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Escapement Goal Recommendations for Select Arctic-Yukon-Kuskokwim Region Salmon Stocks, 2019

by

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and

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December 2018

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

An Alaska Department of Fish and Game (ADF&G) escapement goal review team evaluated salmon stocks in the Arctic-Yukon-Kuskokwim (AYK) region in advance of the January 2019 Alaska Board of Fisheries (BOF) meeting. At the time of this review there existed 65 escapement goals for salmon stocks in the AYK region, including 5 optimum escapement goals established by the BOF. The review team did not recommend any new escapement goals be established at this time. The review team has recommended that 12 escapement goals be revised and 7 escapement goals be discontinued. The recommendations made by the review team were intended to align salmon escapement goals throughout the region with current fishery management practices and status of escapement monitoring programs. Within the Norton Sound-Port Clarence Area, the review team recommended discontinuing the Norton Sound Subdistrict 1 aggregate chum salmon *Oncorhynchus keta* goal and revising goals for the Eldorado, Nome, and Snake rivers which contribute to the aggregate. Revisions were also recommended for chum salmon goals established for the Kwiniuk and Tubutulik rivers and the sockeye salmon *O. nerka* goal established for Salmon Lake/Grand Central River. Within the Kotzebue Area, the review team recommended discontinuing the Kotzebue-wide aggregate chum salmon goal and individual chum salmon goals for the Salmon, Squirrel, and Tutuksuk rivers. Additionally, revisions were recommended for the 2 remaining chum salmon escapement goals established for the Noatak and Upper Kobuk/Selby rivers. Within the Yukon Area, the review team recommended discontinuation of the Tanana River fall chum salmon goal and revisions to fall chum salmon goals for the Delta and Chandalar rivers. Within the Kuskokwim Area, the review team recommended discontinuation of the Holitna River Chinook salmon *O. tschawytscha* aerial survey goal and revised the existing Chinook and sockeye salmon goals for the Middle Fork of Goodnews River.

Key words: Pacific salmon, *Oncorhynchus* spp., escapement goal, stock status, Arctic-Yukon-Kuskokwim, Kuskokwim Area, Yukon Area, Norton Sound-Port Clarence Area, Arctic-Kotzebue Sound Area

INTRODUCTION

This report presents escapement goal recommendations for salmon stocks of Norton Sound-Port Clarence, Arctic-Kotzebue Sound, Yukon, and Kuskokwim areas (AYK Region; Figure 1). The Alaska Department of Fish and Game (ADF&G) is responsible for establishing, reviewing, and modifying escapement goals as described by the *Policy for Statewide Salmon Escapement Goals* (Escapement Goal Policy: 5 AAC 39.223) and the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP: 5 AAC 39.222), which were adopted into regulation by the Alaska Board of Fisheries (BOF). ADF&G is responsible for notifying the public whenever a new escapement goal is established or an existing escapement goal is modified. Similarly, ADF&G is responsible for notifying the BOF whenever allocative impacts arise from management actions necessary to achieve a new or modified escapement goal. Since 2001, escapement goal reviews have been conducted every 3 years, concurrent with the BOF regulatory cycle. This report provides documentation and notification of ADF&G's escapement goal review and recommendations for the 2019 review cycle.

Escapement goals consistent with the SSFP definitions and the Escapement Goal Policy process were established for the first time during the 2001 regulatory cycle (Clark 2001a-c; Clark and Sandone 2001; Eggers 2001; Evenson 2002). Escapement goal reviews were subsequently conducted during the 2004, 2007, 2010, 2013, and 2016 cycles (ADF&G 2004; Brannian et al. 2006; Volk et al. 2009; Conitz et al. 2012; Conitz et al. 2015). Performance of meeting existing escapement goals in the AYK Region (and all other regions) have been reported annually, with tabulations of the most recent 10 years' escapement estimates (e.g., Munro 2018). The 2019 review cycle focused on a detailed evaluation of existing goals (i.e., those established or left unchanged in the 2016 cycle) to determine where revisions were needed. This included consideration of goals to be discontinued due to lack of assessment information and revisions to goals.

The 2019 AYK Region escapement goal review was led by a review team comprised of regional research coordinators and fisheries scientists from Divisions of Commercial Fisheries and Sport Fish. This team met 9 times between November 2017 and August 2018 (Table 1) to plan, conduct, and review escapement goal analyses considering current fishery and stock status, changes in assessment methodology, new escapement data, and public input since the previous review cycle(s). Members of the review team worked directly with area research staff and a statewide biometrician to facilitate escapement goal reviews as planned through consultation with fishery managers. Two public meetings were held and included participation from U.S. Fish and Wildlife Service and representatives from numerous fishery advisory groups, Tribal groups, and engaged stakeholders. The first public meeting was held in Anchorage on 26–27 February 2018. This meeting served 3 primary functions: 1) provide stakeholders with background regarding escapement goals and the escapement goal review process; 2) notify stakeholders of ADF&G's preliminary recommendations to retain, revise, or discontinue select goals prior to the BOF proposal deadline; and 3) provide an opportunity for stakeholder input to the review process. Escapement goal recommendations were not available for Kuskokwim River Chinook salmon *Oncorhynchus tschawytscha* at the time of the February 2018 meeting. A follow-up stakeholder meeting was held in Bethel and Anchorage on 7 August 2018 to discuss Kuskokwim River Chinook salmon goals.

The result of the AYK Region escapement goal review process, as outlined above, was a set of escapement goal recommendations provided by the review team to the directors of the Divisions of Commercial Fisheries and Sport Fish. The review team did not recommend any new escapement goals for AYK Region during the 2019 cycle. The review team did recommend that several existing escapement goals be revised or discontinued. A majority of the revisions were driven by a desire to align escapement goals with the geographic scale of existing fisheries and current assessment programs.

The SSFP provides the following definitions for biological and sustainable escapement goals as discussed in this review.

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.

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 due to the absence of a stock specific catch estimate; the SEG is the primary management objective for the escapement, unless an optimal escapement or inriver run goal has been adopted by the board, and will be developed from the best available biological information; the SEG will be determined by the department and will be stated as a range that takes into account data uncertainty; the department will seek to maintain escapements within the bounds of the SEG.

Both types of escapement goals are designed to provide for sustainable salmon fisheries. The decision to establish a BEG or SEG is dependent on the availability of stock-specific information and the nature of the fishery. Establishment of a BEG requires information about total run, harvest, and escapement to estimate the range of escapements that will maximize yield. Furthermore, establishment of a BEG, requires harvest management to achieve escapements within ranges that will maximize yield where possible and appropriate given the nature of the fishery. Subsistence fisheries are particularly important in the AYK Region and providing stable subsistence harvests large enough to meet subsistence needs may be a higher priority management objective than maximizing yield. In these cases, a SEG may be established based on a detailed stock-specific yield analysis where the resulting SEG goal range does not have the greatest potential for maximum sustained yield. Relatively few stocks in the AYK Region have adequate information to establish a BEG or SEG based on a yield analysis; in particular, stock-specific harvest estimates are often unavailable. For this reason, most escapement goals in the AYK Region are SEGs based on good quality escapement data where the goal ranges have been shown to produce sustainable harvest in the past and are intended to produce similar levels of harvest in the future. Management implications of escapement goals are also acknowledged, and ADF&G is directed to address issues in management plans and regulations as needed.

During its regulatory process, the BOF reviews the BEGs and SEGs that have been recommended by the review team to the directors of the Divisions of Commercial Fisheries and Sport Fish. With the assistance of ADF&G, the BOF may also consider establishing or revising an optimal escapement goal, which is defined as follows.

5 AAC 39.222 (f)(25) "optimal escapement goal" or "(OEG)" means a specific management objective for salmon escapement that considers biological and allocative factors and may differ from the SEG or BEG; an OEG will be sustainable and may be expressed as a range with the lower bound above the level of SET, and will be adopted as a regulation by the board; the department will seek to maintain evenly distributed escapements within the bounds of the OEG;

There are currently 5 OEGs established by the BOF for the AYK Region. During the 2019 review cycle, the review team recommended changes to all 5 of the SEGs or BEGs upon which those OEGs were based. At the BOF's discretion, revision or removal of the OEGs should be considered for consistency with revised methodology in escapement goal determination.

METHODS

The 2019 review cycle focused on a detailed evaluation of existing goals (i.e., those established or left unchanged in the 2016 cycle) to determine if any should be revised or discontinued. The extent of each escapement goal review was dependent on the availability of new information such as significant changes in stock assessment methods, fisheries, and trends or patterns in the data series for each stock. Central to the review was an in-depth discussion with fishery managers to evaluate how each escapement goal has been utilized in management and how well it has been performing as a management tool.

Data, previous analyses, and estimates for all stocks reviewed were obtained primarily from published research and management reports, and the AYK database management system (http://www.adfg.alaska.gov/CommFishR3/WebSite/AYKDBMSWebsite/Default.aspx). When necessary, data were supplemented from unpublished staff data sources. In nearly all cases, escapement goal reviews considered data through the 2017 project year. Data from 2018 was not

available at the time of review. Data quality control measures were integral to the review process, and escapement goals were evaluated based upon the most consistent and reliable data sets that could be obtained. For example, only those aerial survey data listed as "fair" or "good" in the survey notes were used in review analyses. Similarly, estimates of missed passage at weirs/tower projects were reviewed to ensure comparability of escapement estimates throughout the time series. Historical data series, in which older estimates were not comparable with newer ones, due to changes in methodologies over time, were statistically adjusted if possible. Poor surveys, incomplete assessment, and non-comparable estimates were omitted from the data series as they may introduce bias and the time series would more accurately represent escapement without them.

Each of the recommendations made during the 2019 review cycle to revise an existing goal was based on the Percentile Approach by Clark et al. (2014). Each of these stocks, for which a revision was recommended, currently lack stock-specific harvest information required to estimate total run and conduct a yield analysis. The review team determined that the Percentile Approach was the most appropriate method for setting a SEG for these fished stocks based on ranges of historic escapement that produce some level of sustained yield over a given time period. The Percentile Approach has been commonly used across Alaska and provides a valid proxy for the range of escapements likely to produce maximum sustained yield (*Smsy*). The recommendations as presented in Clark et al. 2014 were applied to each stock, with consideration of harvest rate, data contrast (contrast indicates the ratio of highest to lowest observed escapement), and measurement error. Percentile-based escapement goal ranges were defined in Clark et al. 2014 as follows:

- Tier 1 – high contrast (>8) and high measurement error (aerial and foot surveys) with low to moderate harvest rates (<0.40), the 20th to 60th percentiles;
- Tier 2 – high contrast (>8) and low measurement error (weirs, towers) with low to moderate harvest rates (<0.40), the 15th to 65th percentiles; and
- Tier 3 – low contrast (8 or less) with low to moderate harvest rates (<0.40), the 5th to 65th percentiles.

The Percentile Approach was not recommended in cases of high harvest rates (greater than or equal to 0.40), or a combination of very low contrast (4 or less) and high measurement error (aerial or foot surveys).

The review team updated spawner-recruit and yield analyses for Yukon River fall chum salmon *O. keta* SEG, Yukon River summer chum salmon BEG, and Kuskokwim River Chinook salmon SEG. Review of these goals was needed to determine if recent methodology changes which affected historical total run and escapement estimates warranted a revision to the existing BEG. The Yukon River summer and fall chum salmon analyses both incorporate data from Pilot Station sonar, and historical estimates of sonar passage were recently revised (Pfisterer et al. 2017). Similarly, the historical time series of total run and escapement of Kuskokwim River Chinook salmon was revised following an extensive review of the statistical model used to estimate abundance of that stock (Liller et al. 2018).

Methods used to review the Yukon River summer chum, Yukon River fall chum, and Kuskokwim River Chinook salmon goals were consistent with those used to establish the existing goals for those stocks (Fleishman and Borba 2009; Hamazaki et al. 2012; Hamazaki and Conitz 2015). Spawner-recruit analyses have traditionally used a Ricker 2-parameter model

(Hilborn and Walters 1992) to estimate *Smsy*. From that, the range of escapements that produce 90% or more of maximum sustained yield (MSY) has typically been calculated as the escapement goal range most likely to achieve MSY. This traditional escapement goal analysis has been further refined and developed within ADF&G to include better accounting for uncertainty in both assessment data and spawner and recruitment estimates. Ricker spawner-recruit model parameters are estimated in the framework of a state-space model, which may directly incorporate a run reconstruction sub-model, often using Bayesian methods. State-space models relate unobserved process or "state" variables to observed data and incorporate specification of both stochastic fluctuation inherent in the system ("process error") and observation error, allowing for a robust and realistic characterization of uncertainty (Rivot et al. 2004; Su and Peterman 2012; Fleischman et al. 2013). State-space models have been shown to provide less biased estimates of population parameters and reference points than traditional stock-recruitment methods (Su and Peterman 2012).

The remainder of this report presents the review team's recommendations and rationale for revising or discontinuing select escapement goals in each area within the AYK Region. Limited discussion will be provided for select stocks for which substantial reviews were conducted but the review team recommended no change to the existing goal. Final approval of escapement goals will be made by the directors of Divisions of Commercial Fisheries and Sport Fish following the 2019 BOF meeting.

NORTON SOUND-PORT CLARENCE AND ARCTIC-KOTZEBUE SOUND AREAS

A total of 28 escapement goals for 22 stocks exist in the Norton Sound-Port Clarence and Kotzebue Areas (Table 2; Conitz et al. 2015). BEGs exist for 4 stocks: Norton Sound Subdistrict 1 chum salmon, Tubutulik River chum salmon, Kwiniuk River chum salmon, and Kotzebue (all areas) chum salmon. A total of 19 SEGs exist for 18 stocks (1 pink salmon *O. gorbuscha* stock has separate even and odd year goals). Additionally, optimal escapement goals (OEG) were established by the BOF for 5 chum salmon stocks that also have associated BEGs or SEGs. Three of those OEGs are identical to the established SEGs.

All stocks with an existing BEG or SEG were reviewed during the 2019 cycle. The review team has recommended that 8 escapement goals be revised and 5 escapement goals be discontinued (Table 2). A majority of the recommendations are related to the aggregate goals established for chum salmon in the Norton Sound Subdistrict 1 and Kotzebue Area. This relatively large number of recommendations pertaining to chum salmon was intended to align existing escapement goals with the needs of the fishery and current state of assessment programs. The following sections are focused on those goals for which the review team recommended revision or discontinuation. In addition, we provided a brief discussion of North River Chinook salmon, which was reviewed but no action was taken.

The review team recommended that all other existing escapement goals for salmon stocks in the Norton Sound-Port Clarence and Kotzebue areas continue without revision.

CHUM SALMON

Escapement goals for Norton Sound Subdistrict 1 chum salmon have undergone regular review and revision since 2001. The Norton Sound Subdistrict 1 chum salmon aggregate BEG was established in 2001 based on a spawner-recruit analysis (Clark 2001c), and individual goals were

concurrently established for 7 of the 9 chum salmon spawning tributaries that drain into the subdistrict based on their proportional contribution to the aggregate. Goals were reviewed during the 2004 cycle (ADF&G 2004) and individual Subdistrict 1 goals were clarified as being SEGs rather than BEGs. In 2010, 4 of the 7 tributary SEGs were discontinued, citing unreliability of the surveys (Volk et al. 2009); although, surveys for each tributary have been continued in most years because they are required to assess the Subdistrict 1 aggregate BEG. During the 2016 escapement goal review cycle, the review team recommended that Subdistrict 1 aggregate BEG and remaining SEGs on the Eldorado, Nome, and Snake rivers be reviewed and potentially revised to better reflect current fishery management practices and stock productivity, but that review was deferred until additional data could be considered (Conitz et al. 2015).

Following extensive consideration, the review team has recommended that the aggregate Norton Sound Subdistrict 1 chum salmon BEG be discontinued. The Subdistrict 1 goal has not been a useful management tool because chum salmon productivity and capacity to support harvest has been variable among tributaries within the subdistrict. In particular, recent production of stocks east of Cape Nome has outpaced stocks west of Cape Nome, and when viewed through the lens of the aggregate goal, these patterns are not apparent. As a result, regulatory changes have been enacted to allow chum salmon within the district to be managed separately, east and west of Cape Nome. A recent marine tagging study conducted in 2015 and 2016 provided general support for the current practice of managing chum salmon stocks east and west of Cape Nome separately (Bell et al. 2018). In lieu of the Norton Sound Subdistrict 1 BEG, ADF&G staff and Arctic Area stakeholders have agreed that assessment of subdistrict escapement is more accurately indicated by the 3 individual river goals on the Eldorado, Nome, and Snake rivers.

Given the recommendation to discontinue the Norton Sound Subdistrict 1 chum salmon BEG, the review team recommended revising the SEGs for the Eldorado, Nome, and Snake rivers to be based on direct assessment of escapement to those systems rather proportions of the aggregate goal. The review team recommended that the Eldorado River expanded peak aerial survey SEG of 6,000–9,200 be revised to a weir-based SEG of 4,400–14,200, the Nome River weir SEG of 2,900–4,300 be revised to a SEG of 1,600–5,300, and the Snake River tower/weir SEG of 1,600–2,500 be revised to 2,000–4,200. Each of the revised goals was based on percentile ranges of historical escapement (Appendices A1–3). The decision to use weir-based escapement for revision of the Eldorado River SEG represents a methodology change. The current Eldorado River escapement goal uses expanded aerial surveys, but sufficient weir data are now available and provide greater accuracy and precision of escapement estimates than expanded aerial survey. The BOF has established OEGs for each of these 3 stocks in 2001 which were based on and identical to the goals established by ADF&G at that time. Those BOF-generated goals are listed in 5 AAC 04.358 and OEGs are mentioned in 5 AAC 01.190.

The review team has recommended to discontinue the Kotzebue Area chum salmon aggregate BEG and individual SEGs established for the Salmon, Squirrel, and Tutuksuk rivers. An aggregate BEG was established for all Kotzebue Area chum salmon in 2007 based on a spawner-recruit analysis that relied on reconstructed total run and escapement estimates (Eggers and Clark 2006). Assessment of Kotzebue Area chum salmon escapement has been accomplished through peak aerial surveys flown throughout the Noatak and Kobuk rivers. Reconstructed total escapement was converted to unexpanded aerial survey units and used to establish individual SEGs for the Noatak River (including the Eli River); the Upper Kobuk River (including the Selby River); and the Salmon, Squirrel, and Tutuksuk rivers, which are tributaries of the Kobuk

River drainage. Aerial surveys have not been flown on the Salmon, Squirrel, or Tutuksuk rivers since 1999 (except for 1 year in 2005), which has prevented assessment of those individual SEGs and the associated BEG for the entire Kotzebue Area. Logistical challenges including funding, weather, and availability of survey planes have prevented regular assessment of chum salmon escapement to these systems. There are no plans to continue regular assessment of these systems in the near future.

Given the recommendation to discontinue the Kotzebue Area chum salmon aggregate BEG, the review team recommended revising the SEGs for the Noatak River and Upper Kobuk River (including the Selby River) to be based on direct assessment of escapement to those systems rather than proportions of the aggregate goal. Aerial surveys have been used with some success to monitor escapement to both systems, and at least intermittent annual surveys are expected to continue in the future. The review team recommended that the Noatak River/Eli River peak aerial survey SEG of 42,000–91,000 be revised to 43,000–121,000 and the Upper Kobuk/Selby River peak aerial survey SEG of 9,700–21,000 be revised to 12,000–32,100. The revised SEGs were based on percentile ranges (Appendices A4 and A5). The percentile range for the Noatak River was based on aerial survey counts from the Noatak River mainstem combined with counts from Eli and Kelly rivers, which are tributaries of the Noatak River. The recommendation presented here for the Noatak River SEG differs from what was presented by ADF&G in a memo to the directors of the divisions of Commercial Fisheries and Sport Fish dated October 1, 2018, due to a calculation error that was identified and corrected after the memo was submitted.

Use of the Percentile Approach was tenuous for both the Noatak River and Upper Kobuk River situations. This method is not recommended for stocks with average harvest rates of 0.40 or greater, or when escapement data exhibit very low contrast (4 or less) and is assessed with a high degree of measurement error. The average harvest rate of all Kotzebue Area chum salmon from 1962 to 2004 was 0.41, based on reconstructed total run estimates (Eggers and Clark 2006), and average stock-specific harvest may be greater. Both stocks are assessed with aerial surveys, which have high measurement error. Furthermore, data contrast was low (6.7) for the Upper Kobuk River; albeit, the observed contrast was not categorized as “very low”. Ultimately, the review team decided to use standard Tier 1–3 recommendations as presented by Clark et al. 2014. That decision resulted in a more conservative goal range compared to the existing goal ranges for both stocks.

The review team recommended revising the goal range for both the Kwiniuk River and Tubutulik River chum salmon and reclassifying those goals from BEGs to SEGs. An individual BEG was established for each stock in 2001, based on a poorly informed spawner-recruit analysis (Clark 2001b). Specifically, stock specific harvest information in marine waters of Subdistrict 3 was not available and a generalized assumption was made that harvest composition was proportional to freshwater run size. Freshwater run size, however, was not known with certainty for the Tubutulik River and was approximated annually using 2 compounding expansions intended to convert aerial survey counts to total abundance. The review team determined that both goals should be revised based on direct assessment of escapement. The Kwiniuk River tower BEG of 10,000–20,000 should be revised to a SEG of 9,100–32,600 and the Tubutulik River expanded peak aerial survey BEG of 8,000–16,000 should be revised to a SEG of 3,100–9,900 based on unexpanded peak aerial survey counts. The revised goals were based on percentile ranges of historical escapement (Appendices A6 and A7). Escapement to the Kwiniuk River was estimated as the tower count minus inriver subsistence harvest. The decision

to use Tubutulik River unexpanded aerial surveys compared to expanded survey counts represented a methodology change and may give the appearance of a lower goal simply because unexpanded counts were used.

The BOF established an individual OEG for both the Kwiniuk River and Tubutulik River chum salmon stocks in 2001 and those OEG goal ranges are listed in 5 AAC 04.390. The OEGs represented a 15% increase to ADF&G's BEG at that time, and were intended to account for some level of unknown subsistence harvest which occurs in both systems upriver from where escapement monitoring occurs. Beginning in 2004, ADF&G implemented subsistence harvest permits as the primary harvest reporting tool (Menard et al. 2017). Strict enforcement has resulted in nearly a 99% rate of return of all permits issued. As a result, ADF&G can now accurately account for the total inriver subsistence harvest that occurs in both the Kwiniuk and Tubutulik rivers. Permit data has been used to document subsistence harvest location within the Kwiniuk River, and less than 3% of total inriver harvest since 2004 has occurred upriver from the Kwiniuk River counting tower and total escapement can be determined. Similarly, permit data has provided information about the timing of subsistence harvest within the Tubutulik River, and the majority of harvest activity has ceased prior to when aerial surveys of chum salmon escapement are flown. As such, the aerial survey counts of chum salmon escapement to the Tubutulik River are considered to be a reliable index of escapement.

SOCKEYE SALMON

The review team has recommended revising the Salmon Lake/Grand Central River sockeye salmon *O. nerka* peak aerial survey SEG of 4,000–8,000 to a weir-based SEG of 6,800–36,000. The existing goal was based on peak aerial survey counts of sockeye salmon escapement to Salmon Lake and Grand Central River, which is the primary tributary that feeds into Salmon Lake, whose outflow begins at the Pilgrim River. A salmon counting weir has been operated on the Pilgrim River since 2003 (Bell and Leon 2018), and the review team determined that sufficient data was now available to establish a SEG based on percentile ranges of historical weir counts from 2003 to 2016. The Pilgrim River weir is located approximately mid-drainage between Salmon Lake and Imuruk Basin, downriver from where sockeye salmon spawning occurs. Substantial subsistence harvest of sockeye salmon occurs throughout the Pilgrim River drainage upriver from the weir site and including Salmon Lake. Subsistence harvest has been reported annually since 2004 using harvest permits (Menard et al. 2017). Sockeye salmon escapement for Salmon Lake/Grand Central River was calculated as the number of sockeye salmon estimated past the Pilgrim River weir minus total subsistence harvest of sockeye salmon upriver from the weir. Subsistence harvest data for the 2017 project year was not available at the time of review and, therefore, the 2017 escapement estimate was not used to determine the recommended SEG range (Appendix A8).

GOALS REVIEWED BUT NO ACTION TAKEN

Chinook salmon

The review team anticipated revisions to the North River (Unalakleet River) Chinook salmon SEG during this cycle. The existing escapement goal was established as a SEG in 2004 based on historical tower counts. Since that time, 12 additional years of tower-based escapement estimates were available and there have been improvements made to the recommendations of percentile ranges that should be used to establish SEGs for harvested stocks (Clark et al. 2014). The review

team discussed a potential revision to the SEG goal range based on the 5th and 65th percentiles of historical tower counts, with consideration that the escapement data had low contrast. If implemented, the lower bound of the revised goal range would have been reduced by 25%. ADF&G staff and Arctic Area stakeholders were generally not in support of a substantial reduction to the SEG at this time because Norton Sound Subdistricts 5 and 6 (Shaktoolik and Unalakleet) Chinook salmon are currently listed as a Stock of Yield Concern. Alternate percentile ranges (e.g., 25th–75th) were discussed which also would have resulted in lowering the goals range. The final decision was to retain the existing goal and reevaluate during the next cycle.

YUKON AREA

In the Yukon Area, which includes the entire Yukon River drainage within Alaska, there are currently 14 established escapement goals: 6 Chinook salmon, 3 summer chum salmon, 4 fall chum salmon, and 1 coho salmon *O. kisutch* (Table 3; Conitz et al. 2015). Seven of these goals are BEGs and 7 are SEGs. Not included in this listing are 3 goals for Canadian stocks that were established as part of the *Yukon River Salmon Agreement*. Escapement targets for these Canadian stocks (mainstem Yukon River Chinook salmon, mainstem Yukon River fall chum salmon, and Fishing Branch River fall chum salmon) are set annually by the Yukon River Panel (JTC 2018).

All stocks with an existing BEG or SEG were reviewed during the 2019 cycle. The review team has recommended that 2 escapement goals be revised and 1 escapement goal be discontinued (Table 3). Each recommendation was related to fall chum salmon and was intended to align existing escapement goals with the current state of assessment programs. The following sections are focused on those goals for which the review team recommended revision or discontinuation. In addition, we provided a brief discussion of Chinook salmon aerial survey goals, the summer chum salmon drainagewide goal, and the fall chum salmon drainagewide goal which was reviewed but no action was taken.

The review team recommended that all other existing escapement goals for salmon stocks in the Yukon Area continue without revision.

FALL CHUM SALMON

The review team has recommended that the Tanana River fall chum salmon BEG be discontinued. The BEG was established in 2001 based on a spawner-recruit analysis (Eggers 2001). Total run and escapement estimates used in the spawner-recruit analysis were informed by mark–recapture estimates of fall chum salmon abundance returning to the Tanana River (Upper Tanana and Toklat rivers combined). From 2001 to 2007, the escapement goal was assessed using mark–recapture estimates of total fall chum salmon abundance to the Tanana River (Upper Tanana and Kantishna rivers combined; Cleary and Hamazaki 2008) minus inriver harvests taken in commercial, subsistence, and personal use fisheries (Estensen et al. 2018). The mark–recapture programs were discontinued at the end of the 2007 project year, due to funding shortfalls. Since that time, neither fall chum salmon total abundance nor total escapement has been directly measured for the entire Tanana River drainage. Beginning in 2008, the Tanana River BEG has been evaluated using relationships with other assessment projects. From 2008 to 2012, escapement estimates were based on the relationship with the Delta River (a tributary of the Tanana River), and from 2013–present estimates were based on regression with the Canadian-stock (i.e., Mainstem Yukon) after adjusting for harvest. The review team determined

that these indirect efforts to evaluate the goal were inconsistent with how the goal was established. The current assessment program prevents evaluation of the goal and the status of the assessment program is unlikely to change in the near future. For those reasons the goal should be discontinued.

The review team recognized the significance of the Tanana River fall chum salmon fishery and the management utility of having an escapement goal(s) for this stock. The Tanana River drainage supports the second largest component of the Yukon River fall chum salmon run and viable commercial, subsistence, personal use, and sport fisheries are prosecuted annually throughout the drainage (Estensen et al. 2018). The *Tanana River Salmon Management Plan* (5AAC 05.367) directs ADF&G to manage fisheries to achieve established escapement goals. The review team discussed alternative options to evaluate the Tanana River goal or establish a new goal that is consistent with current assessment. A recent feasibility study conducted by ADF&G demonstrated that mainstem sonar could be used successfully to estimate total run of Tanana River fall chum salmon (Brodersen et al. 2016), but the program did not advance beyond feasibility due to funding shortfalls. The team also discussed options for establishing an alternate goal based on abundance estimates informed by Pilot Station sonar and genetic mixed stock analysis (MSA; Flannery 2008; Estensen et al. 2018). However, those methods would likely underestimate abundance because annual operation of Pilot Station sonar and MSA sampling end before the entire Tanana River fall chum salmon stock has migrated past the sonar. Given the recommendation to discontinue the Tanana River BEG and previous decisions to discontinue the Toklat River fall chum BEG (Volk et al. 2009), the Delta River will be the only remaining escapement goal for fall chum salmon within the Tanana River drainage. The review team agreed that the Delta River would provide an adequate index of fall chum salmon escapement to the Tanana River.

The review team recommended that the Delta River fall chum salmon BEG of 6,000–13,000 be revised to a SEG of 7,000–20,000 based on direct assessment of escapement to that system rather than as a proportion of the Tanana River goal. The existing BEG was established in 2001 by partitioning the Tanana River BEG based on average (1974–1999) proportion of the Tanana River reconstructed escapements attributed to the Delta River (9.3%; Eggers 2001). The review team determined that the goal should be revised to a SEG using percentile ranges based on escapement estimates from 44 years of historical foot-survey counts from 1974–2017 (Appendix A9). The 15th–65th percentile range (Tier 2) was selected instead of the 20th–60th (Tier 1) because the replicate foot survey methods used to estimate escapement have low measurement error.

The review team recommended that the Chandalar River fall chum salmon BEG of 74,000–152,000 be revised to a SEG of 85,000–234,000 based on direct assessment of escapement to that system rather than as a proportion of a larger aggregate goal. In 2001, ADF&G reconstructed total run and escapement for the Upper Yukon River tributary aggregate which was comprised of the Chandalar, Sheenjek, and Fishing Branch rivers. BEGs were established at that time for the Upper Yukon River tributary aggregate using a spawner-recruit analysis and individually for the Chandalar and Sheenjek rivers based on (1974–1999) average contribution to the aggregate escapement, which was 48.6% and 33.4%, respectively (Eggers 2001). Since that time, the aggregate BEG and the BEG for the Sheenjek River have been discontinued because the requisite monitoring programs had been discontinued (Conitz et al. 2015). The Chandalar River has been monitored annually with sonar since 1995 (Melegari and McGuire 2017) and

operations are expected to continue into the future. The review team determined the existing BEG should be revised to a SEG using percentile ranges of historical sonar estimates from 1995 to 2017 (Appendix A10). In this analysis, published sonar estimates were expanded to account for fall chum salmon that passed after annual sonar operations ended. Annual expansions ranged between 2% and 20% across all years.

GOALS REVIEWED BUT NO ACTION TAKEN

Chinook salmon

The review team worked with Yukon Area staff to review and standardize aerial survey index reaches for the Anvik, Nulato, and West Fork of the Andreafsky rivers. A review of Yukon River Chinook salmon aerial survey-based goals was recommended during the 2016 review cycle, citing assessment challenges due to changes to the survey areas over time (Conitz et al. 2015). The need for this review was highlighted following the 2017 survey when the spatial extent of the Anvik River survey was questioned.

The review team decided that the Anvik River Chinook salmon aerial survey SEG should be assessed using the cumulative count of live and dead Chinook salmon within 4 mainstem index reaches 103–106 and 3 tributary reaches 108 (Beaver Creek), 110 (Swift River), and 111 (Otter Creek). Prior to 2005, there existed both a mainstem index goal and a drainagewide goal which excluded the Yellow River in at least 1 year (Buklis 1993). The current SEG was established in 2005 as a drainagewide goal (ADF&G 2004), but the spatial extent of the survey was not clarified and surveyors have had discretion to determine the spatial extent of the survey annually based on fish availability and logistical considerations. The review team decided that a standardized survey area was needed to improve comparability in Chinook salmon abundance over time. The standardized area selected represented more than 96% of the total Chinook salmon escapement to the Anvik River and was the group of index reaches flown most often since 1960 (Figure 2; Appendix B1). The percentile range of historical escapements for this standardized area was consistent with the existing SEG and no changes to the goal range were recommended.

Similar to the Anvik River, the review team decided that the spatial extent of the Nulato River and West Fork Andreafsky River Chinook salmon aerial survey SEGs should be standardized (Figures 3 and 4; Appendix B1). The Nulato River should be assessed using 4 index reaches representing the North and South forks of the Nulato River. Two reaches were selected within the North Fork: 101 (mouth to the confluence of North and South Forks) and 102 (mouth of North Fork upriver to Kalasik Creek). Two reaches were selected within the South Fork: 101 (mouth of South Fork upriver to Drill Hole) and 102 (Drill Hole upriver to Township Line). The West Fork of the Andreafsky River should be assessed using index reaches 101 (community of St. Mary's upriver to the confluence of Allen Creek) and 102 (confluence of Allen Creek upriver to approximately 62.958715 N, 162.124570 W). The selected reaches for the Nulato River and West Fork Andreafsky River represent nearly 100% of the historical Chinook salmon survey counts for those systems. The percentile ranges of historical escapements for these standardized areas were consistent with the existing SEGs and no changes to the existing goal ranges are recommended.

Summer and fall chum salmon

Existing drainagewide escapement goals established for Yukon River summer and fall chum salmon were reviewed to determine if recent changes to historical data had an effect on the goal ranges. The summer chum salmon drainagewide BEG was established in 2016 and incorporated Pilot Station sonar estimates as data input (Conitz et al. 2015; Hamazaki and Conitz 2015). A drainagewide BEG was established for fall chum salmon in 2001 based on a spawner recruit analysis that was independent of Pilot Station assessment because limited data were available at that time (Eggers 2001). In 2009, the Yukon River fall chum salmon spawner recruit analysis was updated and included Pilot Station sonar estimates of abundance (Fleischman and Borba 2009). Results of that updated analysis led to a recommendation to retain the existing goal range but reclassify the goal from a BEG to a SEG (Volk et al. 2009) because the goal range was sustainable but not likely to maximize yield. Historical abundance data from Pilot Station sonar was recently revised (Pfisterer et al. 2017) and the review team was concerned that those data revisions may have implications for existing summer and fall chum salmon goals. The spawner recruit relationship was evaluated for both species following published methods consistent with those used to establish the current goals (Hamazaki and Conitz 2015; Fleishman and Borba 2009). Input data for both reviews were updated through 2017 and included changes to historical Pilot Station sonar estimates. In general, the spawner-recruit analysis and estimated biological reference points (e.g., *Smsy* and *Seq*) were consistent with previous analyses providing no justification to update either of these goals at this time.

KUSKOKWIM AREA

The Kuskokwim Area, which includes the Kuskokwim River and Kuskokwim Bay drainages, currently has 23 established escapement goals for 14 Chinook salmon, 2 chum salmon, 3 coho salmon, and 4 sockeye salmon stocks (Table 4; Conitz et al. 2015). A total of 21 goals are SEGs and 2 goals are BEGs.

All stocks with an existing BEG or SEG were reviewed during the 2019 cycle. The review team has recommended that 2 escapement goals be revised and 1 escapement goal be discontinued (Table 4). The following sections are focused on those goals for which the review team recommended revision or discontinuation. In addition, we provided a brief discussion of Kuskokwim River Chinook salmon escapement goals which were reviewed but no action was taken.

CHINOOK SALMON

There are currently 2 Chinook salmon SEGs established for portions of the Holitna River. A SEG was established for a portion of the Holitna River mainstem in 2005 based on peak aerial surveys (ADF&G 2004). A separate weir-based SEG was established in 2005 based on Chinook salmon escapement to the Kogrukluk River (ADF&G 2004), which was revised in 2013 to align with the drainagewide goal established for the entire Kuskokwim River (Conitz et al. 2012). Of the 2 goals, the Kogrukluk River weir SEG is the primary goal used by ADF&G to assess escapement to the Holitna River.

The review team has recommended that the Holitna River Chinook salmon aerial survey goal be discontinued for several reasons. Assessment of the Holitna River aerial survey goal is difficult due to the size, depth, and complexity of the river channel. Furthermore, the established survey index reach ends abruptly at the Kogrukluk River weir, and weir operations can have substantial

influence on the index of total abundance within the survey reach. Tagging studies have shown that the Kogrukluk River weir is a reliable index of Chinook salmon escapement to the Holitna River (Stroka and Brase 2004). The weir is the longest running salmon escapement weir project in the Kuskokwim Area with 33 nonconsecutive estimates of total annual escapement to the Kogrukluk River. The review team determined that the Holitna River aerial survey goal was redundant with the Kogrukluk River weir-based goal and less suited for the purpose of assessing overall escapement to the Holitna River. For those reasons the goal should be discontinued. ADF&G plans to continue flying the Holitna River aerial surveys annually because those counts are used in combination with other data to estimate total run and escapement of all Kuskokwim River Chinook salmon (e.g., Liller et al. 2018).

The review team has recommended that the Middle Fork Goodnews River weir Chinook salmon BEG of 1,500–2,900 be revised to a SEG of 1,500–3,600. The Goodnews River is comprised of 2 prominent forks: North Fork and Middle Fork. Nearly all harvest occurs in Goodnews Bay and nearshore marine waters and is a mixture of fish returning to the North and Middle Forks. Chinook salmon escapement to both forks has been monitored annually with aerial survey methods and the Middle Fork is also monitored with a weir (Head and Smith 2018). A BEG was established for the Middle Fork Goodnews River in 2007 based on a spawner-recruit analysis that lacked reliable estimates of stock-specific harvest (Molyneaux and Brannian 2006). Instead, estimates of aerial survey observer efficiency and aerial survey expansions were used to approximate the relative abundance of Chinook salmon that escaped annually to each fork. Harvest was assumed to be proportional to escapement. The review team determined that the weir-based goal should be revised based on direct assessment of escapement. The revised goal was based on percentile ranges of historical Middle Fork Goodnews River weir counts (Appendix A11).

SOCKEYE SALMON

The review team has recommended that the Middle Fork Goodnews River weir sockeye salmon BEG of 18,000–40,000 be revised to a SEG of 22,000–43,000. Similar to Middle Fork Goodnews River Chinook salmon, described in the previous section of this report, a BEG was established for Middle Fork Goodnews River sockeye salmon in 2007 based on a poorly informed spawner-recruit analysis that lacked stock-specific harvest information (Molyneaux and Brannian 2006). The review team determined that the weir-based goal should be revised based on direct assessment of escapement. The revised goal was based on percentile ranges of historical Middle Fork Goodnews River weir counts (Appendix A12). Record escapements were observed in 2016 and 2017. Those escapements were attributed, in part, to the lack of a commercial fishery in District 5, which represented a substantial reduction in harvest of Middle Fork Goodnews River sockeye salmon. The review team did not use the 2016 or 2017 escapements in the percentile-based analysis because ADF&G lacks return data from these record escapements.

GOALS REVIEWED BUT NO ACTION TAKEN

Chinook Salmon

The review team did not recommend any changes to the existing drainagewide SEG for Kuskokwim River Chinook salmon, the 3 weir-based tributary SEGs, or 6 of 7 aerial survey-based tributary SEGs during this review cycle. However, the review team did conduct extensive

review of the drainagewide goal and discussed at length the current utility of the 11 interrelated escapement goals established for this single stock. The following highlights those efforts and provides recommendations for future escapement goal review cycles.

Kuskokwim River Chinook salmon goals were discussed at 2 separate stakeholder meetings, both of which were attended by the review team; ADF&G Kuskokwim Area staff; fishery research analysts and managers from U.S. Fish and Wildlife Service (USFWS); members of the Kuskokwim River Salmon Management Working Group; members of the Kuskokwim River Inter-Tribal Fish Commission (KRITFC), and select fishery biologists and program coordinators from various tribal and non-agency groups. The stakeholder meeting held in Anchorage on 26 February 2018 was primarily limited to discussion of non-Chinook salmon goals and Chinook salmon aerial survey goals. Detailed discussion of the Kuskokwim River drainagewide goal and associated weir-based tributary goals was deferred to a separate meeting held on 7 March 2018. Both the USFWS and KRITFC submitted written comments and recommendations to ADF&G in advance of the 7 March 2018 meeting.

The perspectives shared at these stakeholder meetings were varied but tended to center around 4 common themes. First, there was general recognition that Kuskokwim River Chinook salmon are managed principally as a single stock and fishery management options to control escapement at the tributary level is limited. Second, there was broad support for implementing precautionary approaches to escapement goal setting in the face of assessment and management uncertainty. In particular, there was considerable discussion regarding establishing a drainagewide goal that would mitigate the risk of overharvesting individual sub-stocks and reasonably ensure adequate escapement levels to individual tributaries. The performance of the existing drainagewide goal has not yet been formally evaluated in this way, and there was support for such an analysis in the future. Third, there was general support for basing the drainagewide goal on the range of escapements that would maximize future run size instead of future yield. The primary fishery is subsistence and maximizing yield may be a lower management priority compared to maintaining consistently large runs that would allow for adequate opportunity for subsistence users to meet harvest goals. Finally, the utility of maintaining individual tributary goals was discussed but there was no consensus. Perspectives regarding retention or discontinuation of existing tributary goals were focused on the management utility of existing goals and the accountability of ADF&G to achieve sustainable escapement levels throughout the drainage.

Review of the existing drainagewide escapement goal was necessary because the statistical model used by ADF&G to estimate historical total run and escapement was recently revised (Liller et al. 2018). The drainagewide escapement goal was established in 2013 based on a spawner-recruit analysis that explicitly incorporated data and process uncertainties (Conitz et al. 2012; Hamazaki et al. 2012). Under normal circumstances ADF&G would not have conducted a comprehensive review of this goal during the 2019 cycle, because full brood year returns are not available for any year since the goal was established. However, revisions to the statistical model used to establish and evaluate the goal resulted in smaller estimates of drainagewide abundance and escapement (Liller et al. 2018) which led to smaller estimates of total recruits from individual brood years. ADF&G conducted a Bayesian state-space spawner recruit analysis using the most up-to-date estimates of total run, total escapement, and age composition for 42 years (1976–2017). The analysis conducted was identical to that described in Hamazaki et al. 2012 which formed the basis for the existing SEG. The only difference was the updated input data. In general, the spawner-recruit analysis and estimated biological reference points (e.g., *Smsy*, *Smax*,

and *Seq*) were consistent with the previous analysis conducted by Hamazaki et al. 2012 and provided no justification to update the goal at this time. The review did reveal that the Kuskokwim River Chinook salmon stock may not be as productive as previously thought. The previous goal analysis determined that escapements within the goal range of 65,000–120,000 had a greater than 90% probability of producing average yields in excess of 100,000, which is large enough to support unrestricted subsistence fisheries and limited other uses (Hamazaki et al. 2012). The updated analysis indicated that the current goal range is sustainable, includes the range of escapements with the highest likelihood of maximizing future runs sizes, but does not ensure future yields large enough to support unrestricted subsistence fisheries.

All Kuskokwim River Chinook salmon escapement goals should be readdressed during the next escapement goal review cycle with the expressed purpose of ensuring the drainagewide and tributary goals are aligned and consistent with the existing management plan and geographic scale at which fisheries are managed. In particular, the drainagewide goal should be revisited during the next cycle after full returns from record low escapement events from 2011 to 2013 are available. To the extent practical, the relationship between the drainagewide goal and the spatial distribution of tributary escapement should be evaluated. Individual tributary goals should be evaluated in the context of fishery management and unnecessary or redundant goals should be discontinued to simplify the escapement goal structure for this stock. Special attention should be paid to the methods used to establish relevant tributary escapement goals. The proportional method used in 2013 to link the 3 weir-based tributary goals to the drainagewide goal (Conitz et al. 2012) was not based on biological principles and may not serve the intended purpose. The Percentile Approach used to establish the existing aerial survey-based goals has been revised since those goals were established and may not be appropriate given the level of data uncertainty associated with aerial surveys and the relatively high harvest rates throughout much of the time series.

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TABLES AND FIGURES

Table 1.–Escapement goal planning meetings facilitated by ADF&G during the 2019 review cycle.

Date	Meeting	Description
11/6/2017	Arctic Area	ADF&G - Division of Commercial Fisheries staff meeting and escapement goal planning
12/18/2017	Escapement Goal Review team [a]	Arctic-Yukon-Kuskokwim Region escapement goal planning
1/17/2018	Yukon Area	Fall chum salmon escapement goal planning
2/8/2018	Yukon Area	Chinook salmon aerial survey standardization
2/26/2018	Stakeholder [b,c]	Kuskokwim Area escapement goals
2/27/2018	Stakeholder [b,c]	Yukon, Norton Sound/Port Clarence, and Kotzebue Area escapement goals
7/26/2018	Escapement Goal Review team [a]	Kuskokwim River Chinook salmon escapement goal planning
7/26/2018	Kuskokwim Area [d]	ADF&G / USFWS discussion regarding Kuskokwim River Chinook salmon escapement goals
8/7/2018	Stakeholder [b,e]	Kuskokwim River Chinook salmon escapement goals

[a] Included regional research coordinators and fishery scientists from Division of Commercial Fisheries and Sport Fish. Meetings were attended by area research and management staff as needed.

[b] Invitations to participate were sent to representatives of federal, Tribal, fishery advisory, non-government, and stakeholder groups. Teleconference options were provided for individual participants upon request.

[c] Meeting was held in Anchorage.

[d] USFWS Yukon Delta National Wildlife Refuge staff requested a teleconference to share results of an independent review of ADF&G's drainagewide escapement goal for Kuskokwim River Chinook salmon. Written comments and recommendations were submitted in writing to ADF&G and distributed during the public meeting held on 8/7/18.

[e] Meeting location options were provided in Anchorage and Bethel and joined via teleconference.

Table 2.–Summary of salmon escapement goal recommendations for Norton Sound/Port Clarence and Kotzebue Areas, 2019.

Stock unit	Assessment method	Current escapement goal			Escapement goal recommendation for 2019		
		Goal	Type	Year established or last revised	Action	Goal	Type
Norton Sound and Port Clarence Area							
Chinook Salmon							
Kwiniuk River	Tower	>250	LB SEG	2016	No change		
North River (Unalakleet R.)	Tower	1,200–2,600	SEG	2005	No change		
Chum Salmon							
Nome Subdistrict 1 Aggregate	Multiple	23,000–35,000	BEG	2001	Discontinue		
Eldorado River	Expanded peak aerial survey	6,000–9,200	OEG	2001	Revise or discontinue - BOF action		
Eldorado River		6,000–9,200	SEG	2005	Revise	4,400–14,200	SEG
Nome River	Weir	2,900–4,300	OEG	2001	Revise or discontinue - BOF action		
Nome River	Weir	2,900–4,300	SEG	2005	Revise	1,600–5,300	SEG
Snake River	Tower/weir	1,600–2,500	OEG	2001	Revise or discontinue - BOF action		
Snake River	Tower/weir	1,600–2,500	SEG	2005	Revise	2,000–4,200	SEG
Kwiniuk River	Tower	11,500–23,000	OEG	2001	Revise or discontinue - BOF action		
Kwiniuk River	Tower	10,000–20,000	BEG	2001	Revise	9,100–32,600	SEG
Tubutulik River	Expanded peak aerial survey	9,200–18,400	OEG	2001	Revise or discontinue - BOF action		
Tubutulik River		8,000–16,000	BEG	2001	Revise	3,100–9,900	SEG

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Table 2.–Page 2 of 3.

Stock unit	Assessment method	Current escapement goal			Escapement goal recommendation for 2019		
		Goal	Type	Year established or last revised	Action	Goal	Type
Coho Salmon							
Kwiniuk River	Peak aerial survey	650–1,300	SEG	2005	No change		
Niukluk River/Ophir Creek	Peak aerial survey	750–1,600	SEG	2016	No change		
North River (Unalakleet R.)	Peak aerial survey	550–1,100	SEG	2005	No change		
Pink Salmon							
Kwiniuk River (all yrs.)	Tower	>8,400	LB SEG	2005	No change		
Nome River (even yrs.)	Weir	>13,000	LB SEG	2005	No change		
Nome River (odd yrs.)	Weir	>3,200	LB SEG	2005	No change		
North R. (Unalakleet. R. all yrs)	Tower	>25,000	LB SEG	2005	No change		
Sockeye Salmon							
Salmon Lake	Peak aerial survey	4,000–8,000	SEG	2005	Revise	6,800–36,000	SEG
Glacial Lake	Peak aerial survey	800–1,600	SEG	2005	No change		

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Table 2.–Page 3 of 3.

Stock unit	Assessment method	Current escapement goal			Escapement goal recommendation for 2019		
		Goal	Type	Year established or last revised	Action	Goal	Type
Kotzebue Area							
Chum Salmon							
Kotzebue (all areas)	Expanded peak aerial survey	196,000–421,000	BEG	2007	Discontinue		
Noatak/Eli Rivers	Peak aerial survey	42,000–91,000	SEG	2007	Revise	43,000–121,000	SEG
Salmon River (Kobuk River)	Peak aerial survey	3,300-7,200	SEG	2007	Discontinue		
Squirrel River (Kobuk River)	Peak aerial survey	4,900–10,500	SEG	2007	Discontinue		
Tutuksuk River (Kobuk River)	Peak aerial survey	1,400–3,000	SEG	2007	Discontinue		
Upper Kobuk and Selby Rivers	Peak aerial survey	9,700–21,000	SEG	2007	Revise	12,000–32,100	SEG

Note: LB means lower bound.

Table 3.–Summary of salmon escapement goal recommendations for the Yukon Area, 2019.

		Current escapement goal			Escapement goal recommendation for 2019		
Stock unit	Assessment method	Goal	Type	Year established or last revised	Action	Goal	Type
Chinook salmon[a]							
Andreafsky River (East Fork)	Weir	2,100–4,900	SEG	2010	No change		
Andreafsky River (West Fork)	Peak aerial survey	640–1,600	SEG	2005	No change		
Nulato River (forks combined)	Peak aerial survey	940–1,900	SEG	2005	No change		
Anvik River	Peak aerial survey	1,100–1,700	SEG	2005	No change		
Chena River	Tower/Mark-recapture	2,800–5,700	BEG	2001	No change		
Salcha River	Tower/Mark-recapture	3,300–6,500	BEG	2001	No change		
Chum Salmon, Summer							
Yukon River (entire drainage)	Multiple[b]	500,000–1,200,000	BEG	2016	No change		
East Fork Andreafsky River	Weir	>40,000	LB SEG	2010	No change		
Anvik River	Sonar	350,000–700,000	BEG	2005	No change		

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Table 3.–Page 2 of 2.

Stock unit	Assessment method	Current escapement Goal			Escapement goal recommendation for 2019		
		Goal	Type	Year established or last revised	Action	Goal	Type
Chum Salmon, Fall[c]							
Yukon R Drainage[d]	Multiple[b]	300,000–600,000	SEG/ biological analysis	2010	No change		
Tanana River	Multiple[b]	61,000–136,000	BEG	2001	Discontinue		
Delta River	Foot survey	6,000–13,000	BEG	2001	Revise	7,000–20,000	SEG
Chandalar River	Sonar	74,000–152,000	BEG	2001	Revise	85,000–234,000	SEG
Coho Salmon							
Delta Clearwater River	Boat survey	5,200–17,000	SEG	2005	No change		

Note: LB means lower bound.

[a] The Canadian border king salmon escapement goal was established under the Yukon River Salmon Agreement and is reviewed annually by the Yukon River Panel. It is not included as part of this summary.

[b] Includes combination of any of the following methods: foot survey, aerial survey, weir, and sonar.

[c] The Canadian fall chum salmon mainstem border and Fishing Branch River escapement goals, established under the Yukon River Salmon Agreement and reviewed annually by the Yukon River Panel, are not included in this summary.

[d] This goal includes all Alaskan and Canadian stocks.

Table 4.–Summary of salmon escapement goal recommendations for the Kuskokwim Area, 2019.

Stock Unit	Assessment method	Current escapement goal			Escapement goal recommendation for 2019		
		Goal	Type	Year established or last revised	Action	Goal	Type
Chinook salmon – Kuskokwim R. and tributaries							
Kuskokwim River	Run reconstruction[a]	65,00–120,000	SEG/ biological analysis	2013	No change		
Aniak River	Peak aerial survey	1,200–2,300	SEG	2005	No change		
Cheeneetnuk River	Peak aerial survey	340–1,300	SEG	2005	No change		
Gagarayah River	Peak aerial survey	300–830	SEG	2005	No change		
George River	Weir	1,800–3,300	SEG	2013	No change		
Holitna River	Peak aerial survey	970–2,100	SEG	2005	Discontinue		
Kisaralik River	Peak aerial survey	400–1,200	SEG	2005	No change		
Kogrukluk River	Weir	4,800–8,800	SEG	2013	No change		
Kwethluk River	Weir	4,100–7,500	SEG	2013	No change		
Pitka Fork Salmon River	Peak aerial survey	470–1,600	SEG	2005	No change		
Salmon R. (Aniak Drainage)	Peak aerial survey	330–1,200	SEG	2005	No change		
Chinook salmon – Kuskokwim Bay							
Kanektok River	Peak aerial survey	3,900—12,000	SEG	2016	No change		
Middle Fork Goodnews R.	Weir	1,500–2,900	BEG	2005	Revise	1,500–3,600	SEG
North Fork Goodnews R.	Peak aerial survey	640–3,300	SEG	2005	No change		

Table 4.–Page 2 of 2.

Stock Unit	Assessment method	Current escapement goal			Escapement goal recommendation for 2019		
		Goal	Type	Year established or last revised	Action	Goal	Type
Chum salmon – Kuskokwim R. and tributaries							
Kogrukluk River	Weir	15,000–49,000	SEG	2005	No change		
Chum salmon – Kuskokwim Bay							
Middle Fork Goodnews River	Weir	>12,000	LB SEG	2005	No change		
Coho salmon – Kuskokwim R. and tributaries							
Kogrukluk River	Weir	13,000–28,000	SEG	2005	No change		
Kwethluk River	Weir	>19,000	LB SEG	2010	No change		
Coho salmon – Kuskokwim Bay							
Middle Fork Goodnews River	Weir	>12,000	LB SEG	2005	No change		
Sockeye salmon – Kuskokwim R. and tributaries							
Kogrukluk River	Weir	4,400–17,000	SEG	2010	No change		
Sockeye salmon – Kuskokwim Bay							
Kanektok River	Peak aerial survey	15,300–41,000	SEG	2016	No change		
North Fork Goodnews River	Peak aerial survey	9,600—18,000	SEG	2016	No change		
Middle Fork Goodnews River	Weir	18,000–40,000	BEG	2007	Revise	22,000–43,000	SEG

Note: LB means lower bound.

[a] Run reconstruction is conducted postseason and uses a model to estimate total return from harvest and escapement monitoring projects.

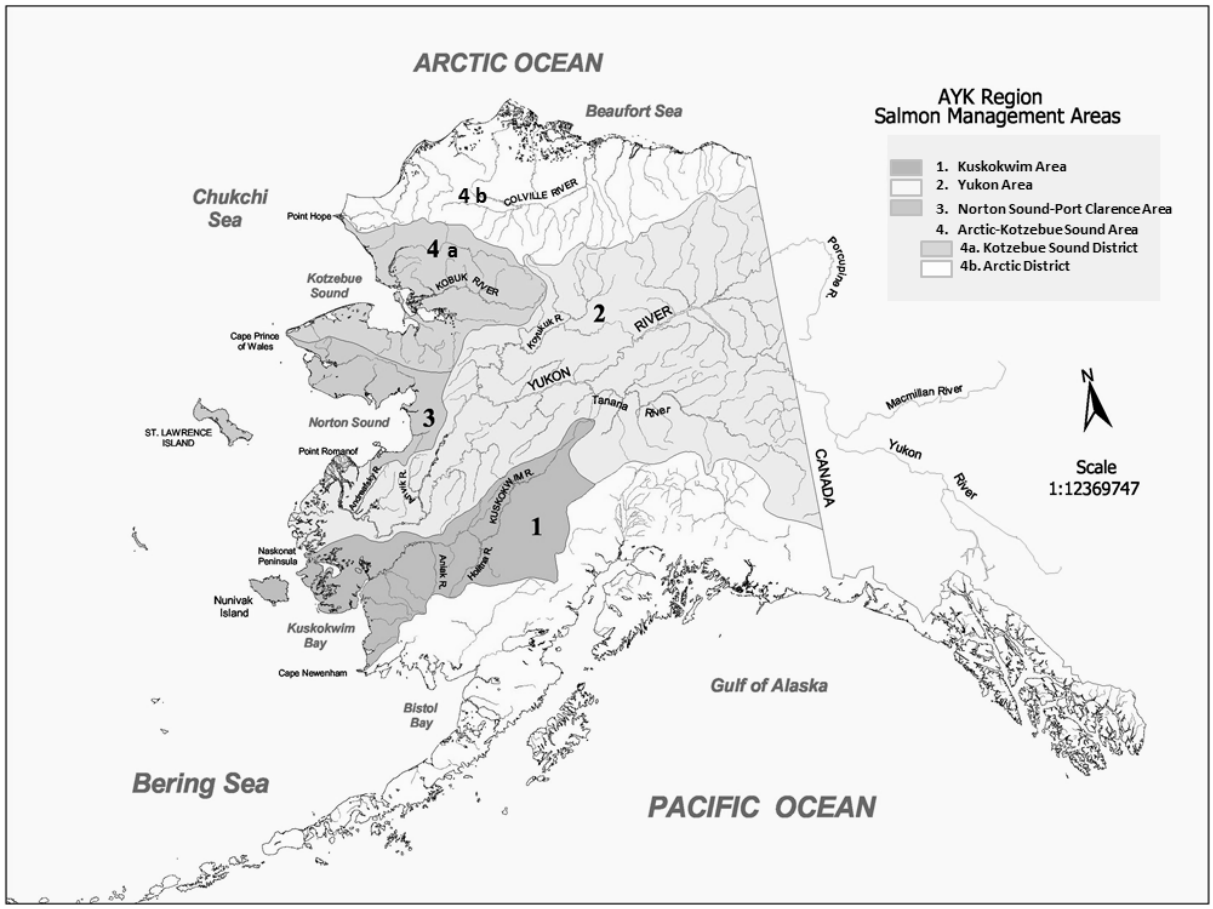

Figure 1.–Arctic-Yukon-Kuskokwim Region salmon management areas for the Division of Commercial Fisheries, ADF&G.

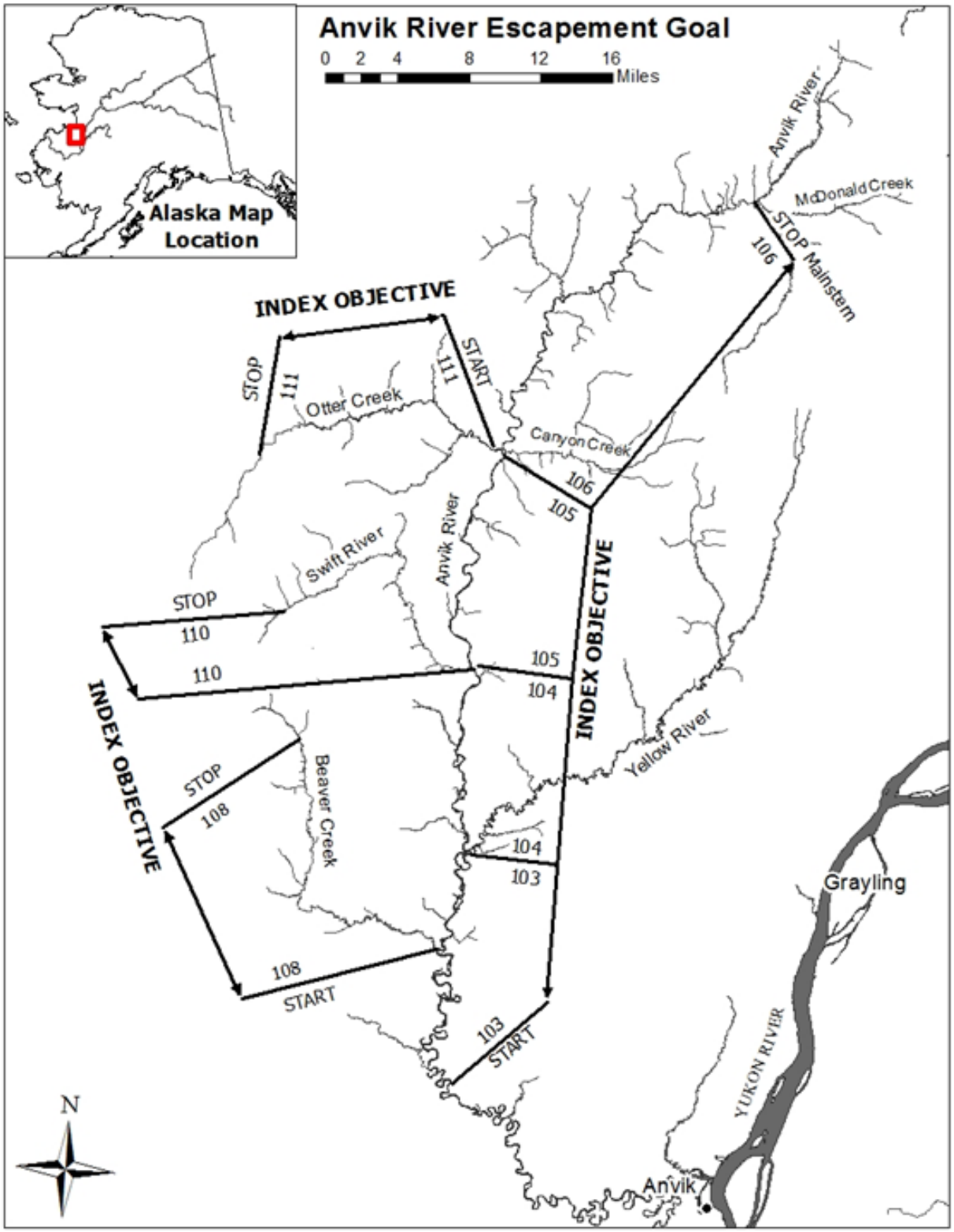

Figure 2.–Location of standardized index reaches used to evaluate the Anvik River Chinook salmon peak aerial survey sustainable escapement goal.

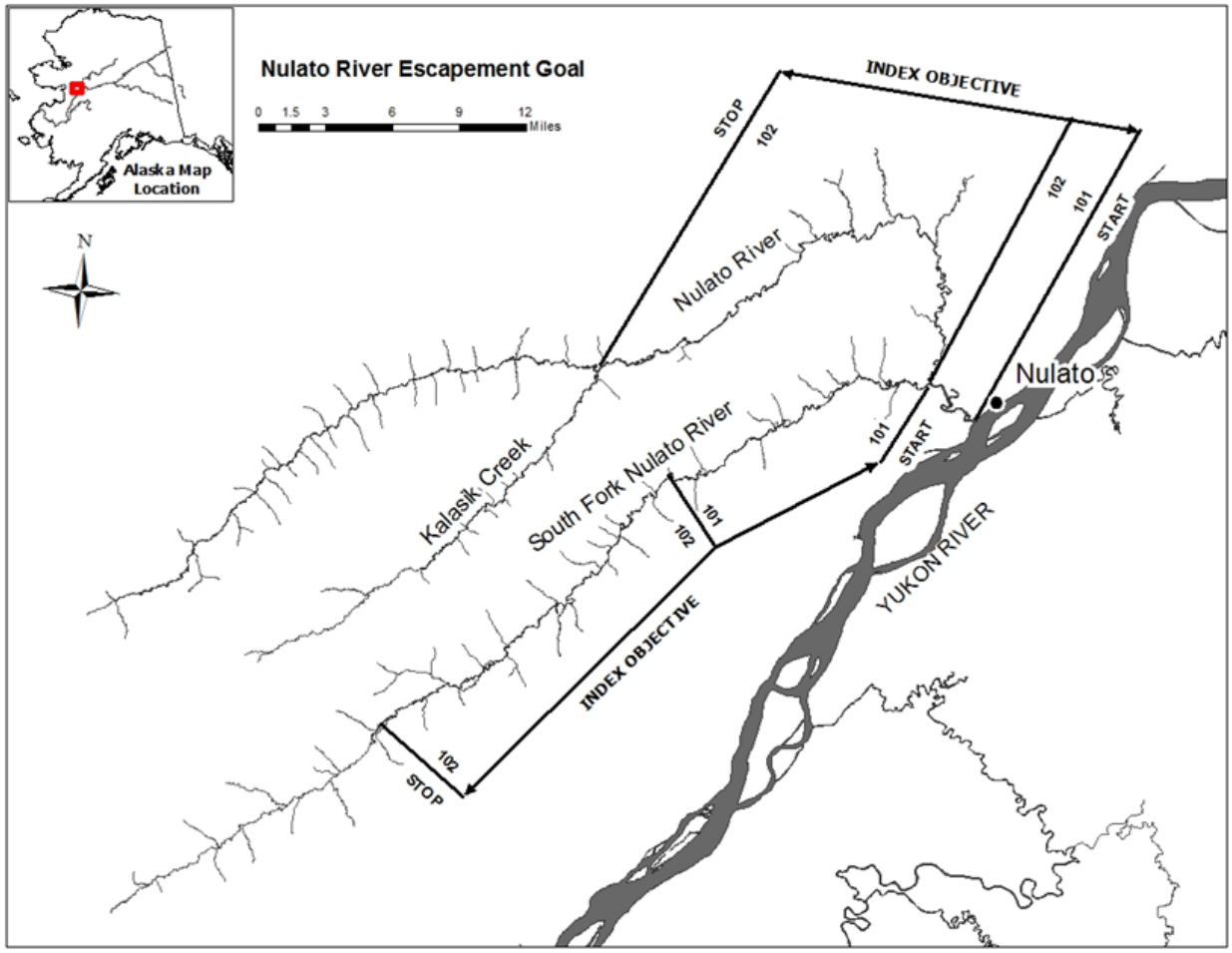

Figure 3.–Location of standardized index reaches used to evaluate the Nulato River Chinook salmon peak aerial survey sustainable escapement goal.

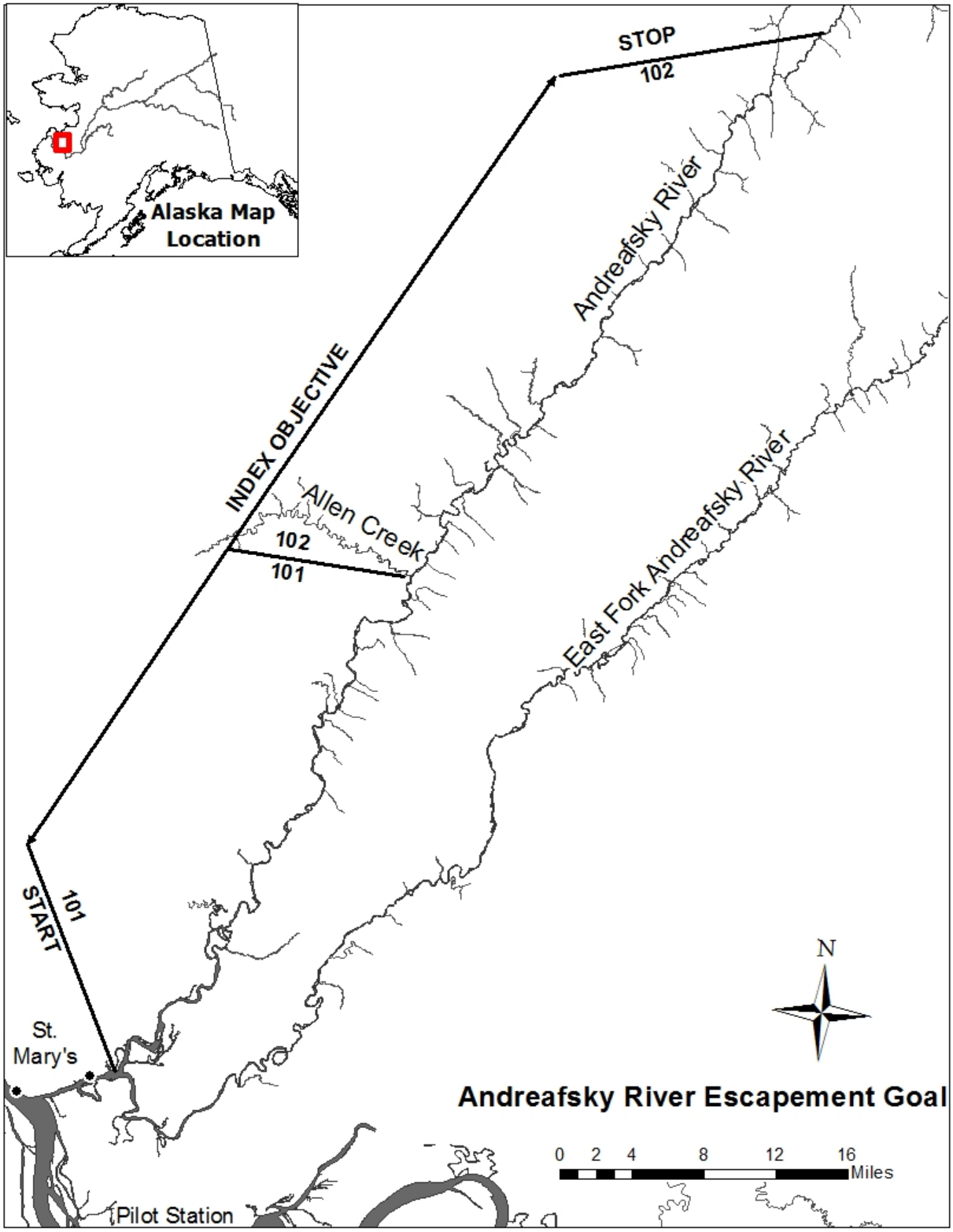

Figure 4.–Location of standardized index reaches used to evaluate the West Fork Andreafsky River Chinook salmon peak aerial survey sustainable escapement goal.

APPENDIX A: ESCAPEMENT DATA AND ESCAPEMENT GOAL REVISION SUMMARIES

Appendix A1.–Eldorado River chum salmon escapement data and summary of the recommended escapement goal revision.

Year	Weir passage	Harvest [a]	Escapement	
1995	39,868	-	39,868	
1996	12,655	-	12,655	
1997	14,302	-	14,302	
1998	13,808	-	13,808	
1999	4,218	-	4,218	
2000	11,617	-	11,617	
2001	11,635	-	11,635	
2002	10,215	-	10,215	
2003	3,591	-	3,591	
2004	3,277	41	3,236	
2005	10,369	0	10,369	
2006	42,105	159	41,946	
2007	21,312	246	21,066	
2008	6,746	124	6,622	[b]
2009	4,943	197	4,746	
2010	21,211	424	20,787	[b]
2011	16,273	115	16,158	
2012	13,348	296	13,052	[b]
2013	26,131	0	26,131	
2014	27,054	16	27,038	[b]
2015	25,560	11	25,549	[b]
2016	18,938	0	18,938	[b]
2017	73,882	0	73,882	[b]

Summary of goal revision	
Years	16
Min.	3,236
Max.	41,946
Contrast [c]	12.96
Assessment	Weir
Data uncertainty	Low
Harvest rate	Low / Moderate
Tier [d]	2
15^{th} - percentile	4,350
65^{th} - percentile	14,179
Goal range	4,400-14,200
Goal type	SEG

Note: Dash indicates data not available.

[a] Harvest upriver from weir.

[b] Data not included in escapement goal analysis because weir operations were stopped prior to the end of the chum salmon run. Adequacy of the project operational period for indexing annual escapement was based on an informal 1% rule (i.e., escapement for each of the last 3 days of weir operations was less than 1% of the cumulative escapement). Years 2008, 2010, 2012, 2014–2017 did not meet the 1% rule and were not used to calculate the percentile range upon which the recommended escapement goal was based.

[c] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[d] Recommended percentile ranges as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate).

Appendix A2.–Nome River chum salmon escapement data and summary of the recommended escapement goal revision.

Year	Weir passage	Harvest [a]	Escapement	
1993	1,859	-	1,859	
1994	2,969	-	2,969	
1995	5,093	-	5,093	
1996	3,339	-	3,339	[b]
1997	5,147	-	5,147	
1998	1,930	-	1,930	
1999	1,048	-	1,048	
2000	4,056	-	4,056	
2001	2,859	-	2,859	
2002	1,720	-	1,720	
2003	1,957	-	1,957	
2004	3,903	1	3,902	
2005	5,584	2	5,582	
2006	5,677	3	5,674	
2007	7,034	72	6,962	
2008	2,607	0	2,607	
2009	1,565	0	1,565	
2010	5,877	1	5,876	
2011	3,578	2	3,576	
2012	2,028	2	2,026	[b]
2013	4,811	4	4,807	
2014	5,589	0	5,589	
2015	6,111	11	6,100	
2016	7,093	8	7,085	
2017	8,324	3	8,321	

Summary of goal revision	
Years	23
Min.	1,048
Max.	8,321
Contrast [c]	7.94
Assessment	Weir
Data uncertainty	Low
Harvest rate	Low
Tier [d]	3
5^{th} - percentile	1,581
65^{th} - percentile	5,278
Goal range	1,600-5,300
Goal type	SEG

Note: Dash indicates data not available.

[a] Harvest upriver from weir.

[b] Data not included in escapement goal analysis because weir operations were stopped prior to the end of the chum salmon run. Adequacy of the project operational period for indexing annual escapement was based on an informal 1% rule (i.e., escapement for each of the last 3 days of weir operations was less than 1% of the cumulative escapement). Years 1996 and 2012 did not meet the 1% rule and were not used to calculate the percentile range upon which the recommended escapement goal was based.

[c] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[d] Recommended percentile range as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate).

Appendix A3.–Snake River chum salmon escapement data and summary of the recommended escapement goal revision.

Year	Weir passage	Harvest [a]	Escapement
1995	4,395	-	4,395
1996	2,772	-	2,772
1997	6,184	-	6,184
1998	11,067	-	11,067
1999	484	-	484
2000	1,911	-	1,911
2001	2,182	-	2,182
2002	2,776	-	2,776
2003	2,201	-	2,201
2004	2,146	1	2,145
2005	2,967	0	2,967
2006	4,160	15	4,145
2007	8,147	2	8,145
2008	1,244	0	1,244
2009	891	0	891
2010	6,973	0	6,973
2011	4,352	0	4,352
2012 [b]			
2013	2,755	0	2,755
2014	3,983	1	3,982
2015	4,241	0	4,241
2016	3,666	15	3,651
2017	4,759	0	4,759

Summary of goal revision	
Years	22
Min.	484
Max.	11,067
Contrast [c]	22.87
Assessment	Weir
Data uncertainty	Low
Harvest rate	Low / Moderate
Tier [d]	2
15^{th} - percentile	1,946
65^{th} - percentile	4,207
Goal range	2,000-4,200
Goal type	SEG

Note: Dash indicates data not available. All escapement data except 2012 was determined to be a reliable account of total escapement based on an informal 1% rule (i.e., escapement for each of the last 3 days of weir operations was less than 1% of the cumulative escapement).

[a] Harvest upriver from weir.

[b] Partial escapement data was available but not included in escapement goal analysis because weir operations ended mid-season due to high water that caused the weir to wash out.

[c] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[d] Recommended percentile range as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate).

Appendix A4.–Noatak River chum salmon escapement data and summary of the recommended escapement goal revision.

Year	Noatak R. Count	Eli R. Count	Kelly R. Count	Total Escapement
1963 [a]	1,970	-	600	
1964 [a]	89,798	-		
1965 [a]	6,152	-	3,155	
1966 [a]	101,640	-	570	
1967 [a]	29,120	-	225	
1968 [a]	39,394	-	375	
1969 [a]	27,825	-	150	
1970 [a]	138,145	-		
1971 [a]	41,056	-		
1972 [a]	64,315	[c]		
1973 [a]	32,144	-	2,590	
1974	129,640	[c]	1,381	131,021
1975 [a]	96,509	-	3,937	
1976 [a]	44,574	[c]	217	
1977 [a]	11,221	[c]	290	
1978 [a]	37,817	[c]	168	
1979 [a]	19,655	[c]	3,200	
1980	164,474	[c]	7,416	171,890
1981	116,352	[c]	13,770	130,122
1982 [a]	20,682	[c]	11,604	
1983 [a]	79,773	[c]	12,137	
1984	67,873	[c]	3,499	71,372
1985	43,529	[c]	1,200	44,729
1986	37,227	[c]	839	38,066
1987 [a]	5,515	[c]	950	
1988 [a]	45,930	[c]	1,460	
1989 [b]				
1990 [a]	23,685		330	
1991	82,750	[c]	654	83,404
1992	34,335	[c]	726	35,061
1993 [a]	30,210	4,795	9	
1994 [b]				
1995 [a]	167,303		8,384	
1996	336,940	[c]	1,644	338,584
1997 [a]				
1998 [a]	350	2,760	2,631	
1999 [a]	59,225	24,860	3,419	
2000 [b]				

Summary of goal revision	
Years	14
Min.	35,061
Max.	490,814
Contrast [d]	14.00
Assessment	Peak air survey
Data uncertainty	High
Harvest rate	Moderate / High
Tier [e]	1
20th - percentile	42,964
60th - percentile	120,778
Goal range	43,000-121,000
Goal type	SEG

-continued-

Year	Noatak R. Count	Eli R. Count	Kelly R. Count	Total Escapement	Summary of goal revision
2001 [b]					
2002 [a]	700		1,116		
2003	34,575	4,176	1,566	40,317	
2004	49,541	2,917	2,987	55,445	
2005 [b]					
2006 [a]	38,500	1,285			
2007 [b]					
2008	257,695	13,052	1,865	272,612	
2009	67,265	2,607	3,986	73,858	
2010 [b]					
2011 [b]					
2012 [b]					
2013 [b]					
2014	421,110	32,174	37,530	490,814	
2015 [b]					
2016 [b]					
2017 [b]					

Note: Total escapement was the sum of the aerial survey counts for the Noatak, Eli, and Kelly rivers and was determined to be a reliable index of annual escapement if the following 3 criteria were true: 1) escapement data was available for each tributary; 2) survey rating was "good" or "fair", 3) the timing of each survey was similar (i.e., within the same week).

[a] Data was not used in the calculation of the percentile range which formed the basis of the escapement goal recommendation for at least 1 of the following reasons: 1) escapement data was not available for 1 or more tributary; 2) 1 or more of the tributary surveys were rated "poor"; or 3) individual tributary surveys dates were separated by 7 or more days.

[b] Surveys were not flown.

[c] Eli River count was included in the aerial survey count of the Noatak River.

[d] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[e] Recommended percentile range as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate). Harvest rate consideration was ignored for this analysis and standard 1–3 Tier recommendations were used.

Appendix A5.–Upper Kobuk/Selby River chum salmon escapement data and summary of the recommended escapement goal revision.

Year	Upper Kobuk R. Count	Selby R. Count	Total Escapement
1963 [a]	4,535		
1964 [a]	7,985		
1965 [a]	2,750		
1966 [a]	1,474		
1967 [a]	2,495		
1968 [a]	2,370		
1969 [a]	7,500		
1970 [a]	13,908		
1971 [a]	17,202		
1972 [a]	18,155		
1973 [a]	2,470		
1974	28,120	3,608	31,728
1975 [a]	10,702		
1976 [a]	2,522		
1977 [b]			
1978 [a]	1,981		
1979 [a]	2,008		
1980 [a]	11,472		
1981 [a]	8,648		
1982 [a]	14,674		
1983 [a]	33,746		
1984	10,621	3,802	14,423
1985 [a]	6,278		
1986 [a]	6,015		
1987 [a]	8,210		
1988	11,895	1,355	13,250
1989 [b]			
1990	14,935	420	15,355
1991	23,065	620	23,685
1992 [a]	10,935	750	
1993	11,334	824	12,158
1994 [b]			
1995	32,361	3,364	35,725
1996	74,770	3,725	78,495
1997 [a]	7,660	853	
1998 [a]	906		
1999	27,340	770	28,110
2000 [b]			

Summary of goal revision	
Years	15
Min.	11,602
Max.	78,495
Contrast [c]	6.77
Assessment	Peak air survey
Data uncertainty	High
Harvest rate	Moderate / High
Tier [d]	3
5^{th} - percentile	11,991
65^{th} - percentile	32,128
Goal range	12,000-32,100
Goal type	SEG

-continued-

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Year	Upper Kobuk R. Count	Selby R. Count	Total Escapement	Summary of goal revision
2001	11,640	1,780	13,420	
2002 [a]	3,572			
2003	11,175	427	11,602	
2004	26,018	3,760	29,778	
2005 [b]				
2006 [a]	48,250	500		
2007 [b]				
2008	41,597	1,025	42,622	
2009	44,947	208	45,155	
2010 [b]				
2011 [b]				
2012 [b]				
2013 [b]				
2014	63,540	2,113	65,653	
2015 [b]				
2016 [b]				
2017 [b]				

Note: Total escapement was the sum of the aerial survey counts for the Upper Kobuk River including the Selby River and was determined to be a reliable index of annual escapement if the following 3 criteria were true: 1) escapement data was available for both tributaries; 2) survey rating was "good" or "fair", 3) the timing of each survey occurred between 16 August and 16 September (inclusive) as defined by Fair, L., C. Lean, J. Magdanz, and R. McLean, Proposed Salmon BEG's for Norton Sound and Kotzebue Sound. Alaska Department of Fish and Game, Memorandum, March 24, 1999.

[a] Data was not used in the calculation of the percentile range which formed the basis of the escapement goal recommendation for at least 1 of the following reasons: 1) escapement data was not available for 1 of 2 tributaries; 2) 1 or both of the tributary surveys were rated "poor"; or 3) tributary surveys were not flown within the required date range.

[b] Surveys were not flown.

[c] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[d] Recommended percentile range as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate). Harvest rate consideration was ignored for this analysis and standard 1–3 Tier recommendations were used.

Appendix A6.–Kwiniuk River chum salmon escapement data and summary of the recommended escapement goal revision.

Year	Tower passage	Harvest [a]	Escapement	
1981	34,565	-	34,565	
1982	44,099	-	44,099	
1983	56,907	-	56,907	
1984	54,043	-	54,043	
1985	9,013	-	9,013	
1986	24,700	-	24,700	[b]
1987	16,133	-	16,133	[b]
1988	13,303	-	13,303	
1989	14,529	-	14,529	
1990	13,957	-	13,957	[b]
1991	19,801	-	19,801	[b]
1992	12,077	-	12,077	
1993	15,824	-	15,824	
1994	33,012	-	33,012	
1995	42,500	-	42,500	
1996	28,493	-	28,493	
1997	20,119	-	20,119	
1998	24,247	-	24,247	
1999	8,763	-	8,763	[b]
2000	12,879	-	12,879	
2001	16,598	-	16,598	
2002	37,995	-	37,995	
2003	12,123	-	12,123	
2004	10,362	247	10,115	
2005	12,083	52	12,031	
2006	39,519	31	39,488	
2007	27,756	16	27,740	
2008	9,483	291	9,192	
2009	8,739	53	8,686	
2010	71,403	211	71,192	
2011	32,239	81	32,158	
2012	5,577	40	5,537	
2013	5,625	0	5,625	
2014	39,759	162	39,597	
2015	37,812	149	37,663	
2016	8,526	3	8,523	
2017	32,553	12	32,541	

Summary of goal revision	
Years	32
Min.	5,537
Max.	71,192
Contrast [c]	12.86
Assessment	Tower
Data uncertainty	Low
Harvest rate	Low
Tier [d]	2
15th - percentile	9,130
65th - percentile	32,612
Goal range	9,100-32,600
Goal type	SEG

-continued-

Note: Dash indicates data not available.

[a] Harvest upriver from weir.

[b] Data not included in escapement goal analysis because weir operations were stopped prior to the end of the chum salmon run. Adequacy of the project operational period for indexing annual escapement was based on an informal 1% rule (i.e., escapement for each of the last 3 days of weir operations was less than 1% of the cumulative escapement). Years 1986, 1987, 1990, 1991, and 1999 did not meet the 1% rule and were not used to calculate the percentile range upon which the recommended escapement goal was based.

[c] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[d] Recommended percentile range as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate).

Appendix A7.–Tubutulik River chum salmon escapement data and summary of the recommended escapement goal revision.

Year	Escapement count		Year	Escapement count	
1963	16,069		1993	8,740	
1964	15,469		1994		[a]
1965		[a]	1995	16,518	
1966	5,514		1996	10,790	
1967		[a]	1997	3,105	
1968		[a]	1998	10,180	
1969	12,040		1999		[a]
1970	53,290		2000		[a]
1971	16,820		2001	863	[b]
1972	8,070	[b]	2002		[a]
1973	5,383		2003	1,352	
1974	9,560		2004	200	
1975	17,141		2005	1,336	
1976	101		2006		[a]
1977	8,540		2007	7,045	
1978	5,865		2008		[a]
1979	812		2009	3,161	
1980	10,000		2010	16,097	
1981	2,105	[b]	2011	14,127	
1982	2,044		2012		[a]
1983	16,345		2013	4,532	[b]
1984	56,210		2014		[a]
1985	13,645		2015	9,835	
1986	5,975		2016		[a]
1987	9,605		2017		[a]
1988	4,662				
1989		[a]			
1990	4,350				
1991	7,085				
1992	2,595				

Summary of goal revision	
Years	37
Min.	101
Max.	56,210
Contrast [c]	556.53
Assessment	Peak air survey
Data uncertainty	High
Harvest rate	Low / Moderate
Tier [d]	1
20^{th} - percentile	3,116
60^{th} - percentile	9,934
Goal range	3,100-9,900
Goal type	SEG

[a] Surveys were not flown.

[b] Data was not used in the calculation of the percentile range which formed the basis of the escapement goal recommendation because the aerial survey was rated "poor".

[c] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[d] Recommended percentile range as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate).

Appendix A8.–Salmon Lake/Grand Central River sockeye salmon escapement data and summary of the recommended escapement goal revision.

Year	Weir passage	Harvest [a]	Escapement	
2003	42,729	-	42,729	
2004	85,417	1,413	84,004	
2005	55,951	1,110	54,841	
2006	52,323	1,435	50,888	
2007	43,432	2,078	41,354	
2008	20,452	1,094	19,358	
2009	953	6	947	
2010	1,654	25	1,629	
2011	8,449	45	8,404	
2012	7,090	67	7,023	
2013	12,428	807	11,621	
2014	9,719	541	9,178	
2015	36,052	4,425	31,627	
2016	15,066	2,872	12,194	
2017	55,764	1,934	53,830	[b]

Summary of goal revision	
Years	14
Min.	947
Max.	84,004
Contrast [c]	88.71
Assessment	Weir
Data uncertainty	Low
Harvest rate	Low / Moderate
Tier [d]	2
15^{th} - percentile	6,753
65^{th} - percentile	36,004
Goal range	6,800-36,000
Goal type	SEG

Note: "–" data not available.

[a] Harvest upriver from weir.

[b] Data not used in calculation of percentile range which formed the basis of the escapement goal recommendation because harvest data were not available at the time of review. Data are included in this table for completeness.

[c] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[d] Recommended percentile range as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate).

Appendix A9.–Delta River fall chum salmon escapement data and summary of the recommended escapement goal revision.

Year	Survey count	Year	Survey count
1974	5,915	1996	19,758
1975	3,734	1997	7,705
1976	6,312	1998	7,804
1977	16,876	1999	16,534
1978	11,136	2000	3,001
1979	8,355	2001	8,103
1980	5,137	2002	11,992
1981	23,508	2003	22,582
1982	4,235	2004	25,073
1983	7,705	2005	28,132
1984	12,411	2006	14,055
1985	17,276	2007	18,610
1986	6,703	2008	23,055
1987	21,180	2009	13,492
1988	18,024	2010	17,993
1989	21,342	2011	23,639
1990	8,992	2012	9,377
1991	32,905	2013	31,955
1992	8,893	2014	32,480
1993	19,857	2015	33,401
1994	23,777	2016	21,913
1995	20,587	2017	48,793

Summary of goal revision	
Years	44
Min.	3,001
Max.	48,793
Contrast [a]	16.26
Assessment	Replicate foot survey
Data uncertainty	Low
Harvest rate	Low / Moderate
Tier [b]	2
15^{th} - percentile	7,154
65^{th} - percentile	20,551
Goal range	7,000-20,000
Goal type	SEG

[a] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[b] Recommended percentile range as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate). Tier 2 was selected because replicate foot survey methods have low data uncertainty.

Appendix A10.–Chandalar River fall chum salmon escapement data and summary of the recommended escapement goal revision.

Year	Sonar estimate [a]
1995	323,586
1996	230,450
1997	211,914
1998	83,899
1999	92,685
2000	71,048
2001	112,664
2002	94,472
2003	221,343
2004	169,848
2005	526,838
2006	254,778
2007	243,805
2008	178,278
2009	150,000
2010	167,532
2011	298,223
2012	205,791
2013	252,710
2014	221,421
2015	164,486
2016	295,023
2017	509,115

Summary of goal revision	
Years	23
Min.	71,048
Max.	526,838
Contrast [b]	7.42
Assessment	Sonar
Data uncertainty	Low
Harvest rate	Low / Moderate
Tier [c]	3
5^{th} - percentile	84,778
65^{th} - percentile	234,457
Goal range	85,000-234,000
Goal type	SEG

[a] Published sonar estimates were expanded to account for fall chum salmon that passed after annual sonar operations ended. Annual expansions ranged from 2–20% across all years.

[b] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[c] Recommended percentile range as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate).

Appendix A11.–Middle Fork Goodnews River Chinook salmon escapement data and summary of the recommended escapement goal revision.

Year	Weir passage	
1991	2,080	
1992	1,445	
1993	2,132	
1994	3,061	
1995	4,678	
1996		[a]
1997	2,897	
1998	3,553	
1999	3,703	
2000	2,670	
2001	5,351	
2002	3,025	
2003	2,248	
2004	4,438	
2005	4,781	
2006	4,572	
2007	3,914	
2008	2,223	
2009	1,669	
2010	2,176	
2011	2,045	
2012	524	
2013	1,187	
2014	750	
2015	1,494	
2016	3,767	
2017	6,881	

Summary of goal revision	
Years	26
Min.	524
Max.	6,881
Contrast [b]	13.13
Assessment	Weir
Data uncertainty	Low
Harvest rate	Low / Moderate
Tier [c]	2
15^{th} - percentile	1,482
65^{th} - percentile	3,591
Goal range	1,500-3,600
Goal type	SEG

[a] Partial escapement data was available but not used to calculate the percentile range upon which the escapement goal recommendation was based, because more than 40% of the run was missed due to weir operational challenges.

[b] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[c] Recommended percentile range as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate).

Appendix A12.–Middle Fork Goodnews River sockeye salmon escapement data and summary of the recommended escapement goal revision.

Year	Weir passage	
1991	41,656	
1992		[a]
1993	24,957	
1994	56,503	
1995	37,776	
1996		[a]
1997	34,322	
1998	38,493	
1999	49,321	
2000	40,828	
2001	21,194	
2002	21,329	
2003	37,933	
2004	54,035	
2005	118,969	
2006	127,245	
2007	73,768	
2008	43,879	
2009	27,494	
2010	36,574	
2011	19,643	
2012	29,531	
2013	23,545	
2014	41,473	
2015	57,809	
2016	170,574	[b]
2017	179,897	[b]

Summary of goal revision	
Years	23
Min.	19,643
Max.	127,245
Contrast [c]	6.48
Assessment	Weir
Data uncertainty	Low
Harvest rate	Low / Moderate
Tier [d]	3
5^{th} - percentile	21,208
65^{th} - percentile	42,323
Goal range	22,000-43,00
Goal type	SEG

[a] Partial escapement data was available but not used to calculate the percentile range upon which the escapement goal recommendation was based, because more than 40% of the run was missed due to weir operational challenges.

[b] Record high escapements observed in 2016 and 2017 were not used to calculate the percentile range upon which the escapement goal recommendation was based because return data were not available.

[c] Contrast is equal to the maximum escapement divided by the minimum escapement. Contrast values greater than 8 were defined as high while contrast values of 8 or less were defined as low (Clark et al. 2014).

[d] Recommended percentile range as defined by Clark et al. 2014, based on data contrast and measurement error with the consideration that harvest rate is less than 0.4 (i.e., low/moderate).

APPENDIX B: STANDARDIZED AERIAL SURVEY INDEX AREAS FOR YUKON RIVER CHINOOK SALMON ESCAPEMENT GOALS

Appendix B1.–Standardized aerial survey index areas for Yukon River Chinook salmon escapement goals.

Drainage	Stream	Index reach	Description	Latitude	Longitude	SEG [a]	% Contribution [b]
Anvik River		101	Mouth to Goblet Creek	62.679840	-160.205600	0	0.3%
		102	Goblet Creek to sonar site	62.714280	-160.569920	0	0.5%
		103	Sonar site to Yellow River	62.736805	-160.679788	1	12.0%
		104	Yellow River to Swift River	62.921803	-160.684043	1	36.5%
		105	Swift River to Otter Creek	63.071431	-160.716139	1	17.0%
		106	Otter Creek to McDonald Creek	63.243064	-160.694597	1	19.9%
		107	McDonald Creek to headwaters	63.464272	-160.290725	0	0.1%
		STOP	Upper reach	63.548560	-160.192753		
	Beaver Creek	108	Beaver Creek	62.842600	-160.722171	1	5.8%
	Beaver Creek	STOP	Upper reach	63.001184	-161.008667		
	Yellow River	109	Yellow River	62.921737	-160.683564	0	2.0%
	Yellow River	STOP	Upper reach	63.097441	-160.268548		
	Swift River	110	Swift River	63.071247	-160.717259	1	1.6%
	Swift River	STOP	Upper reach	63.096464	-161.688500		
	Otter Creek	111	Otter Creek	63.242938	-160.695576	1	3.6%
	Otter Creek	STOP	Upper reach	63.219032	-161.128174		
	Canyon Creek	112	Canyon Creek	63.244379	-160.693367	0	0.4%
	Canyon Creek	STOP	Upper reach	63.261670	-160.414889		
	McDonald Creek	113	McDonald Creek	63.464272	-160.290725	0	0.3%
	McDonald Creek	STOP	Upper reach	63.472261	-160.097793		
Andreafsky River		101	East Fork Andreafsky River to Allen Creek	62.056654	-163.115037	1	78.0%
		102	Allen Creek to headwaters	62.483890	-162.738730	1	22.0%
		STOP	Upper reach	62.958715	-162.124571		

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Drainage	Stream	Index reach	Description	Latitude	Longitude	SEG [a]	% Contribution [b]
Nulato River		101	Mouth to South Fork	64.706590	-158.141630	1	4.9%
	North Fork	102	Conflence with South Fork to Kalasik Creek	64.729505	-158.209230	1	58.4%
	North Fork	103	Kalasik Creek to headwaters	64.724864	-158.707717	0	0.2%
	North Fork	STOP	Upper reach	64.556611	-159.376212		
	South Fork	101	Mouth to	64.729505	-158.209230	1	26.0%
	South Fork	102	Drill Hole to line separating Range 1/2 West	64.659259	-158.592522	1	10.6%
	South Fork	103	Township to headwaters	64.484689	-158.996731	0	0.0%
	South Fork	STOP	Upper reach	64.376355	-159.302657		

[a] Sections designated with a "1" are required index reaches. The cumulative sum of live and dead Chinook salmon observed within required index reaches should be used to evaluate existing aerial survey escapement goals.

[b] Average historical percent contribution of observed Chinook salmon by index reach to the total number of Chinook salmon observed throughout the entire aerial survey. On average, the standardized index reaches represent 96.4%, 100%, and 99.9% of the total observed escapement to the Anvik, Andreafsky, and Nulato rivers respectively.