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A Review of Escapement Goals for Salmon Stocks in Lower Cook Inlet, Alaska, 2013

by

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and

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November 2013

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 Pacific salmon *Oncorhynchus* spp. escapement goals for major river systems in Lower Cook Inlet (LCI). There were 40 escapement goals evaluated in LCI during this review. Except for 2 Chinook salmon *Oncorhynchus tshawytscha*, stocks (Anchor and Ninilchik rivers) and 5 sockeye salmon *O. nerka* stocks (English Bay, Bear, Mikfik, Chenik, and Delight lakes), salmon escapements in LCI are primarily monitored by single or multiple aerial and/or foot surveys of stream reaches that can be monitored. The resulting escapement indices do not provide absolute abundance estimates suitable for estimating biological escapement goals (BEG). Consequently, ADF&G developed sustainable escapement goals (SEG) for 2 Chinook, 12 chum *O. keta*, 17 pink *O. gorbuscha*, and 8 sockeye salmon stocks monitored in LCI. There are no escapement goals for coho salmon *O. kisutch* in LCI. Escapement performance for Chinook, chum, pink, and sockeye salmon relative to these new goals has been good during the past 4 years, with harvestable surpluses available in 50–88% of streams during most years. This report discusses changing 1 existing escapement goal and establishing 1 new escapement goal in LCI. The committee recommended recalibrating the SEG for sockeye salmon at Mikfik Lake, which was originally derived from aerial survey indices, but is now monitored by remote video. The committee also recommended creating a pink salmon escapement goal for Dogfish Lagoon Creeks stock, which is now targeted for commercial fishing due to improved market conditions for this species.

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

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) reviews escapement goals for Lower Cook Inlet (LCI) salmon stocks on a schedule that corresponds to the Alaska Board of Fisheries (BOF) 3-year cycle for considering area regulatory proposals. This report describes LCI salmon escapement goals that were reviewed in 2013 and presents 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 a review of the methods used in 2001 to develop the majority of the current escapement goals.

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, all escapement goals in LCI, including 3 Chinook *Oncorhynchus tshawytscha*, 13 chum *O. keta*, 31 pink *O. gorbuscha*, and 8 sockeye salmon *O. nerka*, were considered BEGs.

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 are 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:

> 5 AAC 39.222(f)(3) "*biological escapement goal*" or "(BEG)" means the escapement that provides the greatest potential for maximum sustained yield; BEG will be the primary management objective for the escapement unless an optimal escapement or inriver run goal has been adopted; BEG will be developed from the best available biological

information, and should be scientifically defensible on the basis of available biological information; BEG will be determined by the department and will be expressed as a range based on factors such as salmon stock productivity and data uncertainty; the department will seek to maintain evenly distributed salmon escapements within the bounds of a BEG;

and

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

Salmon management in LCI, to the extent possible, has focused on terminal fishing areas associated with individual streams. Consequently, escapement goals in LCI were developed for each one of the 47 stocks (3 Chinook, 12 chum, 24 pink, and 8 sockeye salmon) that have historically received fishing pressure. The escapement goal of each of these stocks was reviewed in 2001 under the 2 previously mentioned BOF policies, resulting in 47 new SEGs (Bue and Hasbrouck[1]; Otis 2001). Area review of LCI escapement goals in 2004 (Otis and Hasbrouck 2004) resulted in changes to 4 stocks. The escapement goal for Anchor River Chinook salmon was eliminated because a sonar and weir project begun in 2003 indicated historical aerial surveys did not accurately index total escapement. It was anticipated that continuation of the sonar/weir project would provide sufficient data to conduct more comprehensive analyses and recommend a new goal during the 2007 review (Otis and Hasbrouck 2004). In 2004, ADF&G eliminated the escapement goals for Little and Big Kamishak River pink salmon because no fishery targets these stocks and escapement monitoring is inconsistent. Additionally, ADF&G replaced the individual goals for pink salmon in Bear and Salmon creeks in Resurrection Bay with a single SEG representing both streams. In 2007, ADF&G increased the SEG for McNeil River chum salmon, effectively restoring the previous long-standing goal to encourage greater seeding of upriver spawning habitats and increase streamwide production once that run recovers. ADF&G also increased the length of the escapement monitoring period and, consequently, the SEG for Ninilchik River Chinook salmon (550–1,300), and established a lower-bound SEG (5,000) for Anchor River Chinook salmon (Otis and Szarzi 2007; Szarzi et al. 2007). Area review of LCI escapement goals in 2010 (Otis et al. 2010) led to changes for 7 stocks. The Anchor River Chinook salmon goal was converted from a lower-bound SEG (5,000) to an SEG range of 3,800–10,000 fish; SEG ranges for Delight Creek and Chenik Lake were transitioned from aerial survey to weir- and video-based goals, respectively, to account for new monitoring methods; and the SEG ranges for 4 pink salmon stocks in Resurrection Bay (Bear/Salmon creeks, Thumb Cove, Humpy Cove, and Tonsina Creek) were eliminated because they were modest producers

[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 Alaska Board of Fisheries, November 2001 (and February 2002), Anchorage.
Subsequently referred to as Bue and Hasbrouck (*Unpublished*).

that rarely received commercial fishing effort and were therefore inconsistently monitored. During the 2013 review process, escapement goals for the following 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 spring of 2013, ADF&G established an escapement goal review committee (hereafter referred to as the committee), consisting of divisions of Commercial Fisheries and Sport Fish personnel. The committee formally met via teleconference on March 29 and June 11 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 2013 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; and
4) Recommend new goals if appropriate and eliminate existing goals that are no longer appropriate.

METHODS

ASSESSING ESCAPEMENT AND HARVEST

The LCI commercial salmon fishery management area is comprised of 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 non-fishing district, with the remaining 4 districts (Southern, Outer, Eastern, and Kamishak Bay) separated into approximately 30 subdistricts and sections to facilitate commercial fisheries management of discrete stocks of salmon (Hollowell et al. 2013). The LCI sport fisheries management area includes the waters west of the longitude of Gore Point and north of the latitude of Cape Douglas and waters south of a line from the south end of Chisik Island to the south bank of the Kasilof River (Figure 2). 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 the management areas (Figures 1 and 2) primarily produce pink and chum salmon, but also support smaller and less numerous runs of sockeye, coho *O. kisutch*, and Chinook salmon.

Escapements for most systems 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 a ranking of escapement magnitude across years, but provide limited information on the total number of fish in the escapement. Escapement indices for stocks of pink and chum salmon are calculated by applying the area-under-the-curve (AUC) method (Bue et al. 1998; Neilson and Geen 1981), which accounts for multiple sightings of the same fish during consecutive surveys by applying an average stream-life factor.

Consistent weir data exist only for Anchor and Ninilchik River Chinook salmon and Bear, Delight, and English Bay Lake sockeye salmon. 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 that are 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 testing a digital time-lapse video recording system to remotely census fish returns in small, clear streams (Otis and Dickson 2002). On select streams, this technology may eventually allow 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 and in 2013 sufficient data were available to do the same for Mikfik Lake sockeye salmon. Dual frequency identification sonar (DIDSON; Belcher et al. 2002) has been operated to count Chinook salmon escapement in the Anchor River since 2003. The total Chinook salmon escapement has been enumerated with DIDSON in conjunction with a weir since 2004. A full probability spawner–recruit model was used to establish a lower bound SEG for Anchor River Chinook salmon in 2007 (Szarzi et al. 2007) and again to create an SEG range in 2010 (Otis et al. 2010).

Commercial harvest data are obtained from the fish ticket database. Estimates of sport harvest are from the postal survey conducted annually by the Division of Sport Fish (Jennings et al. 2011).

HISTORICAL DEVELOPMENT OF ESCAPEMENT GOALS

Chinook salmon escapements have been monitored since 1962 using a combination of foot and aerial surveys. Starting in 1976, single helicopter surveys indexed Chinook salmon escapements. Escapement goals for Deep Creek and Ninilchik and Anchor River stocks were first adopted in 1993, representing the average of the escapement indices in each system (Fried 1994). In 1999, point goals were changed to ranges by multiplying the respective point goal by 0.8 and 1.6, similar to the method used to estimate the escapement range that produces 90% or more of the maximum sustained yield (MSY; Eggers 1993).

Chum salmon escapement surveys began in the early 1970s. Escapement goals were established from these indices beginning in 1979. Many of the original goals were based on a subjective assessment of the quality of available spawning habitat and the level of commercial harvests resulting from various levels of escapement (Fried 1994). In the case of McNeil River chum

salmon, managers targeted the upper end of the escapement goal range during years when more fish successfully ascended McNeil Falls and reached the plentiful, high-quality spawning habitat available upstream.

Pink salmon escapement surveys began during the 1960s with many starting in either 1960 or 1962. Pink salmon escapement goals for some systems were first established in 1970, while goals for many other systems were established in either 1976 or 1982. Origins of these goals are not well documented. Those in the Outer and Eastern districts were based on quantitative estimates of available spawning areas, assuming an optimal density of 1.5–2.0 spawners per square meter (Fried 1994).

Aerial surveys to monitor sockeye salmon escapement indices began in LCI in 1960. In the case of Bear Lake, a complete count or estimate of escapements has been monitored through a weir since 1960. Although escapement goals were first established for sockeye salmon in 1982, goals for additional systems were added throughout the 1980s. Methods and rationales for setting these goals were generally not well documented.

DEVELOPMENT OF CURRENT ESCAPEMENT GOALS

The majority of escapement goals in LCI are based on foot or aerial surveys. The surveys typically cover less than 100% of the stream due to practical constraints (e.g., dense riparian areas, etc.) and different people have conducted the surveys over the years under a wide variety of conditions. While the commercial fisheries in LCI primarily occur in terminal areas, stock mixing sometimes does take place, especially in areas such as Port Dick and Resurrection bays. Lack of stock identification data prevents allocating 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. In 2001, with the definitions of escapement goals adopted into policy by the BOF and the uncertainties in estimating escapements and stock-specific commercial harvests, ADF&G changed all LCI goals to SEGs (Otis 2001).

Beginning in 2001, the SEG for each stock within the management area was developed using percentiles of observed escapement estimates or indices that also incorporated contrast in the escapement data (Bue and Hasbrouck *Unpublished*; Otis 2001; Otis and Hasbrouck 2004; Otis and Szarzi 2007; Otis et al. 2010). To calculate the percentiles, escapement data are first ranked from the smallest to the largest value, with the smallest value representing the 0^{th} percentile (i.e., none of the escapement values are less than the smallest). The percentile of all remaining escapement values is a summation of 1/(n-1), where n is the number of escapement values. Contrast in the escapement data is simply the maximum observed value divided by the minimum observed value. As contrast increases, the percentiles used to estimate the SEG range are narrowed, primarily from the upper range, to allow the SEG to include a wide range of escapements. For exploited stocks with a high contrast, the lower end of the SEG range is increased to the 25^{th} percentile as a precautionary measure for stock protection. The percentiles used at different levels of contrast are as follows:

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

All resulting SEG ranges were rounded to the nearest 50 fish. Percentiles were calculated for nearly all stocks using aerial and foot survey escapement indices from 1976 through 2001 (through 2000 for Chinook salmon stocks). Aerial and foot survey data prior to 1976 were excluded due to inconsistencies in data collection methods. Survey data since 1976 were not used for 3 stocks: Ninilchik River Chinook salmon, Tutka Lagoon Creek pink salmon, and Bear Lake sockeye salmon.

The Ninilchik River Chinook salmon SEG was based on the weir count of naturally-produced Chinook salmon observed between July 8 and 24 from 1994 to 2000. This river has been stocked since 1988 with hatchery-produced Chinook salmon from Ninilchik River brood stock. Hatchery-stocked fish have been marked with an adipose fin clip. Early in the stocking program, only a portion of each release group was marked, but beginning in 1995, all stocked fish were marked. During 1994–2000 a weir was consistently in place to collect brood stock and count fish, examining each fish for a missing adipose fin. Based on the marking and recovery data, ADF&G estimated the number of hatchery-stocked fish that passed through the weir. The number of naturally-produced fish was estimated by subtracting the estimated number of hatchery fish from the total number of fish observed. Wild fish sacrificed during egg takes were not subtracted from the count used to develop the SEG. The Ninilchik weir count is still considered an index because it does not account for all Chinook salmon in the escapement. Nonetheless, weir counts are considered more reliable than aerial surveys.

In 2007, the Ninilchik River Chinook salmon SEG was changed from 400–800 to 550–1,300 by extending the number of days of weir counts annually that the goal is based upon from 17 (July 8–24) to 29 (July 3–31) and subtracting the wild fish sacrificed for egg takes during the period. Bounds were the 15th percentile and maximum wild escapement upstream of the egg-take weir during July 3 and 31 each year from 1999 to 2007. The change was to represent a greater proportion of the wild escapement to encompass more of the variability in run timing and reduce the likelihood of mistaking a low escapement count for late run timing.

The Anchor River Chinook salmon escapement goal was developed in 2007 based on a spawner–recruit model that used 31 years (1977–2007) of aerial survey escapement indices and inriver recreational harvest estimates, plus 5 years (2003–2007) of weir/sonar estimates of escapement and age composition (Szarzi et al. 2007). Marine harvests were estimated from harvest rates of nearby stocks. The outcome was compared to the results from a spawner–recruit analysis with only weir/sonar escapement counts, age composition and freshwater harvest data from 2003 to 2006, and assumptions about marine sport harvests and productivity from other stocks. The recommended lower-bound SEG of 5,000 was based on the point estimate (Bayes posterior median) of S_{MSY} from the full probability model. The 2010 SEG range of 3,800–10,000 was based on an updated spawner–recruit model with escapement, age composition data through 2010 and harvest data through 2009. The lower bound of the SEG was the point estimate (Bayes posterior median) of S_{MSY} and the upper bound was the point estimate of carrying capacity from the updated full probability model.

For Tutka Lagoon Creek pink salmon, survey data from 1959 to 1975 were used to exclude years with hatchery supplementation, which began in 1976 and continued until 2005. The Tutka Bay Lagoon Hatchery began rearing and releasing pink salmon again in 2011/2012 after a 7-year hiatus. For Bear Lake sockeye salmon, weir data from 1985 to 2001 were used because prior to 1985 the lake was managed to limit sockeye salmon production in favor of coho salmon.

RESULTS AND DISCUSSION

We recommend revising the escapement goal for the Mikfik Lake sockeye salmon stock so it is derived from remote-video data, the method currently used to monitor escapement and manage the fishery in season. The committee also recommends adding a pink salmon escapement goal for Dogfish Lagoon Creeks to provide staff with appropriate tools to facilitate inseason management of this stock, which has recently experienced an increase in targeted exploitation by the commercial purse seine fleet. The following sections provide additional details on these recommendations and a review of recent salmon escapements relative to the goals currently in place.

CHINOOK SALMON

The committee recommends no change to the 3 existing escapement goals for LCI Chinook salmon stocks (Table 1). Chinook salmon escapements from 2011 to 2013 were sufficient to meet their respective escapement goals (Figure 3), with the exception of the Anchor River, which failed to meet escapement in 2011 (Table 1).

Continued collection and analysis of stock assessment data for Anchor River Chinook salmon is necessary to evaluate the performance of the SEG because there are no empirical production data from escapements at or near the estimate of S_{MSY} (3,800) for this stock. To better understand production from escapements near the estimated S_{MSY} (i.e., escapements in 2009–2013), complete returns from these escapements are desirable, which will occur in 2019.

CHUM SALMON

The committee recommends no change to the 12 existing escapement goals for LCI chum salmon stocks (Table 1). Recent escapements have been sufficient, relative to the current SEGs, to provide a harvestable surplus for most chum salmon stocks. From 2010 to 2013, only 32% of chum salmon stocks had escapements below their current SEG ranges and 30% were above the current SEG ranges (Figure 4). Relatively modest returns and lack of tender service contributed to diminished commercial fishing effort, particularly in Kamishak Bay District. This, in turn, has contributed to some chum salmon stocks occasionally realizing escapements above their existing SEG range (Figure 4).

PINK SALMON

Currently, there are 17 pink salmon stocks in LCI with escapement goals (Table 1). Recent pink salmon escapements have been sufficient, relative to the current SEGs, to provide a harvestable surplus for most stocks. From 2010 to 2013, 26% of pink salmon stocks had escapements below their current SEG ranges, while 21% had escapements above the current SEG ranges (Figure 5). Improved market conditions for pink salmon has led to greater exploitation of LCI pink salmon stocks in general, but relatively modest returns and lack of tender service continues to contribute to diminished commercial fishing effort for pink salmon in Kamishak Bay District. This, in turn, has contributed to some pink salmon systems realizing escapements above their existing SEG ranges (Figure 5).

Dogfish Lagoon Creeks

Returns of pink and chum salmon to Dogfish Lagoon Creeks in Outer District have been monitored by aerial survey for over 35 years. However, a pink salmon escapement goal was not

considered necessary because fishing effort focused on the chum salmon stock with inconsequential harvest of later returning pink salmon. Recently however, a rise in the value of pink salmon has led to increased targeted exploitation of the Dogfish Lagoon Creeks pink salmon stock, such that the committee felt an escapement goal was necessary for inseason management.

Aerial and ground surveys have been used to monitor pink and chum salmon escapements into Dogfish Lagoon Creeks since 1977. Survey effort has generally focused on chum salmon because that stock was consistently targeted for exploitation and it already had an escapement goal. Pink salmon run timing is later than chum salmon; however, the 2 overlapped sufficiently that surveyors consistently documented the majority of the pink salmon return as well. Consequently, the committee had a 36-year escapement time series (1977–2013) from which to develop an escapement goal for Dogfish Lagoon Creeks (Table 2). Escapement indices over this period ranged from 200 to 26,400 fish, yielding an escapement contrast of 132. Modest but consistent commercial exploitation of the Dogfish Lagoon Creeks pink salmon stock occurred during 1977–1984 (average harvest: 4,800 fish), but then diminished to zero during most of the past 25 years. The recent increase in value of pink salmon has resulted in a substantial increase in targeted effort on several modestly producing pink salmon stocks around LCI, including Dogfish Lagoon Creeks in Outer District. In the past 3 years, the average pink salmon harvest from Dogfish Bay Subdistrict (232-01) was 53,800 fish, including an all-time record harvest of 89,000 pink salmon in 2013 (Table 2). Consequently, the committee recommends using the 25^{th}–75^{th} percentiles to establish a new SEG for Dogfish Lagoon Creeks of 1,200–8,400 pink salmon (Table 2).

SOCKEYE SALMON

Annual escapement for most LCI sockeye salmon stocks since the last escapement goal review has fallen within or above the current escapement goal range. From 2010 to 2013, 37% of sockeye salmon stocks had escapements below their current SEG ranges, while 25% had escapements above the current SEG ranges (Figure 6). Currently, there are 8 sockeye salmon stocks with escapement goals (Table 1). The majority of the 26-year time series (1976–2001) of data used to establish these goals in 2002 was comprised of peak aerial survey counts, with the exception of Bear and English Bay lakes, both of which have long-standing weir projects. Since 2001, the Delight Lake stock has continued to be monitored by weir and 2 others (Mikfik and Chenik lakes) are currently monitored using remote video. In 2010, ADF&G recalibrated Delight and Chenik Lake sockeye salmon goals so they were consistent with the methods currently used to monitor those stocks (weir and remote video data, respectively).

A considerable amount of literature exists documenting that aerial surveys, and especially peak aerial surveys, tend to underestimate total escapement, often by 30–50% or more (e.g., Bevan 1961; Shardlow et al. 1987; Bue et al. 1998; Jones et al. 2007). It is also well known that weirs are capable of providing an accurate census of adult salmon escaping to points upstream of the weir (Cousens et al. 1982; Zimmerman and Zabkar 2007). To determine where remote video falls within this spectrum of escapement monitoring accuracy, the video system was validated against a weir at Chenik Lake in 2005 and 2007 (Hammarstrom and Dickson 2006, Hammarstrom and Ford 2008). Daily counts were very similar between the 2 methods, except on rare occasions when the video temporarily lost power (weir counts higher) or the weir crew lost some hourly count data before recording it (video counts higher; Figure 7).

Mikfik Lake

Development and testing of the remote video escapement recorder (RVER) system began at Mikfik Lake in 1998. During its first 10 years of operation the system experienced sporadic power interruptions due to the local topography inhibiting sun and wind power generation. The video down time caused by these interruptions sometimes occurred during the peak of the run, compromising the quality of the video counts (e.g., 1999, 2003, 2004, 2008; Table 3). In 2009 staff sought to remedy this problem by moving the power generation equipment to a location with greater access to sun and wind.

It's difficult to quantify the extent to which short periods of video failure affected escapement indices derived by remote video since 1998. Even during years when video down time occurred during the peak of the run, the video count at Mikfik Lake always exceeded the peak aerial survey count in the lake (Table 3). During years without significant loss of video, on average the video count was 2.7 times greater than the peak aerial survey count in Mikfik Lake (range 0.7–5.8; Table 3). However, the peak streamwide aerial survey count was, on average, 1.1 times greater than the video count into Mikfik Lake (range 0.5–2.1; Table 3). Along with the aforementioned tendency for aerial survey indices to be conservative, comparison of streamwide peak aerial survey indices with video counts at Mikfik Lake is complicated by 2 additional factors: 1) species identification and 2) predation by bears. Sockeye salmon are the only anadromous species that return to Mikfik Lake. However, fish observed by aerial observers in the tidal lagoon inside the spit at McNeil Cove likely include some early-run chum salmon returning to McNeil River. Due to their differential run timing, species misidentification is probably not a major consideration prior to late June. Brown bear predation on sockeye salmon in Lower Mikfik Creek has much greater potential to create disparity between streamwide aerial counts and video counts at Mikfik Lake. During a recent 2-year radiotelemetry study (Peirce et al. 2011), it was estimated that brown bears killed approximately half of the chum salmon returning to nearby McNeil River (Peirce et al. 2013). Anecdotal observations on Lower Mikfik Creek suggest similar predation rates likely occur on sockeye salmon attempting to return to Mikfik Lake.

Despite these challenges to accurately estimating sockeye salmon escapement into Mikfik Lake, the committee felt estimates derived by remote video since 1998 were an improvement over aerial survey indices and were sufficient to recalibrate the escapement goal to this new monitoring method. During 1998–2013, video escapement estimates of sockeye salmon entering Mikfik Lake ranged from 291 to 20,965, yielding an escapement contrast of 72. Exploitation of this stock is historically very low, so the committee used the 15^{th}–75^{th} percentiles and recommends changing the Mikfik Lake sockeye salmon escapement goal from 6,300 to 12,150 fish to 3,400 to 13,000 fish (Table 3). This will bring the goal into alignment with the current means by which the escapement is monitored and the fishery is managed.

SUMMARY

The committee recommended that most escapement goals for LCI salmon stocks remain status quo (Table 1). Through their respective time frames, data in the appendices were used in the review of escapement goals and development of SEGs of LCI salmon stocks in 2001 (Otis 2001), 2004 (Otis and Hasbrouck 2004), 2007 (Otis and Szarzi 2007), 2010 (Otis et al. 2010) and in this review.

In summary, the escapement goal committee reviewed 40 LCI salmon escapement goals with recommendations to recalibrate one SEG range (Mikfik Lake sockeye salmon) and create one new goal (Dogfish Lagoon Creeks pink salmon).

ACKNOWLEDGMENTS

We thank all ADF&G staff who routinely conducted the aerial and ground surveys to collect the escapement data used in this report, most recently Glenn Hollowell, Lee Hammarstrom, Ethan Ford, Sigfus (Tom) Sigurdsson, Patrick Houlihan, Joseph Loboy, Carol Kerkvliet, and Michael Booz. Michael Parish and Lydia Ames were instrumental in acquiring remote video-based salmon escapement data during 2010–2013. Carol Kerkvliet (ADF&G, LCI Assistant Area Sport Fish Biologist) supervised the successful operation of the Chinook salmon sonar and weir projects with the assistance of Mike Booz. A draft of this report benefited from review comments provided by Glenn Hollowell and Ethan Ford (ADF&G, LCI Area and Assistant Area Finfish Management Biologists, respectively), and other area, regional and headquarters staff from both divisions.

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TABLES AND FIGURES

Table 1.–Current escapement goals, escapements observed from 2010 through 2013, and escapement goal recommendations in 2013 for 3 Chinook, 12 chum, 17 pink, and 8 sockeye salmon stocks in Lower Cook Inlet, Alaska.

Species/System	Escapement Data[a]	Escapement Goal Type	Escapement Goal Range	Recent Escapements[b] 2010	2011	2012	2013	Recommendation
Chinook Salmon								
Anchor River	Sonar/Weir	SEG	3,800–10,000	4,449	3,545	4,509	4,393[c]	No Change
Deep Creek	SAS	SEG	350–800	387	696	447	475	No Change
Ninilchik River[d]	Weir	SEG	550–1,300	605	668	555	571[c]	No Change
Chum Salmon								
Port Graham River	MFS	SEG	1,450–4,800	1,395	1,764	669	1,944	No Change
Dogfish Lagoon	MFS	SEG	3,350–9,150	12,703	12,936	8,842	9,300	No Change
Rocky River	MAS or MFS	SEG	1,200–5,400	1,271	4,480	3,165	8,148	No Change
Port Dick Creek	MAS or MFS	SEG	1,900–4,450	2,439	7,087	8,400	4,133	No Change
Island Creek	MAS or MFS	SEG	6,400–15,600	3,408	11,755	14,863	8,772	No Change
Big Kamishak River	MAS	SEG	9,350–24,000	NS	5,532	12,400	3,280	No Change
Little Kamishak River	MAS	SEG	6,550–23,800	18,414	19,310	30,250	6,744	No Change
McNeil River	MAS	SEG	24,000–48,000	10,520	30,977	10,388	9,498	No Change
Bruin River	MAS	SEG	6,000–10,250	6,200	3,486	16,795	8,942	No Change
Ursus Cove	MAS	SEG	6,050–9,850	11,765	10,636	2,840	10,339	No Change
Cottonwood Creek	MAS	SEG	5,750–12,000	15,848	4,730	4,111	5,206	No Change
Iniskin Bay	MAS	SEG	7,850–13,700	19,252	16,522	3,049	5,928	No Change
Pink Salmon								
Humpy Creek	MFS	SEG	21,650–85,550	70,686	1,670	67,934	6,749	No Change
China Poot Creek	MFS	SEG	2,900–8,200	2,220	3,462	8,392	7,119	No Change
Tutka Lagoon Creek	MFS	SEG	6,500–17,000	2,141	21,974	10,436	9,541	No Change
Barabara Creek	MFS	SEG	1,900–8,950	13,935	8,186	1,412	17,377	No Change
Seldovia River	MFS	SEG	19,050–38,950	25,886	46,231	44,722	36,824	No Change
Port Graham River	MFS	SEG	7,700–19,850	16,586	20,883	34,486	11,893	No Change

-continued-

Table 1.–Page 2 of 2.

Species/System	Escapement Data[a]	Escapement Goal Type	Escapement Goal Range	Recent Escapements[b] 2010	2011	2012	2013	Recommendation
Pink Salmon Cont'd								
Dogfish Lagoon Creeks	MAS or MFS			6,300	3,900	11,400	26,448	Establish SEG: 1,200–8,400
Port Chatham	MFS	SEG	7,800–21,000	2,992	15,830	5,430	57,447	No Change
Windy Creek Right	MFS	SEG	3,350–10,950	6,408	1,722	5,823	11,704	No Change
Windy Creek Left	MFS	SEG	3,650–29,950	24,241	12,210	11,691	47,849	No Change
Rocky River	MAS or MFS	SEG	9,350–54,250	27,045	22,706	15,684	75,791	No Change
Port Dick Creek	MAS or MFS	SEG	18,550–58,300	41,090	16,868	18,057	55,828	No Change
Island Creek	MAS or MFS	SEG	7,200–28,300	69,525	10,181	20,079	26,004	No Change
S. Nuka Island Creek	MAS or MFS	SEG	2,700–14,250	NS	NS	1,250	8,442	No Change
Desire Lake Creek	MAS	SEG	1,900–20,200	2,978	600	2,260	56,921	No Change
Bruin River	MAS	SEG	18,650–155,750	40,256	4,534	31,800	15,020	No Change
Sunday Creek	MAS	SEG	4,850–28,850	6,607	844	1,348	6,132	No Change
Brown's Peak Creek	MAS	SEG	2,450–18,800	3,092	2,035	2,800	4,061	No Change
Sockeye Salmon								
English Bay[e]	PAS, Weir	SEG	6,000–13,500	12,253	9,920	3,574	10,891[c]	No Change
Delight Lake[f]	PAS, Weir	SEG	7,500–17,650	23,775	20,190	10,887	5,961	No Change
Desire Lake	PAS	SEG	8,800–15,200	6,320	9,630	8,840	8,400	No Change
Bear Lake[e]	Weir	SEG	700–8,300	8,880	9,608	8,031	8,999[c]	No Change
Aialik Lake	PAS	SEG	3,700–8,000	5,315	3,480	2,140	3,530	No Change
Mikfik Lake	PAS, Video	SEG	6,300–12,150	11,330	395	3,141	4,042	Change SEG to 3,300-13,000
Chenik Lake	PAS, Video	SEG	3,500–14,000	17,312	10,330	16,505	11,333	No Change
Amakdedori Creek	PAS	SEG	1,250–2,600	1,210	3,412	770	1,540	No Change

[a] SAS = Single Aerial Survey, MAS = Multiple Aerial Survey, MFS = Multiple Foot Survey, PAS = Peak Aerial Survey.

[b] NS = No Survey.

[c] Preliminary.

[d] 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.

[e] 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.

[f] Delight Lake escapements are a combination of weir and aerial survey counts.

Table 2.–Escapement, harvest, total run (thousands of fish), and harvest rate for the Dogfish Lagoon Creeks pink salmon stock in Outer District, 1977–2013.

Year	Escapement[a]	Commercial Harvest	Total Run	Harvest Rate
1977	8.1	1.4	9.5	15%
1978	0.6	0.0	0.6	0%
1979	7.3	7.4	14.7	50%
1980	0.3	4.7	5.0	94%
1981	2.6	22.9	25.5	90%
1982	2.6	1.7	4.3	40%
1983	1.0	0.2	1.2	17%
1984	0.6	0.1	0.7	14%
1985	0.2	0.0	0.2	0%
1986	0.4	0.0	0.4	0%
1987	1.2	0.0	1.2	0%
1988	0.3	0.0	0.3	0%
1989	0.2	0.0	0.2	0%
1990	7.1	0.0	7.1	0%
1991	9.3	0.0	9.3	0%
1992	NA	NA	NA	NA
1993	0.3	0.0	0.3	0%
1994	1.3	0.0	1.3	0%
1995	13.3	0.0	13.3	0%
1996	2.3	0.0	2.3	0%
1997	20.0	0.0	20.0	0%
1998	6.7	0.0	6.7	0%
1999	12.4	0.0	12.4	0%
2000	11.1	0.0	11.1	0%
2001	2.0	0.0	2.0	0%
2002	1.3	0.0	1.3	0%
2003	5.2	0.0	5.2	0%
2004	3.2	0.0	3.2	0%
2005	22.3	0.0	22.3	0%
2006	8.0	0.0	8.0	0%
2007	4.1	0.0	4.1	0%
2008	8.0	0.0	8.0	0%
2009	9.2	0.0	9.2	0%
2010	6.3	0.0	6.3	0%
2011	3.9	72.3	76.2	95%
2012	11.4	0.0	11.4	0%
2013	26.4	89.0	115.5	77%
Average	6.1	5.5	11.7	14%
Max	26.4	89.0	115.5	95%
Min	0.2	0.0	0.2	0%
Escap. Contrast	High			
n	35		Current SEG	
Exploitation	High		None	
Percentiles	25th–75th			
New SEG Lo	1.2		Recommended SEG	
New SEG Hi	8.4		1.20–8.40 thousand	

[a] Escapement is area-under-the-curve index derived from multiple ground and/or aerial surveys.

Table 3.–Comparison of video counts and peak aerial survey counts for Mikfik Lake sockeye salmon, 1998–2013, and the 15th–75th percentile escapement goal ranges resulting from each data set.

Year	Video Count (into Lake)	Peak Aerial Survey (in Lake)	Peak Aerial Survey (Streamwide)[a]	Comments
1998	9,515	2,550	12,630	
1999	20,000[b]	8,930	15,717	Periods of lost video during run
2000	10,386	7,650	10,910	
2001	3,289	2,500	5,350	
2002		5,170	16,650	No video counts in 2002
2003	11,000[b]	3,700	12,830	Periods of lost video during run
2004	16,000[b]	5,480	14,020	Periods of lost video during run
2005	6,499	1,120	5,070	
2006	14,983	4,500	17,700	
2007	10,975	3,900	11,190	
2008	10,000[b]	4,400	5,560	Periods of lost video during run
2009	20,965	9,150	15,130	
2010	5,221	1,650	11,330	
2011	291	395	395	
2012	3,131		2,520	No aerial survey of Mikfik Lake in 2012
2013	4,042	1,700	1,940	
Average	9,753	4,186	9,953	
Max	20,965	9,150	17,700	
Min	291	395	395	
Escap. Contrast	High	23	45	Current SEG[c]
n	15	15	16	6,300–12,150
Percentiles	15th–75th	15th–75th	15th–75th	
New SEG Lo	3,400	1,700	3,200	Recommended SEG
New SEG Hi	13,000	5,300	14,300	3,400–13,000

[a] Streamwide survey count includes fish ultimately lost to predation by bears below Mikfik Lake.

[b] Video count includes a portion of the aerial survey count to compensate for video down-time during the run.

[c] Current sustainable escapement goal is based on peak aerial survey counts (streamwide) from 1976 to 2001 (Otis 2001).

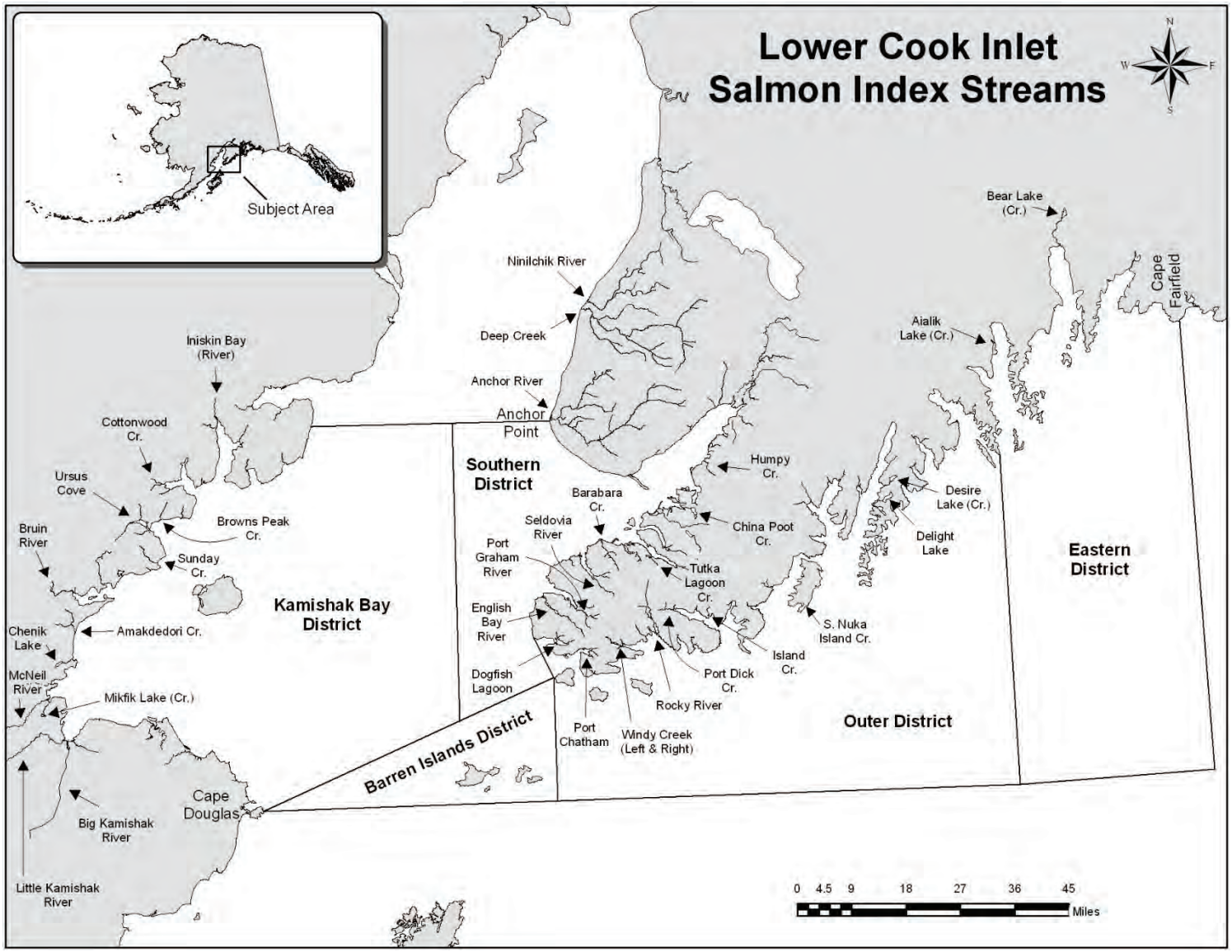

Figure 1.–Lower Cook Inlet commercial fisheries management area, illustrating the locations of salmon-producing streams with escapement goals, by district.

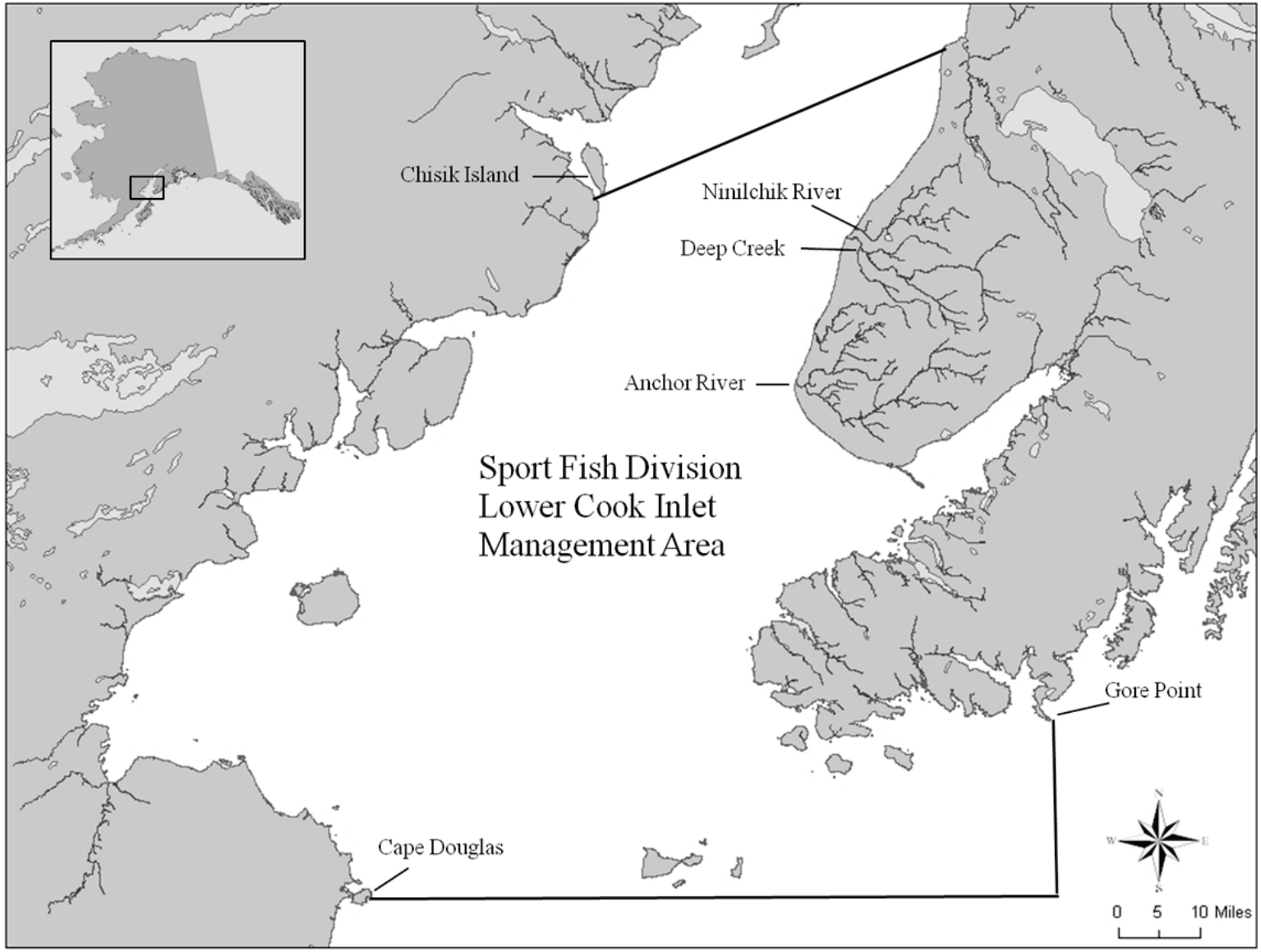

Figure 2.–Lower Cook Inlet sport fisheries management area, illustrating the locations of Chinook salmon-producing streams with escapement goals.

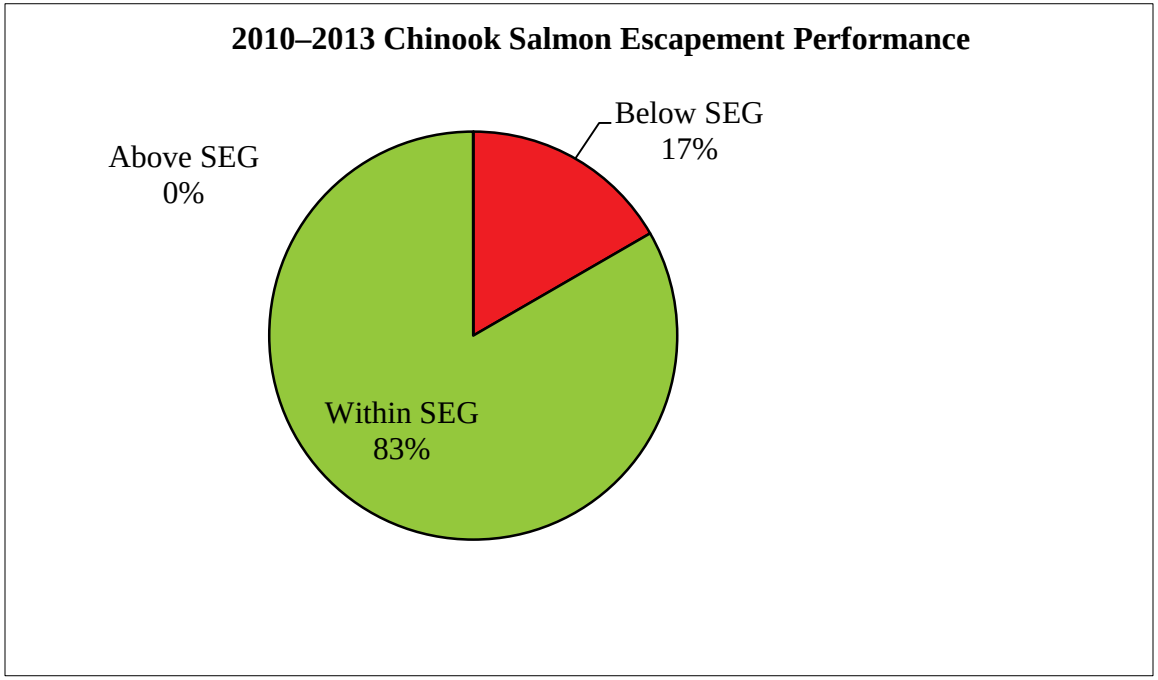

Figure 3.–Lower Cook Inlet Chinook salmon escapement performance for 3 stocks relative to their current sustainable escapement goal range (SEG), 2010–2013.

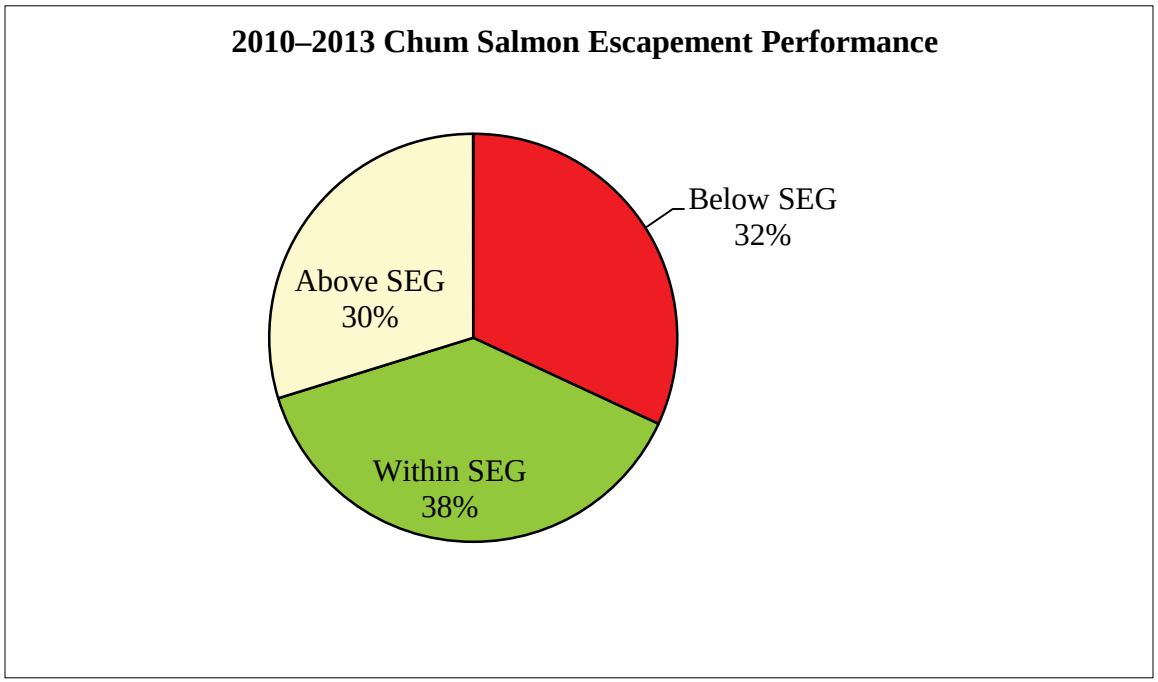

Figure 4.–Lower Cook Inlet chum salmon escapement performance for 12 stocks relative to their current sustainable escapement goal range (SEG), 2010–2013.

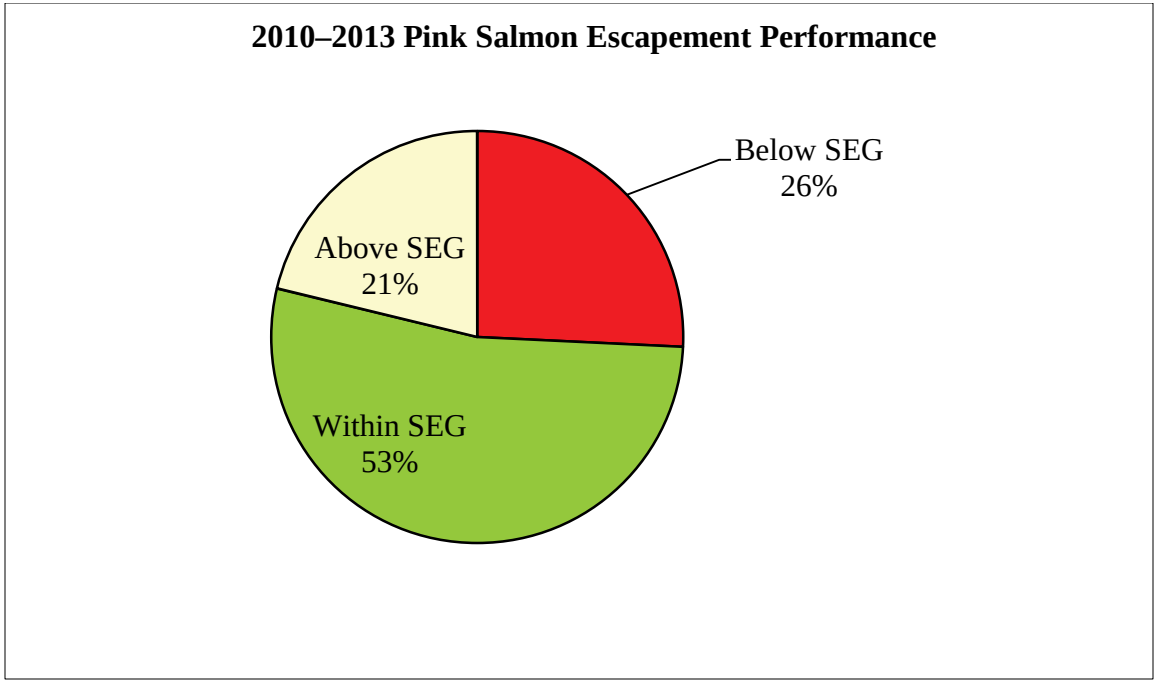

Figure 5.–Lower Cook Inlet pink salmon escapement performance for 17 stocks relative to their current sustainable escapement goal range (SEG), 2010–2013.

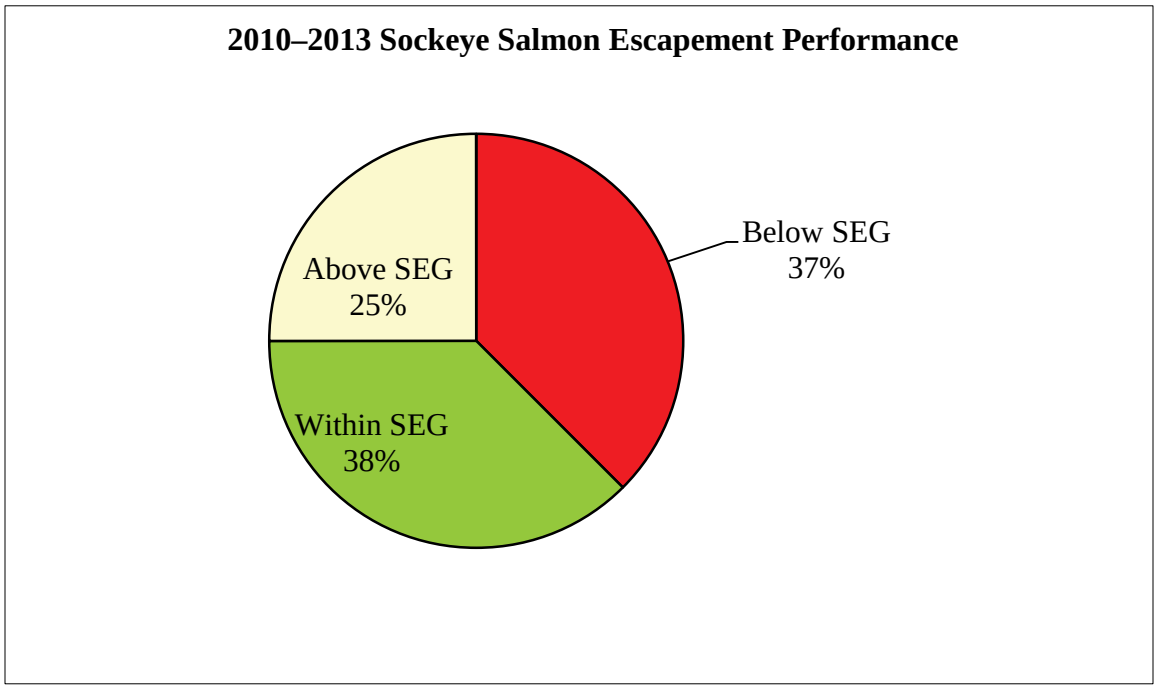

Figure 6.–Lower Cook Inlet sockeye salmon escapement performance for 8 stocks relative to their current sustainable escapement goal range (SEG), 2010–2013.

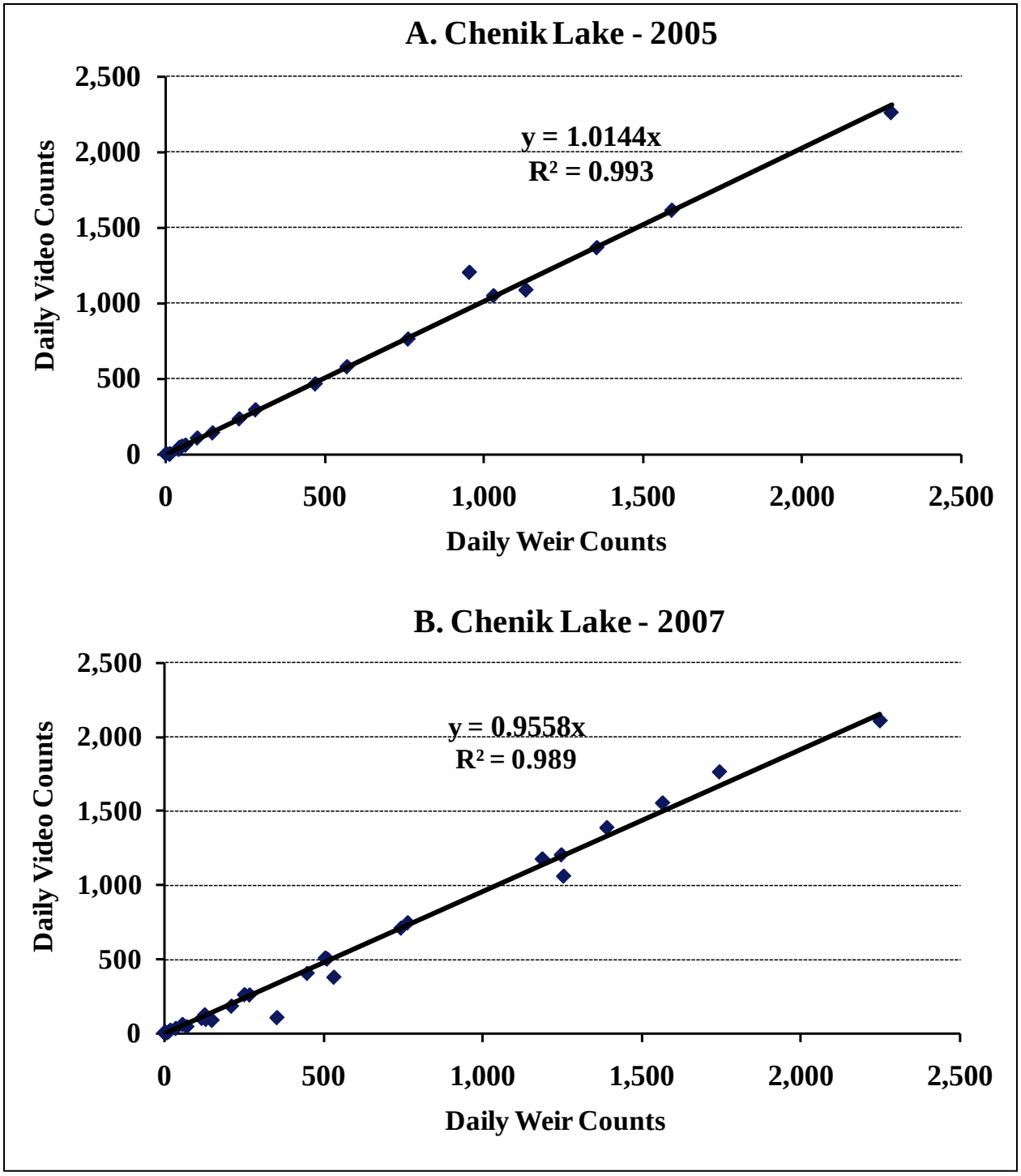

Figure 7.–Comparison of daily weir and video counts of sockeye salmon returning to Chenik Lake in 2005(A) and 2007(B).

APPENDIX A.
SUPPORTING INFORMATION FOR LOWER COOK INLET CHINOOK SALMON ESCAPEMENT GOALS

Appendix A1.–Data available for analysis of Anchor River Chinook salmon escapement goal.

Year	Aerial Index[a]	Weir/Sonar Count	Sport Harvest[b]
1977	3,585		1,077
1978	2,209		2,109
1979	1,335		1,913
1980			605
1981	1,066		1,069
1982	1,493		718
1983	1,033		1,269
1984	1,087		998
1985	1,328		672
1986	2,287		1,098
1987	2,524		761
1988	1,458		976
1989	940		578
1990	967		1,479
1991	589		1,047
1992	99		1,685
1993	1,110		2,787
1994	837		2,478
1995			1,475
1996	277		1,482
1997	477		1,563
1998	789		783
1999	685		1,409
2000	752		1,730
2001	414		889
2002	748		1,047
2003	680	9,238	1,011
2004	834	12,016	1,561
2005	651	11,156	1,432
2006	899	8,945	1,394
2007	678	9,622	2,081
2008	528	5,806	1,486
2009		3,455	737
2010		4,449	364
2011		3,545	573[c]
2012		4,509	38[c]
2013		4,393[c]	

Note: The current sustainable escapement goal is based on a full-probability spawner–recruit model using aerial survey indices (1977–2008) and weir/sonar escapement and sport harvest data from 2003 to 2009 (Otis et al 2010; Jennings et al. 2011, *In prep* a, b).

[a] Escapement not surveyed or monitored during years with no escapement value.

[b] Harvest data not yet available during years with no harvest value.

[c] Preliminary.

Appendix A2.–Data available for analysis of Deep Creek Chinook salmon escapement goal.

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

Note: The current sustainable escapement goal is based on aerial survey indices during 1976–2001.

[a] Escapement not surveyed or monitored during years with no escapement value. Escapement index is from a one-day aerial survey.

Appendix A3.–Data available for analysis of Ninilchik River Chinook salmon escapement goal.

Year	Escapement[a]
1999	1,283
2000	1,265
2001	897
2002	897
2003	517
2004	679
2005	1,259
2006	1,013
2007	543
2008	586
2009	528
2010	605
2011	668
2012	555
2013	571[b]

Note: The current sustainable escapement goal is based on July 3–31 weir counts from 1999 to 2007.

[a] Escapement index at broodstock weir at river km 7.7 from July 3 to 31.

[b] Preliminary.

APPENDIX B.
SUPPORTING INFORMATION FOR LOWER COOK INLET CHUM SALMON ESCAPEMENT GOALS

Appendix B1.–Data available for analysis of Port Graham River chum salmon escapement goal.

Year	Escapement[a]
1976	0.4
1977	5.2
1978	4.8
1979	2.2
1980	1.1
1981	4.8
1982	2.5
1983	1.9
1984	2.1
1985	0.5
1986	0.6
1987	1.5
1988	3.0
1989	1.3
1990	2.6
1991	1.1
1992	1.4
1993	2.5
1994	5.2
1995	3.8
1996	3.7
1997	4.1
1998	5.1
1999	6.6
2000	11.4
2001	6.0
2002	5.3
2003	2.9
2004	1.2
2005	0.7
2006	2.2
2007	1.9
2008	1.8
2009	1.0
2010	1.4
2011	1.8
2012	0.7
2013	1.9

Note: The current sustainable escapement goal is based on ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix B2.–Data available for analysis of Dogfish Lagoon chum salmon escapement goal.

Year	Escapement [a]
1976	3.0
1977	6.4
1978	9.3
1979	8.2
1980	4.0
1981	11.5
1982	8.5
1983	5.3
1984	8.6
1985	4.9
1986	2.5
1987	2.0
1988	8.6
1989	1.8
1990	1.0
1991	3.1
1992	0.8
1993	5.4
1994	11.3
1995	4.2
1996	6.7
1997	12.7
1998	9.8
1999	18.8
2000	19.6
2001	6.1
2002	10.1
2003	13.3
2004	3.6
2005	2.7
2006	5.4
2007	4.9
2008	6.2
2009	4.4
2010	12.7
2011	12.9
2012	8.8
2013	9.3

Note: The current sustainable escapement goal is based on ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix B3.–Data available for analysis of Rocky River chum salmon escapement goal.

Year	Escapement [a]
1976	12.0
1977	10.5
1978	6.3
1979	35.0
1980	23.0
1981	12.5
1982	2.8
1983	4.0
1984	3.5
1985	2.5
1986	2.0
1987	0.2
1988	0.3
1989	1.2
1990	0.8
1991	
1992	1.7
1993	0.1
1994	1.9
1995	5.1
1996	2.0
1997	1.1
1998	0.7
1999	5.4
2000	4.2
2001	3.0
2002	5.7
2003	5.5
2004	17.2
2005	6.1
2006	11.2
2007	1.6
2008	3.8
2009	2.5
2010	1.3
2011	4.5
2012	3.2
2013	8.1

Note: The current sustainable escapement goal is based on aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement not surveyed or monitored during years with no escapement value. Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix B4.–Data available for analysis of Port Dick Creek chum salmon escapement goal.

Year	Escapement [a]
1976	1.5
1977	5.0
1978	8.9
1979	4.0
1980	4.2
1981	4.1
1982	1.7
1983	4.5
1984	2.7
1985	1.0
1986	1.7
1987	6.1
1988	9.0
1989	3.3
1990	1.1
1991	7.4
1992	5.4
1993	2.5
1994	3.5
1995	3.3
1996	2.3
1997	1.9
1998	1.8
1999	2.9
2000	3.4
2001	1.8
2002	12.3
2003	5.6
2004	8.6
2005	4.8
2006	2.8
2007	2.8
2008	11.8
2009	5.6
2010	2.4
2011	7.1
2012	8.4
2013	4.1

Note: The current sustainable escapement goal is based on aerial/ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix B5.–Data available for analysis of Island Creek chum salmon escapement goal.

Year	Escapement [a]
1976	1.0
1977	11.1
1978	16.9
1979	16.8
1980	10.9
1981	17.5
1982	8.7
1983	36.2
1984	25.6
1985	9.1
1986	8.6
1987	13.2
1988	7.8
1989	4.8
1990	2.3
1991	17.3
1992	6.7
1993	3.6
1994	8.8
1995	7.7
1996	6.9
1997	5.2
1998	3.4
1999	16.4
2000	12.1
2001	6.3
2002	15.3
2003	16.3
2004	15.1
2005	20.7
2006	5.6
2007	3.1
2008	12.9
2009	9.3
2010	3.4
2011	11.8
2012	14.9
2013	8.8

Note: The current sustainable escapement goal is based on aerial/ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix B6.–Data available for analysis of Big Kamishak River chum salmon escapement goal.

Year	Escapement [a]
1976	24.0
1977	
1978	23.0
1979	15.0
1980	10.0
1981	11.0
1982	25.0
1983	25.0
1984	19.0
1985	6.0
1986	24.0
1987	12.0
1988	15.0
1989	30.0
1990	2.5
1991	8.7
1992	4.5
1993	9.1
1994	
1995	
1996	11.1
1997	
1998	7.1
1999	11.6
2000	45.3
2001	36.3
2002	17.4
2003	16.4
2004	57.9
2005	25.7
2006	58.2
2007	14.8
2008	4.5
2009	15.0
2010	
2011	5.5
2012	12.4
2013	3.3

Note: The current sustainable escapement goal is based on aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement not surveyed or monitored during years with no escapement value. Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix B7.–Data available for analysis of Little Kamishak River chum salmon escapement goal.

Year	Escapement [a]
1976	21.0
1977	
1978	30.0
1979	15.0
1980	13.0
1981	6.0
1982	18.0
1983	25.0
1984	12.0
1985	4.5
1986	17.0
1987	18.0
1988	13.0
1989	12.0
1990	7.9
1991	8.4
1992	7.1
1993	6.3
1994	9.0
1995	
1996	4.4
1997	
1998	9.7
1999	8.9
2000	26.9
2001	27.2
2002	16.4
2003	22.2
2004	45.3
2005	12.1
2006	42.9
2007	15.6
2008	21.3
2009	4.2
2010	18.4
2011	19.3
2012	30.3
2013	6.7

Note: The current sustainable escapement goal is based on aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement not surveyed or monitored during years with no escapement value. Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix B8.–Data available for analysis of McNeil River chum salmon escapement goal.

Year	Escapement [a]
1976	7.1
1977	41.2
1978	109.1
1979	10.5
1980	9.9
1981	45.2
1982	36.6
1983	56.3
1984	26.6
1985	10.8
1986	31.9
1987	32.7
1988	59.1
1989	49.3
1990	13.9
1991	6.8
1992	23.3
1993	19.3
1994	12.7
1995	12.2
1996	23.1
1997	32.4
1998	19.9
1999	10.2
2000	17.7
2001	16.9
2002	17.5
2003	29.3
2004	14.6
2005	22.5
2006	17.4
2007	21.6
2008	10.6
2009	18.8
2010	10.5
2011	31.0
2012	10.4
2013	9.5

Note: The current sustainable escapement goal is based on aerial survey indices, adjusted for run-timing, during 1976–2007 (Otis and Szarzi 2007).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (area-under-the-curve method) with a run-timing adjustment unless otherwise specified.

Appendix B9.–Data available for analysis of Bruin River chum salmon escapement goal.

Year	Escapement [a]
1976	4.0
1977	18.0
1978	4.0
1979	15.0
1980	15.0
1981	10.0
1982	10.0
1983	5.5
1984	8.0
1985	2.0
1986	1.0
1987	10.0
1988	7.0
1989	8.0
1990	4.0
1991	6.0
1992	8.5
1993	6.0
1994	6.1
1995	6.6
1996	14.9
1997	8.8
1998	9.4
1999	10.3
2000	13.6
2001	21.8
2002	9.9
2003	13.1
2004	15.9
2005	21.2
2006	7.0
2007	3.1
2008	17.5
2009	10.1
2010	6.2
2011	3.5
2012	16.8
2013	8.9

Note: The current sustainable escapement goal is based on aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix B10.–Data available for analysis of Ursus Cove chum salmon escapement goal.

Year	Escapement [a]
1976	6.0
1977	9.3
1978	9.7
1979	5.0
1980	8.0
1981	10.0
1982	9.0
1983	7.7
1984	7.0
1985	3.0
1986	11.0
1987	9.9
1988	9.4
1989	6.3
1990	3.8
1991	1.3
1992	1.7
1993	7.7
1994	6.2
1995	11.1
1996	7.6
1997	6.2
1998	4.6
1999	21.0
2000	41.7
2001	37.7
2002	17.1
2003	30.4
2004	16.0
2005	12.2
2006	15.7
2007	20.9
2008	6.5
2009	12.9
2010	11.8
2011	10.6
2012	2.8
2013	10.3

Note: The current sustainable escapement goal is based on aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix B11.–Data available for analysis of Cottonwood Creek chum salmon escapement goal.

Year	Escapement [a]
1976	5.0
1977	10.0
1978	12.5
1979	2.5
1980	4.2
1981	9.0
1982	7.0
1983	8.3
1984	6.5
1985	3.0
1986	11.0
1987	17.0
1988	16.0
1989	8.0
1990	4.3
1991	7.7
1992	6.1
1993	12.0
1994	10.2
1995	15.4
1996	16.1
1997	5.6
1998	2.3
1999	12.0
2000	24.1
2001	15.9
2002	42.2
2003	72.8
2004	16.3
2005	17.9
2006	13.2
2007	12.5
2008	11.6
2009	19.4
2010	15.8
2011	4.7
2012	4.1
2013	5.2

Note: The current sustainable escapement goal is based on aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix B12.–Data available for analysis of Iniskin Bay chum salmon escapement goal.

Year	Escapement [a]
1976	13.5
1977	4.4
1978	11.4
1979	4.0
1980	9.3
1981	9.0
1982	12.8
1983	12.0
1984	9.8
1985	5.0
1986	5.9
1987	9.1
1988	9.5
1989	5.9
1990	8.4
1991	8.3
1992	3.4
1993	8.0
1994	18.9
1995	22.7
1996	7.8
1997	15.4
1998	18.6
1999	23.3
2000	23.6
2001	13.8
2002	28.5
2003	18.7
2004	22.0
2005	16.5
2006	15.6
2007	5.3
2008	20.0
2009	30.8
2010	19.3
2011	16.5
2012	3.0
2013	5.9

Note: The current sustainable escapement goal is based on aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

APPENDIX C.
SUPPORTING INFORMATION FOR LOWER COOK INLET PINK SALMON ESCAPEMENT GOALS

Appendix C1.–Data available for analysis of Humpy Creek pink salmon escapement goal.

Year	Escapement [a]
1976	27.2
1977	86.0
1978	46.1
1979	200.0
1980	64.4
1981	115.0
1982	31.9
1983	104.0
1984	84.2
1985	117.0
1986	49.7
1987	26.6
1988	21.4
1989	93.0
1990	27.0
1991	17.4
1992	14.9
1993	36.0
1994	14.1
1995	89.3
1996	9.0
1997	78.3
1998	17.5
1999	12.8
2000	22.4
2001	30.5
2002	37.1
2003	90.9
2004	28.9
2005	93.8
2006	48.4
2007	54.0
2008	90.9
2009	5.2
2010	70.7
2011	1.7
2012	67.9
2013	6.7

Note: The current sustainable escapement goal is based on ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C2.–Data available for analysis of China Poot Creek pink salmon escapement goal.

Year	Escapement [a]
1976	2.0
1977	3.9
1978	11.2
1979	20.6
1980	12.3
1981	5.0
1982	3.1
1983	14.1
1984	8.4
1985	1.9
1986	11.5
1987	3.1
1988	3.9
1989	8.5
1990	4.2
1991	2.6
1992	4.1
1993	1.6
1994	5.7
1995	2.0
1996	2.8
1997	2.8
1998	5.7
1999	0.7
2000	7.5
2001	6.6
2002	6.5
2003	6.7
2004	3.3
2005	9.2
2006	7.2
2007	6.2
2008	5.1
2009	1.1
2010	2.2
2011	3.5
2012	8.4
2013	7.1

Note: The current sustainable escapement goal is based on ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C3.–Data available for analysis of Tutka Lagoon Creek pink salmon escapement goal.

Year	Escapement[a]	Year	Escapement[a]
1960	15.0	1987	4.8
1961	15.0	1988	11.2
1962	30.0	1989	11.9
1963	10.0	1990	38.5
1964	20.0	1991	16.8
1965	20.0	1992	26.7
1966	12.0	1993	27.4
1967	7.0	1994	14.5
1968	7.9	1995	15.9
1969	6.5	1996	3.5
1970	6.5	1997	45.0
1971	16.7	1998	17.5
1972	1.5	1999	27.9
1973	6.5	2000	19.0
1974	2.6	2001	4.5
1975	17.6	2002	15.9
1976	11.5	2003	30.9
1977	14.0	2004	17.8
1978	15.0	2005	133.6
1979	10.6	2006	25.8
1980	17.3	2007	5.7
1981	21.1	2008	14.1
1982	18.5	2009	3.8
1983	12.9	2010	2.1
1984	10.5	2011	22.0
1985	14.0	2012	10.4
1986	13.4	2013	9.5

Note: The current sustainable escapement goal is based on ground survey indices (area-under-the-curve (AUC) method) from 1960 to 1975, prior to commencement of pink salmon enhancement at Tutka Lagoon (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C4.–Data available for analysis of Barabara Creek pink salmon escapement goal.

Year	Escapement [a]
1976	0.2
1977	5.7
1978	1.4
1979	10.0
1980	5.8
1981	16.8
1982	2.1
1983	14.8
1984	1.0
1985	1.6
1986	1.8
1987	0.3
1988	0.7
1989	4.5
1990	3.9
1991	10.9
1992	2.2
1993	11.9
1994	4.5
1995	10.8
1996	2.4
1997	12.5
1998	2.8
1999	3.9
2000	5.6
2001	2.3
2002	3.2
2003	5.1
2004	5.4
2005	14.4
2006	3.6
2007	25.2
2008	16.6
2009	2.6
2010	13.9
2011	8.2
2012	1.4
2013	17.4

Note: The current sustainable escapement goal is based on ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C5.–Data available for analysis of Seldovia River pink salmon escapement goal.

Year	Escapement [a]
1976	25.6
1977	35.7
1978	24.6
1979	43.7
1980	65.5
1981	62.7
1982	38.4
1983	27.9
1984	14.2
1985	22.8
1986	28.2
1987	7.6
1988	16.9
1989	26.2
1990	27.8
1991	30.0
1992	14.7
1993	43.4
1994	24.4
1995	48.5
1996	17.8
1997	39.1
1998	31.5
1999	12.2
2000	53.5
2001	12.3
2002	26.9
2003	35.1
2004	56.8
2005	98.6
2006	70.0
2007	69.4
2008	53.5
2009	14.6
2010	25.9
2011	46.2
2012	44.7
2013	36.8

Note: The current sustainable escapement goal is based on ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C6.–Data available for analysis of Port Graham River pink salmon escapement goal.

Year	Escapement [a]
1976	6.5
1977	20.6
1978	6.7
1979	32.7
1980	40.2
1981	18.4
1982	28.9
1983	4.6
1984	10.9
1985	26.3
1986	17.5
1987	3.8
1988	7.9
1989	19.1
1990	20.1
1991	29.0
1992	5.4
1993	12.8
1994	7.6
1995	10.0
1996	7.0
1997	12.5
1998	12.6
1999	9.7
2000	15.6
2001	10.3
2002	58.5
2003	14.9
2004	44.0
2005	69.1
2006	31.2
2007	25.6
2008	24.7
2009	14.0
2010	16.6
2011	20.9
2012	34.5
2013	11.9

Note: The current sustainable escapement goal is based on ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C7.–Data available for analysis of Port Chatham creeks pink salmon escapement goal.

Year	Escapement [a]
1976	
1977	14.2
1978	0.3
1979	20.8
1980	7.7
1981	11.2
1982	2.0
1983	3.5
1984	7.8
1985	8.9
1986	11.5
1987	10.2
1988	21.0
1989	31.7
1990	27.8
1991	23.8
1992	4.3
1993	22.2
1994	3.3
1995	14.0
1996	8.6
1997	42.7
1998	22.2
1999	10.7
2000	16.7
2001	17.9
2002	18.1
2003	35.0
2004	26.4
2005	44.4
2006	24.2
2007	14.5
2008	16.4
2009	25.3
2010	3.0
2011	15.8
2012	5.4
2013	57.4

Note: The current sustainable escapement goal is based on ground survey indices (area-under-the-curve (AUC) method) from 1977 to 2001 (Otis 2001).

[a] Escapement not surveyed or monitored during years with no escapement value. Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C8.–Data available for analysis of Windy Creek Right pink salmon escapement goal.

Year	Escapement [a]
1976	0.2
1977	11.1
1978	0.3
1979	10.4
1980	3.3
1981	4.7
1982	4.7
1983	4.3
1984	3.4
1985	5.4
1986	2.5
1987	2.0
1988	1.3
1989	6.6
1990	7.1
1991	20.7
1992	3.9
1993	13.6
1994	2.2
1995	11.4
1996	9.9
1997	13.9
1998	19.5
1999	5.2
2000	23.0
2001	10.3
2002	14.4
2003	23.3
2004	12.0
2005	22.2
2006	17.1
2007	18.3
2008	12.5
2009	15.0
2010	6.4
2011	1.7
2012	5.8
2013	11.7

Note: The current sustainable escapement goal is based on ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C9.–Data available for analysis of Windy Creek Left pink salmon escapement goal.

Year	Escapement [a]
1976	0.2
1977	47.3
1978	1.1
1979	74.8
1980	10.9
1981	31.3
1982	4.4
1983	11.9
1984	2.5
1985	8.9
1986	2.2
1987	5.6
1988	3.4
1989	25.2
1990	7.5
1991	34.5
1992	8.2
1993	25.9
1994	3.0
1995	31.6
1996	2.5
1997	64.6
1998	12.9
1999	24.0
2000	20.1
2001	61.8
2002	28.9
2003	82.8
2004	23.3
2005	72.0
2006	65.2
2007	37.3
2008	64.1
2009	57.3
2010	24.2
2011	12.2
2012	11.7
2013	47.8

Note: The current sustainable escapement goal is based on ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C10.–Data available for analysis of Rocky River pink salmon escapement goal.

Year	Escapement [a]
1976	2.7
1977	36.7
1978	8.2
1979	85.0
1980	6.4
1981	25.0
1982	6.6
1983	16.6
1984	9.0
1985	12.1
1986	12.0
1987	4.5
1988	5.4
1989	10.3
1990	18.0
1991	26.1
1992	25.4
1993	70.0
1994	17.1
1995	56.3
1996	80.1
1997	48.1
1998	165.0
1999	17.2
2000	131.6
2001	73.0
2002	112.5
2003	287.4
2004	53.8
2005	198.7
2006	67.8
2007	190.0
2008	90.9
2009	173.6
2010	27.0
2011	22.7
2012	15.7
2013	75.8

Note: The current sustainable escapement goal is based on ground and aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C11.–Data available for analysis of Port Dick Creek pink salmon escapement goal.

Year	Escapement [a]
1976	12.7
1977	109.3
1978	44.9
1979	116.0
1980	56.1
1981	106.0
1982	19.9
1983	64.1
1984	44.6
1985	65.3
1986	41.6
1987	4.5
1988	12.0
1989	55.4
1990	41.7
1991	54.2
1992	6.9
1993	37.0
1994	18.1
1995	6.6
1996	23.2
1997	36.9
1998	59.1
1999	8.5
2000	124.4
2001	44.7
2002	108.0
2003	107.7
2004	13.3
2005	122.2
2006	51.5
2007	44.2
2008	34.2
2009	41.7
2010	41.1
2011	16.9
2012	18.1
2013	55.8

Note: The current sustainable escapement goal is based on aerial and ground survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C12.–Data available for analysis of Island Creek pink salmon escapement goal.

Year	Escapement [a]
1976	
1977	0.6
1978	0.4
1979	0.6
1980	2.2
1981	25.0
1982	15.0
1983	15.3
1984	35.0
1985	27.9
1986	16.6
1987	0.1
1988	7.2
1989	6.7
1990	25.0
1991	24.4
1992	12.5
1993	12.1
1994	28.3
1995	10.6
1996	40.1
1997	71.1
1998	83.6
1999	8.6
2000	70.8
2001	81.8
2002	44.1
2003	118.6
2004	33.6
2005	26.4
2006	107.7
2007	87.2
2008	49.7
2009	44.5
2010	69.5
2011	10.2
2012	20.1
2013	26.0

Note: The current sustainable escapement goal is based on aerial and ground survey indices (area-under-the-curve (AUC) method) from 1977 to 2001 (Otis 2001).

[a] Escapement not surveyed or monitored during years with no escapement value. Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C13.–Data available for analysis of S. Nuka Island Creek pink salmon escapement goal.

Year	Escapement [a]
1976	
1977	12.0
1978	
1979	15.0
1980	0.3
1981	16.0
1982	0.4
1983	22.2
1984	0.6
1985	3.6
1986	7.0
1987	2.8
1988	1.2
1989	7.3
1990	13.3
1991	16.4
1992	6.1
1993	34.3
1994	1.4
1995	6.2
1996	6.8
1997	9.3
1998	14.0
1999	2.4
2000	13.6
2001	20.7
2002	14.8
2003	41.4
2004	6.4
2005	11.2
2006	5.1
2007	6.6
2008	12.3
2009	19.9
2010	
2011	
2012	1.3
2013	8.4

Note: The current sustainable escapement goal is based on aerial and ground survey indices (area-under-the-curve (AUC) method) from 1977 to 2001 (Otis 2001).

[a] Escapement not surveyed or monitored during years with no escapement value. Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C14.–Data available for analysis of Desire Lake Creek pink salmon escapement goal.

Year	Escapement [a]
1976	0.6
1977	0.8
1978	1.0
1979	3.0
1980	16.0
1981	5.0
1982	12.0
1983	8.5
1984	23.0
1985	62.5
1986	32.0
1987	11.0
1988	2.5
1989	47.0
1990	1.0
1991	1.3
1992	0.4
1993	19.3
1994	
1995	
1996	
1997	6.2
1998	6.2
1999	6.8
2000	21.1
2001	67.5
2002	78.4
2003	34.8
2004	24.3
2005	46.0
2006	74.8
2007	11.8
2008	9.5
2009	73.9
2010	3.0
2011	0.6
2012	2.3
2013	56.9

Note: The current sustainable escapement goal is based on aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement not surveyed or monitored during years with no escapement value. Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C15.–Data available for analysis of Bruin River pink salmon escapement goal.

Year	Escapement [a]
1976	13.5
1977	60.0
1978	33.0
1979	200.0
1980	400.0
1981	95.0
1982	75.0
1983	4.0
1984	110.0
1985	3.5
1986	1,200.0
1987	24.0
1988	29.0
1989	350.0
1990	19.0
1991	74.9
1992	3.2
1993	86.4
1994	5.9
1995	307.3
1996	27.5
1997	162.7
1998	134.9
1999	2.9
2000	176.7
2001	18.5
2002	1,598.5
2003	138.7
2004	66.5
2005	98.3
2006	515.1
2007	350.4
2008	150.7
2009	1,067.4
2010	40.3
2011	4.5
2012	31.8
2013	15.0

Note: The current sustainable escapement goal is based on aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C16.–Data available for analysis of Sunday Creek pink salmon escapement goal.

Year	Escapement [a]
1976	0.3
1977	9.0
1978	0.2
1979	12.0
1980	5.2
1981	14.2
1982	12.0
1983	4.7
1984	12.0
1985	11.4
1986	109.0
1987	29.7
1988	18.0
1989	103.0
1990	2.8
1991	20.9
1992	2.9
1993	57.8
1994	3.1
1995	95.9
1996	2.8
1997	52.5
1998	24.0
1999	5.3
2000	39.8
2001	26.2
2002	81.9
2003	346.7
2004	31.5
2005	116.2
2006	70.0
2007	394.8
2008	20.4
2009	106.3
2010	6.6
2011	0.8
2012	1.3
2013	6.1

Note: The current sustainable escapement goal is based on aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

Appendix C17.–Data available for analysis of Brown's Peak Creek pink salmon escapement goal.

Year	Escapement [a]
1976	1.2
1977	13.0
1978	0.9
1979	15.0
1980	2.3
1981	17.7
1982	3.5
1983	1.7
1984	6.8
1985	7.0
1986	28.0
1987	40.2
1988	17.0
1989	120.0
1990	1.0
1991	16.7
1992	5.0
1993	41.6
1994	1.3
1995	96.7
1996	2.4
1997	42.3
1998	7.9
1999	2.6
2000	9.8
2001	19.2
2002	27.5
2003	285.0
2004	18.1
2005	61.0
2006	35.7
2007	249.4
2008	17.4
2009	63.6
2010	3.1
2011	2.0
2012	2.8
2013	4.1

Note: The current sustainable escapement goal is based on aerial survey indices (area-under-the-curve (AUC) method) from 1976 to 2001 (Otis 2001).

[a] Escapement (thousands of fish) estimated by multiple aerial/ground survey (AUC method) unless otherwise specified.

APPENDIX D.
SUPPORTING INFORMATION FOR LOWER COOK INLET SOCKEYE SALMON ESCAPEMENT GOALS

Appendix D1.–Data available for analysis of English Bay Lakes sockeye salmon escapement goal.

Year	Escapement [a]
1976	6.0[b]
1977	12.5[b]
1978	13.5[b]
1979	4.4[b]
1980	12.0[b]
1981	10.5[b]
1982	20.0[b]
1983	12.0[b]
1984	11.1[b]
1985	5.0[b]
1986	2.8[b]
1987	7.0[b]
1988	2.5[b]
1989	4.5[b]
1990	3.3[b]
1991	7.0[b]
1992	6.4[b]
1993	8.9
1994	13.8
1995	20.7
1996	11.1
1997	14.4
1998	14.1
1999	14.6
2000	11.2
2001	10.5
2002	15.0
2003	19.8
2004	15.0
2005	7.6
2006	16.5
2007	16.5
2008	12.0
2009	18.2
2010	12.3
2011	9.9
2012	3.4
2013	10.9

Note: The current sustainable escapement goal is based on peak aerial survey indices (1976–1992) and weir counts (1993–2001; Otis 2001).

[a] Escapement (thousands of fish) estimated by weir counts unless otherwise specified.

[b] Escapement indexed by peak aerial survey.

[c] Preliminary.

Appendix D2.–Data available for analysis of Delight Lake sockeye salmon escapement goal.

Year	Escapement [a]
1976	6.0[b]
1977	5.2[b]
1978	8.0[b]
1979	8.0[b]
1980	10.0[b]
1981	7.3[b]
1982	25.0[b]
1983	7.0[b]
1984	10.5[b]
1985	26.0[b]
1986	13.0[b]
1987	10.5[b]
1988	1.2[b]
1989	7.7[b]
1990	5.2[b]
1991	4.1[b]
1992	5.9[b]
1993	5.6[b]
1994	5.6[b]
1995	15.8[b]
1996	7.7[b]
1997	27.8
1998	9.2
1999	17.0
2000	12.3[b,c]
2001	10.1
2002	19.6
2003	7.5
2004	7.3
2005	15.2
2006	10.9
2007	44.0
2008	23.9
2009	12.7
2010	23.8
2011	20.2
2012	10.9
2013	6.0

Note: The current sustainable escapement goal is based on weir counts from 1997 to 1999 and 2001 to 2010 (Otis et al. 2010).

[a] Escapement (thousands of fish) estimated by weir counts unless otherwise specified.

[b] Escapement indexed by peak aerial survey.

[c] The weir was not operated in 2000.

Appendix D3.–Data available for analysis of Desire Lake sockeye salmon escapement goal.

Year	Escapement [a]
1976	11.0
1977	10.7
1978	10.0
1979	12.0
1980	17.0
1981	12.0
1982	18.0
1983	12.0
1984	15.0
1985	18.0
1986	10.0
1987	13.4
1988	9.0
1989	9.0
1990	9.5
1991	8.2
1992	11.9
1993	11.0
1994	10.5
1995	15.8
1996	9.4
1997	14.7[b]
1998	7.9
1999	14.6
2000	4.0
2001	5.5
2002	16.0
2003	8.4
2004	10.7
2005	4.8
2006	18.6
2007	10.0
2008	10.7
2009	16.0
2010	6.3
2011	9.6
2012	8.8
2013	8.4

Note: The current sustainable escapement goal is based on peak aerial survey indices (1976–1996, 1998–2001) and weir counts (1997; see Otis 2001).

[a] Escapement (thousands of fish) estimated by peak aerial survey unless otherwise specified.

[b] A weir was used to estimate escapement in 1997.

Appendix D4.–Data available for analysis of Bear Lake sockeye salmon escapement goal.

Year	Escapement [a]
1976	0.6
1977	
1978	
1979	
1980	1.5
1981	0.7
1982	0.5
1983	0.7
1984	0.5
1985	1.1
1986	0.8
1987	0.3
1988	0.1
1989	0.1
1990	0.1
1991	0.7
1992	1.9
1993	4.8
1994	7.3[b]
1995	6.5[b]
1996	6.2[b]
1997	7.2[b]
1998	6.2[b]
1999	5.8[b]
2000	7.8[b]
2001	8.6[b]
2002	8.3[b]
2003	9.5[b]
2004	8.2[b]
2005	10.3[b]
2006	8.3[b]
2007	8.6[b]
2008	9.3[b]
2009	10.4[b]
2010	8.9[b]
2011	9.6[b]
2012	8.0[b]
2013	9.0[b]

Note: The current sustainable escapement goal is based on weir counts from 1985 to 2001, prior to commencement of enhanced returns (Otis 2001).

[a] Escapement (thousands of fish) estimated with weirs; escapement limited by Bear Lake Management Plan since 1971.

[b] Beginning in 1994, Bear Lake escapement derived from total weir count minus number of fish collected for hatchery broodstock.

Appendix D5.–Data available for analysis of Aialik Lake sockeye salmon escapement goal.

Year	Escapement [a]
1976	8.0
1977	5.0
1978	3.0
1979	5.0
1980	6.6
1981	1.8
1982	22.4
1983	20.0
1984	22.0
1985	8.0
1986	7.6
1987	9.2
1988	13.0
1989	6.5
1990	5.7
1991	3.7
1992	2.5
1993	3.0
1994	7.3
1995	2.6
1996	3.5
1997	11.4
1998	4.9
1999	3.8
2000	4.3
2001	5.1
2002	6.1
2003	5.4
2004	10.1
2005	5.3
2006	4.8
2007	5.4
2008	4.2
2009	3.1
2010	5.3
2011	3.5
2012	2.1
2013	3.5

Note: The current sustainable escapement goal is based on peak aerial survey counts from 1976 to 2001 (Otis 2001).

[a] Escapement estimated by peak aerial survey unless otherwise specified.

Appendix D6.–Data available for analysis of Mikfik Lake sockeye salmon escapement goal.

	Escapement [a]	
Year	Peak Aerial Survey	Video
1976	10.0	
1977	9.8	
1978	12.0	
1979	6.0	
1980	6.5	
1981	5.3	
1982	35.0	
1983	7.0	
1984	6.0	
1985	20.0	
1986	7.8	
1987	9.0	
1988	10.1	
1989	11.5	
1990	8.8	
1991	9.7	
1992	7.8	
1993	6.4	
1994	9.5	
1995	10.1	
1996	6.5	
1997	8.5	
1998	12.6	9.5
1999	15.7	20.0
2000	10.9	10.4
2001	5.4	3.3
2002	16.7	
2003	12.8	11.0
2004	14.0	16.0
2005	5.1	6.5
2006	17.7	15.0
2007	11.2	11.0
2008	5.6	10.0
2009	15.1	21.0
2010	11.3	5.2
2011	0.4	0.3
2012	2.5	3.1
2013	1.9	4.0

Note: The current sustainable escapement goal (SEG) is based on peak aerial survey counts from 1976 to 2001 (Otis 2001). The new recommended SEG is based on remote video counts from 1998 to 2013.

[a] Escapement (thousands of fish) not surveyed or monitored during years with no escapement value.

Appendix D7.–Data available for analysis of Chenik Lake sockeye salmon escapement goal.

Year	Escapement [a]
1976	0.9
1977	0.2
1978	0.1
1979	0.0
1980	3.5
1981	2.5
1982	8.0
1983	11.0
1984	13.0
1985	3.5
1986	7.0
1987	10.0
1988	9.0
1989	12.0[b]
1990	17.0[b]
1991	10.2[b]
1992	9.3[b]
1993	4.0[b]
1994	0.8[b]
1995	1.1[b]
1996	3.0[b]
1997	2.3[b]
1998	1.9
1999	2.9
2000	4.8
2001	0.3
2002	4.7
2003	13.8
2004	17.0
2005	12.8[b]
2006	8.5[b]
2007	17.4[b]
2008	10.7[c]
2009	15.3[c]
2010	17.3[c]
2011	10.3[c]
2012	16.5[c]
2013	11.3[c]

Note: The current sustainable escapement goal is based on remote video and weir counts from 1989 to 1997 and 2005 to 2010 (Otis et al. 2010).

[a] Escapement (thousands of fish) estimated by peak aerial survey unless otherwise specified.

[b] Escapement derived from weir counts.

[c] Escapement derived from video counts.

Appendix D8.–Data available for analysis of Amakdedori Creek sockeye salmon escapement goal.

Year	Escapement [a]
1976	1.6
1977	2.6
1978	2.6
1979	1.0
1980	2.6
1981	1.9
1982	3.2
1983	1.2
1984	1.4
1985	0.9
1986	1.9
1987	1.1
1988	0.4
1989	1.2
1990	1.8
1991	1.9
1992	1.9
1993	2.0
1994	0.8
1995	2.4
1996	2.9
1997	1.5
1998	4.1
1999	8.8
2000	3.3
2001	2.7
2002	3.2
2003	11.8
2004	7.2
2005	1.7
2006	0.3
2007	3.8
2008	3.2
2009	2.2
2010	1.2
2011	3.4
2012	0.8
2013	1.5

Note: The current sustainable escapement goal is based on peak aerial survey indices from 1976 to 2001 (Otis 2001).

[a] Escapement estimated by peak aerial survey unless otherwise specified.