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A Review of Escapement Goals for Salmon Stocks in Lower Cook Inlet Alaska, 2023

by

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November 2023

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

The Alaska Department of Fish and Game (ADF&G) interdivisional escapement goal review committee (committee) reviewed 41 escapement goals for Pacific salmon *Oncorhynchus* spp. stocks in Lower Cook Inlet (LCI). Escapement goals were reviewed based on the Policy for the Management of Sustainable Salmon Fisheries (5 AAC 39.222) and the Policy for Statewide Salmon Escapement Goals (5 AAC 39.223) adopted by the Alaska Board of Fisheries into regulation in 2001. All of the existing goals were adopted in 2017, except for 1 chum salmon *O. keta* stock (McNeil River, adopted 2007) and 2 sockeye salmon *O. nerka* stocks (Bear and English Bay Lakes, adopted 2001). Except for 2 Chinook salmon *O. tshawytscha* stocks (Anchor and Ninilchik Rivers) and 4 sockeye salmon stocks (English Bay, Bear, Mikfik, and Chenik Lakes), salmon escapements in LCI are primarily monitored by single or multiple aerial and/or foot surveys of appropriate stream reaches. The resulting escapement indices do not provide absolute abundance estimates suitable for estimating biological escapement goals (BEG). Consequently, all LCI goals are sustainable escapement goals (SEG). There are no escapement goals for coho salmon *O. kisutch* in LCI. To improve management flexibility and consistency between management areas in Alaska, the committee supported LCI transitioning from stock-specific SEGs for pink (*O. gorbuscha*, 18 stocks) and chum (12 stocks) salmon to aggregate escapement goals for each of the 3 LCI districts with commercial fisheries targeting these species (Southern, Outer, and Kamishak). ADF&G will continue managing LCI Chinook (3 stocks) and sockeye (8 stocks) salmon using stock-specific SEGs, with 2 Chinook (Anchor and Ninilchik Rivers) and 2 sockeye salmon (Bear and English Bay Lakes) goals changing during this review period.

Keywords Lower Cook Inlet, sustainable escapement goals, Chinook salmon, *Oncorhynchus tshawytscha*, chum salmon, *O. keta*, pink salmon, *O. gorbuscha*, sockeye salmon, *O. nerka*, coho salmon, *O. kisutch*, escapement, Southern District, Outer District, Eastern District, Kamishak District, Alaska Board of Fisheries, BOF

INTRODUCTION

This report is a summary of escapement goal analyses recently conducted for the major Pacific salmon *Oncorhynchus* spp. stocks of the Lower Cook Inlet (LCI) management area (Figure 1). The Alaska Department of Fish and Game (ADF&G, or the deparment) reviews escapement goals for LCI salmon stocks on a schedule that corresponds to the Alaska Board of Fisheries (BOF) 3-year cycle for considering area regulatory proposals. In this report, we describe LCI salmon escapement goals that were reviewed in 2022/2023 and present information from the past 3 years in the context of these goals. A brief summary of LCI stock assessment and management methods is also provided, along with an analysis of the methods used to review and recommend new sustainable escapement goals (SEGs) for LCI salmon stocks during this BOF cycle.

Following adoption of ADF&G's Salmon Escapement Goal Policy in 1992, Fried (1994) documented all existing escapement goals for LCI. Under this policy, escapement goals were categorized as biological escapement goals (BEG), optimal escapement goals, or inriver goals. At that time, there were 56 BEGs in LCI, including 3 Chinook *Oncorhynchus tshawytscha*, 13 chum *O. keta*, 31 pink *O. gorbuscha*, and 9 sockeye salmon *O. nerka*.

Since 2001, escapement goals have been reviewed based on the Policy for the Management of Sustainable Salmon Fisheries (SSFP; 5 AAC 39.222) and the Policy for Statewide Salmon Escapement Goals (EGP; 5 AAC 39.223). The BOF adopted these policies into regulation during the winter of 2000–2001 to ensure that the state's salmon stocks were conserved, managed, and developed using the sustained yield principle. The EGP states that it is ADF&G's responsibility to document existing salmon escapement goals for all salmon stocks that are currently managed for an escapement goal and to review existing, or propose new, escapement goals on a schedule that conforms to the BOF's regular cycle of consideration of area regulatory proposals. For this review, there are 2 important terms defined in the SSFP:

1. 5 AAC 39.222(f)(3) “biological escapement goal” or “(BEG)” means the escapement that provides the greatest potential for maximum sustained yield; BEG will be the primary management objective for the escapement unless an optimal escapement or inriver run goal has been adopted; BEG will be developed from the best available biological information, and should be scientifically defensible on the basis of available biological information; BEG will be determined by the department and will be expressed as a range based on factors such as salmon stock productivity and data uncertainty; the department will seek to maintain evenly distributed salmon escapements within the bounds of a BEG; and
2. 5 AAC 39.222(f)(36) “sustainable escapement goal” or “(SEG)” means a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated or managed for; the SEG is the primary management objective for the escapement, unless an optimal escapement or inriver run goal has been adopted by the BOF; the SEG will be developed from the best available biological information; and should be scientifically defensible on the basis of that information; the SEG will be determined by the department and will take into account data uncertainty and be stated as either an “SEG range” or “lower bound SEG”; the department will seek to maintain escapements within the bounds of the SEG range or above the level of a lower bound SEG.

The management objective for LCI is to achieve spawning escapement goals for major stocks while allowing for an orderly harvest of all fish surplus to spawning requirements (Hollowell et al. 2023). To the extent possible, LCI management has focused on terminal fishing areas associated with individual streams. Consequently, escapement goals were initially developed for all 56 stocks that historically received fishing pressure (Fried 1994). In 2001, following adoption of the SSFP and the EGP, there were 47 LCI stocks with escapement goals (3 Chinook, 12 chum, 24 pink, and 8 sockeye salmon), and each of these goals was reviewed under the newly adopted BOF policies, resulting in 47 new SEGs (Otis 2001). Area review of LCI escapement goals has subsequently occurred every 3 years, with the results documented in a series of reports to the BOF (Otis and Hasbrouck 2004; Otis and Szarzi 2007; Otis et al. 2010; Otis et al. 2013; Otis et al. 2016a). The 2019 escapement goal review did not result in any changes, so a report was not produced.

During the 2022/2023 review, escapement goals for the following 41 stocks were reviewed:

- Chinook salmon: Deep Creek, and Anchor and Ninilchik Rivers.
- Chum salmon: Iniskin Bay; Ursus Cove; Cottonwood, Island, and Port Dick Creeks; Dogfish Lagoon; and Port Graham, Rocky, Big Kamishak, Little Kamishak, McNeil, and Bruin Rivers.
- Pink salmon: Port Chatham; Humpy, China Poot, Tutka, Barabara, Windy (right), Windy (left), Port Dick, Island, S. Nuka Island, Desire Lake, Sunday, Brown’s Peak, and Dogfish Lagoon Creeks; and Seldovia, Port Graham, Rocky, and Bruin Rivers.
- Sockeye salmon: English Bay; Amakdedori Creek; and Delight, Desire, Bear, Aialik, Mikfik, and Chenik Lakes.

During winter of 2022/2023, ADF&G established an escapement goal review committee for LCI (hereafter referred to as the committee), consisting of Divisions of Commercial Fisheries and Sport

Fish personnel (Table 1). The committee formally met via teleconference on 24 March 2022 and 9 January 2023 to review escapement goals and develop recommendations. The committee also communicated by email. Committee recommendations are reviewed by ADF&G regional and headquarters staff prior to being adopted by ADF&G as escapement goals per the SSFP and EGP.

OBJECTIVES

Objectives of the 2022/2023 review were to:

1) Review existing goals to determine whether they were still appropriate given (a) new data collected since the last review, (b) current assessment techniques, and (c) current management practices.
2) Review the methods used to establish the existing goals to determine whether alternative methods should be investigated.
3) Consider any new stocks for which there may be sufficient data to develop a goal.
4) Recommend new goals, if appropriate, and eliminate existing goals that are no longer appropriate.

OVERVIEW OF STOCK ASSESSMENT METHODS

STUDY AREA

The LCI commercial salmon fishery management area encompasses all waters west of the longitude of Cape Fairfield, north of the latitude of Cape Douglas, and south of the latitude of Anchor Point, and is divided into 5 fishing districts (Figure 1). Barren Islands District is the only district with no commercial salmon fisheries, with the remaining 4 districts (Southern, Outer, Eastern, and Kamishak Bay) separated into approximately 40 subdistricts and sections to facilitate commercial fisheries management of discrete stocks of salmon (Figures 2 and 3; Hollowell et al. 2023). The LCI sport fisheries management area includes the waters west of the longitude of Gore Point, north of the latitude of Cape Douglas and south of a line from the south end of Chisik Island to the south bank of the Kasilof River (Figure 4). The area includes the Anchor and Ninilchik Rivers and Deep Creek, which flow into Cook Inlet along the west side of the lower Kenai Peninsula, and adjacent marine sport fisheries. Salmon streams in these management areas (Figures 1 and 4) primarily produce pink and chum salmon, but also support smaller and less numerous runs of sockeye, coho *O. kisutch*, and Chinook salmon.

ASSESSING ESCAPEMENT AND HARVEST

Escapements for most salmon stocks in LCI are monitored by foot survey, aerial survey, or a combination of both. Such surveys provide only an index of escapement due to the lack of supporting data such as accurate estimates of stream life and observer efficiency. The indices are a measurement that provides information about the relative level of the escapement. These measurements provide information on trends of escapement across years, but limited information on the total number of fish in the escapement. Escapement indices for LCI stocks of pink and chum salmon are typically calculated by applying the area-under-the-curve method (Neilson and Geen 1981; Bue et al. 1998), which accounts for multiple sightings of the same fish during consecutive surveys by applying an average stream-life factor. An average stream life of 17.5 d has historically been used for all LCI pink and chum salmon stocks, except McNeil River chum salmon, which uses a stream life of 13.8 d based on the results of a 2-year telemetry study (Peirce et al. 2011).

Accounting for observer efficiency, the proportion of fish in the stream that were counted, is pivotal to the accuracy of the total area-under-the-curve index, but determining observer efficiency for each surveyor requires the use of intertidal weirs to confidentially know exactly how many pink and chum salmon are available for them to count at the time each survey is conducted (Bue et al. 1998). That information is not available for LCI surveyors, so observer efficiency is assumed to be 1 (i.e., all fish are counted).

Consistent weir data exist only for Anchor and Ninilchik River Chinook salmon, and Bear and English Bay Lakes sockeye salmon. Provided the weir is fish-tight and operated throughout the run, weir data provide a count or an estimate of the total number of fish in the escapement (i.e., total fish in the spawning population), expressed in units comparable to the estimates of total fish harvested for the same stock. Weir data exist for some other species-year-system combinations but are not complete or consistent.

Since the late 1990s, LCI staff have been developing and refining a digital time-lapse video recording system to remotely monitor fish runs in small, clear streams (Otis and Dickson 2002; Otis 2023). For some stocks (e.g., Mikfik and Chenik Lakes sockeye salmon), this technology has allowed replacement of aerial survey indices with escapement estimates more appropriate for developing census rather than index-based escapement goals. In 2010, LCI staff transitioned the Chenik Lake sockeye salmon SEG from an aerial-survey to a remote-video based goal (Otis et al. 2010), and in 2013, sufficient data were available to do the same for Mikfik Lake sockeye salmon (Otis et al. 2013).

Chinook salmon escapements in the Lower Kenai Peninsula roadside streams have been monitored since 1962. Initial surveys used a combination of foot and aerial surveys, and starting in 1976, transitioned to single aerial surveys via helicopters during peak spawning. Starting in the 1990s, Chinook salmon escapement monitoring transitioned to use of sonar, and live box and video weirs. On the Ninilchik River, escapement monitoring transitioned to a broodstock weir in the 1990s. During most years, the weir was only operated in July; however, from 1999 to 2005 the entire escapement was monitored. Weir counts of naturally produced Chinook salmon were used to develop index-based escapement goals. In 2016, an instream motion sensing video system incorporated within the broodstock weir provided a method for developing an escapement goal based on the entire run. In 2019, escapement monitoring was further refined to include a lower monitoring site at river mile 2, just above the sport fishery. This was accomplished with a resistance board weir and underwater video system. In Deep Creek, weirs have been used for 2 periods (1997–2000 and 2018–2020), but aerial surveys have continued for annual monitoring. Escapement monitoring of Anchor River Chinook salmon transitioned to using a Dual-Frequency Identification Sonar (DIDSON; Belcher et al. 2002) in 2003, then a combination of DIDSON and weir counts beginning in 2004. In the Anchor River, the use of underwater video was included with resistance board weirs starting in 2011. The use of DIDSON was replaced with Adaptive Resolution Imaging Sonar (ARIS) starting in 2019 (Dickson et al. 2020).

All landings of commercially harvested fish are documented on a “fish ticket” that includes the quantity of fish harvested and the date and location (i.e., subdistrict or statistical area) of the harvest. Detailed commercial harvest data can then be obtained from the fish ticket database. Estimates of sport harvest are from the Alaska Sport Fishing Survey (commonly known as the Statewide Harvest Survey [SWHS]), which is a postal survey conducted annually by the Division of Sport Fish (e.g., Romberg et al. 2023).

ESCAPEMENT GOAL DETERMINATION

Since the current definitions of escapement goals were adopted into policy by the BOF in 2001 (SSFP: 5 AAC 39.222 and EGP: 5 AAC 39.223), all escapement goals in LCI have been designated as SEGs rather than BEGs (Otis 2001; Otis et al. 2016a). The majority of escapement goals in LCI are based on foot or aerial survey data. The surveys typically cover less than 100% of the stream due to practical constraints (dense riparian areas, etc.), and different people have conducted the surveys over the years under a wide variety of conditions. Although the purse seine commercial fisheries in LCI primarily occur in terminal areas, stock mixing sometimes takes place, especially in the Port Dick and Windy Bay subdistricts in the Outer District (Figure 2) and the Kamishak River and Ursus Cove subdistricts in the Kamishak District (Figure 3). Set gillnet fisheries in the Southern District also harvest multiple stocks migrating through the area. The mixed-stock nature of these fisheries makes it challenging to allocate commercial harvest to specific stocks. Also, a lack of annual age composition data for many stocks precludes construction of accurate brood tables and adds to the uncertainty in determining total return for many stocks. For these reasons, all LCI goals are SEGs rather than BEGs.

Percentile Approach

Beginning in 2001, the SEG for most LCI stocks was developed using percentiles of observed escapement estimates or indices that also incorporated contrast in the escapement data and estimated harvest rates (Bue and Hasbrouck *Unpublished*;[1] Otis 2001; Otis and Hasbrouck 2004; Otis and Szarzi 2007; Otis et al. 2010; Otis et al. 2013; Otis et al. 2016a). This method for setting SEGs became known as the Percentile Approach (Clark et al. 2014). To calculate the percentiles, escapement data were first ranked from the smallest to the largest value, with the smallest value representing the 0th percentile (i.e., none of the escapement values are less than the smallest). The percentile of all remaining escapement values was a summation of 1/(n-1), where n is the number of escapement values. Contrast in the escapement data was simply the maximum observed value divided by the minimum observed value. As contrast increased, the percentiles used to estimate the SEG range were narrowed, primarily from the upper range, to allow the SEG to include a wide range of escapements.

Since it came into use in 2001, the Percentile Approach has been the principal method used to develop nearly half of the escapement goals currently in use throughout Alaska (Munro and Brenner 2022). Clark et al. (2014) provided a comprehensive evaluation of the Percentile Approach and its use for establishing sustainable escapement goals for stocks lacking sufficient stock productivity information to conduct traditional spawner recruit analyses (SRA). While the concept and basis for the Percentile Approach as a proxy for S_{MSY} was considered robust, Clark et al. (2014) offered the following summation of their review:

> *"All of [our] analyses indicate that the four tiers of the Percentile Approach are likely sub-optimal as proxies for determining a range of escapements around S_{MSY}. The upper bounds of SEGs developed with this approach may actually be unsustainable in that they may specify spawning escapement that is close to or exceeds the carrying capacity of the stock. The lower bound percentile of SEG*

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[1] Bue, B. G., and J. J. Hasbrouck. *Unpublished*. Escapement goal review of salmon stocks of Upper Cook Inlet. Alaska Department of Fish and Game, Report to the Board of Fisheries, November 2001 (and February 2002), Anchorage. Subsequently referred to as "Bue and Hasbrouck *unpublished*."

Tier 1 (25%) also appears somewhat higher than necessary. Escapements in the lower 60 to 65 percentiles are optimal across a wide range of productivities, serial correlation in escapements, and measurement error in escapements."

Clark et al. (2014), therefore, recommended that the 4 tiers of the "Bue-Hasbrouck" Percentile Approach be replaced with the following 3 tiers for stocks with low to moderate (<0.40) average harvest rates:

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

Both percentile methods have been used to develop SEGs in LCI. However, since 2014, only the Clark et al. (2014) method has been used. Therefore, unless otherwise stated, all references to the Percentile Approach hereafter will refer to the 3-tier method outlined in Clark et al. (2014). Clark et al. (2014) recommended against using the Percentile Approach for stocks with average harvest rates ≥0.40, or those that have both very low contrast (≤4) and high measurement error. For a more comprehensive review and analysis of the Percentile Approach, see Clark et al. (2014). LCI staff used the Percentile Approach to revise 37 of 41 SEGs in 2016 (Otis et al. 2016a), and 34 of 41 SEGs during this review period.

Spawner-Recruit Analysis (SRA)

Anchor River Chinook Salmon

The Anchor River escapement goal analysis was updated using data through 2022. This included aerial survey data from 1977 through 2008, escapements from 2003 through 2022, age composition data, SWHS inriver harvest estimates through 2022, and assumed marine harvest rates.

The Bayesian full-probability model used was an update of the SRA from Szarzi et al. (2007) and included all available spawner-recruit data for this stock. The model from Otis et al. (2016a) was not used because it truncated the data set to include only the most recent years, where we had the highest quality data, while omitting data from a higher productivity period for this stock. The data, code, and results of this analysis can be viewed at https://github.com/ADFG-DSF/Anchor_River_Chinook.

LCI Pink and Chum Salmon Stocks

Staff also used SRA to estimate the districtwide spawning escapement of pink and chum salmon, respectively, that produced maximum sustained yield (S_{MSY}) for each species. Source data were not sufficient for a robust analysis that could result in recommending a BEG. For example, (1) only spawner indices were available for pink and chum salmon, rather than absolute abundance estimates with measures of accuracy/precision; (2) mixed stock fisheries complicated apportioning harvest among contributing streams to estimate total run; and (3) annual age composition data were not available to build brood tables to estimate total return for chum salmon. Hence, this analysis was conducted solely as a quality assurance exercise to evaluate the aggregate (by district) SEG ranges that were developed for pink and chum salmon stocks using the Percentile Approach. These SRAs were implemented in an R "shinyapp" package (Pacific Salmon SR Escapement Goal

Analyses) written by Toshihide Hamachan Hamazaki.[2] Since annual age composition data were lacking, we used historical age data to estimate the average annual age composition for each contributing chum salmon stock to facilitate building brood tables for the SRA (Ricker production model; Ricker 1954). The results of these exploratory analyses were generally well aligned with the aggregate SEG ranges developed using the Percentile Approach, substantiating the results of the latter. Use of the new aggregate SEGs, including incorporating additional index streams for each district, should improve the department's ability to annually estimate total run, and thereby better assess recruitment from given spawner levels using more robust SRAs. This may enable the department to revise LCI SEGs in the future using SRA rather than the Percentile Approach, particularly for pink salmon, where annual age data are not required to build brood tables.

Aggregate Escapement Goals

Section (b)(5) of the Policy for Statewide Salmon Escapement Goals (5 AAC 39.223) recognizes the department's responsibility to "establish escapement goals for aggregates of individual spawning populations with similar productivity and vulnerability to fisheries and for salmon stocks managed as units." This criterion applies particularly well to pink and chum salmon stocks, as evidenced by the fact that most management areas around Alaska employ aggregate goals for these species.

LCI currently has 18 pink and 12 chum salmon stocks with individual escapement goals (Otis et al. 2016a), and is the only management area in Alaska with significant commercial harvest targeting these species that has not transitioned to aggregate escapement goals at the district or larger scale. For example, Southeast Alaska (SEAK) manages pink and chum salmon using aggregate goals for each of 3 large management areas (Southern Southeast, Northern Southeast Inside, Northern Southeast Outside; Heinl et al. 2017; Munro and Brenner 2022). Prince William Sound (PWS) currently manages chum salmon using aggregate SEGs for each of 5 fishing districts, and odd- and even-year pink salmon goals for each of 7 fishing districts (Haught et al. 2017; Munro and Brenner 2022). While the scale of aggregation varies by species and across management areas in Westward Region, pink and chum salmon are also managed using goals aggregated by district (e.g., AK Peninsula chum salmon) or entire management areas (e.g., Chignik and Kodiak Archipelago pink salmon; McKinley et al. 2019; Munro and Brenner 2022).

For the 2022/2023 review period, the LCI escapement goal committee was encouraged to explore aggregating SEGs for pink and chum salmon by district in LCI. This effort was undertaken, in part, to better align statewide management strategies, but also to increase management flexibility and improve stock assessment by reducing the uncertainty associated with assigning mixed stock harvest to individual stocks. The committee considered the following pros and cons for aggregating pink and chum salmon goals to the district level in LCI:

- Pros for transitioning to aggregate SEGs for pink and chum salmon:
    - Consistency: LCI is the only management area in Alaska not currently managing these species using aggregate escapement goals; SEAK, PWS, AK Peninsula, Chignik, and Kodiak transitioned to aggregate SEGs years ago.
    - Simplicity: Areas currently using this approach indicate it simplifies inseason management and provides managers with more flexibility. Reducing the number of

[2] Hamazaki, T. 2023. Pacific Salmon Escapement Goal Analyses. (source: https://hamachan.shinyapps.io/Spawner_Recruit_Bayes/).

escapement goal analyses performed in LCI every 3 years from 30 to 6 would also simplify this component of the BOF process.

  - Improved Assessment: While perhaps not as great an issue as in other areas, mixed stock fishing on local stocks does occur in LCI. By aggregating goals to the district level, staff can better assess recruitment from given spawner levels without the uncertainty associated with apportioning mixed-stock harvests among contributing streams.

- Cons for transitioning to aggregate SEGs for pink and chum salmon:
  - It is possible that weak performing stocks could be harmed with a broader management strategy if the district-level SEG is the only metric being considered for inseason management.

The primary concern the committee had with aggregating escapement goals was the potential to harm weak performing stocks in a district that was otherwise having strong runs. However, that outcome can be easily avoided by continuing to monitor individual stocks and selectively closing subdistricts where escapement is lagging behind inseason management objectives. This practice is successfully implemented by managers in other areas with aggregate escapement goals, and the committee agreed it could be a successful strategy in LCI. Hence, the committee's finding is to aggregate pink and chum salmon goals in LCI, while retaining stock-specific goals for LCI's 3 Chinook and 8 sockeye salmon stocks.

Two approaches were considered for developing aggregate escapement goals for pink and chum salmon: (1) summing existing stock-specific SEGs from each district to create district SEGs, and continuing to use the old SEGs as management objectives in season to protect weak-performing stocks; and (2) summing historical annual harvests and escapements from all contributing stocks in each district and performing escapement goal analyses on the resulting time series, similar to how stock-specific goals are developed. The committee strongly recommended the second option as the most robust method for developing aggregate escapement goals, so that was the approach taken. Under option 2, staff would develop inseason management objectives for individual stocks by determining the historical average or median escapement for all monitored stocks in each district, using that value to calculate the proportion of the overall district escapement that stock contributes, and then multiplying that proportion by the lower and upper bounds of the district SEG. When PWS transitioned to aggregate goals in 2001, they used historical average escapements to develop management objectives for contributing index streams (Bue et al. 2002). LCI staff elected to use historical median escapements because the median provides a better measure of central tendency in non-symmetrical data sets and is less influenced by outliers. The committee further decided that Tutka Creek and Port Graham River pink salmon would be excluded from the aggregate Southern District SEG analyses to mitigate the potential to inflate districtwide escapements by including stocks strongly influenced by hatchery enhancement.

STOCK SPECIFIC METHODS, RESULTS, AND RECOMMENDATIONS

Seven years have elapsed since most of the current escapement goals in LCI were implemented (Otis et al. 2016a), but the Percentile Approach remains the most robust method for assessing LCI goals due to the lack of accurate spawner and recruit data. Therefore, during this escapement goal review period, area staff applied the Percentile Approach to the longer time series of available escapement data (1976–2022) to assess if changes to any goals were warranted. Where appropriate, alternative methods (e.g., spawner-recruit analysis) were also evaluated for comparison (e.g., pink and chum salmon aggregate SEGs).

The following sections provide additional information, by species, on the committee's findings for each of the 41 salmon stocks in LCI that have escapement goals. Also provided is a review of recent salmon escapements relative to the current and recommended goals. Relevant details and all data used in the analysis for each Chinook, chum, pink, and sockeye salmon stock reviewed can be found in Appendix A, B, C, and D, respectively.

CHINOOK SALMON

LCI Chinook salmon escapements from 2020 to 2023 reflect a similar trend as the statewide downturn in Chinook salmon runs (Figure 5). Anchor River stock failed to meet its escapement goal (3,800–7,600) in 2020, 2022, and 2023 (Table 2). Deep Creek stock failed to meet its escapement goal (lower bound 350) in 2020 and was not surveyed in 2021–2023 due to budget cuts. Ninilchik River stock failed to meet its escapement goal (750–1,300) in 2022 and 2023. The committee recommended updating the Anchor and Ninilchik River escapement goals (Table 2).

Anchor River

In 2023, the Bayesian full-probability model of Szarzi et al. (2007) was updated using Anchor River aerial survey data from 1977 through 2008, available escapements from 2003 through 2022, age composition data, SWHS inriver harvest estimates through 2022, and assumed marine harvest rates. Recruitment estimates prior to 2000 are based solely on survey data and are highly variable (Figure 6). Starting in 2000, recruitment estimates are based on sonar and weir counts and are estimated with improved precision. Productivity for most brood years after the 2003 brood has been low. The model we used is capable of accounting for these differences in data quality and the estimated median spawner-recruit relationship accounts for environmental variability by including information from both productivity regimes. The estimate of S_{MSY} from this model was 3,933 (95% CI: 2,722–6,710) Chinook salmon (Table 3).

Based on the updated SRA using the Bayesian full-probability model, the current escapement goal range (3,800–7,600) is one of the most conservative (high relative to S_{MSY}) Chinook salmon escapement goals in Alaska, with the lower bound of the current goal approximating S_{MSY} (3,933). Based on this and the updated optimal yield profile (Figure 7), the committee finds that modifying the current SEG to a range of 3,200–6,400 remains conservative while improving the probability of maximizing sustained yield on escapements throughout the escapement goal range (Table 4).

Deep Creek

The current lower bound SEG (350) for Deep Creek was developed using the Percentile Approach in 2016 (Otis et al. 2016a) and first implemented in 2017. Because surveys were conducted in only 4 additional years since this goal was developed, and the index counts were within the range of previously observed values, the escapement goal for this stock was not updated (Table 4).

Ninilchik River

To facilitate moving the escapement assessment to the downstream weir location, the escapement goal for Ninilchik River was updated and adjusted to include fish that spawn between the weir locations. The committee's findings are to change the current SEG (750–1,300) to a SEG of 900–1,600, to be assessed at a weir lower in the Ninilchik River to include the entire Chinook salmon escapement. On average, 18% of the total escapement spawns in between the weir locations. The current SEG is based on wild escapements from the upper brood stock weir operated at river mile 4.8. Weir counts from the upper weir were leveraged with 4 years (2019–2022) of counts from the lower weir (river mile 2.5) to produce updated historical counts expanded to the lower weir location. Given the low contrast and low harvest rates, an escapement goal range of 900–1,600 is warranted using Tier 3 (5th and 65th percentiles) of the Percentile Approach. The new escapement goal increased to account for the difference in escapements between monitoring locations (Table 4).

CHUM SALMON

Recent chum salmon escapements have been sufficient to meet current SEGs and provide a harvestable surplus for most stocks (Table 2). Between 2020 and 2023, LCI chum salmon escapements were below the current SEG range 33% of the time and within or above the SEG range 67% of the time (*n* = 48; Figure 8). Relatively modest runs, low market value, and inconsistent tender service, as well as robust pink salmon runs to other districts in Area H sometimes contributed to diminished commercial fishing effort in the Kamishak District. This, in turn, contributed to chum salmon systems occasionally experiencing escapements above the SEG range (Figure 8).

The committee's findings are to replace the 12 existing LCI SEGs for individual chum salmon stocks into aggregate goals for each of the 3 districts with commercial fisheries targeting chum salmon (Southern, Outer, and Kamishak; Table 5). The transition to aggregate escapement goals by district warranted a comprehensive review of catch and escapement data for all chum salmon producing streams in each district. Streams included in the final analysis for developing district goals were those that had a history of consistent escapement monitoring and where targeted or incidental commercial harvest of that stock also occurred. These criteria resulted in 9 index streams being included that did not previously have individual escapement goals (Table 6). Based on the committee's finding to transition to aggregate escapement goals by district, the 12 current individual chum salmon SEGs for LCI will be replaced by 3 district SEGs (Table 5).

Southern District

Three stocks were used to develop the Southern District chum salmon aggregate SEG (Humpy, Port Graham, and Seldovia), one of which (Port Graham) currently has an SEG (Tables 4 and 5). All 3 stocks are consistently monitored by multiple foot surveys and are incidentally harvested in Southern District purse seine and set gillnet commercial fisheries (Table 6). There were 47 years (1976–2022) of escapement data available for the Southern District chum salmon analysis. The escapement contrast for the aggregate Southern District chum salmon stock was 48 and the average exploitation rate was 0.13, resulting in a Tier 1 classification under the Percentile Approach. The resulting SEG range of 1,500–5,000 chum salmon was therefore based on the 20th and 60th percentiles of observed escapements to the 3 chum salmon index streams in the Southern District (Appendix B1).

To ensure weak performing stocks are not overfished under the aggregate district goal system, escapements will be monitored in season for all contributing index streams and restrictive actions will be taken in subdistricts that are projected to fall short of pre-established management objectives. Management objectives were developed by determining the historical median proportion of the districtwide escapement contributed by each index stream and multiplying that proportion by the lower and upper bounds of the district SEG (Table 6). Relevant details for the aggregate Southern District chum salmon stock, including all data used in the analysis, can be found in Appendix B1.

Outer District

Eight stocks were used to develop the Outer District chum salmon aggregate SEG (Dogfish, Island, Middle, Petrof, Port Chatham, Port Dick, Rocky, and Slide), 4 of which (Dogfish, Island, Port Dick, and Rocky) currently have SEGs. All 8 stocks are consistently monitored by multiple aerial and/or foot surveys and are targeted by, or incidentally harvested in, Outer District purse seine fisheries (Table 6). There were 47 years (1976–2022) of escapement data available for the Outer District chum salmon analysis. The escapement contrast for the aggregate Outer District chum salmon stock was 12 and the average exploitation rate was 0.35, resulting in a Tier 1 classification under the Percentile Approach. The resulting SEG range of 17,500–32,000 chum salmon was therefore based on the 20th and 60th percentiles of observed escapements to the 8 chum salmon index streams in the Outer District (Appendix B2).

To ensure weak performing stocks are not overfished under the aggregate district goal system, escapements will be monitored in season and restrictive actions will be taken in subdistricts that are projected to fall short of pre-established management objectives. Management objectives were developed by determining the historical median proportion of the districtwide escapement contributed by each index stream and multiplying that proportion by the lower and upper bounds of the district SEG (Table 6). Relevant details for the aggregate Outer District chum salmon stock, including all data used in the analysis, can be found in Appendix B2.

Kamishak District

Ten stocks were used to develop the Kamishak District chum salmon aggregate SEG (Big Kamishak, Bruin, Cottonwood, Douglas, Iniskin, Little Kamishak, McNeil, Sugarloaf, Sunday, and Ursus Lagoon), 7 of which (Big Kamishak, Bruin, Cottonwood, Iniskin, Little Kamishak, McNeil, and Ursus Lagoon) currently have SEGs. All 10 stocks are consistently monitored by multiple aerial surveys and are targeted by, or incidentally harvested in, Kamishak District purse seine fisheries (Table 6). There were 47 years (1976–2022) of escapement data available for the Kamishak District chum salmon analysis. The escapement contrast for the aggregate Kamishak District chum salmon stock was 6 and the average exploitation rate was 0.20, resulting in a Tier 3 classification under the Percentile Approach. The resulting SEG range of 50,000–115,000 chum salmon was therefore based on the 5th and 65th percentiles of observed escapements to the 10 chum salmon index streams in the Kamishak District (Appendix B3).

To ensure weak performing stocks are not overfished under the aggregate district goal system, escapements will be monitored in season and restrictive actions will be taken in subdistricts that are projected to fall short of pre-established management objectives. Except for McNeil River, management objectives were developed by determining the historical median proportion of the districtwide escapement contributed by each index stream and multiplying that proportion by the lower and upper bounds of the district SEG (Table 6). Relevant details for the aggregate Kamishak District chum salmon stock, including all data used in the analysis, can be found in Appendix B3.

The inseason management objective for McNeil River chum salmon will remain the SEG range (24,000–48,000) that was in place when the BOF designated it as a stock of management concern in 2016. Further details regarding McNeil River chum salmon and derivation of the current SEG range can be found in Otis and Szarzi (2007). The McNeil River chum salmon action plan

(Otis et al. 2016b) reviews factors contributing to this being a stock of concern, and the management measures being implemented to foster recovery.

PINK SALMON

Recent pink salmon escapements have been sufficient to meet current SEGs and provide a harvestable surplus for most stocks (Table 2). Between 2020 and 2023, LCI pink salmon escapements were below the current SEG range 24% of the time and within or above the current SEG range 76% of the time (n = 71; Figure 9). Relatively modest runs, lack of tender service, and reduced market value contributed to diminished commercial fishing effort in some districts, particularly in 2023. This in turn contributed to the harvestable surplus for some stocks going unharvested, and in some cases, stocks exceeding their existing SEG range (Figure 9). Based on the committee's finding to transition to aggregate escapement goals (by district) for pink and chum salmon, the 18 current individual pink salmon SEGs for LCI will be replaced by 3 district SEGs (Table 7).

Southern District

Four stocks were used to develop the Southern District pink salmon aggregate SEG (Barabara, China Poot, Humpy, and Seldovia), all of which currently have SEGs. All 4 stocks are consistently monitored by multiple foot surveys and are targeted and/or incidentally harvested in Southern District purse seine and set gillnet commercial fisheries (Table 8). There were 47 years (1976–2022) of escapement data available for the Southern District pink salmon analysis. The escapement contrast for the aggregate Southern District pink salmon stock was 12 and the average exploitation rate was 0.34, resulting in a Tier 1 classification under the Percentile Approach. The resulting SEG range of 50,000–110,000 pink salmon was therefore based on the 20th and 60th percentiles of observed escapements to the 4 pink salmon index streams in the Southern District (Appendix C1).

To ensure weak performing stocks are not overfished under the aggregate district goal system, escapements will be monitored in season and restrictive actions will be taken in subdistricts that are projected to fall short of pre-established management objectives. Management objectives were developed by determining the historical median proportion of the districtwide escapement contributed by each index stream and multiplying that proportion by the lower and upper bounds of the district SEG (Table 8). Relevant details for the aggregate Southern District pink salmon stock, including all data used in the analysis, can be found in Appendix C1.

Outer District

Thirteen stocks were used to develop the Outer District pink salmon aggregate SEG (Desire, Dogfish, Island, James Lagoon, Middle, Port Chatham, Port Dick, Rocky, Slide, South Nuka, Taylor Bay, Windy Left, and Windy Right), 9 of which (Desire, Dogfish, Island, Port Chatham, Port Dick, Rocky, South Nuka, Windy Left, and Windy Right) currently have SEGs. All 13 stocks are currently consistently monitored by multiple aerial and/or foot surveys and are targeted by, or incidentally harvested in, Outer District purse seine fisheries (Table 8). There were 47 years (1976–2022) of escapement data available for the Outer District pink salmon analysis. The escapement contrast for the aggregate Outer District pink salmon stock was 50 and the average exploitation rate was 0.48. Although the aggregate district harvest rate was higher than Clark et al. (2014) recommend for the Percentile Approach ($\leq$0.40), of the 13 stocks contributing to the aggregate district goal, only 2 (Port Dick and Island Creeks) had average exploitation rates >0.40. Accurately estimating harvest rate is challenging in mixed-stock fishery situations, like Port Dick Bay in the

Outer District, particularly when some of the stocks contributing to the harvest are not monitored for escapement. Consideration was also given to the fact that area-under-the-curve escapement indices in LCI are likely very conservative because observer efficiency is assumed to be 1 (i.e., all fish in the stream are counted). Bue et al. (1998) found that area-under-the-curve indices that only accounted for stream life and not observer efficiency were on average <50% of the corresponding weir counts. If escapement indices are biased low and harvest is accurately recorded on fish tickets, then exploitation rate estimates (harvest divided by total run, where total run equals escapement plus harvest) will be biased high. The committee thus decided that the Percentile Approach was allowable in this case, and a Tier 1 classification was used based on escapement contrast and measurement error. The resulting SEG range of 105,000–235,000 pink salmon was therefore based on the 20th and 60th percentiles of observed escapements to the 13 pink salmon index streams in the Outer District (Appendix C2).

To ensure weak performing stocks are not overfished under the aggregate district goal system, escapements will be monitored in season and restrictive actions will be taken in subdistricts that are projected to fall short of pre-established management objectives. Management objectives were developed by determining the historical median proportion of the districtwide escapement contributed by each index stream and multiplying that proportion by the lower and upper bounds of the District SEG (Table 8). Relevant details for the aggregate Outer District pink salmon stock, including all data used in the analysis, can be found in Appendix C2.

Kamishak District

Five stocks were used to develop the Kamishak District pink salmon aggregate SEG (Amakdedori, Brown’s Peak, Bruin, Little Kamishak, and Sunday), 3 of which (Brown’s Peak, Bruin, and Sunday) currently have SEGs. All 5 stocks are consistently monitored by multiple aerial surveys and are targeted by, or incidentally harvested in, Kamishak District purse seine fisheries (Table 8). There were 47 years (1976–2022) of escapement data available for the Kamishak District pink salmon analysis. The escapement contrast for the aggregate Kamishak District pink salmon stock was 381 and the average exploitation rate was 0.14, resulting in a Tier 1 classification under the Percentile Approach. The resulting SEG range of 35,000–150,000 pink salmon was therefore based on the 20th and 60th percentiles of observed escapements to the 5 pink salmon index streams in the Kamishak District (Appendix C3).

To ensure weak performing stocks are not overfished under the aggregate district goal system, escapements will be monitored in season and restrictive actions will be taken in subdistricts that are projected to fall short of pre-established management objectives. Management objectives were developed by determining the historical median proportion of the districtwide escapement contributed by each index stream and multiplying that proportion by the lower and upper bounds of the district SEG (Table 8). Relevant details for the aggregate Kamishak District pink salmon stock, including all data used in the analysis, can be found in Appendix C3.

SOCKEYE SALMON

Recent sockeye salmon escapements have been sufficient to meet current SEGs and provide a harvestable surplus for most stocks (Table 2). From 2020 to 2023, LCI sockeye salmon escapements were below their respective SEG ranges 25% of the time and within or above their SEG ranges 75% of the time (n = 32; Figure 10).

The committee's findings are to change 2 (Bear and English Bay Lakes) of the 8 existing SEGs for LCI sockeye salmon stocks. In both cases, the current goal was adopted in 2002 (Table 9) and was based on 4-tier Percentile Approach. Consequently, the committee recommended updating the goal with recent escapement data using the same method (Percentile Approach) used to develop all other LCI sockeye salmon SEGs (Otis et al. 2016a). Relevant details for each sockeye salmon stock reviewed, including all data used in the analysis, can be found in Appendices D1–D8.

Bear Lake

Bear Lake, which flows into the head of Resurrection Bay in the Eastern District (Figure 1), has a complicated history. Drainages in Resurrection Bay support natural runs of pink, chum, coho and sockeye salmon, with coho and sockeye salmon currently being enhanced by annual stocking of fish raised in the Trail Lakes Hatchery, primarily into Seward Lagoon and Bear Lake, respectively (Hollowell et al 2019). Before statehood, a large sport fishery developed in Resurrection Bay targeting coho salmon. This fishery was highly valued and both ADF&G and the BOF implemented several measures in the 1960s and 1970s to control predation and interspecies competition and enhance coho salmon returns to benefit recreational fisheries. These efforts included: (1) ADF&G constructing a barrier/weir at the outlet of Bear Lake to exclude species that may compete with coho salmon; (2) ADF&G enhancing coho salmon production by fertilizing Bear Lake and stocking it with hatchery raised coho salmon fingerlings; (3) ADF&G using rotenone in Bear Lake in 1963 and 1971 to eradicate predators and competitors with coho salmon (McHenry 1982); (4) BOF approving the Resurrection Bay Salmon Management Plan (5 AAC 21.376, adopted in 1966 and amended in 1976), which excluded commercial fisheries from harvesting coho salmon or interfering with the recreational fishery; and (5) BOF approving the Bear Lake Management Plan (e.g., 5 AAC 21.375, adopted in 1971), which placed restrictions on the number of sockeye salmon allowed to enter Bear Lake (Miller and Bosch 2004). These actions contributed to the small natural run of Bear Lake sockeye salmon experiencing very low escapements from 1976–1991 (Appendix D4). However, in 1988, the BOF modified the Bear Lake Management Plan with provisions that included (1) rescinding restrictions of sockeye salmon escapement into Bear Lake; (2) directing ADF&G to establish a sockeye salmon escapement goal for Bear Lake; and (3) allowing enhancement of sockeye salmon in Bear Lake, as long as there was no net loss to coho salmon production (Miller and Bosch 2004).

Escapements to Bear Lake have been monitored by weir since 1964. In 1989, Cook Inlet Aquaculture Association (CIAA) took over operation of the Trail Lakes Hatchery from ADF&G's Fisheries Rehabilitation, Enhancement, and Development (FRED) Division, and operation of the weir from ADF&G's Sport Fish Division. CIAA has continued to operate the Bear Lake weir annually since 1989 and has been releasing hatchery-raised sockeye salmon fry into Bear Lake to enhance that run every year since 1990 (Hollowell et al. 2019). Recruits from those early stockings began showing up as adults around 1992 and by 1994 several thousand sockeye salmon were passing the weir annually. Weir passage is tightly regulated by CIAA to ensure escapement into Bear Lake maintains historical run timing while achieving spawning and broodstock needs. Cost recovery efforts on sockeye salmon occur in both fresh and saltwater. Fish that are surplus to spawning needs (both natural spawning in the lake and broodstock needs by CIAA), are harvested for cost recovery at the weir. Consequently, escapement into Bear Lake has not varied considerably since 1994 (Appendix D4).

Because the current SEG for Bear Lake (700–8,300) was developed in 2001 using the 4-tier Percentile Approach, the committee's findings are to amend the goal using the revised Percentile

Approach (Clark et al. 2014) to be consistent with the methods used to develop all other LCI pink, chum, and sockeye salmon SEGs. There were 44 years (1976, 1980–2022) of weir escapement data available for the Bear Lake sockeye salmon analysis (Appendix D4). The escapement contrast for Bear Lake sockeye salmon was 113 and the average harvest rate was 0.60. Clark et al. (2014) does not recommend using the Percentile Approach when average harvest rates are greater than 0.40; however, their evaluation of this method focused on stocks with natural production only. High harvest rates are not uncommon for hatchery enhanced runs with both common property and cost-recovery harvest efforts targeting the stock. Hence, the committee determined the Percentile Approach could be applied to this stock. Given the high escapement contrast and low measurement error (weir), this stock was designated Tier 2, and the resulting SEG range of 600–8,600 sockeye salmon was therefore based on the 15th and 65th percentiles of observed escapements to Bear Lake (Appendix D4).

English Bay Lakes

The English Bay Lakes system flows into outer Kachemak Bay in the Southern District (Figure 1) and has a history of hatchery enhancement. Natural production from English Bay Lakes was supplemented through hatchery backstocking most years from 1990–2015 (Hollowell et al. 2019). This stock is an important subsistence resource to the residents of Port Graham Subdistrict. Because the current SEG for English Bay Lakes (6,000–13,500) was developed in 2001 using the 4-tier Percentile Approach, the committee's findings are to amend the goal using the revised Percentile Approach (Clark et al. 2014) to be consistent with the methods used to develop all other LCI pink, chum, and sockeye salmon SEGs. There were 47 years (1976–2022) of escapement data available for the English Bay Lakes sockeye salmon analysis (Appendix D1). From 1976 to 1992, multiple aerial surveys were flown to get a peak index of spawners in the lakes. Except for 2021, escapement to English Bay Lakes has been monitored by a weir since 1993. The escapement contrast for English Bay Lakes sockeye salmon was 13 and the average harvest rate was 0.25. Given the high escapement contrast and mix of low and high escapement measurement error (weir and aerial survey), this stock was designated Tier 1 under the Percentile Approach, and the resulting SEG range of 6,300–12,200 sockeye salmon was therefore based on the 20th and 60th percentiles of observed escapements to English Bay Lakes (Appendix D1).

Relevant details for 6 other LCI sockeye salmon SEGs that were reviewed but not changed, including all data used in the analysis, can be found in Appendices D2, D3, and D5–D8. Appendix D6 provides details on the Mikfik Lake sockeye salmon stock, which the BOF voted to designate as a stock of management concern at their October 2023 work session.

EFFECT OF 2023 ESCAPEMENT GOAL FINDINGS ON STOCKS OF CONCERN

The BOF designated McNeil River chum salmon as a stock of management concern in 2016 (Otis et al. 2016b), prior to adoption of the aggregate Kamishak District chum salmon goal presented in this report. Although McNeil River chum salmon will become 1 of the 10 stocks contributing to the new aggregate goal, because it is the only chum salmon stock of concern in the Kamishak District, this stock will continue to be evaluated under its existing SEG range of 24,000–48,000 fish, and it will continue to be managed under guidelines outlined in the McNeil River Chum Salmon Action Plan (Otis et al. 2016b) until such time that it is removed from stock of concern status. At its October 2023 work session, the BOF voted to designate Mikfik Lake sockeye salmon as a stock of management concern. The SEG for that stock did not change during this review and guidelines for managing this stock will be included in an action plan presented to the BOF at the LCI meeting in November. Hence, the 2023 escapement goal findings presented in this report will have no impact on stocks of concern in Lower Cook Inlet.

SUMMARY OF STAFF FINDINGS TO DIRECTORS

The LCI escapement goal review committee analyzed data for 41 salmon escapement goals in 2022/2023 (3 Chinook, 12 chum, 18 pink, and 8 sockeye salmon). Their review resulted in changes to 4 individual stocks (2 Chinook and 2 sockeye), and a finding to transition from stock specific goals to aggregate SEGs (by district) for pink and chum salmon. These findings result in a total of 17 escapement goals for the LCI management area (3 Chinook, 3 chum, 3 pink, and 8 sockeye salmon), all of which are SEGs.

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REFERENCES CITED

Belcher, E. O., W. Hanot, and J. Burch. 2002. Dual-Frequency identification sonar. Pages 187–192 [*In*] Proceedings of the 2002 International Symposium on underwater technology. April 16–19, 2002, Tokyo, Japan,.

Bue, B. G., J. J. Hasbrouck, and M. J. Evenson. 2002. Escapement goal review of Copper and Bering Rivers and Prince William Sound Pacific salmon stocks: Report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 2A02-35.

Bue, B. G., S. Sharr, D. G. Sharp, J. A. Wilcock, and H. J. Geiger. 1998. Estimating salmon escapement using area-under-the-curve, aerial observer efficiency, and stream-life estimates: The Prince William Sound pink salmon example. North Pacific Anadromous Fish Commission Bulletin No. 1:240–250.

Clark, R. A., D. M. Eggers, A. R. Munro, S. J. Fleischman, B. G. Bue, and J. J. Hasbrouck. 2014. An evaluation of the percentile approach for establishing sustainable escapement goals in lieu of stock productivity information. Alaska Department of Fish and Game, Fishery Manuscript No. 14-06, Anchorage.

Dickson, H. I., K. A. Manishin, and M. D. Booz. 2020. Operational Plan: Anchor River Chinook and coho salmon and steelhead stock assessment, 2020–2024. Alaska Department of Fish and Game, Regional Operational Plan No. ROP.SF.2A.2020.03, Anchorage.

Fried, S. M. 1994. Pacific salmon spawning escapement goals for the Prince William Sound, Cook Inlet, and Bristol Bay areas of Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Special Publication No. 8, Juneau.

Haught, S. B., R. E. Brenner, J. W. Erickson, J. W. Savereide, and T. R. McKinley. 2017. Escapement goal review of Copper and Bering Rivers, and Prince William Sound Pacific salmon stocks, 2017. Alaska Department of Fish and Game, Fishery Manuscript No. 17-10, Anchorage.

Heinl, S. C., E. L. Jones III, A. W. Piston, P. J. Richards, L. D. Shaul, B. W. Elliott, S. E. Miller, R. E. Brenner, and J. V. Nichols. 2017. Review of salmon escapement goals in Southeast Alaska, 2017. Alaska Department of Fish and Game, Fishery Manuscript Series No. 17-11, Anchorage.

Hollowell, G., E. O. Otis, and E. Ford. 2019. 2018 Lower Cook Inlet area finfish management report. Alaska Department of Fish and Game, Fishery Management Report No. 19-23, Anchorage.

Hollowell, G., E. O. Otis, and E. Ford. 2023. 2022 Lower Cook Inlet area finfish management report. Alaska Department of Fish and Game, Fishery Management Report No 23-04, Anchorage.

McHenry, E. T. 1982. Coho salmon studies in the Resurrection Bay Area. Alaska Department of Fish and Game, Division of Sport Fish, Volume 23, Study No. G-II-A, Anchorage.

McKinley, T. R., K. L. Schaberg, M. J. Witteveen, M. B. Foster, M. L. Wattum, and T. L. Vincent. 2019. Review of salmon escapement goals in the Kodiak Management Area, 2019. Alaska Department of Fish and Game, Fishery Manuscript No. 19-07, Anchorage.

Miller, M. G., and D. E. Bosch. 2004. Area management report for the recreational fisheries in Resurrection Bay, 2002. Alaska Department of Fish and Game, Fishery Management Report No. 04-10, Anchorage.

Munro, A. R., and R. E. Brenner. 2022. Summary of Pacific salmon escapement goals in Alaska with a review of escapements from 2013 to 2022. Alaska Department of Fish and Game, Fishery Manuscript Series No. 22-02, Anchorage.

Neilson, J. D., and G. H. Geen. 1981. Enumeration of spawning salmon from spawner residence time and aerial counts. Transactions of the American Fisheries Society 110:554–556.

Otis, E. O. 2001. Report to the Alaska Board of Fisheries on sustainable escapement goals for chum, pink, and sockeye salmon in Lower Cook Inlet. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 2A01-21, Anchorage.

Otis, E. O., and M. S. Dickson. 2002. Improved salmon escapement enumeration using remote video and time-lapse recording technology. Exxon Valdez Oil Spill Restoration Project Final Report (Restoration Project 00366), Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

REFERENCES CITED (Continued)

Otis, E. O., and J. J. Hasbrouck. 2004. Escapement goals for salmon stocks in Lower Cook Inlet, Alaska. Alaska Department of Fish and Game, Special Publication No. 04-14, Anchorage.

Otis, E. O., and N. J. Szarzi. 2007. A review of escapement goals for salmon stocks in Lower Cook Inlet, Alaska, 2007. Alaska Department of Fish and Game, Fishery Manuscript No. 07-04, Anchorage.

Otis, E. O., N. J. Szarzi, L. F. Fair, and J. W. Erickson. 2010. A review of escapement goals for salmon stocks in Lower Cook Inlet, Alaska, 2010. Alaska Department of Fish and Game, Fishery Manuscript No. 10-07, Anchorage.

Otis, E. O., L. F. Fair, and J. W. Erickson. 2013. A review of escapement goals for salmon stocks in Lower Cook Inlet, Alaska, 2013. Alaska Department of Fish and Game, Fishery Manuscript No. 13-08, Anchorage.

Otis, E. O., J. W. Erickson, C. Kerkvliet, and T. McKinley. 2016a. A review of escapement goals for salmon stocks in Lower Cook Inlet, Alaska, 2016. Alaska Department of Fish and Game, Fishery Manuscript Series No. 16-08, Anchorage.

Otis, E. O, G. Hollowell, and J. W. Erickson. 2016b. McNeil River chum salmon stock status and action plan, 2016. Alaska Department of Fish and Game, Special Publication No. 16-12, Anchorage.

Otis, E. O. 2023. Lower Cook Inlet remote video salmon escapement monitoring operational plan, 2023. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Operational Plan No. ROP.CF.2A.2023.01, Anchorage.

Peirce, J. M., E. O. Otis, M. S. Wipfli, and E. H. Follmann. 2011. Radiotelemetry to estimate stream life of adult chum salmon in McNeil River, Alaska. North American Journal of Fisheries Management 31(2):315–322.

Ricker, W. E. 1954. Stock and recruitment. Journal of Fisheries and Research Board of Canada 11:559–623.

Romberg, W. J., J. Kirsch, S. Restrepo, K. Sundet, M. Martz, and I. Rafferty. 2023. Estimates of participation, catch, and harvest in Alaska sport fisheries during 2018. Alaska Department of Fish and Game, Fishery Data Series No. 23-06, Anchorage.

Szarzi, N. J., and R. N. Begich. 2004. Recreational fisheries in the Lower Cook Inlet Management Area, 2001-2004: Fisheries under consideration by the Alaska Board of Fisheries 2004. Alaska Department of Fish and Game, Fishery Management Report No. 04-08, Anchorage.

Szarzi, N. J., S. J. Fleischman, R. A. Clark, and C. M. Kerkvliet. 2007. Stock status and recommended escapement goal for Anchor River Chinook Salmon. Alaska Department of Fish and Game, Fishery Manuscript No. 07-05, Anchorage.

TABLES AND FIGURES

Table 1.–List of members of the Alaska Department of Fish and Game Lower Cook Inlet (LCI) salmon escapement goal review committee and other participants who assisted with the escapement goal review.

Name	Position/Management Area	Affiliation
Escapement goal committee:		
Booz, Michael	Area Management Biologist/LCI	Division of Sport Fish
Erickson, Jack	Regional Research Coordinator	Division of Commercial Fisheries
Hamazaki, Hamachan	Biometrician 3	Division of Commercial Fisheries
McKinley, Timothy	Regional Research Coordinator	Division of Sport Fish
Munro, Andrew	Fisheries Scientist	Division of Commercial Fisheries
Otis, Ted	Area Research Biologist/LCI	Division of Commercial Fisheries
Reimer, Adam	Chief Fisheries Scientist	Division of Sport Fish
Templin, William	Chief Fisheries Scientist	Division of Commercial Fisheries
Other participants:		
Bowers, Forrest	Deputy Director	Division of Commercial Fisheries
Dickson, Holly	Assistant Area Management Biologist/LCI	Division of Sport Fish
Dye, Jason	Regional Supervisor	Division of Sport Fish
Hollowell, Glenn	Area Management Biologist/LCI	Division of Commercial Fisheries
Lewis, Bert	Regional Supervisor	Division of Commercial Fisheries
Miller, Matthew	Regional Management Biologist	Division of Sport Fish
Poetter, Aaron	Regional Management Biologist	Division of Commercial Fisheries
Taube, Tom	Deputy Director	Division of Sport Fish

Table 2.–Current sustainable escapement goals (SEGs), recent escapements, and recommended action in 2023 for salmon stocks in Lower Cook Inlet, Alaska.

Species/System	Escapement data[a]	Escapement goal		Recent escapements				Recommendation
		Type	Range	2020	2021	2022	2023[b]	
Chinook salmon								
Anchor River	Sonar/Weir	SEG	3,800–7,600	3,624	4,300	3,123	2,338	Change
Deep Creek	SAS	LB SEG	350	327	NS	NS	NS	No change
Ninilchik River[c]	Weir	SEG	750–1,300	835	772	687	330	Change
Chum salmon								
Port Graham River	MFS	SEG	1,200–2,700	660	1,029	606	1,212	Change
Dogfish Lagoon	MAS or MFS	SEG	3,500–8,600	1,246	4,030	3,319	2,732	Change
Rocky River	MAS	SEG	1,500–4,400	5,010	6,542	5,580	7,912	Change
Port Dick Creek	MAS or MFS	SEG	1,900–4,300	1,040	3,261	2,817	7,126	Change
Island Creek	MAS or MFS	SEG	5,100–11,900	1,399	3,112	2,822	21,469	Change
Big Kamishak River	MAS	SEG	6,800–15,600	19,391	15,987	13,013	11,481	Change
Little Kamishak River	MAS	SEG	8,000–16,800	38,591	35,046	22,330	52,274	Change
McNeil River	MAS	SEG	24,000–48,000	8,850	15,219	17,739	25,142	Change
Bruin River	MAS	SEG	5,200–10,000	22,206	29,655	3,948	14,629	Change
Ursus Cove	MAS	SEG	5,900–10,100	4,367	7,500	6,977	16,190	Change
Cottonwood Creek	MAS	SEG	5,200–12,200	679	5,690	6,588	8,702	Change
Iniskin Bay	MAS	SEG	5,900–13,600	8,804	15,024	12,740	18,615	Change
Pink salmon								
Humpy Creek	MFS	SEG	17, 500–51,400	NS	3,125	2,055	15,478	Change
China Poot Creek	MFS	SEG	2,500–5,600	235	79	145	1,071	Change
Tutka Lagoon Creek	MFS	SEG	6,500–17,000	114,986	50,911	22,908	103,043	Change
Barabara Creek	MFS	SEG	2,000–5,600	6,633	5,451	3,492	14,750	Change
Seldovia River	MFS	SEG	21,800–37,400	39,297	21,849	16,999	45,755	Change
Port Graham River	MFS	SEG	7,700–19,700	34,784	12,824	9,193	20,080	Change

-continued-

Table 2.–Page 2 of 2.

Species/System	Escapement data[a]	Escapement goal Type	Range	Recent escapements 2020	2021	2022	2023[b]	Recommendation
Pink salmon (continued)								
Dogfish Lagoon Creeks	MAS or MFS	SEG	800–7,100	18,387	29,205	11,596	55,978	Change
Port Chatham	MAS or MFS	SEG	7,800–18,100	17,291	20,673	7,126	20,230	Change
Windy Creek Right	MFS	SEG	3,400–11,200	16,720	12,400	17,380	12,919	Change
Windy Creek Left	MFS	SEG	5,400–27,100	74,944	16,133	39,094	50,577	Change
Rocky River	MAS	SEG	11,700–54,800	8,310	41,446	12,542	41,111	Change
Port Dick Creek	MAS or MFS	SEG	17,900–49,800	108,219	115,740	30,411	67,708	Change
Island Creek	MAS or MFS	SEG	9,600–32,500	9,888	99,199	8,550	50,195	Change
S. Nuka Island Creek	MAS	SEG	2,800–11,200	3,943	6,567	2,300	7,161	Change
Desire Lake Creek	MAS	SEG	1,500–18,000	1,357	13,705	3,820	5,907	Change
Bruin River	MAS	SEG	17,800–103,000	57,320	78,374	330	29,617	Change
Sunday Creek	MAS	SEG	4,400–24,900	4,715	38,976	3,208	104,084	Change
Brown's Peak Creek	MAS	SEG	2,600–17,500	21,034	74,976	541	51,114	Change
Sockeye salmon								
English Bay Lakes[d]	PAS, Weir	SEG	6,000–13,500	31,486	6,328	11,452	23,936	Change
Delight Lake[e]	PAS, Weir	SEG	7,500–17,650	12,299	7,496	22,777	6,901	No change
Desire Lake	PAS	SEG	4,800–11,900	4,710	3,744	20,460	14,700	No change
Bear Lake[d]	Weir	SEG	700–8,300	8,222	11,318	9,961	7,975	Change
Aialik Lake	PAS	SEG	3,200–5,400	4,020	2,352	2,863	6,480	No change
Mikfik Lake	PAS, Video	SEG	3,400–11,000	305	2,346	2,870	2,917	No change
Chenik Lake[f]	PAS, Video	SEG	2,900–13,700	11,686	17,134	16,461	9,751	No change
Amakdedori Creek	PAS	SEG	1,200–2,600	6,992	4,370	2,050	1,300	No change

[a] SAS = single aerial survey, MAS = multiple aerial survey, MFS = multiple foot survey, PAS = peak aerial survey, NS = no survey.

[b] Preliminary.

[c] Escapement of naturally produced fish upstream of the weir between July 3 and 31 is the basis for the current Ninilchik River Chinook salmon sustainable escapement goal.

[d] Bear Lake and English Bay Lake escapements include only those fish allowed past the weir to spawn naturally in the lake, not those removed for broodstock.

[e] Delight Lake escapements are a combination of weir (2020–2022) and aerial survey counts (2023).

[f] An additional 3,296 sockeye were counted entering Chenik Lake at night in 2023 while testing a new lighting system, bringing the total escapement to 13,047. However, until there are enough years of night counts to facilitate recalibrating the SEG to 24 h/d monitoring, we will continue to use “day counts” only for inseason management.

Table 3.–Model parameter estimates for Anchor River Chinook salmon, calendar years 1977–2022.

Parameter	Median (95% CI)
S_{MSY}	3,933 (2,772–6,710)
S_{EQ}	9,684 (6,602–17,720)
S_{MSR}	7,552 (4,496–22,605)
$\ln(\alpha)$	1.1 (0.27–2.0)
β	1.32e-04 (4.42e-05–2.22e-04)
α	3.0 (1.3–7.5)
ϕ	0.57 (0.13–0.92)
σ_w	0.45 (0.33–0.66)
U_{MSY}	0.52 (0.22–0.80)
π_1	0.09 (0.07–0.12)
π_2	0.32 (0.28–0.36)
π_3	0.50 (0.45–0.54)
π_4	0.09 (0.07–0.12)
D	25.6 (16.5–38.3)
$\lambda_{survey77-88}$	0.18 (0.10–0.32)
$\lambda_{survey89-07}$	0.07 (0.05–0.09)

Note: Parameters π are the average age composition for ocean ages 1–4, parameter D is the scale of the Dirichlet distribution governing age composition, and parameter λ is an estimate of aerial survey observer efficiency.

Table 4.–Current and recommended sustainable escapement goals (SEGs) for Lower Cook Inlet Chinook salmon stocks, the percent change, and the rationale for the change.

		Current SEG Range				Recommended SEG Range				% Change		Rationale
Appendix table	Stock	Lower		Upper	Year adopted	Lower		Upper	*n*	Lower	Upper	for SEG action
A1	Anchor River	3,800	–	7,600	2017	3,200	–	6,400	46	-16%	-16%	[a]
A2	Deep Creek	350		NA	2017	NA		NA	43	NA	NA	
A3	Ninilchik River	750	–	1,300	2017	900	–	1,600	24	20%	23%	[b]

Note: *n* refers to the number of years used in the escapement goal analysis. For more details on each stock, refer to the appendix table referenced in column 1.

[a] An updated Bayesian full-probability model supported lowering both ends of the SEG range for the Anchor River.

[b] The new goal is for a weir further downstream and is expanded to include the entire escapement.

Table 5.–Current and recommended sustainable escapement goals (SEG) for Lower Cook Inlet chum salmon stocks.

		Current SEG range			Year	Recommended SEG range				% Change[a]		Rationale for
District	Stock	Lower		Upper	adopted	Lower		Upper	*n*	Lower	Upper	SEG action
Southern	Port Graham River	1,200	–	2,700	2017		–		40			[b]
Outer	Dogfish Lagoon	3,500	–	8,600	2017		–		40			[b]
Outer	Rocky River	1,500	–	4,400	2017		–		39			[b]
Outer	Port Dick Creek	1,900	–	4,300	2017		–		40			[b]
Outer	Island Creek	5,100	–	11,900	2017		–		40			[b]
Kamishak	Big Kamishak River	6,800	–	15,600	2017		–		35			[b]
Kamishak	Little Kamishak River	8,000	–	16,800	2017		–		37			[b]
Kamishak	McNeil River	24,000	–	48,000	2008		–		40			[b]
Kamishak	Bruin River	5,200	–	10,000	2017		–		40			[b]
Kamishak	Ursus Cove	5,900	–	10,100	2017		–		40			[b]
Kamishak	Cottonwood Creek	5,200	–	12,200	2017		–		40			[b]
Kamishak	Iniskin Bay	5,900	–	13,600	2017		–		40			[b]
Southern	3 stocks[c]					1,500	–	5,000	47			[b]
Outer	8 stocks[d]					17,500	–	32,000	47			[b]
Kamishak	10 stocks[e]					50,000	–	115,000	47			[b]

Note: *n* refers to the number of years used in the escapement goal analysis. For more details on each stock contributing to district goals, refer to Table 6 and Appendix B.

[a] Current SEGs are stock specific and the recommended SEGs are aggregate goals by district, so the percent change in the goal cannot be calculated.

[b] Transition to aggregate district SEG to improve assessment of stock productivity and be consistent with how this species is managed in other areas throughout Alaska.

[c] Index streams assessed annually and used to develop the aggregate Southern District SEG: Humpy Creek, Port Graham River, and Seldovia River. The Southern District aggregate SEG range was rounded to the nearest 500 fish.

[d] Index streams assessed annually and used to develop the aggregate Outer District SEG: Dogfish Lagoon, Island Creek, Middle Creek, Petrof River, Port Chatham Creeks, Port Dick Creek, Rocky River, and Slide Creek. The Outer District aggregate SEG range was rounded to the nearest 500 fish.

[e] Index streams assessed annually and used to develop the aggregate Kamishak District SEG: Big Kamishak River, Bruin River, Cottonwood Creek, Douglas River, Iniskin River, Little Kamishak River, McNeil River, Sugarloaf Creek, Sunday Creek, and Ursus Lagoon Creeks. The Kamishak District aggregate SEG range was rounded to the nearest 5,000 fish.

Table 6.–List and characteristics of stocks used to develop aggregate (by district) escapement goals for chum salmon in Lower Cook Inlet. Note that each stock has a management objective to inform the need to restrict fishing in subdistricts with weak performing stocks.

District	Stock	History of fishery[a]	Median escapement (1976–2022)	*n*	Proportion of district escapement	Monitoring method[b]	Management objective Lower		Management objective Upper
Southern	Humpy Creek	PS, SGN	1,143	21	20.7%	MFS	300	–	1,000
Southern	Port Graham River[c]	PS, SGN	2,200	47	39.8%	MFS	600	–	2,000
Southern	Seldovia River	PS, SGN	2,188	21	39.6%	MFS	600	–	2,000
	District Total:		5,531		100.0%	District SEG:	1,500	–	5,000
Outer	Dogfish Lagoon Creeks[c]	PS	6,400	47	24.0%	MAS/MFS	4,200	–	7,700
Outer	Island Creek[c]	PS	8,700	47	32.6%	MAS/MFS	5,700	–	10,400
Outer	Middle Creek	PS	745	20	2.8%	MAS/MFS	500	–	900
Outer	Petrof River	PS	920	21	3.4%	MAS	600	–	1,100
Outer	Port Chatham Creeks	PS	493	21	1.8%	MAS/MFS	300	–	600
Outer	Port Dick Creek[c]	PS	3,300	47	12.4%	MAS/MFS	2,200	–	4,000
Outer	Rocky River[c]	PS	4,350	47	16.3%	MAS	2,900	–	5,200
Outer	Slide Creek	PS	1,775	21	6.7%	MAS/MFS	1,200	–	2,100
	District total:		26,683		100.0%	District SEG:	17,500	–	32,000
Kamishak	Big Kamishak River[c]	PS	14,900	44	15.7%	MAS	7,900	–	18,100
Kamishak	Bruin River[c]	PS	9,900	47	10.4%	MAS	5,200	–	12,000
Kamishak	Cottonwood Creek[c]	PS	8,300	47	8.8%	MAS	4,400	–	10,100
Kamishak	Douglas River	PS	3,225	20	3.4%	MAS	1,700	–	3,900
Kamishak	Iniskin River[c]	PS	12,000	47	12.7%	MAS	6,300	–	14,500
Kamishak	Little Kamishak River[c]	PS	15,335	44	16.2%	MAS	8,100	–	18,600
Kamishak	McNeil River[c,d]	PS	19,290	47	20.3%	MAS	24,000	–	48,000
Kamishak	Sugarloaf Creek	PS	1,606	20	1.7%	MAS	800	–	1,900
Kamishak	Sunday Creek	PS	1,290	19	1.4%	MAS	700	–	1,600
Kamishak	Ursus Lagoon Creeks[c]	PS	9,000	47	9.5%	MAS	4,700	–	10,900
	District total:		94,846		100.0%	District SEG:	50,000	–	115,000

Note: *n* refers to the number of years of data available from each stock for the escapement goal analysis.

[a] SGN = set gillnet, PS = purse seine.

[b] MAS = multiple aerial survey, MFS = multiple foot survey.

[c] Designates a stock that currently has an individual escapement goal.

[d] The management target for McNeil River chum salmon would be the 10,000–23,000 under the "median proportion of district escapement approach" used for all other stocks. However, until McNeil River is delisted as a stock of management concern, ADF&G will continue to use the SEG range that was in place at the time the stock was listed.

Table 7.–Current and recommended sustainable escapement goals (SEG) for Lower Cook Inlet pink salmon stocks.

		Current SEG range				Recommended SEG range				% Change[a]		Rationale for SEG action
District	Stock	Lower		Upper	Year adopted	Lower		Upper	*n*	Lower	Upper	
Southern	Humpy Creek	17,500	–	51,400	2017		–		40			[b]
Southern	China Poot Creek	2,500	–	6,300	2017		–		40			[b]
Southern	Tutka Creek	6,500	–	17,000	2002		–		25			[b]
Southern	Barabara Creek	2,000	–	5,600	2017		–		40			[b]
Southern	Seldovia Creek	21,800	–	37,400	2017		–		40			[b]
Southern	Port Graham River	7,700	–	19,700	2017		–		22			[b]
Outer	Dogfish Lagoon Creeks	800	–	7,100	2017		–		38			[b]
Outer	Port Chatham	7,800	–	18,100	2017		–		39			[b]
Outer	Windy Creek Right	3,400	–	11,200	2017		–		40			[b]
Outer	Windy Creek Left	5,400	–	27,100	2017		–		40			[b]
Outer	Rocky River	11,700	–	54,800	2017		–		40			[b]
Outer	Port Dick Creek	17,900	–	49,800	2017		–		40			[b]
Outer	Island Creek	9,600	–	32,500	2017		–		39			[b]
Outer	S. Nuka Island Creek	2,800	–	11,200	2017		–		36			[b]
Outer	Desire Lake	1,500	–	18,000	2017		–		37			[b]
Kamishak	Bruin River	17,800	–	103,000	2017		–		40			[b]
Kamishak	Sunday Creek	4,400	–	24,900	2017		–		40			[b]
Kamishak	Brown's Peak Creek	2,600	–	17,500	2017		–		40			[b]
Southern	4 stocks[c]					50,000	–	110,000	47			
Outer	13 stocks[d]					105,000	–	235,000	47			
Kamishak	5 stocks[e]					35,000	–	150,000	47			

Note: *n* refers to the number of years used in the escapement goal analysis. For more details on each stock contributing to district goals, refer to Table 8 and Appendix C.

[a] Current SEGs are stock specific and the recommended SEGs are aggregate goals by district, so the percent change in the goal cannot be calculated.

[b] Transition to aggregate district SEG to improve assessment of stock productivity and be consistent with how this species is managed in other areas throughout Alaska.

[c] Index streams assessed annually and used to develop the aggregate Southern District SEG: Barabara, China Poot, Humpy, and Seldovia; Tutka and Port Graham excluded due to hatchery influence. The Southern District aggregate SEG range was rounded to the nearest 5,000 fish.

[d] Index streams assessed annually and used to develop the aggregate Outer District SEG: Desire, Dogfish, Island, James Lagoon, Middle, Port Chatham, Port Dick, Rocky, Slide, South Nuka, Taylor Bay, Windy Left, and Windy Right. The Outer District aggregate SEG range was rounded to the nearest 5,000 fish.

[e] Index streams assessed annually and used to develop the aggregate Kamishak District SEG: Amakdedori, Brown's Peak, Bruin, Little Kamishak, and Sunday. The Kamishak District aggregate SEG range was rounded to the nearest 5,000 fish.

Table 8.–List and characteristics of stocks used to develop aggregate (by district) escapement goals for Lower Cook Inlet pink salmon. Note that each stock has a management objective to inform the need to restrict fishing in subdistricts with weak performing stocks.

							Management objective		
District	Stock	History of fishery[a]	Median escapement (1976–2022)	*n*	Proportion of district escapement	Monitoring method[b]	Lower		Upper
Southern	Barabara Creek[c]	PS, SGN	5,100	47	6.4%	MFS	3,200	–	7,000
Southern	China Poot Creek[c]	PS, SGN	3,900	47	4.9%	MFS	2,400	–	5,300
Southern	Humpy Creek[c]	PS, SGN	41,213	47	51.4%	MFS	25,700	–	56,500
Southern	Seldovia River[c]	PS, SGN	30,000	47	37.4%	MFS	18,700	–	41,100
	District total:		80,213		100.0%	District SEG:	50,000	–	110,000
Outer	Desire Lake[c]	PS	9,000	46	4.6%	MAS	4,800	–	10,700
Outer	Dogfish Lagoon Creeks[c]	PS	6,700	47	3.4%	MAS or MFS	3,600	–	8,000
Outer	Island Creek[c]	PS	25,000	47	12.7%	MAS or MFS	13,300	–	29,800
Outer	James Lagoon Creeks	PS	3,842	28	2.0%	MAS	2,000	–	4,600
Outer	Middle Creek	PS	5,004	20	2.5%	MAS or MFS	2,700	–	6,000
Outer	Port Chatham Creeks[c]	PS	16,550	47	8.4%	MAS or MFS	8,800	–	19,800
Outer	Port Dick Creek[c]	PS	44,700	47	22.7%	MAS or MFS	23,800	–	53,400
Outer	Rocky River[c]	PS	26,100	47	13.3%	MAS	13,900	–	31,200
Outer	Slide Creek	PS	13,471	21	6.8%	MAS or MFS	7,200	–	16,100
Outer	South Nuka Island Creek[c]	PS	2,453	47	1.2%	MAS	1,300	–	2,900
Outer	Taylor Bay Creeks	PS	10,857	20	5.5%	MAS	5,800	–	13,000
Outer	Windy Bay Left Creek[c]	PS	23,300	47	11.8%	MAS	12,400	–	27,800
Outer	Windy Bay Right Creek[c]	PS	9,900	47	5.0%	MAS	5,300	–	11,800
	District total:		196,876		100.0%	District SEG:	105,000	–	235,000
Kamishak	Amakdedori Creek	PS	2,497	41	2.3%	MAS	800	–	3,400
Kamishak	Brown's Peak Creek[c]	PS	15,000	54	13.8%	MAS	4,800	–	20,700
Kamishak	Bruin River[c]	PS	74,900	55	68.9%	MAS	24,100	–	103,400
Kamishak	Little Kamishak River	PS	2,100	32	1.9%	MAS	700	–	2,900
Kamishak	Sunday Creek[c]	PS	14,200	54	13.1%	MAS	4,600	–	19,600
	District total:		108,697		100.0%	District SEG:	35,000	–	150,000

Note: *n* refers to the number of years of data available from each stock for the escapement goal analysis.

[a] SGN = set gillnet, PS = purse seine.

[b] MAS = multiple aerial survey, MFS = multiple foot survey.

[c] Designates a stock that currently has an individual escapement goal.

Table 9.–Current and recommended sustainable escapement goals (SEGs) for Lower Cook Inlet sockeye salmon stocks, the percent change, and the rationale for the change.

Appendix table	Stock	Current SEG range			Year adopted	Recommended SEG range			*n*	% Change		Rationale for SEG action
		Lower		Upper		Lower		Upper		Lower	Upper	
D1	English Bay	6,000	–	13,500	2002	6,300	–	12,200	47	5%	-10%	[a,b,c]
D2	Delight Lake	5,100	–	10,600	2017	5,100	–	10,600	35	0%	0%	[d]
D3	Desire Lake	4,800	–	11,900	2017	4,800	–	11,900	40	0%	0%	[d]
D4	Bear Lake	700	–	8,300	2002	600	–	8,600	47	-14%	4%	[a,c]
D5	Aialik Lake	3,200	–	5,400	2017	3,200	–	5,400	40	0%	0%	[d]
D6	Mikfik Lake	3,400	–	11,000	2017	3,400	–	11,000	17	0%	0%	[d]
D7	Chenik Lake	2,900	–	13,700	2017	2,900	–	13,700	20	0%	0%	[d]
D8	Amakdedori Creek	1,200	–	2,600	2017	1,200	–	2,600	40	0%	0%	[d]
						Average for stocks with an SEG change:				-5%	-3%	

Note: *n* refers to the number of years used in the escapement goal analysis. For more details on each stock, refer to the appendix table referenced in column 1.

[a] There were 21 years of additional escapement data available for analysis, including some with escapements outside the current SEG range.

[b] Analyses presented in Clark et al. (2014) suggest the long-term productivity of this stock may benefit from revising the SEG range.

[c] To be consistent and base all LCI SEGs on the most current and robust methods available for stocks lacking stock productivity information (Clark et al. 2014).

[d] Goal was last revised in 2017 using the Percentile Approach (Clark et al. 2014); review of recent escapement data indicate no change is warranted.

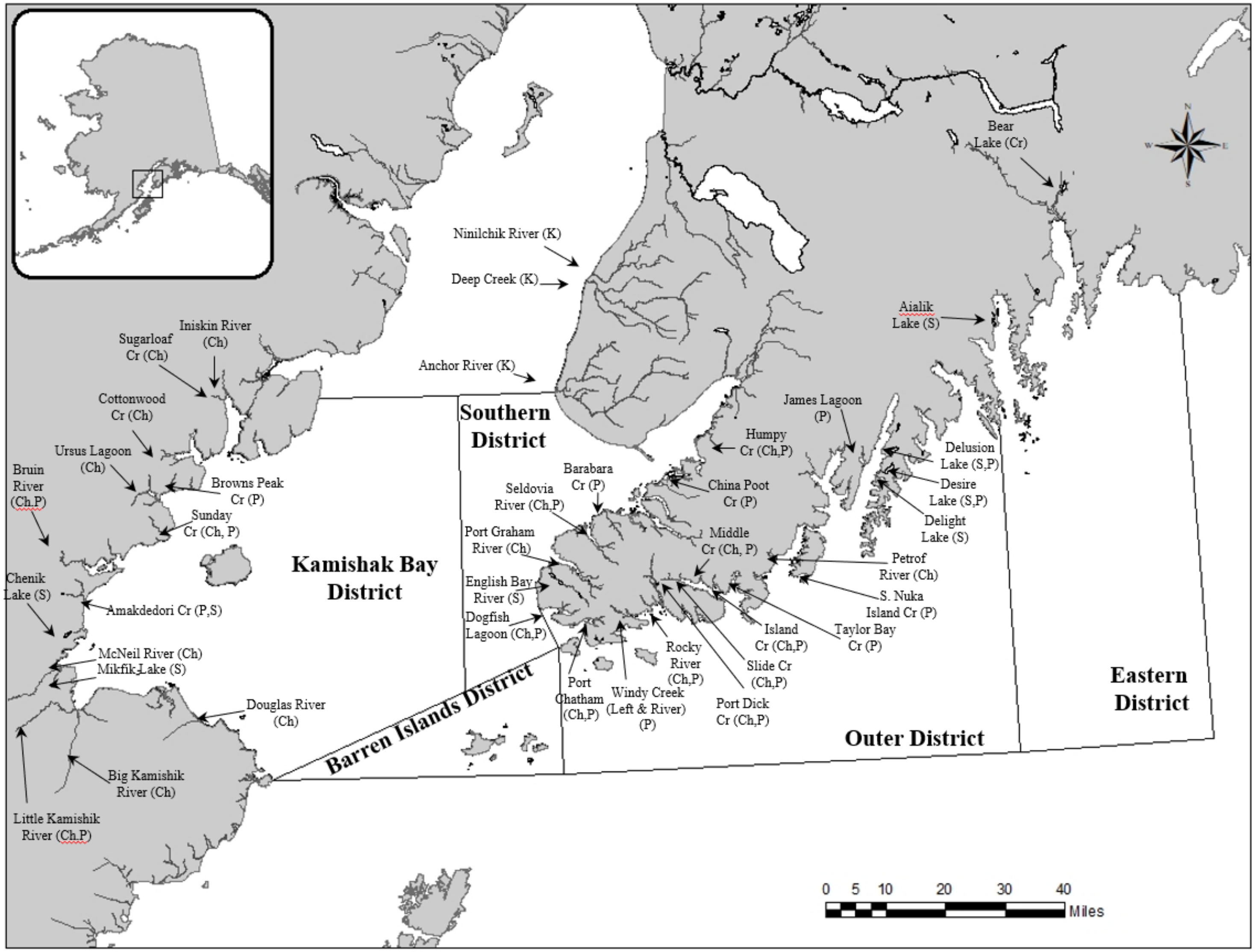

Figure 1.–Lower Cook Inlet commercial fisheries management area, illustrating the 5 management districts and the locations of salmon-producing streams with escapement goals, or used as index streams for monitoring species managed by aggregate district goals (pink and chum salmon). K = King (Chinook), Ch = chum, P = pink, S = sockeye.

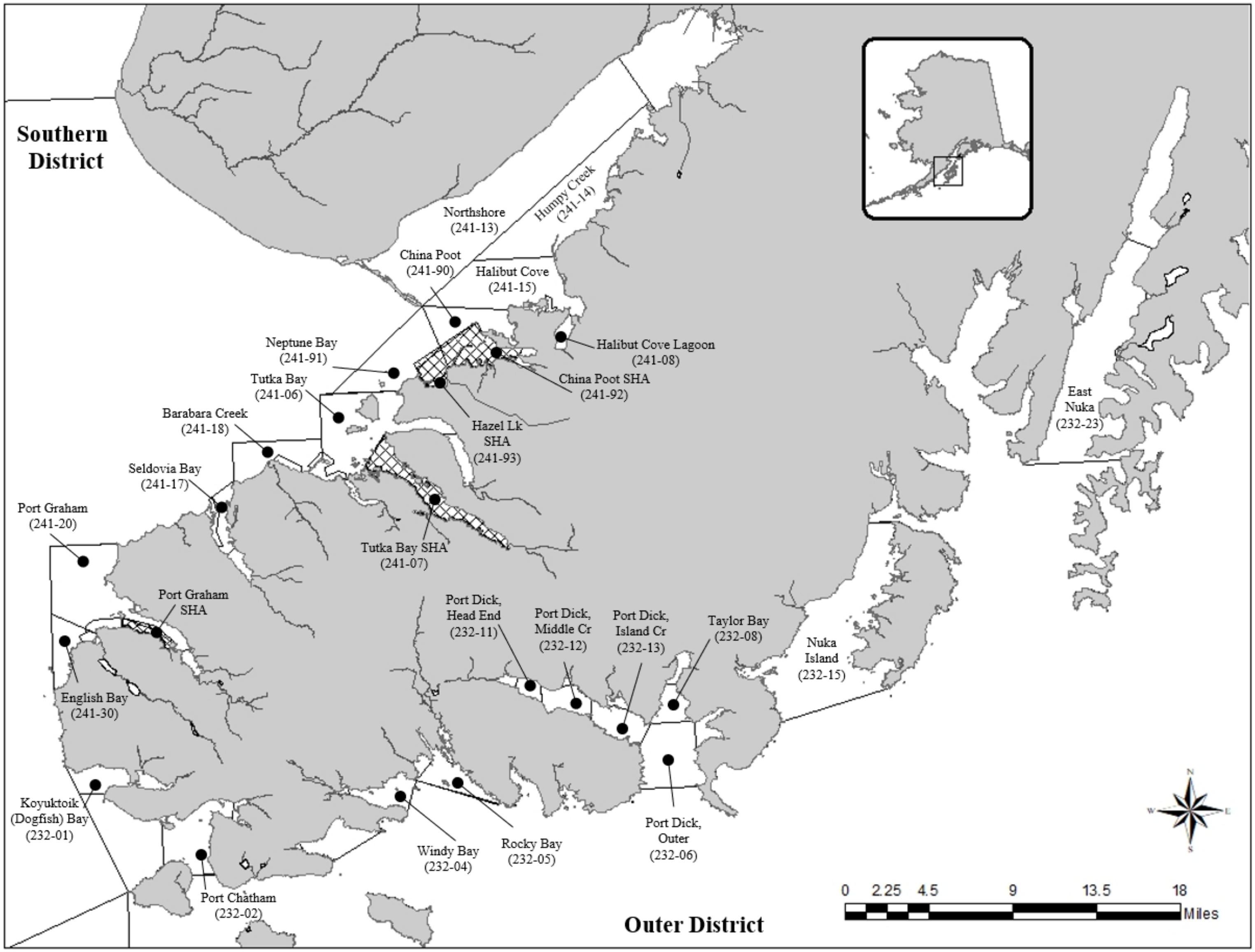

Figure 2.–Map illustrating subdistricts and hatchery special harvest areas (SHA: hatched polygons) in the Southern and Outer districts that are used to manage commercial fisheries targeting stocks returning to those areas.

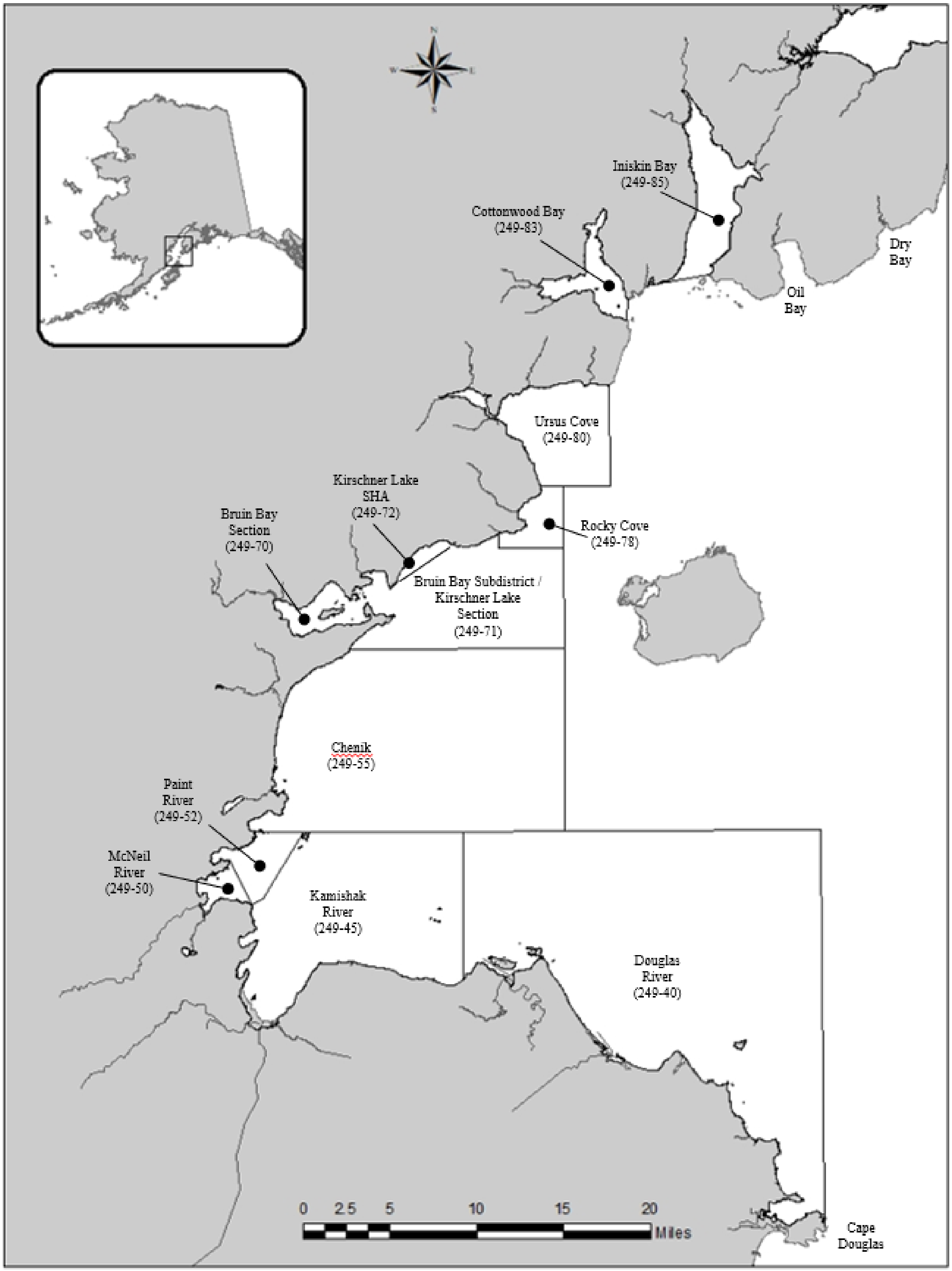

Figure 3.–Map illustrating subdistricts and hatchery special harvest areas (SHA) in the Kamishak District that are used to manage commercial fisheries targeting stocks returning to those areas.

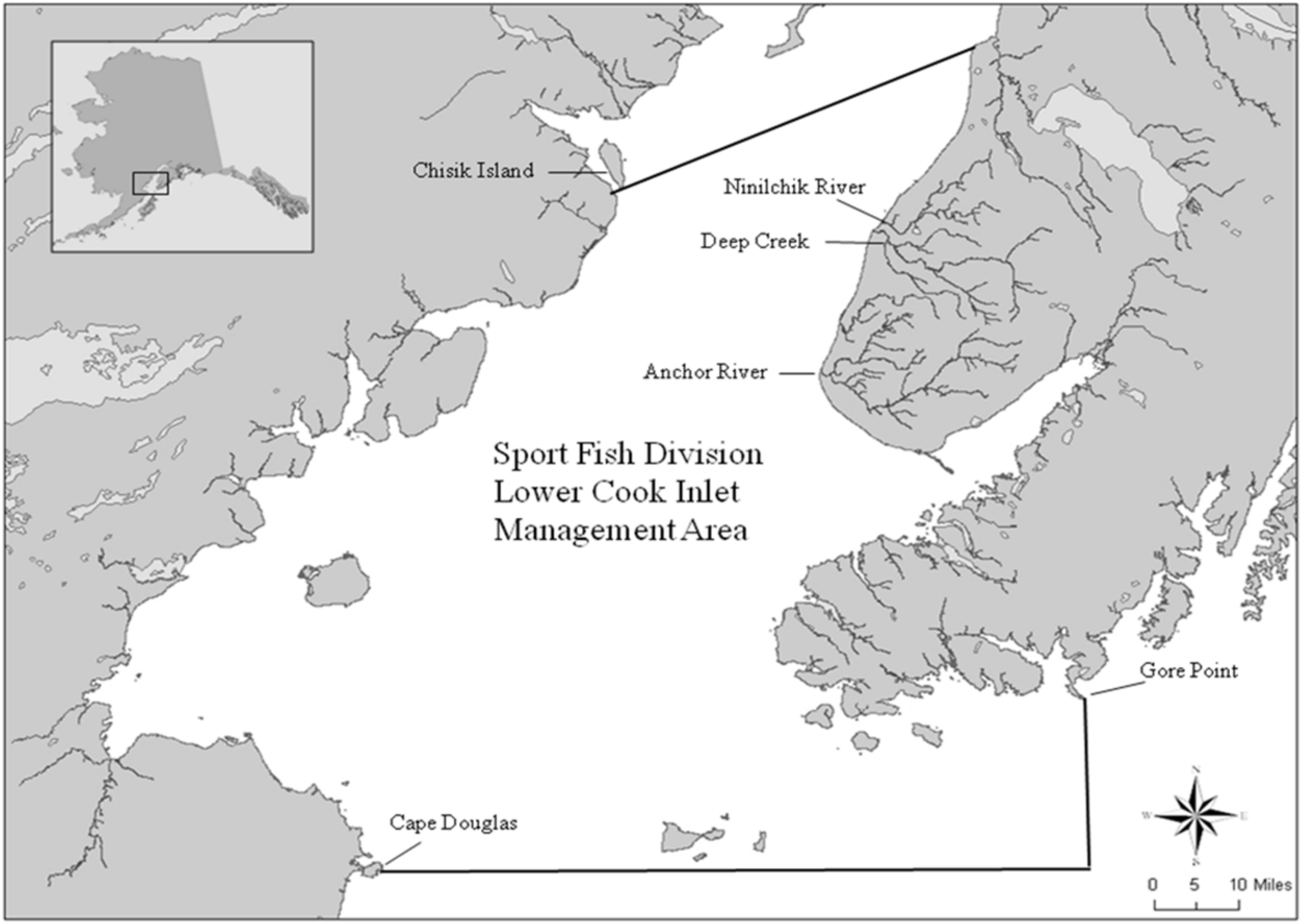

Figure 4.–Lower Cook Inlet sport fish management area, illustrating the locations of Chinook salmon-producing streams with escapement goals.

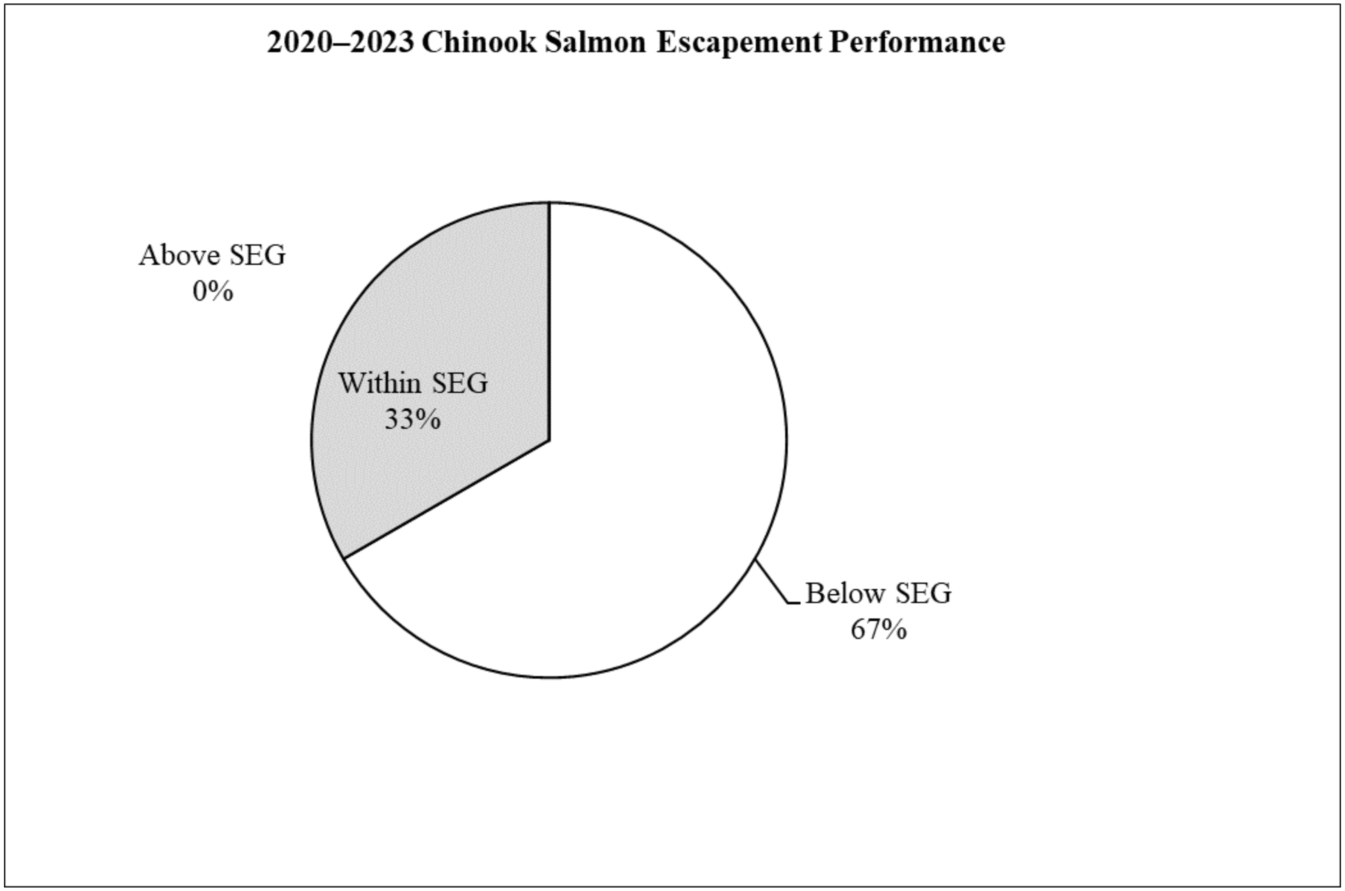

Figure 5.–2020–2023 Lower Cook Inlet Chinook salmon escapement performance for 3 stocks relative to their current sustainable escapement goal range (*n* = 9; no survey of Deep Creek in 3 of 4 years)

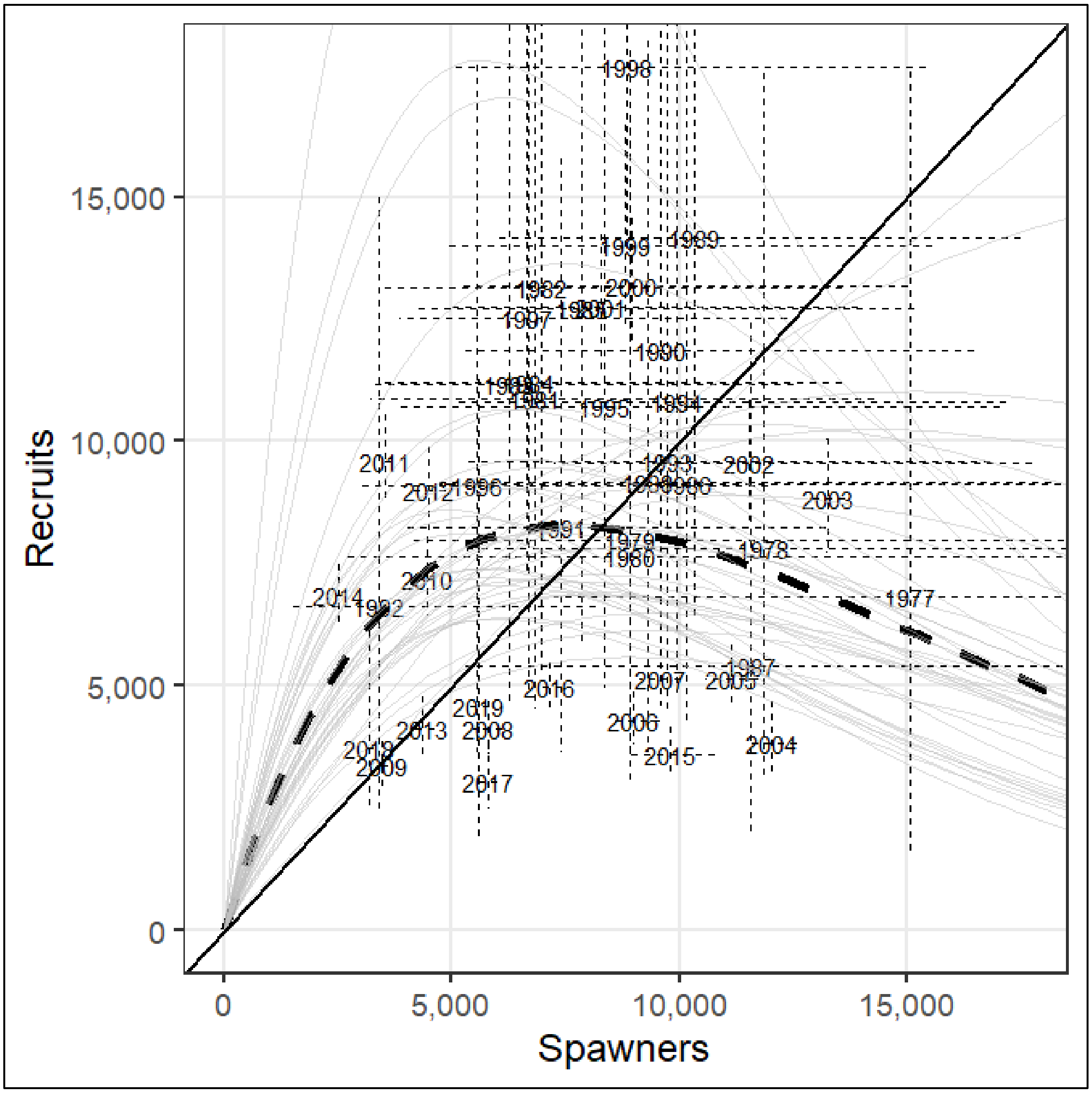

Figure 6.–Plausible spawner-recruit relationships for the Anchor River Chinook salmon stock as derived from an age-structured state-space model fitted to abundance, harvest, and age data for 1977–2022.

Note: Posterior means of R and S are plotted as brood year labels with 95% credibility intervals plotted as light dashed lines. The heavy dashed line is the Ricker relationship constructed from ln(α′) and β posterior medians. Ricker relationships are also plotted (light grey lines) for 40 paired values of ln(α′) and β sampled from the posterior probability distribution, representing plausible Ricker relationships that could have generated the observed data. Recruits replace spawners (R = S) on the diagonal line.

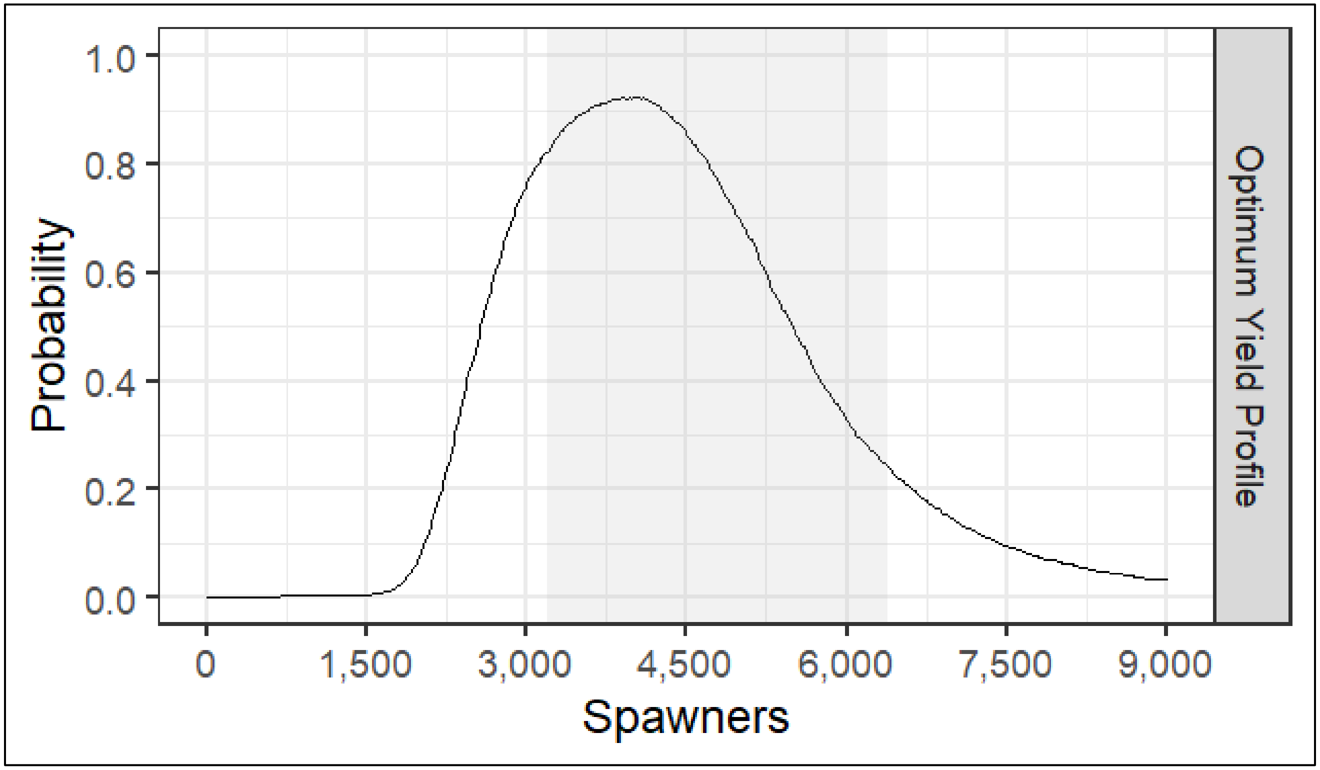

Figure 7.–Optimal yield profile for Anchor River Chinook salmon. Profiles show the probability that a specified spawning abundance will result in 90% of maximum sustained yield. Grey shaded area brackets the proposed goal range (3,200–6,400; SMSY=3,933 (95% CI: 2,772–6,710).

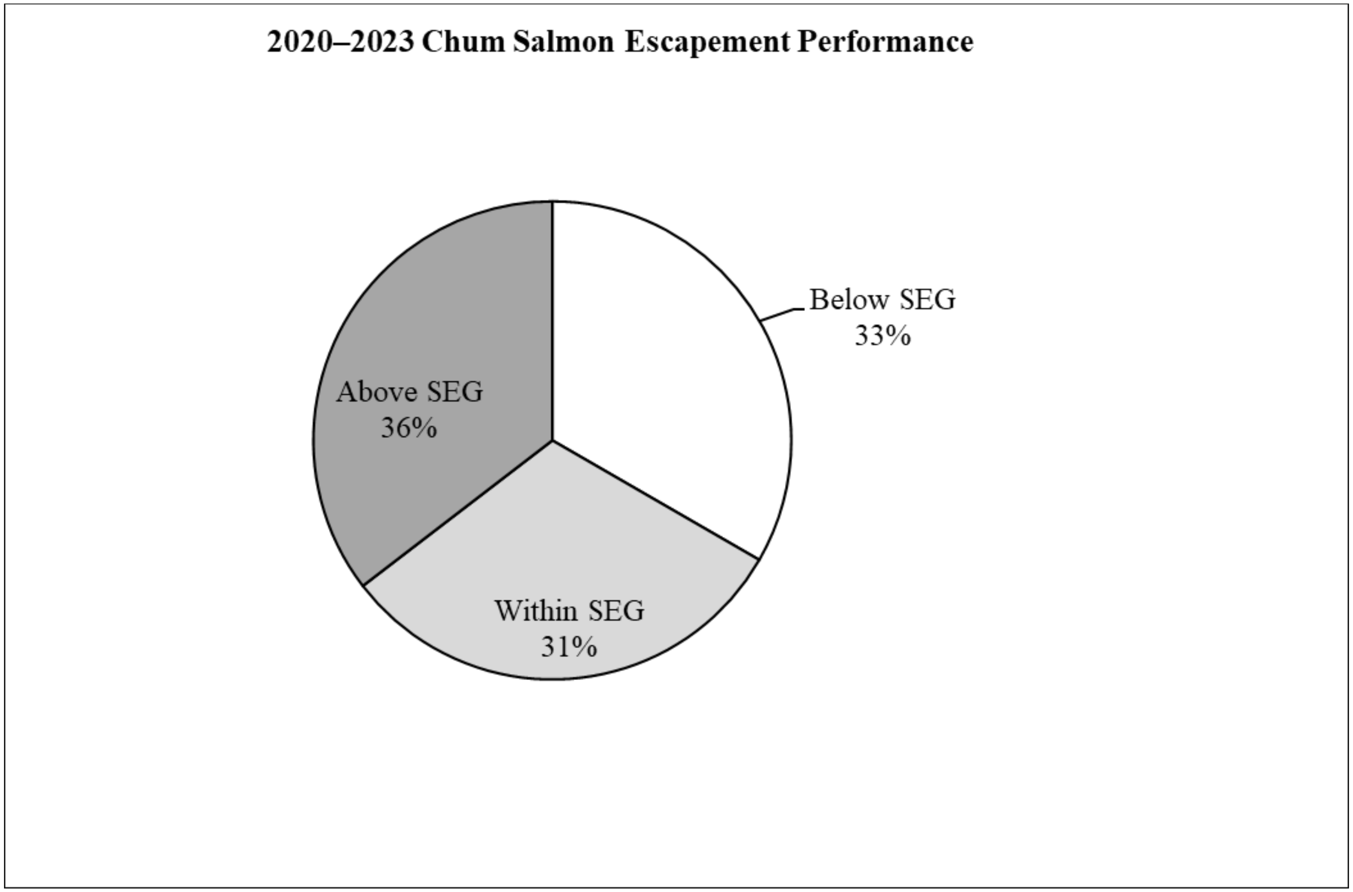

Figure 8.–2020–2023 Lower Cook Inlet chum salmon escapement performance for 12 stocks relative to their current sustainable escapement goal range (n = 48).

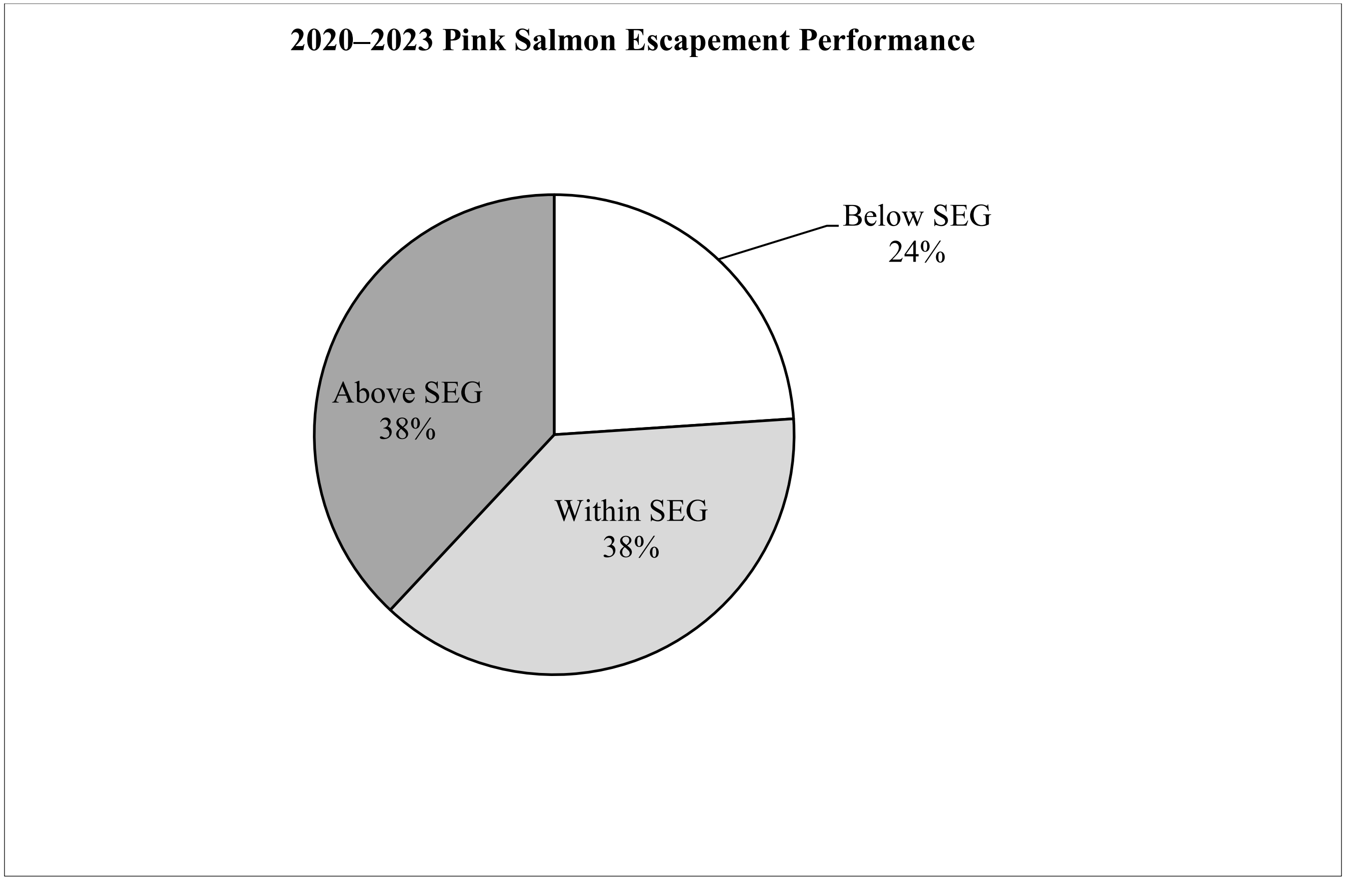

Figure 9.–2020–2023 Lower Cook Inlet pink salmon escapement performance for 18 stocks relative to their current sustainable escapement goal range (*n* = 71; no escapement estimate for Humpy Creek in 2020).

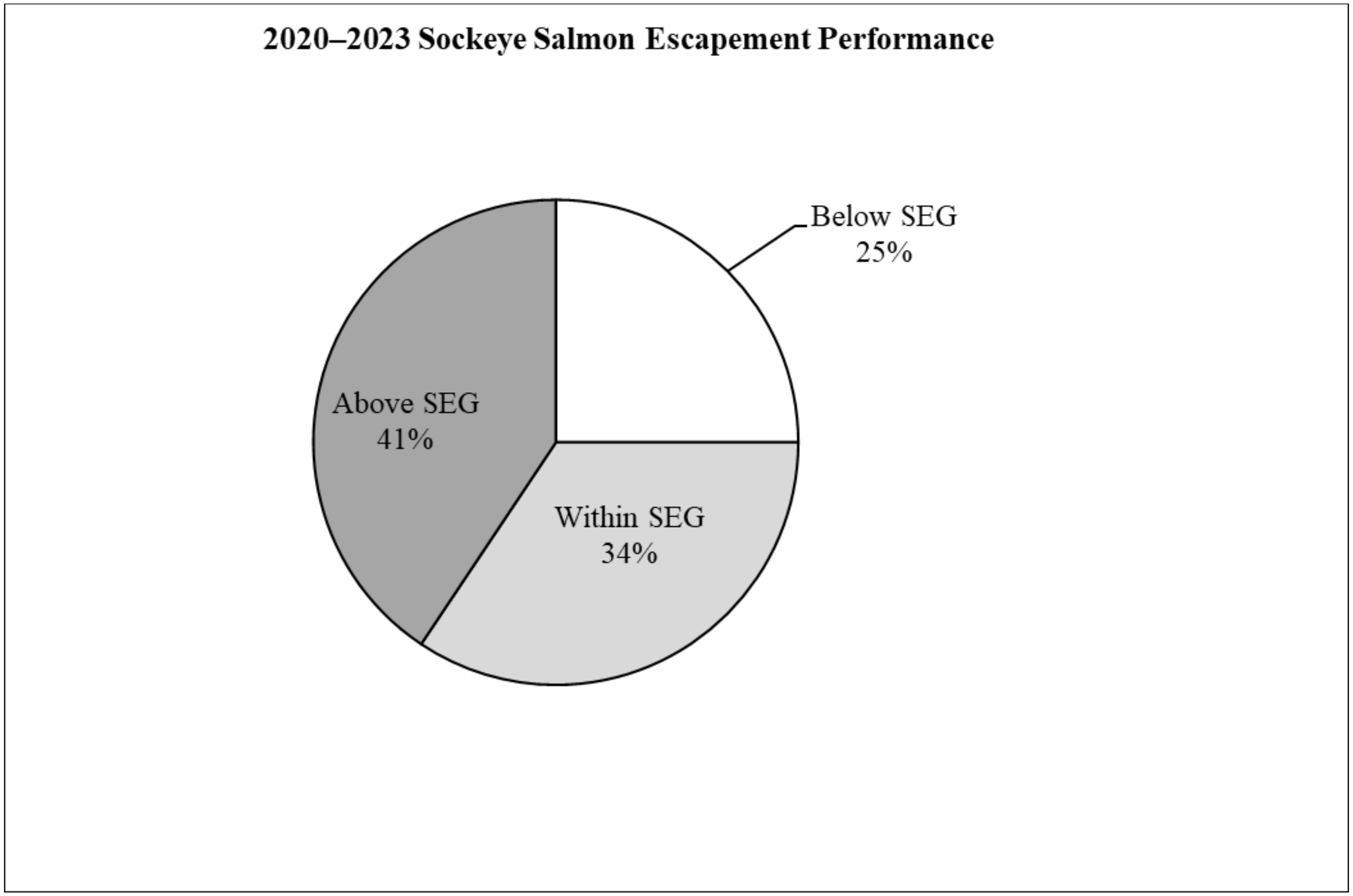

Figure 10.–2020–2023 Lower Cook Inlet sockeye salmon escapement performance for 8 stocks relative to their current sustainable escapement goal range (n = 32).

APPENDIX A: SUPPORTING INFORMATION FOR CHINOOK SALMON GOALS

Appendix A1.–Escapement data and stock characteristics used to update analysis of Anchor River Chinook salmon escapement goal.

Stock:	Anchor River		**Species:**	Chinook salmon
Monitoring method:	Weir/sonar		**No. of years:**	46
Analysis used:	Bayesian full-probability model (BFPM)			

Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Sonar/weir escapement indices:	2,499	12,016	6,259	Contrast = 4.8
Harvest rate:	0.00	0.20	0.09	
Current SEG[a]:	3,800	7,600	Year adopted:	2017
Updated SEG analysis[b]:	3,200	6,400		
% Difference:	-16%	-16%		
Finding:	Change the SEG to 3,200–6,400 fish.			

Rationale for recommendation: The committee recommended adjusting the lower and upper bounds of the SEG range for this stock after examination of yield curves produced from the BFPM.

Year	Aerial survey escapement[c]	Year	Aerial survey escapement[c]	Year	Sonar/weir escapement
1977	3,585	1997	477	2003	11,917 [d]
1978	2,209	1998	789	2004	12,016 [d]
1979	1,335	1999	685	2005	11,156 [d]
1980	NS	2000	752	2006	8,945 [d]
1981	1,066	2001	414	2007	9,622 [d]
1982	1,493	2002	748	2008	5,806 [d]
1983	1,033	2003	680	2009	3,455 [d]
1984	1,087	2004	834	2010	4,449 [d]
1985	1,328	2005	651	2011	3,545 [d]
1986	2,287	2006	899	2012	4,509 [d]
1987	2,524	2007	678	2013	4,401 [e]
1988	1,458	2008	528	2014	2,499 [f]
1989	940	–	–	2015	10,241 [f]
1990	967	–	–	2016	7,142 [f]
1991	589	–	–	2017	5,700 [f]
1992	99	–	–	2018	3,129 [f]
1993	1,110	–	–	2019	5,603 [g]
1994	837	–	–	2020	3,624 [g]
1995	NS	–	–	2021	4,300 [g]
1996	277	–	–	2022	3,123 [g]

[a] The Bayesian full-probability model was used to develop the current SEG range using aerial survey data from 1997 through 2008 and sonar/weir estimates from 2003–2015 (methods of Szarzi et al. 2007).

[b] The Bayesian full-probability model was used to develop the updated SEG analysis using aerial survey data from 1977 through 2008 and sonar/weir estimates from 2003 to 2022 (updated with escapement and harvest data through 2022).

[c] Aerial survey escapement indices during 1977–2008 were derived from single helicopter surveys of the South Fork of the Anchor River, conducted around the peak of the run. NS = no survey.

[d] Chinook salmon were monitored in the mainstem Anchor River below the confluence of the North/South forks using DIDSON sonar and/or resistance board weir and/or instream video during 2003–2012. Monitoring occurred throughout the run, except in 2003, when an expansion was applied.

[e] A series of floods rendered the mainstem Anchor River site unsuitable for escapement monitoring. A combination of mainstem DIDSON sonar and weir/video systems operated on both the North and South forks was used to assess escapement throughout the run in 2013.

[f] DIDSON sonar and/or resistance board weirs equipped with instream video were used to monitor Chinook salmon escapement throughout the run on both the North and South forks of the Anchor River during 2014–2018.

[g] ARIS sonar and/or resistance board weirs equipped with instream video were used to monitor Chinook salmon escapement throughout the run on both the North and South forks of the Anchor River during 2019–2022.

Appendix A2.–Escapement data and stock characteristics used to update analysis of Deep Creek Chinook salmon escapement goal.

Stock:	Deep Creek		**Species:**	Chinook salmon
Monitoring method:	Single aerial survey		**No. of years:**	43
Analysis used:	Percentile Approach (Clark et al. 2014)			
Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	63	1,190	580	Contrast = 18.9
Harvest rate:	Low	Moderate	Low	
Percentiles used:	0.20	–	–	Tier 1
Current SEG[a]:	350	–	Year adopted:	2017
Updated SEG analysis[b]:	350	–	–	Lower bound SEG
% Difference:	0%	NA	–	–
Finding:	No change.			

Rationale for recommendation: The committee recommended no change to the Lower Bound SEG.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	1,075	1992	63	2008	205
1977	848	1993	486	2009	483
1978	582	1994	364	2010	387
1979	726	1995	229	2011	696
1980	NS	1996	193	2012	447
1981	427	1997	136	2013	475
1982	977	1998	676	2014	601
1983	550	1999	1,190	2015	535
1984	380	2000	556	2016	NS
1985	644	2001	551	2017	753
1986	976	2002	696	2018	182
1987	968	2003	1,008	2019	753
1988	409	2004	1,075	2020	327
1989	561	2005	1,076	2021	NS
1990	347	2006	507	2022	NS
1991	294	2007	553		

[a] The Percentile Approach (Clark et al. 2014) was used for the SEG analysis using single aerial survey indices from 1976 to 2015.

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using single aerial survey indices from 1976 to 2022.

[c] Escapement was estimated from single aerial survey data unless otherwise specified. NS = no survey.

Appendix A3.–Escapement data and stock characteristics used to update analysis of Ninilchik River Chinook salmon escapement goal.

Stock:	Ninilchik River		**Species:**	Chinook salmon
Monitoring method:	Weir		**No. of years:**	24
Analysis used:	Percentile Approach (Clark et al. 2014)			
Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	687	2,076	1,123	Contrast = 3.0
Harvest rate:	Low	Moderate	Moderate	
Percentiles used:	0.05	0.65		Tier 3
Current SEG[a]:	750	1,300	Year adopted:	2017
Updated SEG analysis[b]:	900	1,600		
% Difference:	20%	23%		
Recommendation:	Change the SEG to 900–1,600 fish.			

Rationale for recommendation: The committee recommended revising the SEG for this stock to change the goal, so it represents the entire run at the lower weir.

Year	Escapement[c]	Year	Escapement[c]
1999	1,925	2011	1,248
2000	1,900	2012	931
2001	1,539	2013	1,043
2002	1,662	2014	1,568
2003	1,394	2015	1,556
2004	1,717	2016	1,886
2005	2,552	2017	1,056
2006	1,754	2018	1,201
2007	1,028	2019	1,420
2008	1,095	2020	988
2009	906	2021	861
2010	1,033	2022	957

[a] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using weir counts from 1999 to 2016.

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using expanded weir counts from 1999 to 2022.

[c] Escapements during 1999–2018 were expanded from the broodstock weir location to the lower weir location by the average percent of Chinook salmon that were counted at both locations in 2019–2022. Escapements from 2019 to 2022 are counts from the lower weir location.

Appendix A4.–Additional escapement data and associated information used to update analysis of Ninilchik River Chinook salmon escapement goal.

		Wild Chinook salmon counts					
Year	Estimated % of the run monitored	Upper weir count	Expanded weir count[a]	Expanded weir count[b]	Total removals	Total upper weir escapement	Total lower weir escapement
1999	100.0	1,644	NA	1,993	68	1,576	1,925
2000	100.0	1,634	NA	1,981	81	1,553	1,900
2001	100.0	1,414	NA	1,714	175	1,239	1,539
2002	100.0	1,516	NA	1,838	176	1,340	1,662
2003	100.0	1,258	NA	1,525	131	1,127	1,394
2004	100.0	1,525	NA	1,849	132	1,393	1,717
2005	100.0	2,241	NA	2,717	165	2,076	2,552
2006	74.5	1,139	1,530	1,855	101	1,429	1,754
2007	71.2	679	954	1,157	129	825	1,028
2008	75.8	772	1,019	1,235	140	879	1,095
2009	79.3	620	781	947	41	740	906
2010	73.1	623	852	1,033	0	852	1,033
2011	75.2	835	1,111	1,347	99	1,012	1,248
2012	77.2	609	789	957	26	763	931
2013	75.9	674	888	1,077	34	854	1,043
2014	72.3	990	1,369	1,660	92	1,277	1,568
2015	73.9	1,002	1,356	1,644	88	1,268	1,556
2016	100.0	1,676	NA	2,032	146	1,530	1,886
2017	100.0	945	NA	1,146	90	855	1,056
2018	100.0	1,046	NA	1,268	67	979	1,201
2019	100.0	1,327	NA	1,655	235	1,092	1,420
2020	100.0	960	NA	1,113	125	835	988
2021	100.0	820	NA	909	48	772	861
2022	100.0	741	NA	1,011	54	687	957

[a] 2006–2015 expanded to full run at broodstock weir.

[b] Expanded to lower weir. 2019–2022 actual lower weir counts.

APPENDIX B: SUPPORTING INFORMATION FOR CHUM SALMON GOALS

Appendix B1.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to develop the aggregate Southern District chum salmon escapement goal.

Stock:	Southern District (Aggregate SEG)		**Species:**	Chum salmon
Monitoring method:	Ground survey		**No. of years:**	47
Analysis used:	Percentile Approach (Clark et al. 2014)			
Index streams:	Humpy, Port Graham, Seldovia			
Data quality:	Fair. Escapement indices, commercial harvest by subdistrict, and sporadic age data.			

Stock characteristics	Minimum	Maximum	Average	Comments
Escapement indices:	400	19,200	4,800	Contrast = 48.0
Harvest rate:	0.00	0.74	0.13	
Percentiles used:	0.20	0.60	Tier 1	
Current SEG[a]:	NA	NA	Year adopted:	NA
Recommended SEG[b]:	1,500	5,000		
Recommendation:	Change to aggregate district SEG: 1,500–5,000 fish			

Rationale for recommendation: The committee recommended transitioning from discrete stock to aggregate district goals for chum salmon using the Percentile Approach for the following reasons:

(1) To be consistent with all other management areas in Alaska.

(2) To improve stock assessment by reducing uncertainty associated with apportioning mixed-stock harvests among contributing streams when evaluating stock productivity.

(3) To enable simpler and more flexible inseason management. See Table 6 for stock specific management objectives for chum salmon index streams contributing to this district SEG.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	400	1992	1,400	2008	5,700
1977	5,200	1993	2,500	2009	4,500
1978	4,800	1994	5,200	2010	3,900
1979	2,200	1995	3,800	2011	6,800
1980	1,100	1996	3,700	2012	2,300
1981	4,800	1997	4,100	2013	7,200
1982	2,500	1998	8,300	2014	9,300
1983	1,900	1999	11,200	2015	6,500
1984	2,100	2000	19,200	2016	3,300
1985	500	2001	16,800	2017	10,700
1986	600	2002	11,300	2018	6,000
1987	1,500	2003	7,400	2019	3,400
1988	3,000	2004	4,900	2020	1,000
1989	1,300	2005	2,900	2021	2,300
1990	2,600	2006	7,500	2022	1,400
1991	1,100	2007	6,000		

[a] This is the first aggregate district chum salmon goal for the Southern District, so there is no predecessor for comparison.

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using ground survey indices from 1976 to 2022. Results were rounded to the nearest 500 fish.

[c] Annual district escapement (the sum of escapements to 3 index streams, rounded to the nearest 100 fish) was estimated from multiple ground surveys using the area-under-the-curve method unless otherwise specified.

Appendix B2.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to develop the aggregate Outer District chum salmon escapement goal.

Stock:	Outer District (Aggregate SEG)	**Species:**	Chum salmon
Monitoring method:	Aerial/ground survey	**No. of years:**	47
Analysis used:	Percentile Approach (Clark et al. 2014)		
Index streams:	Dogfish, Island, Middle, Petrof, Port Chatham, Port Dick, Rocky, Slide		
Data quality:	Fair. Escapement indices, comm. harvest by subdistrict, and sporadic age data.		

Stock Characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	5,200	64,000	30,800	Contrast = 12.3
Harvest rate:	0.00	0.83	0.35	
Percentiles used:	0.20	0.60	Tier 1	
Current SEG[a]:	NA	NA	Year adopted:	NA
Recommended SEG[b]:	17,500	32,000		

Recommendation: Change to aggregate district SEG: 17,500–32,000 fish

Rationale for recommendation: The committee recommended transitioning from discrete stock to aggregate district goals for chum salmon using the Percentile Approach for the following reasons:

(1) To be consistent with all other management areas in Alaska.

(2) To improve stock assessment by reducing uncertainty associated with apportioning mixed-stock harvests among contributing streams when evaluating stock productivity.

(3) To enable simpler and more flexible inseason management. See Table 6 for stock specific management objectives for chum salmon index streams contributing to this district SEG.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	17,500	1992	14,600	2008	50,800
1977	33,000	1993	11,600	2009	27,900
1978	41,400	1994	25,500	2010	21,300
1979	64,000	1995	20,300	2011	42,600
1980	42,100	1996	17,900	2012	44,200
1981	45,600	1997	20,900	2013	34,400
1982	21,700	1998	19,500	2014	26,400
1983	50,000	1999	47,800	2015	60,900
1984	40,400	2000	45,700	2016	36,100
1985	17,500	2001	20,300	2017	30,400
1986	14,800	2002	49,500	2018	16,500
1987	21,500	2003	55,900	2019	22,300
1988	25,700	2004	60,000	2020	9,200
1989	11,100	2005	47,900	2021	23,000
1990	5,200	2006	30,400	2022	21,700
1991	27,800	2007	14,500		

[a] This is the first aggregate district chum salmon goal for the Outer District, so there is no predecessor for comparison.

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using ground survey indices from 1976 to 2022. Results were rounded to the nearest 500 fish.

[c] Annual district escapement (the sum of escapements to 8 index streams, rounded to the nearest 100 fish) was estimated from multiple aerial/ground surveys using the area-under-the-curve method unless otherwise specified.

Appendix B3.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to develop the aggregate Kamishak District chum salmon escapement goal.

Stock:	Kamishak District (Aggregate SEG)	**Species:**	Chum salmon
Monitoring method:	Aerial survey	**No. of years:**	47
Analysis used:	Percentile Approach (Clark et al. 2014)		
Index streams:	Big Kamishak, Bruin, Cottonwood, Douglas, Iniskin, Little Kamishak, McNeil, Sugarloaf, Sunday, Ursus		
Data quality:	Fair. Escapement indices, comm. harvest by subdistrict and sporadic age data.		

Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	34,000	209,000	108,500	Contrast = 6.1
Harvest rate:	0.00	0.63	0.20	
Percentiles used:	0.05	0.65	Tier 3	
Current SEG[a]:	NA	NA	Year adopted:	NA
Recommended SEG[b]:	50,000	115,000		
Recommendation:	Change aggregate district SEG: 50,000–115,000 fish			

Rationale for recommendation: The committee recommended transitioning from discrete stock to aggregate district goals for chum salmon using the Percentile Approach for the following reasons:

(1) To be consistent with all other management areas in Alaska.

(2) To improve stock assessment by reducing uncertainty associated with apportioning mixed-stock harvests among contributing streams when evaluating stock productivity.

(3) To enable simpler and more flexible inseason management. See Table 6 for stock specific management objectives for chum salmon index streams contributing to this district SEG.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	83,000	1992	54,600	2008	99,200
1977	77,500	1993	68,400	2009	117,000
1978	199,700	1994	66,100	2010	88,600
1979	67,000	1995	67,900	2011	99,600
1980	69,500	1996	86,300	2012	85,200
1981	99,600	1997	68,200	2013	72,600
1982	118,400	1998	73,000	2014	74,100
1983	139,800	1999	106,000	2015	108,200
1984	88,900	2000	205,900	2016	85,800
1985	34,000	2001	182,400	2017	185,400
1986	101,800	2002	155,500	2018	106,700
1987	116,500	2003	209,000	2019	147,700
1988	129,700	2004	199,000	2020	107,900
1989	119,100	2005	132,300	2021	146,600
1990	44,800	2006	181,200	2022	86,700
1991	47,200	2007	96,500		

[a] This is the first aggregate district chum salmon goal for the Kamishak District, so there is no predecessor for comparison.

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using ground survey indices from 1976 to 2022. Results were rounded to the nearest 5,000 fish.

[c] Annual district escapement (the sum of escapements to 10 index streams, rounded to the nearest 100 fish) was estimated from multiple aerial surveys using the area-under-the-curve method unless otherwise specified.

APPENDIX C: SUPPORTING INFORMATION FOR PINK SALMON GOALS

Appendix C1.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to develop the aggregate Southern District pink salmon escapement goal.

Stock:	Southern District (Aggregate SEG)	**Species:**	Pink salmon
Monitoring method:	Ground survey	**No. of years:**	47
Analysis used:	Percentile Approach (Clark et al. 2014)		
Index streams:	Barabara, China Poot, Humpy, Seldovia		
Data quality:	Fair. Escapement indices, commercial harvest by subdistrict.		

Stock characteristics	Minimum	Maximum	Average	Comments
Escapement indices:	22,700	274,300	99,000	Contrast = 12.1
Harvest rate:	0.00	0.75	0.34	
Percentiles used:	0.20	0.60	Tier 1	
Current SEG[a]:	NA	NA	Year adopted:	NA
Recommended SEG[b]:	50,000	110,000		
Recommendation:	Change to aggregate district SEG: 50,000–110,000 fish.			

Rationale for recommendation: The committee recommended transitioning from discrete stock to aggregate district goals for pink salmon using the Percentile Approach for the following reasons:

(1) To be consistent with all other management areas in Alaska.

(2) To improve stock assessment by reducing uncertainty associated with apportioning mixed-stock harvests among contributing streams when evaluating stock productivity.

(3) To enable simpler and more flexible inseason management. See Table 8 for stock specific management objectives for pink salmon index streams contributing to this district SEG.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	55,000	1992	35,900	2008	166,100
1977	131,300	1993	92,900	2009	23,500
1978	83,300	1994	48,700	2010	112,700
1979	274,300	1995	150,600	2011	59,600
1980	148,000	1996	32,000	2012	122,400
1981	199,500	1997	132,700	2013	68,000
1982	75,500	1998	57,500	2014	85,300
1983	160,800	1999	29,600	2015	179,400
1984	107,800	2000	89,000	2016	108,900
1985	143,300	2001	51,700	2017	125,500
1986	91,200	2002	73,700	2018	115,200
1987	37,600	2003	137,800	2019	55,000
1988	42,900	2004	94,400	2020	46,200
1989	132,200	2005	216,000	2021	30,500
1990	62,900	2006	129,200	2022	22,700
1991	60,900	2007	154,800		

[a] This is the first aggregate district pink salmon goal for the Southern District, so there is no predecessor for comparison.

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using ground survey indices from 1976 to 2022. Results were rounded to the nearest 5,000 fish.

[c] Annual district escapement (the sum of escapements to 4 index streams, rounded to the nearest 100 fish) was estimated from multiple ground surveys using the area-under-the-curve method unless otherwise specified.

Appendix C2.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to develop the aggregate Outer District pink salmon escapement goal.

Stock:	Outer District (Aggregate SEG)	**Species:**	Pink salmon
Monitoring method:	Aerial/ground survey	**No. of years:**	47
Analysis used:	Percentile Approach (Clark et al. 2014)		
Index streams:	Desire, Dogfish, Island, James Lagoon, Middle, Port Chatham, Port Dick, Rocky, Slide, South Nuka, Taylor Bay, Windy Left, Windy Right		
Data quality:	Fair. Escapement indices, commercial harvest by subdistrict.		

Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	16,400	816,000	249,000	Contrast = 49.8
Harvest rate:	0.00	0.89	0.48*	*see rationale below
Percentiles used:	0.20	0.60	Tier 1	
Current SEG[a]:	NA	NA	Year adopted:	NA
Recommended SEG[b]:	105,000	235,000		

Recommendation: Change to aggregate district SEG: 105,000–235,000 fish

Rationale for recommendation: The committee recommended transitioning from discrete stock to aggregate district goals for pink salmon using the Percentile Approach for the following reasons:

(1) To be consistent with all other management areas in Alaska.

(2) To improve stock assessment by reducing uncertainty associated with apportioning mixed-stock harvests among contributing streams when evaluating stock productivity.

(3) To enable simpler and more flexible inseason management. See Table 8 for stock specific management objectives for pink salmon index streams contributing to this district SEG.

*The committee determined that this harvest rate estimate was likely biased high due to the way escapement and harvest are estimated in this area, and therefore use of the Percentile Approach was allowable in this case. See full explanation on pages 12–13 (Outer District).

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	16,400	1992	62,000	2008	337,900
1977	240,100	1993	203,700	2009	490,600
1978	56,800	1994	75,400	2010	213,700
1979	317,900	1995	144,400	2011	90,600
1980	107,800	1996	166,700	2012	107,100
1981	224,800	1997	303,500	2013	434,500
1982	73,600	1998	414,500	2014	178,500
1983	130,300	1999	102,200	2015	499,300
1984	130,500	2000	528,700	2016	17,100
1985	200,200	2001	416,400	2017	238,100
1986	125,400	2002	476,400	2018	157,500
1987	40,200	2003	816,000	2019	383,800
1988	56,000	2004	210,600	2020	274,500
1989	188,000	2005	634,200	2021	371,900
1990	139,000	2006	492,200	2022	147,100
1991	198,700	2007	466,500		

[a] This is the first aggregate district pink salmon goal for the Outer District, so there is no predecessor for comparison.

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using aerial/ground survey indices from 1976 to 2022. Results were rounded to the nearest 5,000 fish.

[c] Annual district escapement (the sum of escapements to 13 index streams, rounded to the nearest 100 fish) was estimated from multiple aerial/ground surveys using the area-under-the-curve method unless otherwise specified.

Appendix C3.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to develop the aggregate Kamishak District pink salmon escapement goal.

Stock:	Kamishak District (Aggregate SEG)	**Species:**	Pink salmon
Monitoring method:	Aerial survey	**No. of years:**	47
Analysis used:	Percentile Approach (Clark et al. 2014)		
Index streams:	Amakdedori, Brown's Peak, Bruin, Little Kamishak, Sunday		
Data quality:	Fair. Escapement indices, commercial harvest by subdistrict.		

Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	4,500	1,712,200	261,000	Contrast = 380.5
Harvest rate:	0.00	0.59	0.14	
Percentiles used:	0.20	0.60	Tier 1	
Current SEG[a]:	NA	NA	Year adopted:	NA
Recommended SEG[b]:	35,000	150,000		
Recommendation:	Change to aggregate district SEG: 35,000–150,000 fish			

Rationale for recommendation: The committee recommended transitioning from discrete stock to aggregate district goals for pink salmon using the Percentile Approach for the following reasons:

(1) To be consistent with all other management areas in Alaska.

(2) To improve stock assessment by reducing uncertainty associated with apportioning mixed-stock harvests among contributing streams when evaluating stock productivity.

(3) To enable simpler and more flexible inseason management. See Table 8 for stock specific management objectives for pink salmon index streams contributing to this district SEG.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	21,000	1992	14,300	2008	229,600
1977	82,000	1993	187,500	2009	1,247,500
1978	35,400	1994	11,000	2010	50,700
1979	236,500	1995	504,400	2011	24,600
1980	411,900	1996	32,700	2012	48,300
1981	128,400	1997	259,200	2013	35,700
1982	99,000	1998	166,800	2014	140,600
1983	10,600	1999	15,700	2015	157,700
1984	128,900	2000	239,800	2016	92,400
1985	24,500	2001	69,900	2017	177,700
1986	1,345,000	2002	1,712,200	2018	110,600
1987	94,300	2003	770,400	2019	119,100
1988	65,500	2004	119,800	2020	93,300
1989	575,000	2005	275,500	2021	204,600
1990	22,900	2006	753,900	2022	4,500
1991	114,100	2007	1,002,500		

[a] This is the first aggregate district pink salmon goal for the Kamishak District, so there is no predecessor for comparison.

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using aerial survey indices from 1976 to 2022. Results were rounded to the nearest 5,000 fish.

[c] Annual district escapement (the sum of escapements to 5 index streams, rounded to the nearest 100 fish) was estimated from multiple aerial surveys using the area-under-the-curve method unless otherwise specified.

APPENDIX D: SUPPORTING INFORMATION FOR SOCKEYE SALMON GOALS

Appendix D1.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to update analysis of English Bay Lakes sockeye salmon escapement goal.

Stock:	English Bay Lakes	**Species:**	Sockeye salmon
Monitoring method:	Weir and aerial survey	**No. of years:**	47
Analysis used:	Percentile Approach (Clark et al. 2014)		
Data quality:	Fair. Mix of weir and aerial counts, comm. harvest by subdistrict, sporadic age data.		

Stock Characteristics	Minimum	Maximum	Average	Comments
Escapement indices:	2,500	31,500	11,700	Contrast = 12.6
Harvest rate:	0.00	0.81	0.25	
Percentiles used:	0.20	0.60	Tier 1	
Current SEG[a]:	6,000	13,500	Year adopted:	2002 (4-tier)
Updated SEG analysis[b]:	6,300	12,200		
% Difference:	5%	-10%		
Recommendation:	Change the SEG to 6,300–12,200 fish			

Rationale for recommendation: The committee recommended revising the SEG for this stock using the Percentile Approach for the following reasons:

(1) There were 20 years of additional escapement data available for analysis, including years with escapements outside the current SEG range.

(2) Analyses presented in Clark et al. (2014) suggest the long-term productivity of this stock may benefit from revising the SEG range.

(3) To be consistent and use the most current and robust methods available to set the SEGs for LCI salmon stocks sharing similar stock characteristics, unless there is a compelling reason not to.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	6,000	1992	6,400	2008	12,000
1977	12,500	1993	8,900	2009	18,200
1978	13,500	1994	13,800	2010	12,300
1979	4,400	1995	20,700	2011	9,900
1980	12,000	1996	11,100	2012	3,400
1981	10,500	1997	14,400	2013	10,900
1982	20,000	1998	14,100	2014	7,800
1983	12,000	1999	14,600	2015	6,300
1984	11,100	2000	11,200	2016	7,700
1985	5,000	2001	10,500	2017	20,800
1986	2,800	2002	15,000	2018	18,800
1987	7,000	2003	19,800	2019	24,000
1988	2,500	2004	15,000	2020	31,500
1989	4,500	2005	7,600	2021	6,300
1990	3,300	2006	16,500	2022	11,500
1991	7,000	2007	16,500		

[a] The 4-tier Percentile Approach (Bue and Hasbrouck *unpublished*) was used to set the current SEG range using weir and peak aerial survey indices from 1976 to 2001 (Otis 2001). The 25th–75th percentiles were used for this stock.

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using weir and peak aerial survey data from 1976 to 2022. The 20th–60th percentiles were used for this stock.

[c] Escapement (rounded to the nearest 100 fish) was estimated from the peak of multiple aerial surveys flown throughout the run (1976–1992, 2021), or from weir counts (1993–2020, 2022).

Appendix D2.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to update analysis of Delight Lake sockeye salmon escapement goal.

Stock:	Delight Lake		**Species:**	Sockeye salmon
Monitoring method:	Aerial survey		**No. of years:**	42
Analysis used:	Percentile Approach (Clark et al. 2014)			
Data quality:	Fair. Peak aerial index, comm. harvest by subdistrict, sporadic age data.			
Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	800	16,300	7,100	Contrast = 19.7
Harvest rate:	0.00	0.88	0.36	
Percentiles used:	0.20	0.75	Tier 1*	*see rationale below
Current SEG[a]:	5,100	10,600	Year adopted:	2017
Updated SEG analysis[b]:	4,700	9,300		
% Difference:	-8%	-12%		
Recommendation:	No change.			

Rationale for recommendation: The committee recommended not changing the SEG for this stock for the following reasons:

(1) There were only 7 years of additional escapement data available for analysis.

(2) The current goal is based on the Clark et al. (2014) Percentile Approach, the most current and robust method for salmon stocks lacking stock productivity information.

(3) The current goal is based on aerial survey data and that is how this stock is currently monitored.

*This is a Tier 1 stock based on contrast and monitoring method, but the SEG range resulting from using the 20th–60th percentiles was deemed too narrow to manage for, so the committee recommended using the 20th–75th percentiles to revise the SEG range in 2016.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	–	1992	5,900	2008	11,300
1977	5,200	1993	5,000	2009	12,700
1978	5,500	1994	5,600	2010	8,400
1979	–	1995	15,800	2011	7,600
1980	7,300	1996	9,400	2012	7,000
1981	–	1997	6,000	2013	3,400
1982	13,100	1998	5,000	2014	
1983	5,100	1999	5,900	2015	3,200
1984	5,400	2000	12,300	2016	5,100
1985	16,300	2001	10,100	2017	5,400
1986	8,800	2002	12,100	2018	3,700
1987	8,100	2003	9,000	2019	1,100
1988	800	2004	11,000	2020	1,700
1989	4,800	2005	4,600	2021	1,600
1990	–	2006	13,300	2022	4,800
1991	4,100	2007	5,000		

[a] The Percentile Approach (Clark et al. 2014) was used to set the current SEG range using peak aerial survey indices from 1976 to 2016 (Otis et al. 2016a). The 20th–75th percentiles were used for this stock.

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using peak aerial survey indices from 1976 to 2022. The 20th–75th percentiles were used for this stock.

[c] Escapement (rounded to the nearest 100 fish) was estimated from the peak of multiple aerial surveys flown throughout the run, unless otherwise specified. Survey coverage was insufficient to produce an index during years without an escapement value (en dashes).

Appendix D3.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to update analysis of Desire Lake sockeye salmon escapement goal.

Stock:	Desire Lake		**Species:**	Sockeye salmon
Monitoring method:	Aerial survey		**No. of years:**	47
Analysis used:	Percentile Approach (Clark et al. 2014)			
Data quality:	Fair. Peak aerial index, comm. harvest by subdistrict, sporadic age data.			

Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	2,800	20,500	10,800	Contrast = 7.2
Harvest rate:	0.00	0.73	0.34	
Percentiles used:	0.05	0.65	Tier 3	
Current SEG[a]:	4,800	11,900	Year adopted:	2017
Updated SEG analysis[b]:	4,200	11,400		
% Difference:	-13%	-4%		
Recommendation:	No change.			

Rationale for recommendation: The committee recommended not changing the SEG for this stock for the following reasons:

(1) There were only 7 years of additional escapement data available for analysis.

(2) The current goal is based on the Clark et al. (2014) Percentile Approach, the most current and robust method for salmon stocks lacking stock productivity information.

(3) The current goal is based on aerial survey data and that is how this stock is currently monitored.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	11,000	1992	11,900	2008	10,700
1977	10,700	1993	11,000	2009	16,000
1978	10,000	1994	10,500	2010	6,300
1979	12,000	1995	15,800	2011	9,600
1980	17,000	1996	9,400	2012	8,800
1981	12,000	1997	14,700	2013	8,400
1982	18,000	1998	7,900	2014	11,500
1983	12,000	1999	14,600	2015	2,800
1984	15,000	2000	4,000	2016	6,700
1985	18,000	2001	5,500	2017	9,500
1986	10,000	2002	16,000	2018	9,800
1987	13,400	2003	8,400	2019	9,000
1988	9,000	2004	10,700	2020	4,700
1989	9,000	2005	4,800	2021	3,700
1990	9,500	2006	18,600	2022	20,500
1991	8,200	2007	10,000		

[a] The Percentile Approach (Clark et al. 2014) was used to set the current SEG range using peak aerial survey indices from 1976 to 2016 (Otis et al. 2016a). The 5th–65th percentiles were used for this stock (Tier 3).

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using peak aerial survey indices from 1976 to 2022. The 5th–65th percentiles were used for this stock (Tier 3).

[c] Escapement (rounded to the nearest 100 fish) was estimated from the peak of multiple aerial surveys flown throughout the run, unless otherwise specified.

Appendix D4.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to update analysis of Bear Lake sockeye salmon escapement goal.

Stock:	Bear Lake		**Species:**	Sockeye salmon
Monitoring method:	Weir		**No. of years:**	44
Analysis used:	Percentile Approach (Clark et al. 2014)			
Data quality:	Good. Weir counts most years, comm. harvest by subdistrict, sporadic age data.			
Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	100	11,300	6,000	Contrast = 113.2
Harvest rate:	0.00	0.96	0.60*	*see rationale below
Percentiles used:	0.15	0.65	Tier 2	
Current SEG[a]:	700	8,300	Year adopted:	2002 (4-tier)
Updated SEG analysis[b]:	600	8,600		
% Difference:	-14%	4%		
Recommendation:	Change the SEG to 600–8,600 fish.			

Rationale for recommendation: The committee recommended revising the SEG for this stock using the Percentile Approach for the following reasons:

(1) There were 21 years of additional escapement data available for analysis, including years with escapements outside the current SEG range.

(2) To be consistent and use the most current and robust methods available to set the SEGs for LCI salmon stocks sharing similar stock characteristics, unless there is a compelling reason not to.

*Due to this stock being significantly enhanced by hatchery stocking, the committee did not consider the high average harvest rate a disqualifying factor for the Percentile Approach.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	600	1992	1,900	2008	9,300
1977	–	1993	4,800	2009	10,400
1978	–	1994	7,300	2010	8,900
1979	–	1995	6,500	2011	9,600
1980	1,500	1996	6,200	2012	8,000
1981	700	1997	7,200	2013	9,000
1982	500	1998	6,200	2014	9,100
1983	700	1999	5,800	2015	9,500
1984	500	2000	7,800	2016	9,000
1985	1,100	2001	8,600	2017	9,200
1986	800	2002	8,300	2018	10,600
1987	300	2003	9,500	2019	9,200
1988	100	2004	8,200	2020	8,200
1989	100	2005	10,300	2021	11,300
1990	100	2006	8,300	2022	10,000
1991	700	2007	8,600		

[a] The 4-tier Percentile Approach (Bue and Hasbrouck *unpublished*) was used to set the current SEG range using weir and peak aerial survey indices from 1976 to 2001 (Otis 2001). The 25th–75th percentiles were used for this stock.

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using weir data from 1976 to 2022. The 15th–65th percentiles were used for this stock (Tier 2).

[c] Escapement (rounded to the nearest 100 fish) was estimated from weir counts (1976–2022). Weir counts were not available during years with no escapement value (en dashes).

Appendix D5.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to update analysis of Aialik Lake sockeye salmon escapement goal.

Stock:	Aialik Lake		**Species:**	Sockeye aalmon
Monitoring method:	Aerial aurvey		**No. of Years:**	47
Analysis used:	Percentile Approach (Clark et al. 2014)			
Data quality:	Fair. Peak aerial index, comm. harvest by subdistrict, sporadic age data.			
Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	400	22,400	6,000	Contrast = 56.0
Harvest rate:	0.00	0.83	0.19	
Percentiles used:	0.20	0.60	Tier 1	
Current SEG[a]:	3,200	5,400	Year adopted:	2017
Updated SEG analysis[b]:	3,000	5,200		
% Difference:	-6%	-4%		
Recommendation:	No change.			

Rationale for recommendation: The committee recommended not changing the SEG for this stock for the following reasons:

(1) There were only 7 years of additional escapement data available for analysis.

(2) the current goal is based on the Clark et al. (2014) Percentile Approach, the most current and robust method for salmon stocks lacking stock productivity information.

(3) the current goal is based on aerial survey data and that is how this stock is currently monitored.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	8,000	1992	2,500	2008	4,200
1977	5,000	1993	3,000	2009	3,100
1978	3,000	1994	7,300	2010	5,300
1979	5,000	1995	2,600	2011	3,500
1980	6,600	1996	3,500	2012	2,100
1981	1,800	1997	11,400	2013	3,500
1982	22,400	1998	4,900	2014	500
1983	20,000	1999	3,800	2015	3,200
1984	22,000	2000	4,300	2016	400
1985	8,000	2001	5,100	2017	4,900
1986	7,600	2002	6,100	2018	2,600
1987	9,200	2003	5,400	2019	5,000
1988	13,000	2004	10,100	2020	4,000
1989	6,500	2005	5,300	2021	2,400
1990	5,700	2006	4,800	2022	2,900
1991	3,700	2007	5,400		

[a] The Percentile Approach (Clark et al. 2014) was used to set the current SEG range using peak aerial survey indices from 1976 to 2016 (Otis et al. 2016a). The 20th–60th percentiles were used for this stock (Tier 1).

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using peak aerial survey indices from 1976 to 2022. The 20th–60th percentiles were used for this stock (Tier 1).

[c] Escapement (rounded to the nearest 100 fish) was estimated from the peak of multiple aerial surveys flown throughout the run, unless otherwise specified.

Appendix D6.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to update analysis of Mikfik Lake sockeye salmon escapement goal.

Stock:	Mikfik Lake		**Species:**	Sockeye salmon
Monitoring method:	Remote video		**No. of years:**	24
Analysis used:	Percentile Approach (Clark et al. 2014)			
Data quality:	Good. Remote video index, comm. harvest by subdistrict, sporadic age data.			
Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	300	21,000	8,300	Contrast = 68.9
Harvest rate:	0.00	0.26	0.02	
Percentiles used:	0.15	0.65	Tier 2	
Current SEG[a]:	3,400	11,000	Year adopted:	2017
Updated SEG analysis[b]:	2,900	10,200		
% Difference:	-15%	-7%		
Recommendation:	No change.			

Rationale for recommendation: The committee recommended not changing the SEG for this stock for the following reasons:

(1) There were only 7 years of additional escapement data available for analysis.

(2) The current goal is based on the Clark et al. (2014) Percentile Approach, the most current and robust method for salmon stocks lacking stock productivity information.,

(3) The current goal is based on remote video data and that is how this stock is currently monitored.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	–	1992	–	2008	10,000
1977	–	1993	–	2009	21,000
1978	–	1994	–	2010	5,200
1979	–	1995	–	2011	400
1980	–	1996	–	2012	3,100
1981	–	1997	–	2013	4,000
1982	–	1998	9,500	2014	18,100
1983	–	1999	20,000	2015	3,500
1984	–	2000	10,400	2016	10,200
1985	–	2001	3,300	2017	7,500
1986	–	2002	–	2018	5,000
1987	–	2003	11,000	2019	2,900
1988	–	2004	16,000	2020	300
1989	–	2005	6,500	2021	2,300
1990	–	2006	15,000	2022	2,900
1991	–	2007	11,000		

[a] The Percentile Approach (Clark et al. 2014) was used to set the current SEG range using remote video data from 1998 to 2015 (Otis et al, 2016a). The 15th–65th percentiles were used for this stock (Tier 2).

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using remote video data from 1998 to 2022. The 15th–65th percentiles were used for this stock (Tier 2).

[c] Escapement (rounded to the nearest 100 fish) was estimated from remote video counts recorded at the outlet of Mikfik Lake throughout the run (1998–2022). Escapement was not monitored by video during years without an escapement value (en dashes).

Appendix D7.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to update analysis of Chenik Lake sockeye salmon escapement goal.

Stock:	Chenik Lake	**Species:**	Sockeye salmon
Monitoring method:	Weir/remote video	**No. of years:**	27
Analysis used:	Percentile Approach (Clark et al. 2014)		
Data quality:	Good. Weir and remote video escapement indices, comm. harvest by subdistrict, sporadic age data.		

Stock characteristics	Minimum	Maximum	Average	Comments
Escapement indices:	800	21,500	11,900	Contrast = 26.8
Harvest rate:	0.00	0.95	0.44	
Percentiles used:	0.15	0.65	Tier 2	
Current SEG[a]:	2,900	13,700	Year adopted:	2017
Updated SEG analysis[b]:	3,800	15,600		
% Difference:	31%	14%		
Recommendation:	No change.			

Rationale for recommendation: The committee recommended not changing the SEG for this stock for the following reasons:

(1) There were only 7 years of additional escapement data available for analysis.

(2) The current goal is based on the Clark et al. (2014) Percentile Approach, the most current and robust method for salmon stocks lacking stock productivity information.

(3) The current goal is based on remote video data and that is how this stock is currently monitored.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	–	1992	9,300	2008	10,700
1977	–	1993	4,000	2009	15,300
1978	–	1994	800	2010	17,300
1979	–	1995	1,100	2011	10,300
1980	–	1996	3,000	2012	16,500
1981	–	1997	2,300	2013	11,300
1982	–	1998	–	2014	17,800
1983	–	1999	–	2015	19,100
1984	–	2000	–	2016	19,500
1985	–	2001	–	2017	21,500
1986	–	2002	–	2018	6,700
1987	–	2003	–	2019	12,100
1988	–	2004	–	2020	11,700
1989	12,000	2005	12,800	2021	17,100
1990	17,000	2006	8,500	2022	16,500
1991	10,200	2007	17,400		

[a] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using remote-video and weir escapement data from 1989 to 1997, and 2005 to 2015. (Otis et al. 2016a). The 15th–65th percentiles were used for this stock (Tier 2).

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using remote-video and weir escapement data from 1989 to 1997, and 2005 to 2022. The 15th–65th percentiles were used for this stock (Tier 2).

[c] Escapement (rounded to the nearest 100 fish) was estimated from daily weir counts (1989–1997, 2005–2007) and by reviewing video recordings of daily fish passage into Chenik Lake throughout the run (2008–2015). Escapement was not monitored by weir or remote video during years without an escapement value (en dashes).

Appendix D8.–Escapement data (rounded to the nearest 100 fish) and stock characteristics used to update analysis of Amakdedori Creek sockeye salmon escapement goal.

Stock:	Amakdedori Creek		**Species:**	Sockeye salmon
Monitoring method:	Aerial survey		**No. of years:**	47
Analysis used:	Percentile Approach (Clark et al. 2014)			
Data quality:	Fair. Peak aerial index, comm. harvest by subdistrict, sporadic age data.			

Stock characteristics	**Minimum**	**Maximum**	**Average**	**Comments**
Escapement indices:	300	11,800	2,700	Contrast = 39.3
Harvest rate:	0.00	0.95	0.32	
Percentiles used:	0.20	0.60		Tier 1
Current SEG[a]:	1,200	2,600	Year adopted:	2017
Updated SEG analysis[b]:	1,200	2,500		
% Difference:	0%	-4%		
Recommendation:	No change.			

Rationale for recommendation: The committee recommended not changing the SEG for this stock for the following reasons:

(1) There were only 7 years of additional escapement data available for analysis.

(2) the current goal is based on the Clark et al. (2014) Percentile Approach, the most current and robust method for salmon stocks lacking stock productivity information.

(3) the current goal is based on aerial survey data and that is how this stock is currently monitored.

Year	Escapement[c]	Year	Escapement[c]	Year	Escapement[c]
1976	1,600	1992	1,900	2008	3,200
1977	2,600	1993	2,000	2009	2,200
1978	2,600	1994	800	2010	1,200
1979	1,000	1995	2,400	2011	3,400
1980	2,600	1996	2,900	2012	800
1981	1,900	1997	1,500	2013	1,500
1982	3,200	1998	4,100	2014	4,300
1983	1,200	1999	8,800	2015	2,900
1984	1,400	2000	3,300	2016	2,200
1985	900	2001	2,700	2017	1,700
1986	1,900	2002	3,200	2018	1,900
1987	1,100	2003	11,800	2019	1,600
1988	400	2004	7,200	2020	7,000
1989	1,200	2005	1,700	2021	4,400
1990	1,800	2006	300	2022	2,100
1991	1,900	2007	3,800		

[a] The Percentile Approach (Clark et al. 2014) was used to set the current SEG range using peak aerial survey indices from 1976 to 2016 (Otis et al. 2016a). The 20th–60th percentiles were used for this stock (Tier 1).

[b] The Percentile Approach (Clark et al. 2014) was used for the updated SEG analysis using peak aerial survey indices from 1976 to 2022. The 20th–60th percentiles were used for this stock (Tier 1).

[c] Escapement (rounded to the nearest 100 fish) was estimated from the peak of multiple aerial surveys flown throughout the run, unless otherwise specified.