently listed, there will be no recommended revisions, discontinued goals, or new goals that would affect departmental analysis.

Table 10.—Arctic-Yukon-Kuskokwim salmon stocks of concern designated in 2007 and escapement goal recommendations for 2010.

AYK Region Stocks of Concern Designated in 2007 by Alaska Board of Fisheries			
Area/Stock	Salmon Species	Level of Concern	Escapement Goal Recommendations for 2010
Kuskokwim River	none		
Yukon River	Chinook	Yield	1 Discontinued goal, and one revised goal
Norton Sound			
Subdistrict 1	Chum	Yield	4 goals discontinued
Subdistrict 2 and 3	Chum	Yield	No new, discontinued, or revised goals
Subdistrict 5 and 6	Chinook	Yield	No new, discontinued, or revised goals

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**APPENDIX A: DATA FOR NEW OR REVISED  
ESCAPEMENT GOALS-KUSKOKWIM MANAGEMENT  
AREA**

Appendix A1.–Escapement goal for Kwethluk River coho salmon (weir).

**System: Kwethluk River**

**Species: Coho salmon**

**Stock Unit: not applicable**

*Description of stock and escapement goals*

Regulatory Area:	Kuskokwim Area
Management Division:	Commercial Fisheries
Primary Fishery:	Commercial and subsistence
Previous Escapement Goal:	none
Escapement Goal Type:	SEG Threshold
Recommended Escapement Goal:	>19,000
Optimal Escapement Goal:	none
Inriver Goal:	none
Action Points:	none
Escapement Enumeration:	Weir 1992, 2000, 2002–2004, 2006–2008
Summary:	
Data Quality:	Fair
Data Type:	Weir counts; no estimates in 1993–1999, 2001 or 2005
Contrast:	6
Criteria for SEG:	Medium contrast
15th to 85th Percentile:	21,936 to 61,367
Years within recommended SEG:	9 years above SEG Threshold

Comments:

- 52 river miles from the enumeration point to the Kuskokwim River confluence.
- 134 river miles from the enumeration point to the mouth of the Kuskokwim River.
- Kwethluk River is within the Yukon Delta National Wildlife Refuge.
- Tower operations between 1996 and 1999 were discontinued too early to provide useful estimates of coho salmon escapement.
- The weir is a cooperative project between USFWS and the Organized Village of Kwethluk; the tower was operated by the Association of Village Council Presidents and Kwethluk IRA Council.
- The Kwethluk River is a popular location for subsistence and recreational activity due in part to the close proximity of Bethel (population 5,471) and the Yup'ik village of Kwethluk (population 693). The village is located about 1 mile upstream from the Kuskokwim River confluence. Subsistence fishers commonly deploy short gillnets within the lower few miles of the stream in order to harvest salmon and whitefish. Observers have reported as many as dozen gillnets in the Lower Kwethluk River during the height of the Chinook run. Subsistence and recreational fishers use rod and reel gear to harvest resident species including Arctic grayling, rainbow trout and Dolly Varden trout (personal observation; Brown Unpublished). Professional guides for sport fishing and rafting tours operate on the river.
- Discovery of gold in nearby streams in 1909 attracted prospectors to the Kwethluk River basin, but yields were low and most prospectors were gone by 1911. One placer deposit in the Upper Kwethluk basin was worked until World War II (Community Profiles Database 2006). Kwethluk River also served as an access route to gold fields in the Upper Eek River basin.
- The Lower Kwethluk River is tidally influenced.

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**System: Kwethluk River**  
**Species: Coho salmon**  
**Stock Unit: not applicable**

*Data available for analysis of escapement goals.*

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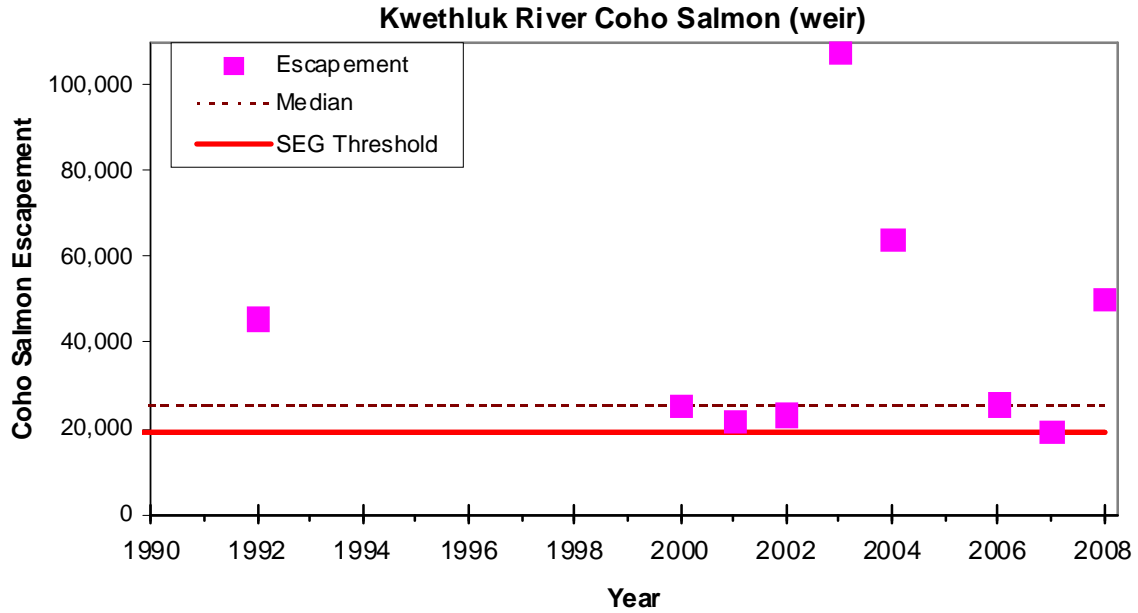
Year	Escapement
1990	
1991	
1992	45,605
1993	
1994	
1995	
1996	
1997	
1998	
1999	
2000	25,610
2001	21,596
2002	23,298
2003	107,789
2004	64,216
2005	
2006	25,664
2007	19,473
2008	49,973

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-continued-

**System: Kwethluk River**  
**Species: Coho salmon**  
**Stock Unit: not applicable**

*Observed escapement by year.*



Appendix A2.–Escapement goal for Kogrukluk River sockeye salmon (weir).

<b>System: Kogrukluk River</b>	
<b>Species: Sockeye salmon</b>	Map Code: 16
<b>Stock Unit: not applicable</b>	
<i>Description of stock and escapement goal history</i>	
Regulatory Area:	Kuskokwim Area
Management Division:	Commercial Fisheries
Primary Fishery:	Commercial and subsistence
Previous Escapement Goal:	>2,000 (established in 1983; documented in Buklis 1993); discontinued approx 1995, but not well documented (Burkey et al. 1999)
Escapement Goal Type:	SEG
Recommended Escapement Goal:	4,400 to 17,000
Optimal Escapement Goal:	none
Inriver Goal:	none
Action Points:	none
Escapement Enumeration:	Weir 1976,1978–1979,1981–1982,1984–1986,1988–2008
Summary:	
Data Quality:	Fair
Data Type:	Weir counts; no estimates in 1977, 1980, 1983 and 1987.
Contrast:	36
Criteria for SEG:	High contrast with at least moderate exploitation
25th to 75th Percentile:	4,359 to 16,526
Years within recommended SEG:	16 of 29 years within SEG range, 7 years below and 6 years above

Comments:

- 136 river miles from the enumeration point to confluence with Kuskokwim River.
- 441 river miles from the enumeration point to the mouth of the Kuskokwim River.
- Kogrukluk River is a tributary of the Holitna River, and is atypical among Western Alaskan sockeye habitats in that it does not include any large lakes
- An SEG threshold was considered in 2003, but rejected because 1) sockeye were not actively managed in the Kuskokwim River; 2) Kogrukluk River sockeye was believed to be a minor component of the annual Kuskokwim River sockeye run; and, 3) Kogrukluk River was not thought to be a good index of the Kuskokwim River sockeye run.
- Two changes of management level significance have occurred since 2003:
  - 1) In 2004 the BOF formally established a limited guideline commercial harvest level of 0 to 50,000 sockeye for the Kuskokwim River (Whitmore et al. 2008).
  - 2) In 2006 and 2007 preliminary findings of a radiotelemetry study identify the Holitna River sub-basin to account for approximately 56% and 50% of the total Kuskowkim River sockeye salmon spawning distribution, with Kogrukluk River accounted for 13% and 12% of the total. The second and third largest spawning concentrations were found to be in the Stony River (15% and 21%) and Aniak River (8% and 8%) sub-basins. More sockeye are observed passing Kogrukluk River weir than any other escapement monitoring location in the Kuskokwim River basin. These findings indicate that the Kogrukluk River may be a reasonable indicator of overall sockeye salmon escapement and should be revisited for consideration of escapement goal development (S. E. Gilk, Commercial Fish Biologist, ADF&G, Anchorage; personal communication).
- The Holitna River is a popular subsistence and recreational location for residents throughout the Kuskokwim River drainage. Local and non-local sport-fish guiding services operate in the sub-basin. Recreational rod and reel fishing is expected to increase should the proposed Donlin Creek mine be developed and the anticipated increase in human populations in nearby Communities.

Beginning in the early 1900s a small number of prospectors explored the Upper Holitna River, but found only limited amount of gold (Brown Unpublished). The area has also supported mercury mines, particularly in the Chukowan River drainage. Cool bed methane extraction has been proposed in the lower drainage.

-continued-

**System: Kogrukluk River**  
**Species: Sockeye salmon**  
**Stock Unit: not applicable**

*Data available for analysis of escapement goals.*

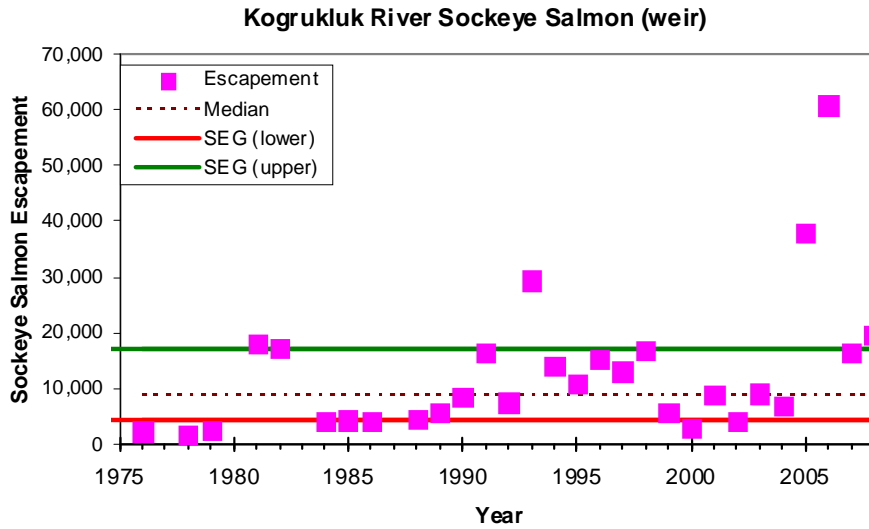
Year	Escapement
1976	2,326
1977	
1978	1,670
1979	2,628
1980	
1981	18,077
1982	17,297
1983	
1984	4,133
1985	4,359
1986	4,247
1987	
1988	4,402
1989	5,810
1990	8,407
1991	16,455
1992	7,539
1993	29,366
1994	14,192
1995	10,996
1996	15,386
1997	13,078
1998	16,773
1999	5,864
2000	2,865
2001	8,776
2002	4,050
2003	9,164
2005	37,939
2006	60,807
2007	16,526
2008	19,675

-continued-



**System: Kogrukluk River**  
**Species: Sockeye salmon**  
**Stock Unit: not applicable**

*Observed escapement by year.*



**Distribution of radio-tagged sockeye in major spawning tributaries in the Kuskokwim River, 2006-2007**

Spawning Stream	2006		2007		Total	
	No. of Tags	%	No. of Tags	%	No. of Tags	%
<b>Aniak R Sub-basin</b>						
Aniak	21	4%	14	3%	35	4%
Kipchuk	4	1%	4	1%	8	1%
Upper Aniak	11	2%	9	2%	20	2%
<b>Subtotal</b>	<b>36</b>	<b>7%</b>	<b>27</b>	<b>6%</b>	<b>63</b>	<b>6%</b>
<b>Holokuk</b>	<b>12</b>	<b>2%</b>	<b>7</b>	<b>1%</b>	<b>19</b>	<b>2%</b>
<b>Oskawalik</b>	<b>5</b>	<b>1%</b>	<b>1</b>	<b>&lt; 1%</b>	<b>6</b>	<b>1%</b>
<b>George</b>	<b>2</b>	<b>&lt; 1%</b>	<b>1</b>	<b>&lt; 1%</b>	<b>3</b>	<b>&lt; 1%</b>
<b>Vreeland</b>	<b>1</b>	<b>&lt; 1%</b>	<b>0</b>	<b>0%</b>	<b>1</b>	<b>&lt; 1%</b>
<b>Holitna R Sub-basin</b>						
Hoholitna	54	11%	63	13%	117	12%
Holitna	122	24%	82	17%	204	21%
Chukowan	27	5%	24	5%	51	5%
Kogrukluk	61	12%	53	11%	114	12%
<b>Subtotal</b>	<b>264</b>	<b>53%</b>	<b>222</b>	<b>45%</b>	<b>486</b>	<b>49%</b>
<b>Stony R Sub-basin</b>						
Stony	21	4%	29	6%	50	5%
Telaquana	23	5%	18	4%	41	4%
Necons	18	4%	28	6%	46	5%
<b>Subtotal</b>	<b>62</b>	<b>12%</b>	<b>75</b>	<b>15%</b>	<b>137</b>	<b>14%</b>
<b>Swift</b>	<b>1</b>	<b>&lt; 1%</b>	<b>0</b>	<b>0%</b>	<b>1</b>	<b>&lt; 1%</b>
<b>Inriver Harvest</b>	<b>3</b>	<b>1%</b>	<b>3</b>	<b>1%</b>	<b>6</b>	<b>1%</b>
<b>Unknown Final</b>	<b>51</b>	<b>10%</b>	<b>64</b>	<b>13%</b>	<b>115</b>	<b>12%</b>
<b>Downstream</b>	<b>44</b>	<b>9%</b>	<b>71</b>	<b>15%</b>	<b>115</b>	<b>12%</b>
<b>Radio Failure</b>	<b>17</b>	<b>3%</b>	<b>17</b>	<b>3%</b>	<b>34</b>	<b>3%</b>
<b>TOTAL</b>	<b>498</b>		<b>488</b>		<b>986</b>	



**APPENDIX B: DATA FOR NEW OR REVISED  
ESCAPEMENT GOALS-YUKON MANAGEMENT AREA**

Appendix B1.–Escapement goal for East Fork Andreafsky River Chinook salmon (weir).

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**System: East Fork Andreafsky River**

**Species: Chinook salmon**

**Stock Unit: not applicable**

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*Description of stock and escapement goals*

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Regulatory Area:	Yukon Area
Management Division:	Commercial Fish
Primary Fishery:	Subsistence and commercial
Previous Escapement Goal:	SEG range of 960–1,700
Escapement Goal Type:	SEG
Recommended Escapement Goal:	Weir based SEG range of 2,100–4,900
Optimal Escapement Goal:	none
Inriver Goal:	none
Action Points:	none
Escapement Enumeration:	Aerial surveys (1961–2008), weir counts (1987–2008)
Summary:	
Data Quality:	Good
Data Type:	Stock specific ASL available 1986–2008
Contrast:	42
Criteria for SEG:	High contrast and at least moderate exploitation
25th to 75th Percentile:	2,100–4,900
Years within recommended SEG:	18 of 36 years

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**Comments:**

Aerial vs. weir linear relationship significant at  $p=0.019$ ; converted aerial data to weir based data.

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-continued-

**System: East Fork Andreafsky River**  
**Species: Chinook salmon**  
**Stock Unit: N/A**

*Data available for analysis of escapement goals.*

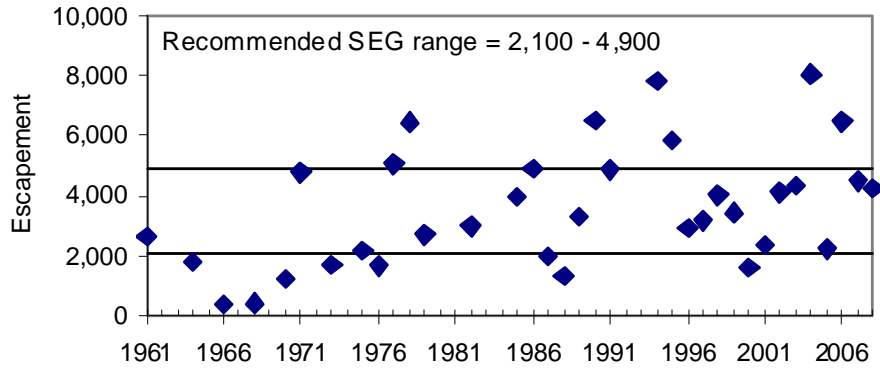
Brood Year	Weir Escapement	Weir and Aerial Escapement
1961		2,662
1962		
1963		
1964		1,819
1965		
1966		378
1967		
1968		432
1969		
1970		1,244
1971		4,774
1972		
1973		1,700
1974		
1975		2,178
1976		1,680
1977		5,070
1978		6,434
1979		2,711
1980		
1981		
1982		2,979
1983		
1984		
1985		3,956
1986	1,530	4,916
1987	2,011	2,011
1988	1,339	1,339
1989		3,335
1990		6,480
1991		4,870
1992		
1993		16,029
1994	7,801	7,801
1995	5,841	5,841
1996	2,955	2,955
1997	3,186	3,186
1998	4,034	4,034
1999	3,444	3,444
2000	1,609	1,609
2001		2,384
2002	4,123	4,123
2003	4,336	4,336
2004	8,045	8,045
2005	2,239	2,239
2006	6,463	6,463
2007	4,504	4,504
2008	4,242	4,242

Shaded cells were not used in the SEG analysis.

-continued-

**System:** East Fork Andreafsky River  
**Species:** Chinook salmon  
**Stock Unit:** N/A

*Observed escapement by year and recommended SEG range (solid line).*



**APPENDIX C: DATA FOR NEW OR REVISED ESCAPEMENT  
GOALS NORTON SOUND–PORT CLARENCE MANAGEMENT  
AREAS**

## Appendix C1.–Revision of Niukluk Chum Salmon Escapement Goal.

Niukluk River is the largest tributary of Fish River drainage that flows into Golovin Bay. Approximately 34% of Fish River chum salmon are Niukluk stock (Todd 2005). The commercial fishery at Golovin Bay (subdistrict 2) targets chum salmon annually and pink salmon during even years (Soong et al. 2008).

Niukluk River chum salmon escapements have been monitored by counting tower since 1995 (Table C1). The current sustainable escapement goal (SEG) for Niukluk River chum salmon was established in 2005 using the escapement data (1995–2003) and applying the percentile method (ADF&G 2004). The goal is a SEG threshold of  $> 30,000$  chum salmon. This threshold was established because of a declining escapement trend from 1995 to 2003. During this period escapement declined by 77% from 86,332 to 20,018 chum salmon.

Because of this decline, the commercial chum salmon fishery has been closed and subsistence salmon harvest permits have been required since 2002. Currently, there is little market interest in a chum salmon fishery, and 10 year (1998–2007) average subsistence chum salmon harvest is about 2,000.

From 2003 to 2009, escapement declined to 10,770 in 2004 and gradually recovered to 50,994 in 2007. While causes of the decline and recovery of escapement is unclear, there is evidence that Niukluk River chum salmon can be viable below the 30,000 threshold, and suggests that revision of the current escapement goal is warranted.

In revising the escapement goal, a risk based method (Bernard et al. 2009) was employed. The risk based escapement goal method is used to assess stocks that are caught incidentally or for stocks experiencing low levels of harvest. The objective of goal setting under these scenarios is not for seeking of maximum sustainable yields, but for avoidance of risk of the fish stock falling into management concern.

Risk of fishery restrictions due to a an unwarranted management concern ( $\pi_k$ ) was estimated directly from the log transformed mean ( $\mu$ ), standard deviation ( $\sigma$ ), and number of consecutive years to warrant a management concern ( $k$ ) for various values of an escapement threshold ( $X$ ) as per Bernard et al (2009) was calculated as:

$$\hat{\pi}_k = \left\{ pr \left[ (N : \hat{\mu}, \hat{\sigma}^2) \leq \ln X \right] \right\}^k.$$

Parameters for this equation were calculated using escapement data from 1995–2007. Using these parameters an additional 1,000 simulated escapements were generated using the ARIMA1 process:

$$\ln x_t = \phi(\ln x_{t-1}) + \mu(1 - \phi) + \varepsilon_t - \phi\varepsilon_{t-1}$$

For Niukluk chum salmon, risk of a management concern was defined as having escapements below a threshold escapement for 4 consecutive years. Risk of detecting a drop in mean escapement was calculated in the same way as risk of an unwarranted restriction, except that the risk of not detecting ( $1 - \hat{\pi}_k$ ) was estimated and the mean escapement ( $\hat{\mu}$ ) was changed by a percentage corresponding to a worrisome drop in mean escapement to be detected with the threshold. Risk was estimated for a drop in mean escapement of 75%. This reflects the lowest observed escapement from which escapements subsequently recovered to higher levels.



Appendix Table C1.–Escapement, harvest, and exploitation rates of Niukluk River chum salmon.

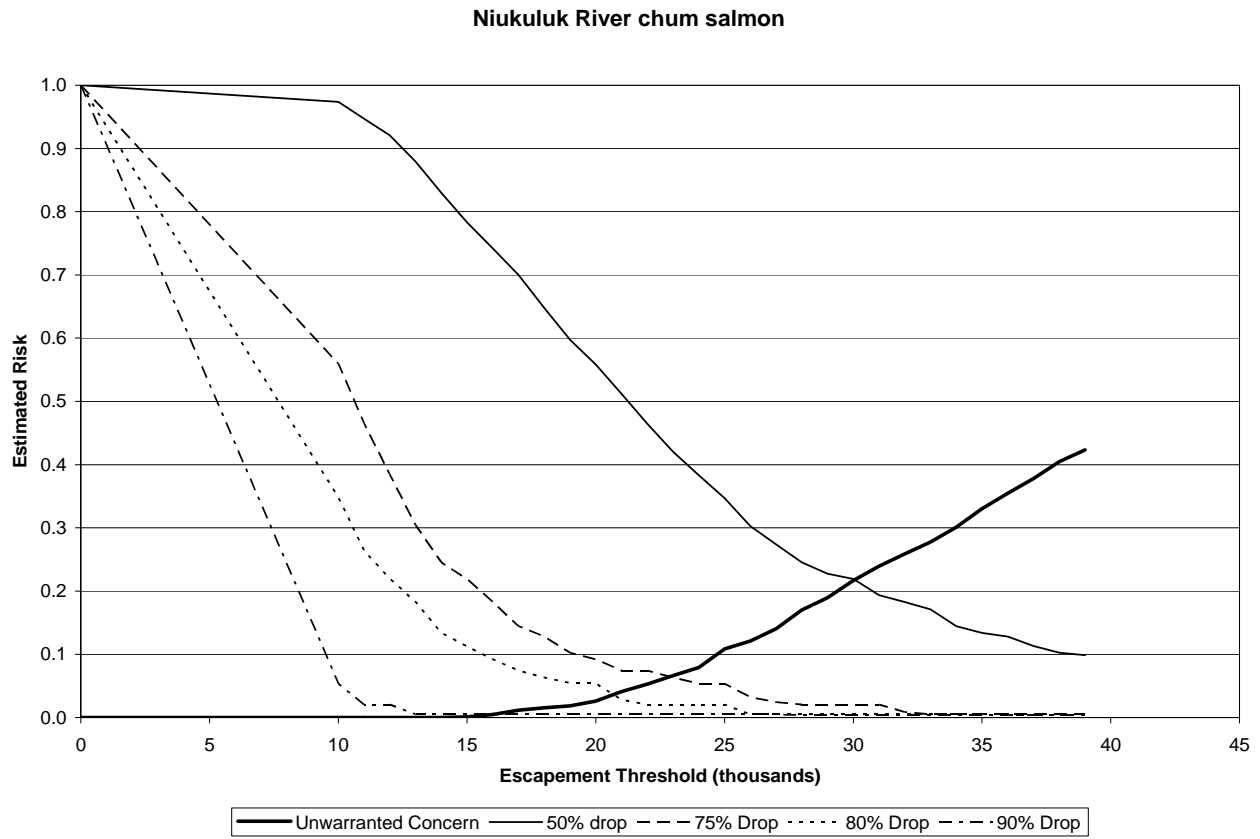
Year	Escapement (Tower Count)	Subsistence Harvest <sup>a,b</sup>	Commercial Harvest <sup>a</sup>	Exploitation Rate <sup>c</sup>
1995	86,332	10,373	1,987	13%
1996	80,178	2,867	0	3%
1997	57,305	4,891	8,003	18%
1998	45,588	1,893	723	5%
1999	35,239	3,656	0	9%
2000	29,573	1,155	164	4%
2001	30,662	3,291	7,094	25%
2002	35,307	1,882	0	5%
2003	20,018	1,477	0	7%
2004	10,770	880	0	8%
2005	25,598	1,852	0	7%
2006	29,199	722	0	2%
2007	50,994	4,217	0	8%

<sup>a</sup>Golovin subdistrict 2, including harvests at Marine Water, Kachavik, Mackinley, Fish, Niukluk, and Klokerblock rivers, and Chinik Creek.

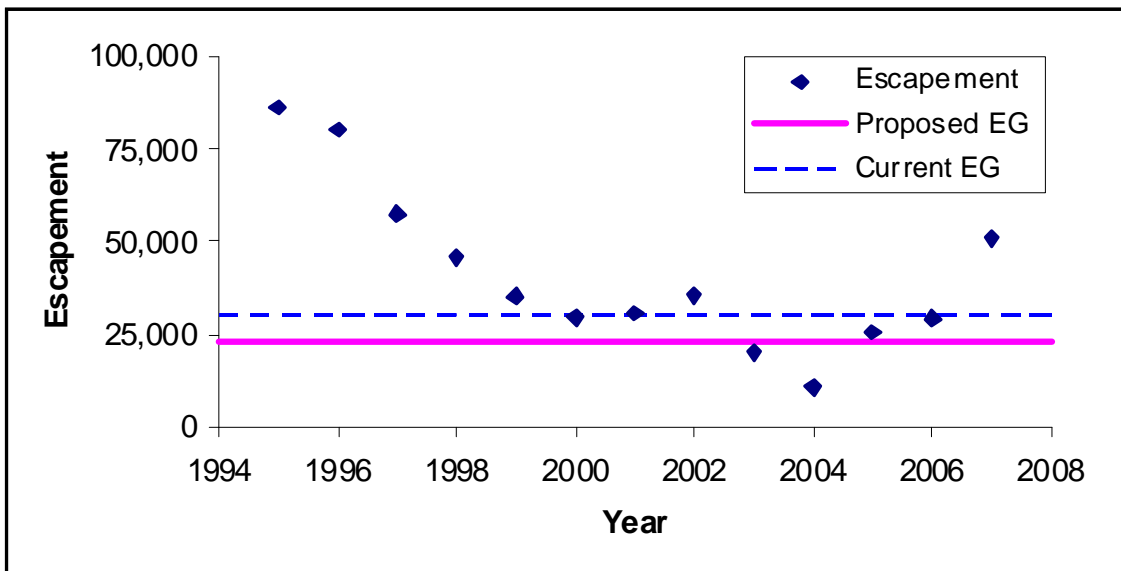
<sup>b</sup>Harvest at Niukluk River accounts for ~ 10% of the subdistrict 2 subsistence harvests.

<sup>c</sup>Assumes that all harvested fish are Niukluk stock, therefore this represents a maximum rate.

An escapement threshold of 23,000 resulted in a 6.6 % estimated risk of a management concern, with a 6.4% estimated risk that a drop in mean escapement of 75% (Figure C1). Hence, an SEG of 23,000 was proposed for a revised goal. Of the 13 observed escapements, two have been lower than the proposed goal (Figure C2)



Appendix Figure C1.—Estimated risk of management error associated with possible threshold escapement values for Niukluk River chum salmon.



Appendix Figure C2.—Annual escapements of Niukluk River chum salmon compared to the current and proposed escapement goals.

Appendix C2.–Escapement goal for Niukluk River coho salmon (tower count).

**System: Niukluk River**

**Species: Coho salmon**

**Stock Unit: not applicable**

*Description of stock and escapement goals*

Regulatory Area:	Norton Sound Area
Management Division:	Commercial Fisheries
Primary Fishery:	Subsistence, sport and commercial
Previous Escapement Goal:	2,400–6,100
Escapement Goal Type:	SEG
Recommended Escapement Goal:	SEG of 2,400–7,200
Optimal Escapement Goal:	none
Inriver Goal:	none
Action Points:	none
Escapement Enumeration:	Counting Tower 1995–2007
Summary:	
Data Quality:	Fair
Data Type:	Counting tower, limited aerial surveys
Contrast:	11
Criteria for SEG:	High contrast, low exploitation rate.
15th to 85th Percentile:	2,429–7,210
Years within recommended SEG:	8 of 13 within goal, 3 above goal, 2 below goal.

**Comments:**

- Harvest above the tower from sport and subsistence fisheries was subtracted from tower counts to estimate escapement.
- Rod and reel became a legal subsistence gear in 2001. Subsistence permits recorded harvest above the tower beginning in 2004.
- The analysis includes an expanded estimate for 1998 because the tower did not operate the entire season.
- A radiotelemetry study in the Fish River drainage during 2005 and 2006 indicated that the Niukluk River supported approximately 0.40 of the coho salmon escapement in the entire drainage. There are limited ASL data available from 1996, 1997, 2002, 2005, and 2006.

-continued-

**System: Niukluk River**  
**Species: Coho salmon**  
**Stock Unit: not applicable**

<i>Data available for analysis of escapement goals</i>				
Year	Tower Count	Sport Harvest <sup>a</sup>	Subsistence Harvest <sup>b</sup>	Escapement <sup>c</sup>
1995	4,713	270	0	4,443
1996	12,781	544	0	12,236
1997	3,994	152	0	3,842
1998	4,195 <sup>d</sup>	104	0	4,091
1999	4,260	450	0	3,810
2000	11,382	384	0	10,998
2001	3,468	319	83	3,066
2002	7,391	98	83	7,210
2003	1,282	71	83	1,128
2004	2,064	96	51	1,917
2005	2,727	132	38	2,557
2006	11,169	312	193	10,664
2007	3,498	259	50	3,189
2008	13,799			

<sup>a</sup> Sport harvest was estimated for the entire Fish River drainage from 1995–2006. In 2007 a creel survey was used to estimate the proportion of the total harvest taken upstream of the tower. That proportion was applied to all years as a means of estimating harvest above the tower.

<sup>b</sup> Rod and reel subsistence harvest became legal in 2001 and permits began differentiating harvest above and below the tower in 2004. The average harvest above the tower was applied to total harvest estimates in 2002–2003 to estimate harvest above the tower. Prior to 2002, harvest was assumed to be negligible.

<sup>c</sup> Escapement was calculated as the tower count estimate minus the total harvest above the tower.

<sup>d</sup> In 1998 the tower only operated until August 14, so the estimate of 839 through that date was expanded by 80% to estimate total passage for the year.

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**System:** Niukluk River  
**Species:** Coho salmon  
**Stock Unit:** not applicable

*Observed escapement by year.*

