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Review of Salmon Escapement Goals in Bristol Bay, Alaska, 2021

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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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The Fishery Manuscript Series was established in 1987 by the Division of Sport Fish for the publication of technically oriented reports presenting a broader outlook on one or more projects. Reports in this series may include the results of several years' work undertaken on a project to address common objectives, overviews of work undertaken through multiple projects to address specific research or management goal(s), or results of projects using new and/or highly technical methods. The series became a joint divisional series in 2004 with the Division of Commercial Fisheries. Fishery Manuscripts are intended for fishery and other technical professionals. Fishery Manuscripts are available through the Alaska State Library and on the Internet: http://www.adfg.alaska.gov/sf/publications/. This publication has undergone editorial and peer review.

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ABSTRACT

The Alaska Department of Fish and Game interdivisional escapement goal review committee reviewed Pacific salmon *Oncorhynchus* spp. escapement goals for the major river systems in Bristol Bay. There were 13 escapement goals reviewed in the Bristol Bay management area for this review. The committee evaluated spawner-return data for all Bristol Bay sockeye salmon *O. nerka* and Chinook salmon *O. tshawytscha* stocks with escapement goals.

For this escapement goal review, the committee recommends that all sockeye salmon escapement goals in the Bristol Bay management area remain the same. After the development of a run reconstruction model recommended at the last cycle, the committee also recommends no change to the Nushagak River Chinook salmon escapement goal for this cycle and that a run reconstruction-based escapement goal be considered during the next Alaska Board of Fisheries cycle.

Keywords: Pacific salmon, *Oncorhynchus* spp., sockeye salmon, *O. nerka*, Chinook salmon, *O. tshawytscha*, chum salmon, *O. keta*, coho salmon, *O. kisutch*, pink salmon, *O. gorbuscha*, Bristol Bay, Kvichak River, Alagnak River, Naknek River, Egegik River, Ugashik River, Wood River, Igushik River, Nushagak River, Togiak River, spawning escapement goal, Alaska Board of Fisheries

INTRODUCTION

This report describes the review of existing Bristol Bay salmon escapement goals by the interdivisional escapement goal review committee and their recommendations to the Divisions of Commercial Fisheries and Sport Fish directors. Many Bristol Bay salmon escapement goals have been set and evaluated at regular intervals since statehood.

The Bristol Bay management area includes all coastal and inland waters east of a line from Cape Newenham to Cape Menshikof (Figure 1). The Bristol Bay management area is divided into 5 management districts (Egegik, Naknek-Kvichak, Nushagak, Togiak, and Ugashik) that correspond to the major river systems. Bristol Bay supports some of the largest sockeye salmon runs in the world with combined runs to Bristol Bay averaging approximately 42.4 million fish since 2001 (Table 1). Nine major river systems produce more than 99% of the returning sockeye salmon: Alagnak, Egegik, Igushik, Kvichak, Naknek, Nushagak, Togiak, Ugashik, and Wood Rivers (Table 1, Figure 1).

The primary management objective for each river is to achieve escapements within established ranges and harvesting fish over escapement goals through orderly fisheries. During the 2015 Statewide Miscellaneous Shellfish Alaska Board of Fisheries (board) meeting the Alaska Department of Fish and Game (department) introduced, and the board approved, regulatory language ". . . to the extent practicable, manage for escapements to fall within the lower or upper portions of escapement goals proportional to the run size based on the preseason forecast and inseason assessment of the run size" (5 AAC 06.355(d)(1)). Regulatory management plans have been adopted for individual species in certain districts. Escapement refers to the annual estimated size of the spawning salmon stock, which is affected by a variety of factors including harvest, predation, disease, and physical and biological changes in the environment. Escapement goals for sockeye salmon have been in place for the major river systems since the early 1960s (Burgner et al. 1967; Fried 1994; Cross et al. 1997; Fair 2000; Fair et al. 2004; Baker et al. 2006, 2009; Fair et al. 2012; Erickson et al. 2015; Erickson et al. 2018). Bristol Bay also contains one of the largest runs of Chinook salmon *O. tshawytscha* in Alaska. The Chinook salmon run in the Nushagak River has averaged 191,000 since 1989. Substantial runs of chum *O. keta*, coho *O. kisutch*, and pink *O. gorbuscha* salmon are also found in many Bristol Bay rivers.

The department reviews Bristol Bay escapement goals on a schedule that corresponds to the board's 3-year cycle for considering area regulatory proposals. This report describes the Bristol Bay salmon escapement goals reviewed in 2021.

The committee reviewed existing escapement goals for the following stocks:

- Chinook salmon: Nushagak River
- chum salmon: Nushagak River
- coho salmon: Nushagak River
- pink salmon: Nushagak River
- sockeye salmon: Egegik, Igushik, Kvichak, Naknek, Nushagak, Togiak, Ugashik, and Wood Rivers

Escapement goals were reviewed based on 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). The board adopted these policies into regulation to ensure that the state's salmon stocks are conserved, managed, and developed using the sustained yield principle. The EGP states that it is the department's responsibility to document existing salmon escapement goals for all salmon stocks that are currently managed for an escapement goal and to review existing, or propose new, escapement goals on a schedule that conforms to the board's regular cycle of consideration of area regulatory proposals. For this review, there are two important terms defined in the SSFP:

> 5 AAC 39.222 (f)(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
>
> 5 AAC 39.222 (f)(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 or managed for; the SEG is the primary management objective for the escapement, unless an optimal escapement or inriver run goal has been adopted by the board; the SEG will be developed from the best available biological information; and should be scientifically defensible on the basis of that information; the SEG will be determined by the department and will take into account data uncertainty and be stated as either an "SEG range" or "lower-bound SEG"; the department will seek to maintain escapements within the bounds of the SEG range or above the level of a lower bound SEG.

An escapement goal for a stock was defined as a BEG if a sufficiently long time series of escapement, harvest, and age estimates were available; the estimates were sufficiently accurate and precise; and the data were considered sufficient to estimate maximum sustained yield (MSY; Hilborn and Walters 1992; Chinook Technical Committee 1999; Quinn and Deriso 1999). An escapement goal for a stock was defined as an SEG if a sufficiently long time series of escapement estimates were available, but there was concern about the spawner-return data (e.g., lack of age composition estimates, concern with stock-specific harvest allocation, insufficient contrast in escapements).

In 2021, the department established an interdivisional escapement goal review committee (committee). The committee consisted of Division of Commercial Fisheries and Division of Sport Fish personnel (Table 2). The committee met formally for the first time in February of 2021 to review existing escapement goals and begin developing findings for the directors of the Divisions of Sport Fish and Commercial Fisheries. As per the SSFP and EGP, department regional and headquarters staff reviewed all committee findings prior to submitting a summary of the escapement goal findings to the board during the 2022 Work Session. The escapement goal findings will be finalized in the form of a written memo signed by the directors after the 2022/2023 board cycle concludes.

OBJECTIVES

Objectives of the 2021 review were to:

1) Review existing goals to determine whether they were still appropriate given (a) new data collected since the last review, (b) current assessment techniques, and (c) current management practices;
2) Review the methods used to establish the existing goals to determine whether alternative methods should be investigated;
3) Consider discontinuing existing goals;
4) Consider any new stocks for which there may be sufficient data to develop a goal; and
5) Recommend new goals, if appropriate.

OVERVIEW OF STOCK ASSESSMENT METHODS

The committee reviewed each of the existing escapement goals using escapement and harvest data (if available), including data collected since the 2018 review. Escapement goals for salmon are ideally based on spawner–recruit relationships (e.g., Ricker 1954; Beverton and Holt 1957), which describe the productivity and carrying capacity of a stock. However, available fisheries data are often not suitable for describing a spawner–recruit relationship (e.g., insufficient contrast in escapements, no stock-specific harvest data, short escapement time series, or inconsistent escapement monitoring). In these cases, other evaluation methods are necessary. Escapement goals are evaluated and revised over time as improved methods are developed, and when new and better information becomes available.

Available escapement, harvest, and age data for each stock were compiled from research reports, management reports, and unpublished historical databases. The committee evaluated the type, quality, and quantity of data for each stock. Escapements within an escapement goal range for a stock should produce sustainable yields.

ESCAPEMENT AND HARVEST DATA

Sockeye salmon escapements have been sampled by beach seine and visually counted using towers at Alagnak, Egegik, Igushik, Kvichak, Naknek, Togiak, Ugashik, and Wood Rivers (West et al. 2012). The department has assessed Alagnak River sockeye salmon escapement using a combination of aerial surveys and towers since its inception (Clark 2005). Salmon escapements were sampled by gillnet or beach seine and estimated using sonar for all Nushagak River salmon species beginning in the early 1980s (Brazil and Buck 2011). Prior to the implementation of sonar, Nushagak River Chinook and sockeye salmon escapements were assessed using aerial surveys. Age data have been collected from both the escapement and harvest for all these stocks. Prior to the 2012 review, harvest allocation for each stock was estimated by harvest location and age composition (Bernard 1983). However, the run reconstruction model of Cunningham et al. (2012) estimated sockeye salmon stock-specific harvest contributions based on genetic markers, age composition, and run timing information going back to 1963. For the current review, the Bristol Bay sockeye salmon run reconstruction was updated retroactively for the length of the data set (brood years 1963–2012) to incorporate the best, most current understanding of genetic baselines in Bristol Bay. Although this board cycle was delayed by one year due to the ongoing COVID-19 pandemic, total return data for all sockeye salmon stocks in this review were taken from the 2020 run reconstruction.

ESCAPEMENT GOAL SETTING

In previous reviews, escapement goals were evaluated for Bristol Bay salmon stocks using the following methods: (1) spawner–recruit analysis; (2) yield analysis; (3) smolt information; and (4) risk analysis. Spawner-return data were generally used to estimate escapement goals when stock-specific estimates of total return (escapement and stock-specific harvest) were reliable and there was sufficient contrast in escapements. Spawner-return data were used to estimate escapement goals based on: (1) escapements producing average yields that were 90–100% of MSY from a spawner–recruit model, and (2) the yield analysis, a visual examination of observed yield versus escapement. Recent smolt information is not available for any Bristol Bay salmon stocks. The risk analysis approach (Bernard et al. 2009) was used to develop a lower-bound SEG when the harvest of a stock was deemed incidental (passively managed) to harvests and management of primary stocks (e.g., chum salmon harvests are incidental to the directed harvests of sockeye and Chinook salmon in the Nushagak District).

Spawner–recruit analysis

Complete spawner–recruit data exist for Nushagak River Chinook and chum salmon, and Alagnak, Egegik, Igushik, Kvichak, Naknek, Nushagak, Togiak, Ugashik, and Wood River sockeye salmon. For this review, spawner–recruit models were used to analyze salmon spawner–recruit data for all available brood years. Although total returns are the sum of escapements and harvests, sport and subsistence harvests were only included in total return estimates for the Nushagak River Chinook salmon, but were considered minor components for the sockeye salmon stocks.

The Bristol Bay analyses used the standard Ricker spawner–recruit (S-R) model (Ricker 1954) written as:

$$R = \alpha S e^{-\beta S} \tag{1}$$

where R is recruitment (i.e., brood year return) and S is brood year escapement, α and β are model parameters.

The model was log transformed to the linearized form

$$\ln(R/S) = \ln(\alpha) - \beta S \tag{2}$$

and its parameters were estimated using a Bayesian approach.

Fishery management parameters S_{EQ}, S_{MSY}, and MSY were estimated from

$$S_{EQ} = \frac{ln\,(\alpha)}{\beta}, \tag{3}$$

$$S_{MSY} \approx S_{EQ}(0.5\text{-}0.07\,ln\,(\alpha)), \tag{4}$$

$$MSY = \alpha S_{MSY} e^{-\beta S_{MSY}} - S_{MSY} \tag{5}$$

Risk analysis

For stocks that are passively managed and coincidentally harvested, lower-bound SEGs are frequently developed using risk analysis (Bernard et al. 2009). The risk analysis approach estimates two types of management errors: (1) the risk of taking an unneeded management action, and (2) the risk of not taking action when management action was warranted (mistaken inaction).

Although sufficient information for stock-recruit analysis is available for Nushagak River chum salmon and Alagnak River sockeye salmon, both stocks are passively managed. Escapement goals for these two stocks are lower-bound SEGs developed using risk analysis.

Percentile approach

Many salmon stocks throughout Alaska have an SEG developed using the percentile approach (Munro and Volk 2017). In 2001, Bue and Hasbrouck (*unpublished*) developed an algorithm using percentiles of observed escapements, whether estimates or indices, that incorporated contrast in the escapement data and exploitation of the stock. Clark et al. (2014) evaluated this approach and recommended several modifications including consideration of the quality of the assessment data when deciding which percentiles are used to set the lower and upper bounds of the escapement goal. Percentile ranking is the percent of all escapement values that fall below a particular value. To calculate percentiles, escapement data are ranked from the smallest to the largest value, with the smallest value the 0 percentile (i.e., none of the escapement values are less than the smallest). The percentile of all remaining escapement values is cumulative, or a summation, of 1/(n-1), where n is the number of escapement values. Contrast in the escapement data is the maximum observed escapement divided by the minimum observed escapement. As contrast increases, meaning more information about the variability of the run size is known, the percentiles used to estimate the SEG are narrowed, primarily from the upper end, to better utilize the yields from the larger runs. Clark et al. (2014) recommended that the percentile approach not be used for stocks with average harvest rates greater than 0.40 or for stocks with very low contrast (<4) and high measurement error (aerial or foot surveys).

Escapement contrast and exploitation (Clark et al. 2014)	SEG range
High contrast (>8); and high measurement error (aerial and foot surveys) with low to moderate average harvest rates (<0.4)	20th to 60th Percentile
High contrast (>8); and low measurement error (weirs and towers) with low to moderate average harvest rates (<0.4)	15th to 65th Percentile
Low contrast (≤8) with low to moderate average harvest rates (<0.40)	5th to 65th Percentile

RESULTS AND DISCUSSION

A total of 12 escapement goals were reviewed for Bristol Bay. The committee updated the escapement goal analyses for Nushagak River Chinook salmon and all Bristol Bay sockeye salmon stocks with the exception of Alagnak River sockeye salmon, which had a thorough review and a new goal set during the last board cycle. As part of the review process, the department developed a run reconstruction model for Nushagak River Chinook salmon (Head and Hamazaki 2022). Nushagak River chum, coho, and pink salmon (even-year) also had no updates. There is no recommendation to establish any new escapement goals in Bristol Bay.

The escapement goal committee findings for each escapement goal follows by species and river.

CHINOOK SALMON

Nushagak River

The current Nushagak River Chinook salmon SEG range is 55,000–120,000 fish (Table 3, Appendix A1). During the 2018 escapement goal review cycle (Erickson et al. 2018), a discrepancy in brood tables between those used to generate the 2012 escapement goal (Fair et al. 2012) and those reported in (Buck et al. 2012) was discovered. The brood table in (Fair et al. 2012) expanded recruitment incorrectly, which resulted in higher recruitment per spawner than presented by Buck et al. (2012). In this review, corrections were made to the historical estimates and the Ricker spawner–recruit model was updated with the most recent complete brood years (2011–2012). Similar to previous reviews, the Ricker spawner–recruit model fit the data well (based on a relatively small regression standard deviation, 0.50), and a relatively small 90% credible interval for S_{MSY} (71,000–95,000; Tables 4 and 5). The updated median point estimate of S_{MSY} (81,800) is well within the current SEG (55,000–120,000) and is slightly less than the point estimate of S_{MSY} (85,000) that the existing goal range was developed from (Fair et al. 2012).

The Nushagak River is approximately 300 m wide at the sonar site and it is not possible to ensonify the middle of the channel. Maxwell et al. (2020) estimated that the ensonified area covers less than a third of the river channel. Results from a 2011–2014 acoustic tagging study estimated that the proportion of Chinook salmon traveling upstream and outside of the sonar beam range was 47–65% with a mean of 57% (Maxwell et al. 2020). Also, a 2014–2016 mark–recapture study estimated the abundance of adult Chinook salmon in the Nushagak River independently from the sonar estimate. Preliminary results from the 2014–2016 mark–recapture study estimated that the Portage Creek sonar project enumerated 76–81% of the adult Chinook salmon passing the sonar (data on file with Central Region Research Group, ADF&G, Division of Commercial Fisheries, Soldotna). These studies prompted the escapement goal review committee to recommend a future update of the Nushagak River Chinook salmon SEG to be based on the total run and escapement of Chinook salmon returning to the Nushagak River, rather than the relatively unreliable index count provided by the sonar assessment project (Erickson et al. 2018). In order to incorporate the 2 types of tagging studies and all available historical data to estimate total run and escapement of Chinook salmon in the Nushagak River, the department has developed a run reconstruction model for Nushagak River Chinook salmon (Head and Hamazaki 2022).

The committee finds no change needs to be made to the existing escapement goal and that the newly developed run reconstruction model be used to develop a spawner–recruit analysis prior to the next Bristol Bay regulatory cycle to generate an escapement goal based on the full Chinook population to replace the current SEG that is based on an unreliable index of Chinook abundance. The committee determined that the updated analysis and preliminary results from this analysis be presented to subsistence, sport, and commercial stakeholders well in advance of the deadline for submitting regulatory proposals.

CHUM SALMON

Nushagak River

The current lower-bound SEG of 200,000 chum salmon based on sonar site (sonar and test fishing) data was established in 2012 using the risk analysis approach (Fair et al. 2012). For that review, historical escapement data through July 20 were used to develop the escapement goal even though the sonar project in recent years has been extended into mid-August. July 20 was chosen as the cut-off date because typically over 90% of the chum salmon escapement has passed the sonar site by this date; and for many years (12 of the 38 years since 1980), sonar operations ceased around July 20.

Escapements since the current goal was adopted were above the lower-bound SEG in 7 of 8 years, and all within the historical range (Appendix B1); therefore, the committee concluded updating the analysis for this stock would not result in a substantially different escapement goal.

The committee finds no change to the current lower-bound SEG of 200,000 for Nushagak River chum salmon is warranted.

COHO SALMON

Nushagak River

The SEG of 50,000–100,000 for Nushagak River coho salmon was discontinued in 2006 (Baker et al. 2006). At that time, sonar operations had been reduced in duration (terminated on July 20), and no longer fully assessed coho salmon abundance. Beginning in 2012, the sonar project operated through August 20 to assess coho and pink salmon because both species are actively managed in the Nushagak District. During the 2012 review, the SEG was reinstated and revised to 60,000–120,000 to account for the difference between Bendix and DIDSON sonar estimation. The current escapement was developed from a Ricker stock-recruitment model (Fair et al. 2012).

Since 2014, the Nushagak River sonar has only operated after July 20 twice (2018 and 2019; Appendix C1) and it is unlikely to be run after July 20 (the key timeframe for coho salmon passage) in the foreseeable future. The committee concluded that updating the analysis for this stock would likely not result in a substantially different escapement goal.

The committee finds no change to the current SEG of 60,000–120,000 for Nushagak River coho salmon is warranted.

PINK SALMON (EVEN-YEAR)

Nushagak River

The current lower-bound SEG of 165,000 was established in 2012 (Fair et al. 2012) and is for even years only. The review in 2006 discontinued an SEG of 600,000–1,100,000 for Nushagak River pink salmon (Baker et al. 2006). At that time, sonar operations had been reduced in duration (terminated on July 20) and no longer assessed pink salmon abundance.

The sonar project has only operated twice (2014 and 2018) during the month of August (the key timeframe for pink and coho salmon passage) since the goal was established.

The committee finds no change to the lower-bound SEG of 165,000 for even-year pink salmon is warranted.

SOCKEYE SALMON

Alagnak River

The Alagnak River sockeye salmon stock is passively managed and incidentally harvested with Kvichak River sockeye salmon. The department is not able to actively manage this stock. It is for this reason that a lower-bound SEG was established in 2007. During the last board cycle, a thorough review of Alagnak River sockeye salmon was done and a new lower-bound SEG of 210,000 was established. Returns in the last 3 years provided no new information which warranted reevaluation of the current escapement goal.

The committee finds no changes to the current Alagnak River sockeye salmon escapement goal is warranted.

Other Bristol Bay sockeye salmon stocks

For this review, the committee updated the sockeye salmon genetic harvest allocations for each stock to better account for mixed stock harvest in each district and to more accurately represent the true production of the primary stocks. Even though the escapement goals were thoroughly reviewed and updated in 2015, the committee elected to update the spawner–recruit analyses (Tables 4 and 5, Figure 2) to determine whether the updated harvest allocations and extension of the times series would result in appreciable changes to the spawner–recruit relationships. The committee concluded there were insufficient changes to the spawner–recruit analyses to warrant modifying the escapement goals at this time. Returns from historic high runs are expected in the coming years and will be more informative to potentially updating goals during the next board cycle.

The committee finds no changes for the Egegik, Igushik, Kvichak, Naknek, Nushagak, Ugashik, Togiak, and Wood River sockeye salmon escapement goals are warranted.

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TABLES AND FIGURES

Table 1.–Bristol Bay sockeye salmon total runs by system in the last 20 years (2001–2020).

Year	Alagnak	Egegik	Igushik	Kvichak	Naknek	Nushagak	Togiak	Ugashik	Wood	Total
2001	1,186,913	3,566,444	818,733	1,940,225	5,991,185	2,093,785	1,109,140	1,467,575	4,644,099	22,818,098
2002	941,301	5,544,322	199,684	897,874	2,813,598	691,785	406,290	2,499,049	3,859,722	17,853,622
2003	4,157,797	3,217,356	492,184	2,001,790	4,861,853	2,409,660	897,566	2,540,240	6,233,372	26,811,817
2004	7,525,884	11,642,565	268,354	8,091,208	4,066,682	2,062,469	507,677	4,202,791	6,430,417	44,798,047
2005	5,224,716	9,402,204	801,087	2,867,679	8,765,371	3,672,976	581,328	3,090,002	5,881,534	40,286,898
2006	3,342,879	8,613,842	727,744	5,715,390	5,342,241	2,731,826	906,036	3,779,176	12,640,215	43,799,349
2007	4,771,233	7,395,032	1,022,675	5,917,492	8,438,492	2,469,463	1,066,972	7,399,703	7,794,243	46,275,306
2008	4,704,660	7,825,252	1,888,898	6,030,620	9,127,188	1,908,901	868,540	2,929,895	6,802,770	42,086,724
2009	2,369,160	12,269,671	1,585,348	6,961,784	4,912,920	2,077,746	856,109	3,851,254	6,673,679	41,557,670
2010	2,815,554	5,145,650	1,407,871	10,779,329	5,436,898	1,206,251	641,004	4,988,743	8,809,667	41,230,968
2011	2,249,302	4,604,185	1,015,858	7,228,364	5,520,113	1,167,743	858,557	4,203,387	4,949,206	31,796,716
2012	2,226,527	5,923,046	507,046	12,263,919	3,321,536	1,037,757	832,938	2,920,818	2,698,060	31,731,648
2013	1,929,767	5,124,466	692,485	6,324,295	3,074,128	2,009,704	592,763	2,633,700	3,286,043	25,667,350
2014	1,620,274	5,078,503	1,436,176	17,600,068	5,320,300	1,510,012	533,288	1,154,017	7,166,061	41,418,700
2015	8,244,526	8,508,004	1,643,379	23,104,927	6,090,738	2,475,985	526,750	4,249,070	5,019,839	59,863,220
2016	4,938,142	9,891,849	1,850,334	14,195,449	5,037,024	2,575,667	737,938	7,192,818	6,384,575	52,803,796
2017	4,430,315	12,441,095	1,230,312	7,250,329	5,975,665	8,199,368	674,286	6,672,738	11,287,414	58,161,522
2018	2,873,550	6,104,312	1,920,088	7,466,680	6,926,060	9,602,179	1,361,343	4,770,223	22,680,173	63,704,607
2019	1,855,136	15,434,052	1,358,927	7,936,269	8,824,530	4,306,596	1,286,738	3,604,963	12,340,740	56,947,951
2020	4,561,208	15,597,219	1,212,549	9,866,665	10,102,212	3,625,517	621,050	5,078,614	8,004,915	58,669,948
Mean	3,598,442	8,166,454	1,103,987	8,222,018	5,997,437	2,891,770	793,316	3,961,439	7,679,337	42,414,198
Median	3,108,214	7,610,142	1,117,612	7,239,347	5,478,506	2,251,722	785,438	3,815,215	6,552,048	41,822,197
Min	941,301	3,217,356	199,684	897,874	2,813,598	691,785	406,290	1,154,017	2,698,060	17,853,622
Max	8,244,526	15,597,219	1,920,088	23,104,927	10,102,212	9,602,179	1,361,343	7,399,703	22,680,173	63,704,607

Note: Total runs calculated during brood table reconstruction in 2020 to account for the most current genetic information. Small runs (less than 1% of total Bristol Bay) of sockeye salmon not shown here occur in the Kulukak, Matogak, Osviak, and Snake Rivers.

Table 2.–List of members on the Alaska Department of Fish and Game (ADF&G) Bristol Bay salmon escapement goal committee and other participants who assisted with the escapement goal review.

Name	Position	Affiliation
Escapement Goal Committee:		
Greg Buck	Area Research Biologist	Division of Commercial Fisheries
Jack Erickson	Regional Research Coordinator	Division of Commercial Fisheries
Hamachan Hamazaki	Biometrician	Division of Commercial Fisheries
James Hasbrouck	Fisheries Scientist	Division of Sport Fish
Jordan Head	Asst. Area Research Biologist	Division of Commercial Fisheries
Tim McKinley	Regional Research Coordinator	Division of Sport Fish
Andrew Munro	Fisheries Scientist	Division of Commercial Fisheries
Bill Templin	Fisheries Scientist	Division of Commercial Fisheries
Stacy Vega	Asst. Area Research Biologist	Division of Commercial Fisheries
Other Participants:		
Lee Borden	Area Management Biologist	Division of Sport Fish
Rich Brenner	Statewide Fisheries Biologist	Division of Commercial Fisheries
Jason Dye	Regional Management Biologist	Division of Sport Fish
Travis Elison	Area Management Biologist	Division of Commercial Fisheries
Bert Lewis	Regional Supervisor	Division of Commercial Fisheries
Matthew Nemeth	Regional Management Biologist	Division of Commercial Fisheries
Adam Reimer	Biometrician	Division of Sport Fish
Tim Sands	Area Management Biologist	Division of Commercial Fisheries
Aaron Tiernan	Area Management Biologist	Division of Commercial Fisheries
Tom Vania	Regional Supervisor	Division of Sport Fish

Table 3.–Summary of current and recommended escapement goals for salmon stocks in Bristol Bay, 2021.

System	Current escapement goal	Type	Year adopted	Escapement data	Action
Chinook Salmon					
Nushagak	55,000–120,000	SEG	2007; Changed to SEG in 2007; range changed in 2012	Sonar	No change
Chum Salmon					
Nushagak	200,000	lower-bound SEG	2007; range changed in 2012	Sonar	No change
Coho Salmon					
Nushagak	60,000–120,000	SEG	2012	Sonar	No change
Pink Salmon					
Nushagak (even years)	165,000	lower-bound SEG	2012	Sonar	No change
Sockeye Salmon					
Alagnak	210,000	lower-bound SEG	2018	Tower	No change
Egegik	800,000–2,000,000	SEG	1995; Changed to SEG in 2007; range changed in March 2015	Tower	No change
Igushik	150,000–400,000	SEG	2001; Changed to SEG in 2007; range changed in March 2015	Tower	No change
Kvichak	2,000,000–10,000,000	SEG	One goal for all years in 2010	Tower	No change
Naknek	800,000–2,000,000	SEG	1983; Changed to SEG in 2007; range changed in March 2015	Tower	No change
Nushagak	370,000–900,000	SEG	1998; Changed to SEG in 2007; range changed in 2012; range changed in March 2015	Sonar	No change
Togiak	120,000–270,000	SEG	2007; Changed from a BEG in 2010	Tower	No change
Ugashik	500,000–1,400,000	SEG	1995; Changed to SEG in 2007; range changed in March 2015	Tower	No change
Wood	700,000–1,800,000	SEG	2001; Changed to SEG in 2007; range changed in March 2015	Tower	No change

Table 4.–Current escapement goals, and updated estimates of S_{MSY}, escapements to achieve 80% of MSY 90% of the time, and S_{EQ} for Bristol Bay salmon.

		Current escapement goal (x thousands)					S_{MSY}				Escapement to achieve 80% of MSY 90% of the time		S_{EQ} ($\ln\alpha / \beta$)
	Goal			Spawner-					90% *CI*				
Sockeye salmon	type	Lower	Upper	return data	*n*	Model	Median	*CV*	Lower	Upper	Lower	Upper	Median
Alagnak[a]	SEG	210		1959–2009	51	Ricker	1,338	0.47	914	2,813	880	1,855	3,176
Egegik	SEG	800	2,000	1963–2012	50	Ricker	2,848	0.57	1,362	7,933	[b]	[b]	7,688
Igushik	SEG	150	400	1963–2012	50	Ricker	357	0.19	266	497	250	440	887
Kvichak	SEG	2,000	10,000	1963–2012	50	Ricker	10,634	0.44	4,631	20,910	6,970[c]	12,095[c]	24,040
Naknek	SEG	800	2,000	1963–2012	50	Ricker	1,903	0.27	1,313	3,077	1,470	2,240	4,823
Nushagak	SEG	370	900	1963–2012	50	Ricker	769	0.17	597	1,049	518	999	1,986
Togiak	SEG	120	270	1963–2012	50	Ricker	195	0.16	155	257	126	263	518
Ugashik	SEG	500	1,400	1963–2012	50	Ricker	1,187	0.24	812	1,755	836	1,408	3,171
Wood	SEG	700	1,800	1963–2012	50	Ricker	1,573	0.22	1,118	2,300	1,110	2,010	4,144
Chinook Salmon													
Nushagak	SEG	55	120	1968–2012	45	Ricker	81.8	0.09	71	95	48	116	207

Note: A Bayesian analysis estimated stock-recruit parameters for a Ricker model with multiplicative error.

[a] All Alagnak River estimates are from the 2018 escapement goal review (Erickson et al. 2018). Credible interval is 95% and lower and upper bounds are listed for escapement to achieve 80–90% of MSY.

[b] Density dependence cannot be reliably estimated of the Egegik River sockeye salmon stock which precludes an estimate of maximum sustained yield.

[c] Kvichak River analysis could not reach the target threshold of 80% of MSY. Bounds listed are for escapement to achieve 70% of MSY 90% of the time.

Table 5.–Current escapement goals and estimates of spawner–recruit parameters (α, β, and σ) for Bristol Bay salmon.

				α				β			σ		
	Spawner-					90% CI			90% CI			95% CI	
Sockeye salmon	return data	n	Model	Median	ln median	Lower	Upper	Median	Lower	Upper	Mean	Lower	Upper
Alagnak[a]	1959–2009	51	Ricker	3.04	1.11	2.32	3.98	3.50E-07	1.49E-07	5.57E-07	0.77	0.62	0.92
Egegik	1963–2012	50	Ricker	6.66	1.90	3.47	10.00	2.42E-07	8.20E-08	5.48E-07	0.64	0.01	0.80
Igushik	1963–2012	50	Ricker	3.82	1.34	2.49	5.57	1.49E-07	1.04E-07	2.01E-07	0.67	0.54	0.82
Kvichak	1963–2012	50	Ricker	2.31	0.84	1.41	3.48	3.40E-08	1.80E-08	5.80E-08	0.67	0.55	0.83
Naknek	1963–2012	50	Ricker	4.57	1.52	3.48	6.07	3.15E-07	1.78E-07	4.92E-07	0.52	0.42	0.64
Nushagak	1963–2012	50	Ricker	4.85	1.58	3.73	1.85	7.90E-07	5.50E-07	1.07E-06	0.65	0.53	0.81
Togiak	1963–2012	50	Ricker	5.81	1.76	4.55	7.80	3.40E-06	2.37E-06	4.65E-06	0.52	0.42	0.64
Ugashik	1963–2012	50	Ricker	5.75	1.75	3.37	10.01	5.50E-07	3.50E-07	7.80E-07	0.73	0.60	0.92
Wood	1963–2012	50	Ricker	5.28	1.66	3.90	7.27	4.04E-06	2.59E-06	5.63E-06	0.50	0.41	0.61
Chinook salmon													
Nushagak	1968–2012	45	Ricker	4.37	1.47	3.17	6.17	7.11E-07	5.54E-07	8.93E-07	0.50	0.38	0.58

Note: A Bayesian analysis estimated spawner–recruitment parameters for a Ricker model with multiplicative error.

[a] All Alagnak River parameters from the 2018 escapement goal review (Erickson et al. 2018). Both α and β parameters show a 95% CI, and the σ estimate is listed as a median.

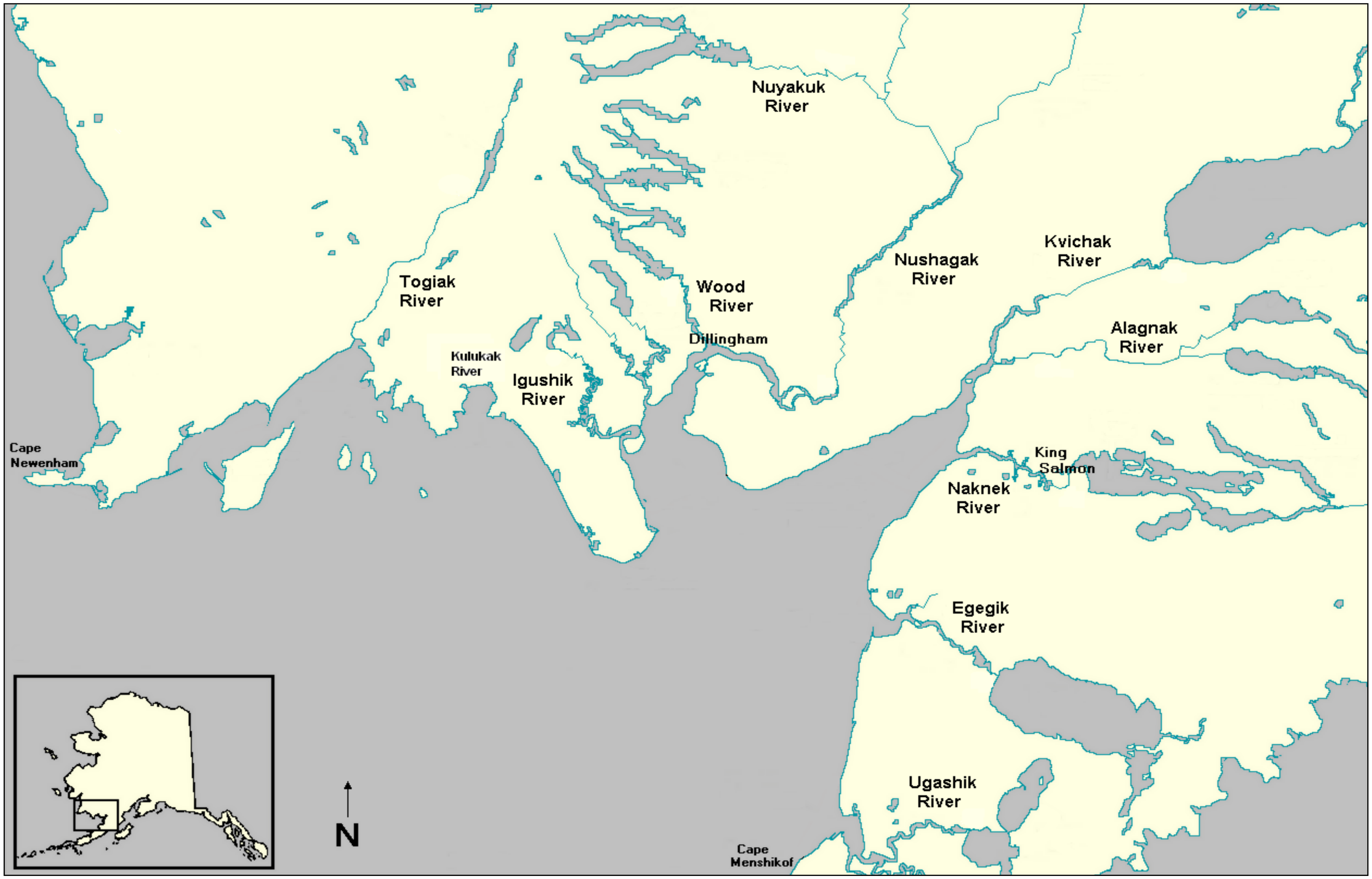

Figure 1.–Map of Bristol Bay, Alaska showing major rivers.

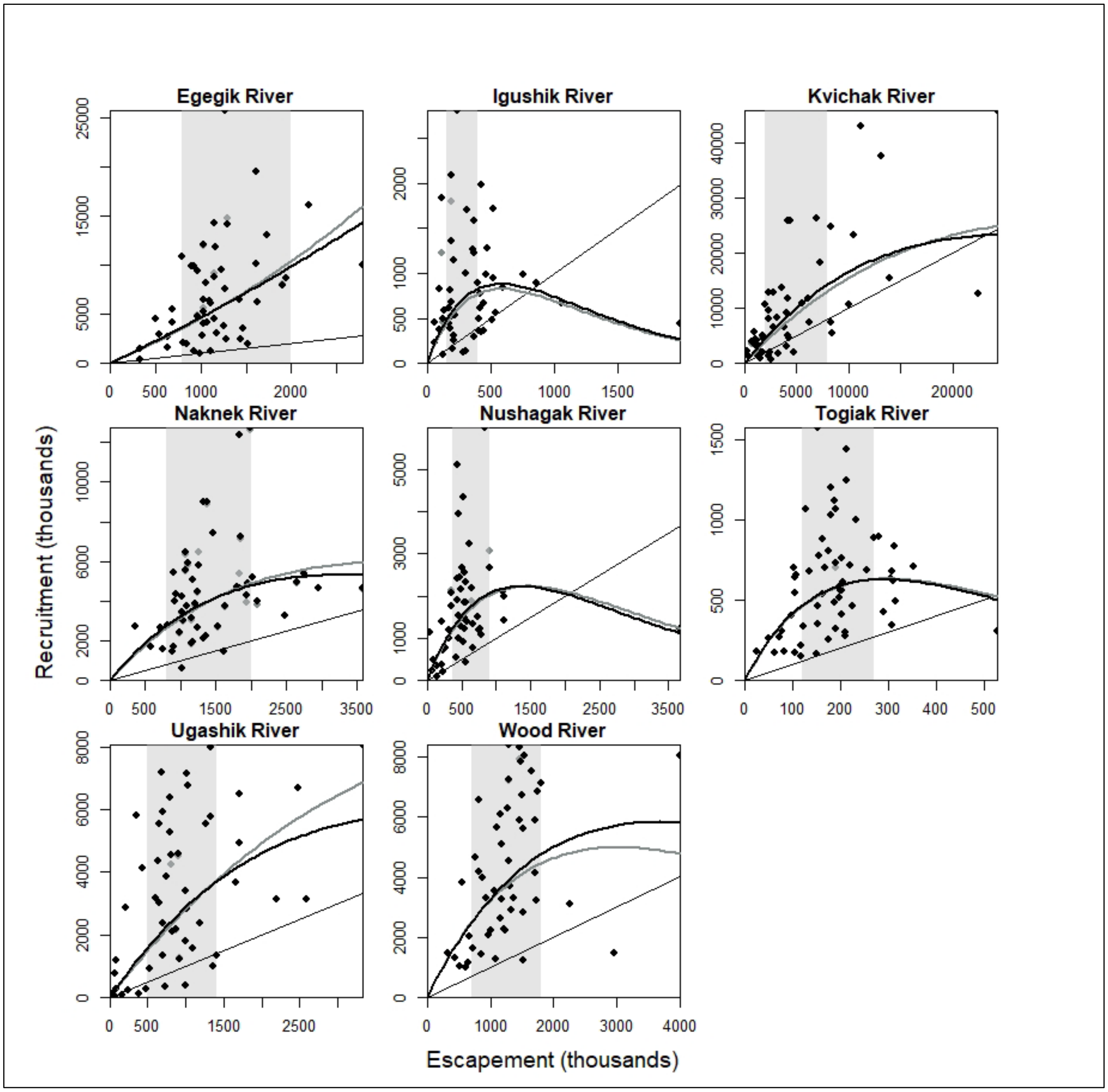

Figure 2.–Comparison of 2012 and 2020 Ricker spawner–recruit analyses for Bristol Bay sockeye salmon. Gray diamonds and curves represent the 2012 run reconstruction estimates and Ricker curves, respectively. Black diamonds and curves represent the 2020 run reconstruction estimates and Ricker curves, respectively. Diagonal black lines are replacement lines. Shaded regions are current escapement goal ranges.

APPENDIX A. CHINOOK SALMON

Appendix A1.–Escapement goal for Nushagak River Chinook salmon.

System: Nushagak River

Species: Chinook salmon

Data available for analysis of escapement goals

Management Division:	Commercial Fisheries
Previous Escapement Goal:	40,000–80,000 BEG (2004); changed to SEG in 2007
Inriver Goal:	90,000
Optimal Escapement Goal:	None
Current Escapement Goal:	55,000–120,000 (2012) SEG
Escapement Estimation:	Expanded aerial survey counts plus Nuyakuk tower from 1968–1979; sonar counts from 1980 to present; converted to DIDSON equivalent 1968 to 2005; DIDSON index counts since 2006; 45 years of complete return data available
Summary:	
Data Quality	Fair to poor
Data Type	Aerial survey, tower, and sonar escapement estimates; sport, subsistence, and commercial harvests; age data
Methodology	Ricker stock-recruit, yield analysis
Years within recommended goal	7 of last 10 years; below SEG in 3 years; below Inriver goal in 4 years

-continued-

System: Nushagak River

Species: Chinook salmon

Data available for analysis of escapement goals

Year	Spawning escapement[a]	Total return	Return per spawner
1968	142,951	175,766	1.23
1969	69,970	83,613	1.19
1972	50,156	348,612	6.95
1973	70,130	297,989	4.25
1974	142,535	191,584	1.34
1975	142,791	608,764	4.26
1976	205,273	406,883	1.98
1977	132,907	711,779	5.36
1978	268,046	239,702	0.89
1979	194,335	339,511	1.75
1980	289,040	194,006	0.67
1981	307,527	262,577	0.85
1982	300,656	137,337	0.46
1983	331,270	153,903	0.46
1984	163,544	123,104	0.75
1985	236,899	188,254	0.79
1986	82,777	219,175	2.65
1987	169,562	283,449	1.67
1988	113,006	315,143	2.79
1989	158,551	315,785	1.99
1990	126,747	145,149	1.15
1991	210,346	282,201	1.34
1992	166,965	252,253	1.51
1993	197,098	368,161	1.87
1994	190,121	151,531	0.80
1995	173,014	167,131	0.97
1996	102,348	178,920	1.75
1997	165,062	185,066	1.12
1998	235,845	284,847	1.21
1999	123,906	333,344	2.69

-continued-

System: Nushagak River

Species: Chinook salmon

Data available for analysis of escapement goals

Year	Spawning escapement[a]	Total return	Return per spawner
2000	110,682	313,352	2.83
2001	184,317	157,782	0.86
2002	174,704	120,171	0.69
2003	158,307	179,369	1.13
2004	233,475	78,789	0.34
2005	223,950	110,790	0.49
2006	117,364	127,187	1.08
2007	50,960	189,016	3.71
2008	91,364	134,849	1.48
2009	74,781	109,686	1.47
2010	56,092	90,383	1.61
2011	101,995	211,679	2.08
2012	167,618	109,294	0.65
2013	104,794	[b]	[b]
2014	62,679	[b]	[b]
2015	91,090	[b]	[b]
2016	118,077	[b]	[b]
2017	52,297	[b]	[b]
2018	91,354	[b]	[b]
2019	41,258	[b]	[b]
2020	40,313	[b]	[b]
1968–2012 Average	159,815	230,546	1.79
No. of years	45	45	45

[a] Spawning escapement is defined as the sonar count minus sport and subsistence harvest occurring above the counting sonar (Buck et al. 2012).

[b] Incomplete returns from brood year.

APPENDIX B. CHUM SALMON

Appendix B1.–Escapement goal for Nushagak River chum salmon.

	System: Nushagak River
	Species: Chum salmon
	Description of stock and escapement goals
Management Division:	Commercial Fisheries
Previous Escapement Goal	190,000 lower-bound SEG (2007)
Current Escapement Goal:	200,000 lower-bound (2012) SEG
Inriver Goal:	None
Optimal Escapement Goal:	None
Escapement Estimation:	Sonar counts since 1980; converted Bendix to DIDSON 1980 to 2005; DIDSON counts uncorrected since 2006; 38 years of escapement data available; converted Bendix counts to DIDSON equivalent counts in 2012. Escapement counts presented are through July 20.
Summary:	
Data Quality	Good
Data Type	Sonar escapement estimates; commercial harvest; age data
Methodology	Risk analysis
Years within recommended goal	9 of last 10 years

-continued-

System: Nushagak River
Species: chum salmon
Data available for analysis of escapement goals

Year	Escapement index[a]	Harvest (number of fish)[b]
1980	415,727	ND
1981	182,021	ND
1982	262,597	ND
1983	107,780	ND
1984	450,031	ND
1985	245,797	396,740
1986	203,810	488,375
1987	175,551	416,476
1988	217,772	371,199
1989	461,456	523,910
1990	373,126	375,631
1991	350,186	463,780
1992	383,303	398,691
1993	272,278	505,799
1994	467,930	328,267
1995	266,432	390,158
1996	279,406	331,494
1997	76,034	185,647
1998	369,447	208,634
1999	296,408	170,806
2000	173,712	114,456
2001	646,984	526,739
2002	509,106	276,787
2003	375,175	740,372
2004	332,347	458,916
2005	569,034	966,069
2006	661,002	1,240,235
2007	161,483	953,285
2008	326,300	492,341
2009	438,481	745,161
2010	273,914	424,234
2011	248,278	296,909
2012	395,162	272,163
2013	628,134	586,117
2014	525,797	242,403

-continued-

System: Nushagak River

Species: chum salmon

Data available for analysis of escapement goals

Year	Escapement index[a]	Harvest (number of animals)[b]
2015	288,929	502,981
2016	419,810	397,757
2017	415,488	804,900
2018	735,628	1,020,624
2019	514,339	856,035
2020	110,592	138,380
1980–2020		
Mean	356,263	489,235
SD	159,547	268,008
Median	350,186	420,355
No. of years	41	36

Note: ND = no data.

[a] Conversion factor of 1.27 was applied to all years prior to 2005 to convert from Bendix to DIDSON count equivalents. Escapement estimate for 2005 used strata- and species-specific correction factors applied to the Bendix north bank counting stratum. Counts from 2006 through 2020 are DIDSON counts. Escapement index counts presented are through July 20.

[b] Harvest shown for informational purposes- not used in escapement goal analysis.

APPENDIX C. COHO SALMON

Appendix C1.–Escapement goal for Nushagak River coho salmon.

System: Nushagak River

Species: coho salmon

Description of stock and escapement goals

Management Division:	Commercial Fisheries
Previous Escapement Goal:	50,000 to 100,000 discontinued in 2007
Inriver Goal:	70,000
Optimal Escapement Goal:	None
Current Escapement Goal:	60,000 to 120,000 SEG
Escapement Estimation:	Sonar counts since 1980; converted Bendix to DIDSON 1980 to 2002; 26 years of complete escapement data available; converted Bendix counts to DIDSON equivalent counts in 2012
Summary:	
Data Quality	Good
Data Type	Sonar escapement estimates; commercial harvest; age data
Methodology	Ricker stock-recruit, yield analysis
Years within recommended goal	2 out of last 10 assessments (1999–2019), 5 years above the SEG, 3 years below the SEG and the Inriver goal

-continued-

System: Nushagak River

Species: coho salmon

Data available for analysis of escapement goals

Year	Spawning escapement[a]	Total return	Return per spawner
1980	95,411	407,100	4.27
1981	141,468	96,740	0.68
1982	294,151	148,150	0.50
1983	36,885	49,151	1.33
1984	140,804	165,050	1.17
1985	82,258	188,273	2.29
1986	45,483	152,472	3.35
1987	21,268	63,074	2.97
1988	130,171	86,853	0.67
1989	81,107	77,353	0.95
1990	140,500	81,822	0.58
1991	37,584	58,024	1.54
1992	NS	ND	ND
1993	42,161	61,619	1.46
1994	80,470	125,739	1.56
1995	45,137	43,677	0.97
1996	182,460	305,932	1.68
1997	55,882	101,893	1.82
1998	103,194	ND	ND
1999	33,991	ND	ND
2000	200,938	ND	ND
2001	72,388	ND	ND
2002	48,054	ND	ND
2003	NS	ND	ND
2004	193,819	ND	ND
2005	NS	ND	ND
2006	NS	ND	ND
2007	NS	ND	ND
2008	NS	ND	ND
2009	NS	ND	ND
2010	NS	ND	ND
2011	NS	ND	ND
2012	329,946	ND	ND
2013	207,222	ND	ND
2014	478,198	ND	ND

-continued-

System: Nushagak River

Species: coho salmon

Data available for analysis of escapement goals

Year	Spawning escapement[a]	Total return	Return per spawner
2015	NS	ND	ND
2016	NS	ND	ND
2017	NS	ND	ND
2018	111,455	ND	ND
2019	51,852	ND	ND
2020	NS	ND	ND
1980–2020 Average	124,438	130,172	1.64
No. of years	28	17	17

Note: NS = no survey; ND = no data.

[a] DIDSON conversion factor of 1.27 applied to all years.

APPENDIX D. PINK SALMON

Appendix D1.–Escapement goal for Nushagak River pink salmon (even-year).

System: Nushagak River

Species: pink salmon (even-year)

Description of stock and escapement goals

Management Division:	Commercial Fisheries
Previous Escapement Goal:	600,000 to 1,100,000 discontinued in 2007
Inriver Goal:	None
Optimal Escapement Goal:	None
Current Goal:	165,000 lower-bound SEG
Escapement Estimation:	Expanded aerial survey in 1958; Nuyakuk tower counts from 1960–1979; sonar counts from 1980–2004; converted Bendix to DIDSON 1958 to 2004; 26 years of escapement data available, even years only
Summary:	
Data Quality	Good
Data Type	Sonar escapement estimates; commercial harvest; age data
Methodology	Percentile approach (Bue and Hasbrouck, unpublished)
Years within recommended goal	8 out of last 10 assessments (1992–2020)

-continued-

System: Nushagak River

Species: pink salmon

Data available for analysis of escapement goals

Year	Escapement[a]
1958	4,440,000
1960	111,000
1962	555,016
1964	1,008,435
1966	1,601,091
1968	2,398,839
1970	169,364
1972	64,975
1974	590,871
1976	928,269
1978	10,169,580
1980	3,052,218
1982	1,788,461
1984	3,145,032
1986	80,130
1988	549,017
1990	889,587
1992	209,429
1994	212,867
1996	911,656
1998	146,966
2000	150,166
2002	352,604
2004	617,233
2006	NS
2008	NS
2010	NS
2012	1,348,606
2014	2,281,831
2016	NS
2018	628,069
2020	NS
Average	1,422,271
Median	628,069
Contrast	157

Note: NS = no survey

[a] DIDSON conversion factor of 1.11 applied to years prior to 2006 (Buck et al. 2012).

APPENDIX E. SOCKEYE SALMON

Appendix E1.–Escapement goal for Alagnak River sockeye salmon.

System: Alagnak River

Species: sockeye salmon

Description of stock and escapement goals

Management Division:	Commercial Fisheries
Previous Escapement Goal:	320,000 lower-bound SEG (2007)
Inriver Goal:	None
Optimal Escapement Goal:	None
Current Escapement Goal:	210,000 lower-bound SEG (2018); based on tower counts;
Escapement Estimation:	Tower counts from 1955–1977, 2002–2011, and 2017–2020; expanded aerial survey counts from 1978–2001 and 2012–2016
Summary:	
Data Quality	Fair to Good
Data Type	Tower counts; aerial surveys; commercial harvest; age data
Methodology	Escapement goal based on risk analysis
Years within recommended goal	Escapement goal minimum has been met in 9 of the last 10 years (2011–2020); this stock is passively managed and coincidentally harvested; the department is not able to actively manage

-continued-

System: Alagnak River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement (towers)	Escapement (aerial survey)	Total return	Return per spawner
1963	203,304	ND	414,873	2.04
1964	248,700	ND	381,900	1.54
1965	175,020	ND	259,729	1.48
1966	174,336	ND	565,584	3.24
1967	202,626	ND	389,349	1.92
1968	193,872	ND	249,192	1.29
1969	182,490	ND	180,185	0.99
1970	177,060	ND	145,642	0.82
1971	187,302	ND	324,752	1.73
1972	151,188	ND	124,168	0.82
1973	35,280	ND	512,940	14.54
1974	214,848	ND	2,290,909	10.66
1975	100,480	ND	1,022,274	10.17
1976	81,822	ND	344,709	4.21
1977	108,911	ND	1,002,659	9.21
1978	584,970	229,400	2,175,584	3.72
1979	750,210	294,200	2,108,488	2.81
1980	759,645	297,900	643,095	0.85
1981	209,636	82,210	1,182,706	5.64
1982	610,215	239,300	773,488	1.27
1983	245,361	96,220	456,604	1.86
1984	549,194	215,470	2,467,947	4.49
1985	300,977	118,030	1,645,393	5.47
1986	586,959	228,180	2,032,311	3.46
1987	393,236	154,210	770,409	1.96
1988	496,307	194,630	1,273,821	2.57
1989	501,738	196,760	2,741,825	5.46
1990	430,338	168,760	1,283,665	2.98
1991	707,852	278,589	3,434,249	4.85
1992	577,940	226,643	186,844	0.32
1993	887,336	347,975	1,506,977	1.70
1994	618,464	242,595	1,563,841	2.53
1995	550,068	215,713	3,896,349	7.08
1996	782,213	306,750	1,421,615	1.82

continued-

System: Alagnak River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement (towers)	Escapement (aerial survey)	Total return	Return per spawner
1997	556,193	218,115	1,391,085	2.50
1998	643,110	252,200	2,777,780	4.32
1999	1,182,180	463,600	3,726,493	3.15
2000	1,150,815	451,300	9,751,286	8.47
2001	680,850	267,000	1,677,183	2.46
2002	766,962	282,100	3,727,475	4.86
2003	3,676,146	2,110,000	6,700,356	1.82
2004	5,396,592	2,911,600	2,514,212	0.47
2005	4,218,990	1,736,000	2,840,332	0.67
2006	1,773,966	900,000	2,439,864	1.38
2007	2,466,414	1,155,000	2,209,010	0.90
2008	2,180,502	1,499,000	1,924,162	0.88
2009	970,818	NS	1,404,671	1.45
2010	1,187,730	NS	6,498,955	5.47
2011	883,794	NS	6,168,138	6.98
2012	ND	861,747	2,828,307	3.28
2013	ND	1,095,950	[a]	[a]
2014	ND	189,452	[a]	[a]
2015	ND	5,452,026	[a]	[a]
2016	ND	1,677,769	[a]	[a]
2017	2,041,824	[a]	[a]	[a]
2018	1,581,426	[a]	[a]	[a]
2019	820,458	[a]	[a]	[a]
2020	2,386,518	[a]	[a]	[a]
1963–2020				
Average	897,079	712,678	1,967,068	3.49
No. of years	48	33	50	50

Note: ND = no data, NS = no survey

[a] Incomplete returns from brood year.

Appendix E2.–Escapement goal for Egegik River sockeye salmon.

System: Egegik River

Species: sockeye salmon

Description of stock and escapement goals

Management Division:	Commercial Fisheries
Previous Escapement Goal:	800,000–1,400,000 BEG (1997); changed to SEG in 2007
Inriver Goal:	None
Optimal Escapement Goal:	None
Current Escapement Goal:	800,000–2,000,000 SEG (2015)
Escapement Estimation:	Tower counts from 1963 to present; smolt data from 1983–2001; 50 years of escapement data available
Summary:	
Data Quality	Excellent quality counts but no information on escapements which failed to replace themselves.
Data Type	Tower counts; commercial harvest; smolt data; age data
Methodology	Escapement goal based on Ricker stock-recruit and yield analysis
Years within recommended goal	6 out of last 10 years (2011–2020). The remaining 4 years have gone over the upper bound of the goal.

-continued-

System: Egegik River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement	Total	Return per spawner
1963	997,602	993,872	1.00
1964	849,576	1,937,882	2.28
1965	1,444,608	2,388,485	1.65
1966	804,246	2,058,271	2.56
1967	636,864	1,631,431	2.56
1968	338,654	377,056	1.11
1969	1,015,554	2,755,728	2.71
1970	919,734	1,202,584	1.31
1971	634,014	2,700,676	4.26
1972	546,402	2,909,902	5.33
1973	328,842	1,451,686	4.41
1974	1,275,630	2,441,308	1.91
1975	1,173,840	3,040,169	2.59
1976	509,160	4,480,475	8.80
1977	692,514	4,167,610	6.02
1978	895,698	9,914,902	11.07
1979	1,032,042	4,039,741	3.91
1980	1,060,860	8,222,418	7.75
1981	694,680	5,441,586	7.83
1982	1,034,628	6,435,075	6.22
1983	792,282	10,811,633	13.65
1984	1,165,345	11,766,356	10.10
1985	1,095,192	6,382,683	5.83
1986	1,152,180	14,207,134	12.33
1987	1,273,553	25,731,443	20.20
1988	1,612,745	19,465,142	12.07
1989	1,611,566	10,134,483	6.29
1990	2,191,582	16,060,318	7.33
1991	2,786,925	9,948,962	3.57
1992	1,945,632	8,668,647	4.46
1993	1,517,000	1,936,034	1.28
1994	1,897,977	7,979,479	4.20
1995	1,266,692	7,522,881	5.94
1996	1,076,460	4,161,328	3.87

-continued-

System: Egegik River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement	Total return	Return per spawner
1997	1,104,004	6,063,053	5.49
1998	1,110,938	1,270,508	1.14
1999	1,728,397	13,004,488	7.52
2000	1,032,138	12,037,958	11.66
2001	968,872	4,786,180	4.94
2002	1,036,092	5,292,059	5.11
2003	1,152,120	8,800,152	7.64
2004	1,290,144	14,138,820	10.96
2005	1,621,734	6,185,018	3.81
2006	1,465,158	3,573,363	2.44
2007	1,432,500	6,440,136	4.50
2008	1,259,568	3,830,060	3.04
2009	1,146,276	4,505,950	3.93
2010	927,054	9,911,273	10.69
2011	961,200	9,363,534	9.74
2012	1,233,900	9,571,851	7.76
2013	1,113,630	[a]	[a]
2014	1,382,466	[a]	[a]
2015	2,160,792	[a]	[a]
2016	1,837,260	[a]	[a]
2017	2,600,982	[a]	[a]
2018	1,608,357	[a]	[a]
2019	2,340,210	[a]	[a]
2020	2,389,728	[a]	[a]
1963–2020			
Average	1,215,191	6,842,836	5.94
No. of years	58	50	50

[a] Incomplete returns from brood year.

Appendix E3.–Escapement goal for Igushik River sockeye salmon.

System: Igushik River

Species: sockeye salmon

Description of stock and escapement goals

Management Division:	Commercial Fisheries
Previous Escapement Goal:	150,000–300,000 BEG (2001); changed to SEG in 2007
Inriver Goal:	None
Optimal Escapement Goal:	None
Current Goal:	150,000–400,000 (2015) SEG
Escapement Estimation:	Tower counts from 1963 to present; 50 years of complete return data available
Summary:	
Data Quality	Excellent
Data Type	Tower counts; commercial harvest; age data
Methodology	Ricker stock-recruit, yield analysis
Years within recommended goal	5 out of last 10 years (2011–2020). The remaining 5 years have gone over the upper bound of the goal.

-continued-

System: Igushik River

Species: sockeye salmon

Description of stock and escapement goals

Year	Escapement	Total return	Return per spawner
1963	92,184	368,205	3.99
1964	128,532	583,060	4.54
1965	180,840	810,920	4.48
1966	206,360	301,093	1.46
1967	281,772	125,745	0.45
1968	194,508	158,923	0.82
1969	512,328	476,722	0.93
1970	370,920	287,436	0.77
1971	210,960	259,415	1.23
1972	60,018	232,049	3.87
1973	59,508	452,000	7.60
1974	358,752	1,267,130	3.53
1975	241,086	2,810,903	11.66
1976	186,120	1,354,667	7.28
1977	95,970	830,426	8.65
1978	536,154	562,275	1.05
1979	859,560	896,476	1.04
1980	1,987,530	443,803	0.22
1981	591,144	838,645	1.42
1982	423,768	346,608	0.82
1983	180,438	391,104	2.17
1984	184,872	522,953	2.83
1985	212,454	1,138,951	5.36
1986	307,728	1,700,597	5.53
1987	169,236	445,515	2.63
1988	170,454	614,898	3.61
1989	461,610	991,784	2.15
1990	365,802	1,229,498	3.36
1991	756,126	983,939	1.30
1992	304,920	139,561	0.46
1993	405,564	358,174	0.88
1994	445,920	659,953	1.48
1995	473,382	1,278,256	2.70
1996	400,746	886,426	2.21

-continued-

System: Igushik River

Species: sockeye salmon

Description of stock and escapement goals

Year	Escapement	Total return	Return per spawner
1997	127,704	99,345	0.78
1998	215,904	536,354	2.48
1999	445,536	362,488	0.81
2000	413,316	767,785	1.86
2001	409,596	490,103	1.20
2002	123,156	495,201	4.02
2003	194,088	2,087,759	10.76
2004	109,650	1,835,271	16.74
2005	365,712	1,579,838	4.32
2006	305,268	1,005,262	3.29
2007	415,452	608,855	1.47
2008	1,054,704	663,700	0.63
2009	514,188	941,767	1.83
2010	518,040	1,714,393	3.31
2011	421,380	1,985,117	4.71
2012	193,326	686,079	3.55
2013	387,036	[a]	[a]
2014	340,590	[a]	[a]
2015	651,172	[a]	[a]
2016	469,230	[a]	[a]
2017	578,700	[a]	[a]
2018	770,772	[a]	[a]
2019	256,074	[a]	[a]
2020	323,814	[a]	[a]
1963–2020			
Average	379,684	812,149	3.28
No. of years	58	50	50

[a] Incomplete returns from brood year.

Appendix E4.–Escapement goal for Kvichak River sockeye salmon.

System:	Kvichak River
Species:	sockeye salmon
	Description of stock and escapement goals
Management Division:	Commercial Fisheries
Previous Escapement Goal:	Prior to current goal there were off-cycle and pre- or peak-cycle goals. The current goal is the off-cycle which was established in 1997 and changed from a BEG to SEG in 2006. The pre, peak-cycle goal was also established in 1997 as BEG and was 6-10 million, changed to SEG in 2006 and eliminated in 2015.
Inriver Goal:	None
Optimal Escapement Goal:	None
Current Escapement Goal:	2,000,000–10,000,000 (2010) SEG
Escapement Estimation:	Tower counts from 1963 to present; smolt data from 1971–2000; 50 years of complete return data available
Summary:	
Data Quality	Excellent
Data Type	Tower counts; smolt data; commercial harvest; age data
Methodology	Ricker stock-recruit, yield analysis
Years within recommended goal	10 of last 10 years (2011–2020)

-continued-

System: Kvichak River
Species: sockeye salmon
Data available for analysis of escapement goals

Year	Escapement	Total return	Return per spawner
1963	338,760	1,388,216	4.10
1964	957,120	5,763,515	6.02
1965	24,325,926	45,820,689	1.88
1966	3,755,185	6,522,062	1.74
1967	3,216,208	1,784,048	0.55
1968	2,557,440	635,324	0.25
1969	8,394,204	5,513,626	0.66
1970	13,935,306	15,363,872	1.10
1971	2,387,392	2,036,285	0.85
1972	1,009,962	3,248,671	3.22
1973	226,554	2,203,241	9.73
1974	4,433,844	25,784,407	5.82
1975	13,140,450	37,439,011	2.85
1976	1,965,282	10,716,323	5.45
1977	1,341,144	3,089,502	2.30
1978	4,149,288	5,055,228	1.22
1979	11,218,434	43,049,770	3.84
1980	22,505,268	12,597,313	0.56
1981	1,754,358	2,048,789	1.17
1982	1,134,840	1,509,246	1.33
1983	3,569,982	13,775,451	3.86
1984	10,490,670	23,287,185	2.22
1985	7,211,046	18,314,833	2.54
1986	1,179,322	4,114,460	3.49
1987	6,065,880	11,648,130	1.92
1988	4,065,216	9,205,714	2.26
1989	8,317,500	24,800,933	2.98
1990	6,970,020	26,298,686	3.77
1991	4,222,788	4,637,250	1.10
1992	4,725,864	1,875,603	0.40
1993	4,025,166	3,130,470	0.78
1994	8,355,936	7,303,050	0.87
1995	10,038,720	10,636,782	1.06
1996	1,450,578	2,260,607	1.56

-continued-

System: Kvichak River
Species: sockeye salmon
Data available for analysis of escapement goals

Year	Escapement	Total return	Return per spawner
1997	1,503,732	816,242	0.54
1998	2,296,074	1,254,499	0.55
1999	6,196,914	7,378,782	1.19
2000	1,827,780	4,261,658	2.33
2001	1,095,348	4,421,265	4.04
2002	703,884	3,881,251	5.51
2003	1,686,804	4,966,281	2.94
2004	5,500,134	10,918,274	1.99
2005	2,320,332	9,582,839	4.13
2006	3,068,226	8,319,191	2.71
2007	2,810,208	12,795,126	4.55
2008	2,757,912	6,577,118	2.38
2009	2,266,140	12,889,440	5.69
2010	4,207,410	25,775,460	6.13
2011	2,264,352	8,130,648	3.59
2012	4,164,444	11,800,942	2.83
2013	2,088,576	[a]	[a]
2014	4,458,540	[a]	[a]
2015	7,341,612	[a]	[a]
2016	4,462,728	[a]	[a]
2017	3,163,404	[a]	[a]
2018	4,398,708	[a]	[a]
2019	2,371,242	[a]	[a]
2020	4,030,968	[a]	[a]
1963–2020			
Average	4,834,847	10,532,546	2.69
No. of years	58	50	50

[a] Incomplete returns from brood year.

Appendix E5.–Escapement goal for Naknek River sockeye salmon.

System: Naknek River

Species: sockeye salmon

Description of stock and escapement goals

Management Division:	Commercial Fisheries
Previous Escapement Goal:	800,000–1,400,000 BEG (1983); changed to SEG in 2007
Inriver Goal:	None
Optimal Escapement Goal:	800,000–2,000,000 (5 AAC 06.360)
Current Escapement Goal:	800,000–2,000,000 (2015) SEG
Escapement Estimation:	Tower counts from 1963 to present; 50 years of complete return data available
Summary:	
Data Quality	Excellent
Data Type	Tower counts; commercial harvest; age data
Methodology	Escapement goal based on Ricker stock-recruit, yield analysis
Years within recommended goal	9 of last 10 years (2011–2020). The remaining 1 year went over the upper bound of the goal.

-continued-

System: Naknek River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement	Total return	Return per spawner
1963	905,358	1,706,836	1.89
1964	1,349,604	2,223,531	1.65
1965	717,798	2,654,768	3.70
1966	1,016,445	4,205,622	4.14
1967	755,640	1,552,168	2.05
1968	1,023,222	638,312	0.62
1969	1,331,202	2,143,778	1.61
1970	732,502	2,535,306	3.46
1971	935,754	4,350,422	4.65
1972	586,518	1,715,207	2.92
1973	356,676	2,742,669	7.69
1974	1,241,058	2,642,513	2.13
1975	2,026,686	5,195,705	2.56
1976	1,320,750	8,991,732	6.81
1977	1,085,856	3,721,059	3.43
1978	813,378	2,788,295	3.43
1979	925,362	3,965,088	4.28
1980	2,644,698	4,930,476	1.86
1981	1,796,220	4,703,787	2.62
1982	1,155,552	1,849,206	1.60
1983	888,294	1,482,526	1.67
1984	1,242,474	4,489,760	3.61
1985	1,849,938	7,264,391	3.93
1986	1,977,645	12,744,734	6.44
1987	1,061,806	5,533,716	5.21
1988	1,037,862	3,025,871	2.92
1989	1,161,984	3,133,263	2.70
1990	2,092,578	3,997,626	1.91
1991	3,578,508	4,629,239	1.29
1992	1,606,650	1,481,553	0.92
1993	1,535,658	2,704,804	1.76
1994	990,810	2,396,222	2.42
1995	1,111,140	5,927,766	5.33
1996	1,078,098	6,473,144	6.00

continued-

System: Naknek River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement	Total return	Return per spawner
1997	1,025,664	3,457,636	3.37
1998	1,202,172	3,869,572	3.22
1999	1,625,364	3,762,439	2.31
2000	1,375,488	9,024,550	6.56
2001	1,830,360	4,633,413	2.53
2002	1,263,918	5,780,190	4.57
2003	1,831,170	12,396,541	6.77
2004	1,939,674	4,303,688	2.22
2005	2,744,622	5,386,596	1.96
2006	1,953,228	4,907,171	2.51
2007	2,945,304	4,634,052	1.57
2008	2,472,690	3,266,706	1.32
2009	1,169,466	1,914,503	1.64
2010	1,463,928	7,419,738	5.07
2011	1,177,074	5,088,655	4.32
2012	900,312	5,422,205	6.02
2013	938,160	[a]	[a]
2014	1,474,428	[a]	[a]
2015	1,920,954	[a]	[a]
2016	1,691,910	[a]	[a]
2017	1,899,972	[a]	[a]
2018	2,221,152	[a]	[a]
2019	2,911,470	[a]	[a]
2020	4,112,160	[a]	[a]
1963–2020			
Average	1,517,661	4,316,175	3.30
No. of years	58	50	50

[a] Incomplete returns from brood year.

Appendix E6.–Escapement goal for Nushagak River sockeye salmon.

	System: Nushagak River
	Species: sockeye salmon
	Description of stock and escapement goals
Management Division:	Commercial Fisheries
Previous Escapement Goal:	340,000–760,000 BEG (1998); changed to SEG in 2007
Inriver Goal:	None
Optimal Escapement Goal:	260,000 (5AAC 06.358)
Current Escapement Goal:	370,000–900,000 (2015) SEG
Escapement Estimation:	Nuyakuk tower and expanded aerial survey counts from 1963–1984; sonar counts from 1985 to present; converted Bendix to DIDSON 1980 to 2005; DIDSON counts uncorrected since 2006; 50 years of complete return data available
Summary:	
Data Quality	Good
Data Type	Tower, aerial survey, and sonar counts; commercial harvest; age data
Methodology	Ricker stock-recruit, yield analysis
Years within recommended goal	7 of last 10 years (2011–2020). Remaining 3 years have gone above the upper bound of the goal.

-continued-

System: Nushagak River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement[a]	Total return	Return per spawner
1963	234,821	214,841	0.91
1964	134,853	93,342	0.69
1965	255,794	779,754	3.05
1966	233,578	701,566	3.00
1967	74,003	227,033	3.07
1968	142,360	344,179	2.42
1969	95,805	493,692	5.15
1970	452,892	988,764	2.18
1971	312,699	1,010,999	3.23
1972	39,851	1,147,980	28.81
1973	210,601	1,380,189	6.55
1974	204,190	383,623	1.88
1975	832,093	5,995,149	7.20
1976	520,303	4,351,924	8.36
1977	611,588	3,236,089	5.29
1978	734,040	1,513,725	2.06
1979	551,272	1,846,153	3.35
1980	3,669,136	1,210,266	0.33
1981	1,118,873	1,976,757	1.77
1982	664,580	1,335,148	2.01
1983	446,845	1,548,738	3.47
1984	655,739	761,247	1.16
1985	551,319	1,416,870	2.57
1986	1,095,241	2,092,574	1.91
1987	429,182	1,905,456	4.44
1988	534,460	2,557,339	4.78
1989	567,863	1,398,722	2.46
1990	752,513	1,189,247	1.58
1991	544,748	1,491,482	2.74
1992	768,816	1,212,574	1.58
1993	790,927	1,074,278	1.36
1994	563,334	425,915	0.76
1995	311,136	1,198,477	3.85
1996	557,057	2,335,512	4.19

-continued-

System: Nushagak River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement[a]	Total return	Return per spawner
1997	412,591	544,302	1.32
1998	507,532	2,665,496	5.25
1999	344,972	1,753,716	5.08
2000	446,286	3,938,655	8.83
2001	897,112	2,662,843	2.97
2002	349,155	2,083,211	5.97
2003	642,093	2,196,683	3.42
2004	543,872	1,836,096	3.38
2005	1,106,703	1,418,239	1.28
2006	548,410	1,237,549	2.26
2007	518,041	911,789	1.76
2008	492,546	2,169,246	4.40
2009	484,149	1,284,511	2.65
2010	468,696	2,452,551	5.23
2011	428,191	2,428,928	5.67
2012	432,438	5,114,329	11.83
2013	894,148	[b]	[b]
2014	618,477	[b]	[b]
2015	796,684	[b]	[b]
2016	680,512	[b]	[b]
2017	2,852,308	[b]	[b]
2018	1,247,460	[b]	[b]
2019	709,431	[b]	[b]
2020	1,228,059	[b]	[b]
1963–2020			
Average	643,317	1,690,755	3.99
No. of years	58	50	50

[a] DIDSON conversion factor of 1.11 applied to all years prior to 2005. Escapement estimate for 2005 used strata- and species-specific correction factors applied to the Bendix north bank counting stratum. Counts from 2006 through 2011 are uncorrected DIDSON counts.

[b] Incomplete returns from brood year.

Appendix E7.–Escapement goal for Togiak River sockeye salmon.

System: Togiak River

Species: Sockeye salmon

Description of stock and escapement goals

Management Division:	Commercial Fisheries
Previous Escapement Goal:	120,000–200,000 BEG (1997); changed to 120,000-270,000 BEG (2007); changed to SEG in 2010
Inriver Goal:	None
Optimal Escapement Goal:	None
Current Escapement Goal	120,000–270,000 (2010) SEG
Escapement Estimation:	Tower counts from 1963 to present; 50 years of complete return data available
Summary:	
Data Quality	Good
Data Type	Tower counts; commercial harvest; age data
Methodology	Ricker stock-recruit, yield analysis
Years within recommended goal	8 out of last 10 years (2011–2020). Remaining 2 years went over the upper bound of the goal.

-continued-

System: Togiak River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement	Total return	Return per spawner
1963	116,196	152,062	1.31
1964	104,874	174,978	1.67
1965	96,486	405,599	4.20
1966	104,198	641,763	6.16
1967	81,330	181,217	2.23
1968	49,918	262,624	5.26
1969	116,666	216,333	1.85
1970	202,896	408,284	2.01
1971	200,242	558,181	2.79
1972	78,570	303,605	3.86
1973	106,930	653,500	6.11
1974	103,592	703,838	6.79
1975	180,562	1,199,909	6.65
1976	189,390	1,068,657	5.64
1977	162,534	883,990	5.44
1978	306,176	681,617	2.23
1979	198,238	582,868	2.94
1980	526,750	305,047	0.58
1981	307,130	344,617	1.12
1982	288,674	425,197	1.47
1983	212,640	1,245,992	5.86
1984	150,978	167,004	1.11
1985	153,482	350,671	2.28
1986	203,384	760,090	3.74
1987	278,276	892,200	3.21
1988	309,012	616,260	1.99
1989	104,240	548,303	5.26
1990	166,297	704,724	4.24
1991	254,088	690,188	2.72
1992	209,516	275,227	1.31
1993	188,610	322,621	1.71
1994	174,172	254,406	1.46
1995	211,226	1,440,819	6.82
1996	187,174	1,118,048	5.97

-continued-

System: Togiak River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement	Total return	Return per spawner
1997	152,223	462,339	3.04
1998	175,476	809,749	4.61
1999	196,136	517,983	2.64
2000	352,245	706,646	2.01
2001	303,346	637,173	2.10
2002	178,577	1,027,566	5.75
2003	232,302	998,354	4.30
2004	135,637	681,185	5.02
2005	155,778	777,908	4.99
2006	312,126	836,553	2.68
2007	269,646	887,883	3.29
2008	205,680	609,588	2.96
2009	313,946	490,026	1.56
2010	188,298	483,172	2.57
2011	190,970	733,108	3.84
2012	203,148	561,921	2.77
2013	128,118	[a]	[a]
2014	151,934	[a]	[a]
2015	218,700	[a]	[a]
2016	200,046	[a]	[a]
2017	190,098	[a]	[a]
2018	511,770	[a]	[a]
2019	351,846	[a]	[a]
2020	261,126	[a]	[a]
1963–2020 Average	205,235	615,232	3.49
No. of years	58	50	50

[a] Incomplete returns from brood year.

Appendix E8.–Escapement goal for Ugashik River sockeye salmon.

System: Ugashik River

Species: sockeye salmon

Description of stock and escapement goals

Management Division:	Commercial Fisheries
Previous Escapement Goal:	500,000–1,200,000 BEG (1995); changed to SEG 2007
Inriver Goal:	None
Optimal Escapement Goal:	None
Current Escapement Goal:	500,000–1,400,000 (2015) SEG
Escapement Estimation:	Tower counts from 1963 to present; 50 years of complete return data available
Summary:	
Data Quality	Excellent
Data Type	Tower counts; commercial harvest; age data
Methodology	Ricker stock-recruit and yield analysis
Years within recommended goal	6 of last 10 years (2011–2020). The remaining 4 years went over the upper bound of the goal.

-continued-

System: Ugashik River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement	Total return	Return per spawner
1963	388,254	132,741	0.34
1964	472,770	274,733	0.58
1965	996,612	392,954	0.39
1966	704,436	2,388,187	3.39
1967	238,830	230,351	0.96
1968	70,896	45,088	0.64
1969	160,380	89,243	0.56
1970	735,024	355,709	0.48
1971	529,752	935,802	1.77
1972	79,428	276,170	3.48
1973	38,988	102,308	2.62
1974	61,854	757,907	12.25
1975	429,336	4,125,834	9.61
1976	356,308	5,801,029	16.28
1977	201,520	2,853,151	14.16
1978	82,435	1,194,448	14.49
1979	1,706,904	6,480,880	3.80
1980	3,335,284	8,062,937	2.42
1981	1,327,699	7,976,426	6.01
1982	1,185,551	2,359,985	1.99
1983	1,001,364	1,789,220	1.79
1984	1,270,318	5,529,834	4.35
1985	1,006,407	2,823,866	2.81
1986	1,015,582	7,142,617	7.03
1987	686,894	7,164,347	10.43
1988	654,412	5,544,646	8.47
1989	1,713,287	4,913,114	2.87
1990	749,478	3,858,559	5.15
1991	2,482,016	6,680,927	2.69
1992	2,194,927	3,149,041	1.43
1993	1,413,454	1,357,580	0.96
1994	1,095,068	1,586,318	1.45
1995	1,321,108	5,773,750	4.37
1996	692,167	1,353,867	1.96

-continued-

System: Ugashik River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement	Total return	Return per spawner
1997	656,641	3,025,123	4.61
1998	924,853	1,247,104	1.35
1999	1,662,042	3,674,140	2.21
2000	638,420	4,355,261	6.82
2001	866,368	2,184,180	2.52
2002	905,584	4,599,316	5.08
2003	790,202	6,372,603	8.06
2004	815,104	4,531,213	5.56
2005	799,612	5,265,096	6.58
2006	1,003,158	3,402,149	3.39
2007	2,599,186	3,139,804	1.21
2008	596,332	3,162,448	5.30
2009	1,364,338	982,544	0.72
2010	830,886	2,113,012	2.54
2011	1,029,853	6,746,034	6.55
2012	695,018	5,917,720	8.51
2013	898,110	[a]	[a]
2014	640,158	[a]	[a]
2015	1,564,638	[a]	[a]
2016	1,635,270	[a]	[a]
2017	1,186,446	[a]	[a]
2018	1,167,792	[a]	[a]
2019	1,547,748	[a]	[a]
2020	1,745,940	[a]	[a]
1963–2020 Average	982,111	3,284,426	4.46
No. of years	58	50	50

[a] Incomplete returns from brood year.

Appendix E9.–Escapement goal for Wood River sockeye salmon.

	System: Wood River
	Species: sockeye salmon
	Description of stock and escapement goals
Management Division:	Commercial Fisheries
Previous Escapement Goal:	700,000–1,500,000 BEG (2001); changed to SEG in 2007
Inriver Goal:	None
Optimal Escapement Goal:	None
Current Escapement Goal:	700,000–1,800,000 (2015) SEG
Escapement Estimation:	Tower counts from 1963 to present; 50 years of complete return data available
Summary:	
Data Quality	Excellent
Data Type	Tower counts; commercial harvest; age data
Methodology	Ricker stock-recruit, yield analysis
Years within recommended goal	4 of last 10 years (2011–2020). Remaining 6 years went over the upper end of the goal.

-continued-

System: Wood River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement	Total return	Return per spawner
1963	721,404	1,632,836	2.26
1964	1,076,112	1,286,903	1.20
1965	675,156	2,021,719	2.99
1966	1,208,682	2,290,780	1.90
1967	515,772	1,054,264	2.04
1968	649,344	1,154,367	1.78
1969	604,338	989,848	1.64
1970	1,161,964	2,648,102	2.28
1971	851,202	1,425,140	1.67
1972	430,602	1,338,679	3.11
1973	330,474	1,460,260	4.42
1974	1,708,836	5,893,430	3.45
1975	1,270,116	6,290,687	4.95
1976	817,008	6,590,536	8.07
1977	561,828	3,824,313	6.81
1978	2,267,238	3,117,207	1.37
1979	1,706,352	4,154,669	2.43
1980	2,969,040	1,471,792	0.50
1981	1,233,318	2,231,913	1.81
1982	976,470	2,085,371	2.14
1983	1,360,968	3,326,753	2.44
1984	1,002,792	2,218,822	2.21
1985	939,000	3,304,167	3.52
1986	818,652	4,176,305	5.10
1987	1,337,172	2,897,914	2.17
1988	866,778	3,978,870	4.59
1989	1,186,410	5,106,291	4.30
1990	1,069,440	3,555,678	3.32
1991	1,159,920	6,110,265	5.27
1992	1,286,250	4,539,123	3.53
1993	1,176,126	3,267,339	2.78
1994	1,471,890	5,887,328	4.00
1995	1,482,162	7,844,736	5.29
1996	1,649,598	7,529,945	4.56

-continued-

System: Wood River

Species: sockeye salmon

Data available for analysis of escapement goals

Year	Escapement	Total return	Return per spawner
1997	1,512,396	1,237,317	0.82
1998	1,755,768	6,866,961	3.91
1999	1,512,426	5,621,078	3.72
2000	1,300,026	7,238,890	5.57
2001	1,458,732	8,311,690	5.70
2002	1,283,682	8,408,970	6.55
2003	1,459,782	8,339,222	5.71
2004	1,543,392	8,064,892	5.23
2005	1,496,550	6,718,864	4.49
2006	4,008,102	8,034,958	2.00
2007	1,528,086	2,825,544	1.85
2008	1,724,676	3,220,111	1.87
2009	1,319,232	3,719,584	2.82
2010	1,804,344	7,124,705	3.95
2011	1,098,006	5,649,705	5.15
2012	764,211	4,655,418	6.09
2013	1,183,348	[a]	[a]
2014	2,764,614	[a]	[a]
2015	1,941,474	[a]	[a]
2016	1,309,707	[a]	[a]
2017	4,274,224	[a]	[a]
2018	7,507,254	[a]	[a]
2019	2,073,276	[a]	[a]
2020	2,243,886	[a]	[a]
1963–2020 Average	1,507,062	4,254,885	3.51
No. of years	58	50	50

[a] Incomplete returns from brood year.

APPENDIX F. RECENT ESCAPEMENT MEMOS AND RECORD COPIES PRESENTED TO THE BOARD OF FISHERIES

Appendix F1.–2015 Escapement goal recommendations for Bristol Bay sockeye salmon.

RC 013

THE STATE of ALASKA

GOVERNOR BILL WALKER

Department of Fish and Game
DIVISIONS OF COMMERICAL FISHERIES
AND SPORT FISH
Headquarters

333 Raspberry Road
Anchorage, Alaska 99518-1565
Office: 907.267.2376

16 March 2015

Mr. Thomas Kluberton – Chairman
Alaska Board of Fisheries

Dear Chairman Kluberton and members of the Board of Fisheries:

Since the December 2012 Bristol Bay Board of Fisheries (board) meeting in Naknek, the Alaska Department of Fish and Game (department) has participated in a series of meetings with a committee of users, processors, and members of the Bristol Bay Science and Research Institute. This committee was charged by the board to prepare recommendations relating to the development of optimal escapement goals for Bristol Bay sockeye salmon. As a part of this effort, the committee reviewed a draft escapement analysis report and presentations prepared by scientists from the School of Fisheries and Aquatic Sciences at the University of Washington and LGL Alaska Research Associates, Inc. that evaluated escapement goals for Bristol Bay sockeye salmon taking into account biological and economic factors. Based on the biological and economic analysis, and the escapement goal analysis conducted by the department in 2012 (Fair et al. 2012), the department recommends the lower bounds of the existing sustainable escapement goals (SEGs) and the upper bounds of the escapement goals following the recommendations from Fair et al. 2012 (Table 1). The department intends to implement these recommendations prior to the 2015 fishing season.

In addition, the department is developing umbrella language for Bristol Bay sockeye salmon management as guidelines for managers. This regulatory language will be introduced during the statewide miscellaneous shellfish board meeting in March of 2015 for the department to manage escapements to fall within the lower or upper half of the adopted river-specific escapement goal ranges, proportionate with pre-season and inseason assessments of run strength to fishing districts.

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Table 1. - Recommended Bristol Bay sockeye salmon escapement goals (in thousands).

	Current SEG		SEG recommendations from Fair, et al. 2012		Recommended SEG	
River	Lower	Upper	Lower	Upper	Lower	Upper
Egegik	800	1,400	900	2,000	800	2,000
Igushik	150	300	200	400	150	400
Kvichak	2,000	10,000	2,000	10,000	2,000	10,000
Naknek	800	1,400	900	2,000	800	2,000
Nushagak	370	840	400	900	370	900
Ugashik	500	1,200	600	1,400	500	1,400
Wood	700	1,500	800	1,800	700	1,800

Citations:

Fair, L.F., C.E. Brazil, X. Zhang, R.A. Clark, and J.W. Erickson. 2012. Review of salmon escapement goals in Bristol Bay, Alaska, 2012. Alaska Department of Fish and Game, Fishery Manuscript Series No. 12-04, Anchorage.

Sincerely,

Jeff Regnart, Director
Division of Commercial Fisheries
Anchorage

Tom Brookover, Acting Director
Division of Sport Fish
Anchorage

RC 4

THE STATE of ALASKA

GOVERNOR BILL WALKER

Department of Fish and Game

DIVISIONS OF SPORT FISH & COMMERCIAL FISHERIES
333 Raspberry Road
Anchorage, AK 99518

MEMORANDUM

TO: Forrest R. Bowers, Acting Director
Division of Commercial Fisheries

Thomas Brookover, Director
Division of Sport Fish

DATE: October 3, 2018

THRU: Bert Lewis, Regional Supervisor BL
Division of Commercial Fisheries, Region II

Thomas Vania, Regional Supervisor TV
Division of Sport Fish, Region II

SUBJECT: Bristol Bay Escapement Goal Memo

FROM: Jack Erickson, Regional Research Coordinator JKE
Division of Commercial Fisheries, Region II

Timothy McKinley, Regional Research Coordinator TRM
Division of Sport Fish, Region II

The purpose of this memo is to report our progress reviewing and recommending escapement goals for the Bristol Bay Management Area (BBMA). The *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223) recognizes the establishment of salmon escapement goals as a joint responsibility of the Alaska Department of Fish and Game (department) and the Alaska Board of Fisheries (board) and describes the concepts, criteria, and procedures for establishing and modifying salmon escapement goals. Under the policy, the board recognizes and describes the department's responsibility for establishing and modifying biological escapement goals (BEG) and sustainable escapement goals (SEG).

Beginning in February 2018, an interdivisional salmon escapement goal committee, including staff from the divisions of Commercial Fisheries and Sport Fish, initially met to discuss salmon escapement goals in the BBMA. Escapement goals for this area have been set and evaluated at regular intervals since statehood and many of these stocks have long-term historical datasets. The review was based on the *Policy for the Management of Sustainable Salmon Fisheries* (5 AAC 39.222) and the *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223). Two important terms are:

> 5 AAC 39.222 (f)(3) *"Biological Escapement Goal* (BEG): the escapement that provides the greatest potential for maximum sustained yield (MSY);" and

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5 AAC 39.222 (f)(36) *"Sustainable Escapement Goal* (SEG): a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated or managed for."

The committee determined the appropriate goal type (BEG or SEG) for each salmon stock with an existing goal and reviewed other monitored stocks without an existing goal. Using available data, we determined the most appropriate methods to develop each escapement goal.

Currently 15 escapement goals are evaluated in BBMA (Table 1). Due to the comprehensive previous analyses in Cross et al. (1997), Fair (2000), Fair et al. (2004), Baker et al. (2006 and 2009), Fair et al. (2012), and Erickson et al. (2015) this review committee only considered reanalyzing goals with recent (2015–2017) escapements that might result in a substantially different escapement goal from the last review, or those that should be eliminated or newly established.

Sockeye salmon

For this review, we updated the sockeye salmon genetic harvest allocations to better account for mixed-stock harvest in each district, and to more accurately represent the true production of the primary stocks (Alagnak, Egegik, Igushik, Kvichak, Naknek, Nushagak, Ugashik, and Wood rivers) in Bristol Bay. The committee reviewed the updated stock-recruit analyses for each of these stocks and recommends no changes for Egegik, Igushik, Kvichak, Naknek, Nushagak, Ugashik, and Wood River sockeye salmon escapement goals.

For this review, the expansion factor (aerial counts to tower counts) for Alagnak River sockeye salmon was updated to include recent aerial surveys and tower counts, and corrections made to the aerial survey data. The committee recommends that the lower-bound SEG of 320,000 Alagnak River sockeye salmon assessed using tower counts be changed to a lower-bound SEG of 210,000. The committee also recommends that the companion lower-bound SEG of 125,000 assessed using a single aerial survey be eliminated in deference to the tower-based lower-bound SEG. Allocative implications associated with a change in this escapement goal are found within the *Alagnak River Sockeye Salmon Special Harvest Area Management Plan* (5 AAC 06.373).

King salmon

For this review, the time series for Nushagak River king salmon was updated to include recent harvest and escapement, and corrections made to the harvest data. The updated stock-recruit analysis resulted in a greater estimate of spawner abundance that maximizes sustained yield (S_{msy}) but the new S_{msy} estimate is well within the current goal. In addition, results from sonic-tagging (2011–2014) and capture-recapture (2014–2016) studies show that substantial numbers of king salmon are not enumerated by the existing sonar assessment. The escapement goal committee recommended no change be made to the existing goal and that a stock-recruit model be developed prior to the next Bristol Bay regulatory-cycle which incorporates the corrected harvest data and uncertainty in king salmon abundance estimated by the sonar.

The committee recommends the king salmon goal for the Alagnak River stock be discontinued because there are indications that aerial surveys conducted since 2015 may not index escapement the same as, or similar to, previous surveys used to develop the escapement goal. This goal was

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recommended to be discontinued during the last board cycle, because funding was unavailable and uncertainty over the current survey observer efficiency in relation to historic aerial survey numbers.

Other recent indicators of relative king salmon abundance in the Alagnak River (e.g., Statewide Harvest Survey estimates of catch, guide logbook data, personal communication with anglers and guide businesses) are on par with years when historical survey index counts were greater than 3,000 fish. The exact reason(s) for these differences are unknown, in part because surveys have been conducted in a different manner (i.e., two observers per survey and multiple surveys per year since 2015 but one observer flying single aerial surveys historically). The department currently lacks the information needed to understand the relationship between current aerial survey data and the existing escapement goal, as well as reported sport fishing data. By discontinuing this goal, the *Alagnak River Sockeye Salmon Special Harvest Area Management Plan* (5 AAC 06.373 (c)) will need to be updated.

Pink, coho, and chum salmon

The committee concluded that updating the analyses for these stocks would not likely result in a substantially different escapement goals; therefore, the committee recommends no changes at this time.

In summary, this comprehensive review of the 15 existing salmon escapement goals in the BBMA resulted in recommendations to update 1 existing sockeye salmon escapement goal and discontinuing 2 escapement goals (one for sockeye salmon, one for king salmon). It is also recommended that a concerted effort be made by the department to develop a run reconstruction and stock-recruit analysis for Nushagak River king salmon that accounts for errors in harvest data used to develop the current escapement goal, and the uncertainty in proportion of king salmon counted by sonar that was identified by recent tagging and capture-recapture studies. Oral and written reports (Erickson et al. *In prep.*) concerning BBMA escapement goals and stock status will be presented to the board in December 2018. These reports will list current escapement goals for BBMA, detailed descriptions of the methods used to develop the goals, and annual escapements through 2018.

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Table 1. – Summary of escapement goals and recommendations for salmon stocks in Bristol Bay Management Area.

System	Escapement Goal	Enumeration Method	Goal Type	Initial Year	Recommendation
KING SALMON					
Nushagak River	55,000 – 120,000	sonar	SEG	2013	No change
Alagnak River	2,700	single aerial survey	lower-bound SEG	2007	discontinue
CHUM SALMON					
Nushagak River	200,000	sonar	lower-bound SEG	2013	No change
COHO SALMON					
Nushagak River	60,000 – 120,000	sonar	SEG	2013	No change
PINK SALMON					
Nushagak River (even years only)	165,000	sonar	lower-bound SEG	2013	No change
SOCKEYE SALMON					
Kvichak River	2,000,000 – 10,000,000	tower count	SEG	2010	No change
Alagnak River	320,000	tower count	lower-bound SEG	2007	correct & update to 210,000
Alagnak River	125,000	single aerial survey	lower-bound SEG	2015	discontinue
Naknek River	800,000 – 2,000,000	tower count	SEG	2015	No change
Egegik River	800,000 – 2,000,000	tower count	SEG	2015	No change
Ugashik River	500,000 – 1,400,000	tower count	SEG	2015	No change
Wood River	700,000 – 1,800,000	tower count	SEG	2015	No change
Igushik River	150,000 – 400,000	tower count	SEG	2015	No change
Nushagak River	370,000 – 900,000	sonar	SEG	2015	No change
	260,000 – 760,000	sonar	OEG	2012	NA
Togiak River	120,000 – 270,000	tower count	SEG	2007	No change

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MEMORANDUM

TO: Samuel Rabung, Director
Division of Commercial Fisheries

David Rutz, Director
Division of Sport Fish

DATE: November 7, 2022

THRU: Bert Lewis, Regional Supervisor BL
Division of Commercial Fisheries, Region II

Jason Dye, Regional Supervisor JED
Division of Sport Fish, Region II

SUBJECT: Corrected (version control) Bristol Bay Escapement Goal Memo

FROM: Jack Erickson, Regional Research Coordinator
Division of Commercial Fisheries, Region II

Timothy McKinley, Regional Research Coordinator TRM
Division of Sport Fish, Region II

The purpose of this memo is to report our progress reviewing and recommending escapement goals for the Bristol Bay Management Area (BBMA). The *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223) recognizes the establishment of salmon escapement goals as a joint responsibility of the Alaska Department of Fish and Game (department) and the Alaska Board of Fisheries (board) and describes the concepts, criteria, and procedures for establishing and modifying salmon escapement goals. Under the policy, the board recognizes and describes the department's responsibility for establishing and modifying biological escapement goals (BEG) and sustainable escapement goals (SEG).

Beginning in November 2020, an interdivisional salmon escapement goal committee, including staff from the divisions of Commercial Fisheries and Sport Fish, met several times to discuss salmon escapement goals in the BBMA. Escapement goals for this area have been set and evaluated at regular intervals since statehood and many of these stocks have long-term historical datasets. The review was based on the *Policy for the Management of Sustainable Salmon Fisheries* (5 AAC 39.222) and the *Policy for Statewide Salmon Escapement Goals* (5 AAC 39.223). Two important terms are:

> 5 AAC 39.222 (f)(3) *"Biological Escapement Goal* (BEG): the escapement that provides the greatest potential for maximum sustained yield (MSY);" and
>
> 5 AAC 39.222 (f)(36) *"Sustainable Escapement Goal* (SEG): a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated or managed for."

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The committee determined the appropriate goal type (BEG or SEG) for each salmon stock with an existing goal and reviewed other monitored stocks that do not have escapement goals. Using available data, we determined the most appropriate methods to develop each escapement goal.

Currently, 13 escapement goals are established in BBMA (Table 1). Due to the comprehensive previous analyses in Cross et al. (1997), Fair (2000), Fair et al. (2004), Baker et al. (2006 and 2009), Fair et al. (2012), Erickson et al. (2015 and 2018) the review committee focused its attention on updating and reviewing the stock-recruit analyses for sockeye and king salmon stocks.

Sockeye salmon

For this review, we updated the sockeye salmon genetic stock-specific harvest estimates from 2006 forward with the current baseline to better account for mixed-stock harvest in each district, and more accurately represent the true production of the sockeye salmon stocks in Bristol Bay. Except for the Alagnak River stock, Ricker stock-recruit models fit in a Bayesian framework were run with updated data through 2020, and for comparison, with data through 2012 (the time series of data from which the current goals were developed) to assess if the recent eight years of returns would provide additional information to modify the existing goals. The updated stock-recruit analyses from this effort were similar to the stock-recruit analyses presented to the board in 2012. Since 2012, Bristol Bay sockeye salmon runs have been very productive and several stocks (most notably Egegik, Naknek, and Wood rivers) have experienced record or near record runs and escapements. While some goals could be revised, the committee recommends no changes to the current escapement goals and will assess the returns from these large escapements over the next 3–6 years; information that will likely better inform some of the stock-recruit relationships. This pending return information may warrant revising escapement goals during the next 1 or 2 board cycles.

King salmon

The current SEG (55,000–120,000) for Nushagak River king salmon was established in 2013. For this review, a run reconstruction was developed for Nushagak River king salmon for brood years 1966–2012. As part of this run reconstruction and stock-recruit analysis the department corrected errors in harvest data used to develop the current escapement goal, and attempted to address the uncertainty in proportion of king salmon indexed by sonar that was identified by recent tagging and capture-recapture studies. The model integrated historical escapement, harvest, inriver run and age composition data to reconstruct drainagewide historical run and escapement, as well as spawner-recruit parameter estimates from which biological reference points such as number of spawners at maximum sustained yield (S_{MSY}) are estimated. Four different time series of spawner-recruit data were analyzed and several recommendations were made to potentially improve the run reconstruction model. Recommendations include indices of sport and commercial catch-per-unit-effort (CPUE). Due to the extensive work required to further improve the run reconstruction, the committee recommends the current escapement goal not be changed at this time. The department will continue development of a run reconstruction model and stock-recruit analyses, and present results and escapement goal recommendation prior to the next Bristol Bay board cycle.

Pink salmon

The current lower-bound SEG (165,000) for even-year Nushagak River pink salmon was established in 2013. The sonar project has only operated twice (2014 and 2018) during August (the key timeframe for pink and coho salmon passage) since the goal was established. The committee concluded updating the analysis for this stock would likely not result in a substantially different escapement goal; therefore, the committee recommends no change at this time.

Coho salmon

The current SEG (60,000–120,000) for Nushagak River coho salmon was established in 2013. The Nushagak River sonar has operated during August four times since the goal was established (2013, 2014, 2018, and 2019). The committee concluded that updating the analysis for this stock would likely not result in a substantially different escapement goal; therefore, the committee recommends no change at this time.

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Chum salmon

The current lower-bound SEG (200,000) for Nushagak River chum salmon was established in 2013. The committee reviewed the recent escapements and concluded that updating the analysis for this stock would not likely result in a substantially different escapement goal; therefore, the committee recommends no change at this time.

Summary

This comprehensive review of the 13 existing salmon escapement goals in the BBMA resulted in the recommendation to maintain all existing escapement goals. Oral and written reports concerning BBMA escapement goals, the Nushagak River king salmon run reconstruction, and stock status will be presented to the board in November 2022. These reports will list current escapement goals for BBMA, detailed descriptions of the methods used to evaluate these goals, and annual escapements through 2021.

Stock of concern recommendations for Bristol Bay salmon will be developed after the 2022 salmon season. These recommendations will be formalized in a memo and presented at the board Work Session in October 2022. A brief oral report concerning escapement goals and stock of concern recommendations will be given to the board at the Work Session.

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Table 1.–Summary of current and recommended escapement goals for salmon stocks in Bristol Bay Management Area.

System	Escapement goal	Enumeration method	Goal type	Initial year	Recommendation
KING SALMON					
Nushagak River	55,000 – 120,000	Sonar	SEG	2013	No change
CHUM SALMON					
Nushagak River	200,000	Sonar	Lower-bound SEG	2013	No change
COHO SALMON					
Nushagak River	60,000 – 120,000	Sonar	SEG	2013	No change
PINK SALMON					
Nushagak River (even years only)	165,000	Sonar	Lower-bound SEG	2013	No change
SOCKEYE SALMON					
Kvichak River	2,000,000 – 10,000,000	Tower count	SEG	2010	No change
Alagnak River	210,000	Tower count	Lower-bound SEG	2019	No change
Naknek River	800,000 – 2,000,000	Tower count	SEG	2015	No change
Egegik River	800,000 – 2,000,000	Tower count	SEG	2015	No change
Ugashik River	500,000 – 1,400,000	Tower count	SEG	2015	No change
Wood River	700,000 – 1,800,000	Tower count	SEG	2015	No change
Igushik River	150,000 – 400,000	Tower count	SEG	2015	No change
Nushagak River	370,000 – 900,000	Sonar	SEG	2015	No change
	260,000 – 760,000	Sonar	OEG	2012	Not applicable
Togiak River	120,000 – 270,000	Tower count	SEG	2010	No change

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