Fishery Manuscript No. 10-07

A Review of Escapement Goals for Salmon Stocks in Lower Cook Inlet, Alaska, 2010

by

Edward O. Otis

Nicole J. Szarzi

Lowell F. Fair

and

Jack W. Erickson

October 2010

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

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Special Publications, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

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

FISHERY MANUSCRIPT NO. 10-07

A REVIEW OF ESCAPEMENT GOALS FOR SALMON STOCKS IN LOWER COOK INLET, ALASKA, 2010

by

Edward O. Otis
Alaska Department of Fish and Game, Division of Commercial Fisheries, Homer

Nicole J. Szarzi
Alaska Department of Fish and Game, Division of Sport Fish, Homer

Lowell F. Fair
Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage

Jack W. Erickson
Alaska Department of Fish and Game, Division of Sport Fish, Anchorage

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

October 2010

The Fishery Manuscript series was established in 1987 by the Division of Sport Fish for the publication of technically-oriented results of several years' work undertaken on a project to address common objectives, provide an overview of work undertaken through multiple projects to address specific research or management goal(s), or new and/or highly technical methods, and became a joint divisional series in 2004 with the Division of Commercial Fisheries. Fishery Manuscripts are intended for fishery and other technical professionals. Fishery Manuscripts are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm This publication has undergone editorial and peer review.

Edward O. Otis and Nicole J. Szarzi
Alaska Department of Fish and Game, Divisions of Commercial Fisheries and Sport Fish,
3298 Douglas Place, Homer, Alaska 99603-8027, USA
and
Lowell F. Fair and Jack W. Erickson
Alaska Department of Fish and Game, Divisions of Commercial Fisheries and Sport Fish,
333 Raspberry Road, Anchorage, Alaska 99518-1565, USA

This document should be cited as:
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.

TABLE OF CONTENTS

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

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). The Alaska Board of Fisheries adopted 2 policies in 2000–2001 that affected development of escapement goals, subsequently, ADF&G revised all salmon escapement goals in Lower Cook Inlet. Except for 2 Chinook salmon *Oncorhynchus tshawytscha*, stocks (Anchor and Ninilchik rivers) and 5 sockeye salmon 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. Consequently, ADF&G developed an algorithm to estimate sustainable escapement goals for each of the 3 Chinook, 12 chum *O. keta*, 21 pink *O. gorbuscha*, and 8 sockeye salmon *O. nerka* stocks ADF&G monitors in Lower Cook Inlet. Escapement performance for chum, pink, and sockeye salmon relative to these new goals has been good during the past 4 years, with harvestable surpluses available in 77–88% of streams during most years. We recommend changes to 7 existing escapement goals in Lower Cook Inlet. Based on additional years of escapement and harvest data, we recommend changing the Anchor River Chinook salmon goal from a lower bound SEG of 5,000 to an SEG range of 3,800 to 10,000 fish. We recommend eliminating escapement goals for 4 inconsistently monitored pink salmon stocks in Resurrection Bay (Bear/Salmon Creeks, Thumb Cove, Humpy Cove, and Tonsina Creek) having modest returns and limited commercial fishing opportunity. We also recommend updating escapement goals for sockeye salmon stocks at Delight Creek and Chenik Lake, both of which were originally derived primarily from aerial survey indices, but are now monitored by weir and/or video projects.

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) interdivisional escapement goal review committee (committee) reviews the 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 2007 and presents information from the subsequent 3 years in the context of these goals. Our objective is to provide historical and current information on LCI salmon escapements and to evaluate the appropriateness of current and recommended escapement goals for LCI salmon stocks. 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, 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 biological escapement goals.

During 2000 and 2001, the BOF adopted 2 policies that currently govern escapement goals: the *Policy for the Management of Sustainable Salmon Fisheries* (sustainable salmon fisheries policy; SSFP) (5 AAC 39.222) and the *Policy for Statewide Salmon Escapement Goals* (escapement goal policy; EGP) (5 AAC 39.223). Under these policies, sustainable escapement goals were added to those goals previously mentioned. Under sections (b) (2) and (3) of the escapement goal policy, ADF&G is to:

> "(2) establish biological escapement goals (BEG) for salmon stocks for which the department can reliably enumerate salmon escapement levels, as well as total annual returns"; and
>
> "(3) establish sustainable escapement goals (SEG) for salmon stocks for which the department can reliably estimate escapement levels when there is not sufficient information to enumerate total annual returns and the range of escapements that are used to develop a BEG."

Section (f) of the sustainable fisheries policy was amended by the BOF in March 2010 to include lower bound SEGs and provides definitions that are more detailed, as follows:

> "(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
>
> "(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 be stated as a range "(SEG Range)" or a lower bound "(Lower Bound SEG)" that takes into account data uncertainty; 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 sustainable escapement goals (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 removed 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

---

[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*).

Hasbrouck 2004). In 2004, ADF&G removed 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 sustainable escapement goal representing both streams. In 2007, ADF&G increased the escapement goal for McNeil River chum salmon, effectively restoring the previous long-standing goal to encourage greater seeding of upriver spawning habitats and increase streamwide production. ADF&G also increased the length of the escapement monitoring period and, consequently, the escapement goal 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). During the 2010 review process, escapement goals for the following stocks were evaluated:

- 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, Seldovia, Windy (right), Windy (left), Port Dick, Island, S. Nuka Island, Desire Lake, Bear and Salmon, Tonsina, Sunday, and Brown's Peak creeks; Thumb and Humpy coves; and Port Graham, Rocky, and Bruin rivers.
- Sockeye salmon: English Bay; Amakdedori Creek; and Delight, Desire, Bear, Aialik, Mikfik, and Chenik lakes.

During spring of 2010, 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 5 February 2010 to review escapement goals and develop recommendations. The committee also communicated by email. All committee recommendations were reviewed by ADF&G regional and headquarters staff prior to being adopted by ADF&G as escapement goals per the SSFP and EGP.

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 management of discrete stocks of salmon (Hammarstrom and Ford 2010). 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 (Figure 1) 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 lakes 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. 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. Dual-Frequency Identification Sonar (DIDSON) 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. The development of a new escapement goal for the Anchor River based on sonar and weir data is addressed in Szarzi et al. (2007).

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. 2010).

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, the 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 sustainable escapement goals (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). 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); Exploited Population	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 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 8 and 24 July from 1994 to 2000. This river has been stocked since the early 1990s with hatchery-produced Chinook salmon from Ninilchik River brood stock. Hatchery stocked fish have been marked with an adipose fin clip and coded wire tag. 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 for use in collecting brood stock. All fish that were passed through the weir were counted and examined 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. Weir data were used because it was 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 15^{th} 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 full probability 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 sonar/weir 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 of an SEG of 5,000 was based on the point estimate (posterior median) of S_{MSY} from the full probability model.

For Tutka 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. For Bear Lake sockeye salmon, weir data from 1985 to 2001 were used because prior to 1985 the lake was managed to limit sockeye production in favor of coho salmon.

RESULTS AND DISCUSSION

We recommend changing the Anchor River Chinook salmon goal from a lower bound SEG of 5,000 to an SEG range of 3,800 to 10,000 based on a full probability model (Szarzi et al. 2007) updated with the recent escapement, age composition and harvest data since 2007. We recommend eliminating escapement goals for 4 pink salmon stocks in Resurrection Bay (Bear/Salmon Creeks, Thumb Cove, Humpy Cove, and Tonsina Creek) having modest returns and limited commercial fishing opportunities. The committee also recommends revising the escapement goals for sockeye salmon stocks at Delight and Chenik lakes so they both are derived from methods currently used to monitor escapement and manage their respective fisheries inseason. The following provides additional details on these recommendations and a review of recent salmon escapements relative to the goals currently in place.

CHINOOK SALMON

Chinook salmon escapements from 2008 to 2010 were average for Deep Creek and below average for the Anchor and Ninilchik rivers. The Chinook salmon escapement index count at Deep Creek was below the SEG in 2008 (Table 1), the first time the Deep Creek Chinook salmon SEG was not achieved since 1998. The Ninilchik River Chinook salmon escapement was below the SEG in 2009 (Table 1). Ninilchik River Chinook salmon escapements were previously below the goal in 2003 and 2007. No change is recommended to the Chinook salmon SEGs for Deep Creek or the Ninilchik River.

The escapements from 2008 to 2010 to the Anchor River were significantly lower than the average annual escapement of 10,435 from 2004 to 2007 (Table 1). A full probability spawner–recruit model (Szarzi et al. 2007) was updated with escapement and harvest data through 2009. The recommended lower bound of the SEG of 3,800 is the point estimate (posterior median) of S_{MSY} from the full probability model, including the recent data. The upper bound is the point estimate of carrying capacity, 10,000 from the updated model. The SEG range of 3,800–10,000 minimizes the risk of overfishing and allows liberalization of the harvest when escapements are large.

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 at all, and particularly from escapements at or near the estimate of S_{MSY} for this stock. Chinook salmon escapement data should be collected for 2 generations or through at least 2017, an additional 7 years, to encompass the entire production of the 2004 spawners, the first year the entire escapement was counted. To fully evaluate the performance of S_{MSY}, enumeration of the production from 2008, the first year of escapements near the lower end of the SEG range, is desirable and will be possible in 2020.

CHUM SALMON

The committee recommends no change to the 12 existing escapement goals for LCI chum salmon stocks (Table 2). Recent escapements have been sufficient, relative to the current SEGs, to provide a harvestable surplus for most chum salmon stocks. From 2007 to 2010, only 23% of chum salmon stocks had escapements below their current SEG ranges and 28% were above the current SEG ranges (Figure 3). Low prices, relatively modest returns, and lack of tender service all 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. At this time, no changes in LCI chum salmon escapement goals are warranted.

PINK SALMON

Currently, there are 21 pink salmon stocks in LCI with escapement goals (Table 3). Recent pink salmon escapements have been sufficient, relative to the current SEGs, to provide a harvestable surplus for most stocks. From 2007 to 2010, only 12% of pink salmon stocks had escapements below their current SEG ranges, while 43% had escapements above the current SEG ranges

(Figure 4). Low prices, relatively modest returns, and lack of tender service all contributed to diminished commercial fishing effort for pink salmon, particularly in Kamishak Bay District. This, in turn, has contributed to many pink salmon systems realizing escapements above their existing SEG ranges.

Returns of pink salmon to Resurrection Bay streams have historically been modest and inconsistent, leading to limited commercial fishing opportunity (Table 4). Consequently, ADF&G's limited escapement monitoring resources were often allocated to more abundant stocks that historically incurred greater targeted fishing effort. As a result, monitoring of pink salmon escapements in Resurrection Bay, even those with escapement goals, has been very inconsistent. The committee recommends that the pink salmon escapement goals for Bear/Salmon Creek, Thumb Cove, Humpy Cove, and Tonsina Creek be eliminated.

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 (Figure 5). Currently, there are 8 sockeye salmon stocks with escapement goals (Table 5). The majority of the 26-year time series (1976–2001) of data used to establish these goals is comprised of peak aerial survey counts, with the exception of Bear and English Bay lakes, both of which have long-standing weir projects. The time series of escapement data used for the Delight Lake sockeye salmon goal includes 4 years of weir counts, with the remaining 22 years of data coming from peak aerial survey indices. Nine years (1989–1997) of weir data were combined with 17 years of peak aerial survey indices to derive the escapement goal for Chenik Lake. Since the current SEGs were established in 2001, the Delight Lake stock has continued to be monitored by weir and 2 others (Mikfik and Chenik lakes) are currently monitored using a combination of aerial survey and remote video.

Given the recent change in monitoring methods for 3 systems (Delight, Mikfik, Chenik), we evaluated recalibrating escapement goals to be consistent with methods currently used to monitor escapements and manage fisheries inseason. A considerable amount of literature exists documenting that aerial surveys, and especially peak aerial surveys, tend to underestimate actual escapement, often by 30–50% or more (e.g., Bevan 1961; Shardlow et al. 1987; Bue et al. 1998; Jones et al. 1998; Jones et al. 2007). It is also generally understood 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. 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 6). In contrast, the peak aerial survey counts at Chenik Lake in 2005 and 2007 were 7% and 46% of the video counts respectively. Fortunately, video and peak aerial survey counts of sockeye salmon are usually not this disparate in LCI. However, it is clear aerial survey indices and video counts can be dissimilar, especially when survey conditions are not ideal. As long as future funding allows continuation of remote video projects at Mikfik and Chenik lakes, and the weir at Delight Lake, eventual recalibration of these escapement goals is necessary to match the current monitoring methods. Whether or not sufficient data exist to do so is examined next.

Delight Lake

A weir has operated in July to monitor Delight Lake sockeye salmon escapement 12 of the past 13 years (Table 6). Each year, we collected age, sex, and length (ASL) data from the weir. Eventually, sufficient data will be available to develop a BEG for this system, but currently total return data exist for only 6 brood years. Hence, we used the percentile approach (Bue and Hasbrouck *Unpublished*) to develop a weir-based SEG for Delight Lake sockeye salmon. The July 1–31 weir escapements at Delight Lake range from 3.8 to 40.4 thousand fish, yielding an escapement contrast of 11. The exploitation rate averaged 30% and ranged from 0 to 67%. These criteria lead to selection of the 25^{th} and 75^{th} percentiles for establishing a new SEG range (Table 6). The committee recommends raising the escapement goal range for Delight Lake sockeye salmon from 5.95–12.55 (weir) thousand fish to 7.55–17.65 (weir) thousand fish (Table 5). This brings the goal into alignment with the current means by which the escapement is monitored and the fishery is managed. This new goal will be used as long as weir funding continues and until sufficient data are accumulated to develop a BEG based on spawner–recruit analyses. If weir funding is lost, ADF&G will revert back to the aerial survey-based escapement goal.

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 during 7 of the past 13 years (the video was not installed in 2001–2002; Table 7). In 2009 this problem was remedied by moving the power generation equipment to a location with greater access to sun and wind.

It's difficult to determine the quality of escapement indices prior to 2009. Even during years when video down time occurred during the peak of the run, the video count at Mikfik Lake always exceeded the aerial survey count in the lake (Table 7). On average, the video count was 2.9 times greater than the peak aerial survey count in Mikfik Lake (range 1.2–5.8). In contrast, the peak streamwide aerial survey count was, on average, 1.2 times greater than the video count into Mikfik Lake (range 0.6–2.2). 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 may include some early-run chum salmon returning to McNeil River. Due to their differential run timing, species misidentification is probably not a major consideration. 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, it was estimated that brown bears killed approximately half of the chum salmon returning to nearby McNeil River (Peirce 2007). Anecdotal observations on Lower Mikfik Creek suggest similar predation rates likely occur there on sockeye salmon returning to Mikfik Lake. Consequently, ADF&G needs to establish a sufficient time series of uncompromised video escapement data at Mikfik Lake before developing a video-based goal that better represents the actual spawning escapement. Until those data are available, the committee recommends no change to the Mikfik Lake sockeye salmon goal.

Chenik Lake

Deployment of the RVER at Chenik Lake to monitor sockeye salmon escapement began in 2005. In 2005 and 2007, validation of the video system against a weir revealed a strong correlation between the daily counts from each method (R^2=0.993 and 0.989, respectively; Figure 6). The Chenik Lake video system has proven to be reliable and area managers are using it to supplement aerial survey results to facilitate more precise inseason management of the commercial fishery. The current escapement goal for Chenik Lake (1.90–9.30 thousand) was derived from a 26-year time series that includes a mix of weir counts (9 years) and peak aerial survey indices (17 years). With remote video now consistently used to monitor escapement and manage the fishery inseason, transition to a video-based goal is desired. However, an insufficient time series (5 years) of video data are available to establish a new SEG. Fortunately, by combining 12 years of weir data with the recent video counts, a 15-year time series of census quality escapement data exists to derive a new SEG (Table 8). The committee recommends raising the escapement goal range for Chenik Lake sockeye salmon from 1.90–9.30 thousand fish to 3.5–14.0 thousand fish (Table 5). This will bring the goal into alignment with the current means by which the escapement is monitored and the fishery is managed. This new goal will be used as long as funding to operate the video system continues. If video funding is lost, ADF&G will revert back to the aerial survey-based goal.

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 Lee Hammarstrom, Ethan Ford, Sigfus (Tom) Sigurdsson, Joseph Loboy, Carol Kerkvliet, and Michael Booz. Michael Parish, Chelsey Nieman, and Lydia Ames were instrumental in acquiring remote video-based salmon escapement data during 2007–2010. 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 Lee Hammarstrom and Ethan Ford (ADF&G, LCI Area and Assistant Area Finfish Management Biologists, respectively), Tracy Lingnau (Regional Management Coordinator, Central Region Commercial Fisheries), James Hasbrouck (Regional Supervisor, Central Region Sport Fish), Robert Clark (Chief Fisheries Scientist, ADF&G Sport Fish), Steve Fleischman (Fisheries Scientist, ADF&G Sport Fish), Andrew Munro, Eric Volk (Fishery Scientist and Chief Fishery Scientist, ADF&G Commercial Fisheries, respectively), Tom Brookover (Deputy Director, ADF&G Sport Fish), and Sue Aspelund (Deputy Director, ADF&G Commercial Fisheries).

REFERENCES CITED

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.

Bevan, D. E. 1961. Variability in aerial counts of spawning salmon. Journal of the Fisheries Research Board of Canada 18:337-348.

Cousens, N. B. F., G. A. Thomas, C. G. Swann, and M. C. Healy. 1982. A review of salmon escapement estimation techniques. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1108. Department of Fisheries and Oceans, Fisheries Research Branch, Pacific Biological Station, Nanaimo, British Columbia. 84 pp.

REFERENCES CITED (Continued)

Eggers, D. M. 1993. Robust harvest policies for Pacific salmon fisheries. Pages 85 to 106 [*In*]: G. Kruse, D. M. Eggers, R. J. Marasco, C. Pautzke, and T. J. Quinn II, editors. Proceedings of the International Symposium on Management Strategies for Exploited Fish Populations. Alaska Sea Grant College Program Report No. 93-02, University of Alaska Fairbanks.

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.

Hammarstrom, L. F., and E.G. Ford. 2010. 2009 Lower Cook Inlet annual finfish management report. Alaska Department of Fish and Game, Fishery Management Report No. 10-17, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/fmr10-17.pdf

Jennings, G. B., K. Sundet, and A. E. Bingham. 2010. Estimates of participation, catch, and harvest in Alaska sport fisheries during 2008. Alaska Department of Fish and Game, Fishery Data Series No. 10-22, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds10-22.pdf

Jones III, E. L., S. Heinl, and K. Pahlke. 2007. Aerial Counts. Pages 399-410 [In]: D. H. Johnson, B. M. Shrier, J. S. O'Neal, J. A. Knutzen, X. Augerot, T. A. O'Neil, and T. N. Pearsons. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.

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.

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. http://www.sf.adfg.state.ak.us/FedAidPDFs/sp04-14.pdf

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. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms07-04.pdf

Peirce, J.M. 2007. Relationships between brown bears and chum salmon at McNeil River, Alaska. M.S. Thesis, University of Alaska, Fairbanks.

Shardlow, T., R. Hilborn, D. Lightly. 1987. Components analysis of instream escapement methods for Pacific salmon (Oncorhynchus spp.). Canadian Journal of Fisheries and Aquatic Sciences 44: 1031-1037.

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. http://www.sf.adfg.state.ak.us/FedAidPDFs/fms07-05.pdf

Zimmerman, C. E., and L. M. Zabkar. 2007. Weirs. Pages 385-398 [*In*]: D. H. Johnson, B. M. Shrier, J. S. O'Neal, J. A. Knutzen, X. Augerot, T. A. O'Neil, and T. N. Pearsons. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.

TABLES AND FIGURES

Table 1.–Current escapement goals, escapements observed from 2007 through 2010, and escapement goal recommendations in 2010 for 3 Chinook salmon stocks in Lower Cook Inlet, Alaska.

			Escapement Goal							
	Escapement	Type				Escapements				
System	Data	(BEG, SEG)	Range			2007	2008	2009	2010	Recommendation[a]
Anchor River	Sonar/Weir	SEG	≥5,000			9,622	5,806	3,455	4,301[b]	SEG range 3,800-10,000
Deep Creek	SAS[c]	SEG	350	-	800	553	205	483	387	NC
Ninilchik River[d]	Weir	SEG	550	-	1,300	532	586	528	612[b]	NC

[a] NC = no change.

[b] Preliminary

[c] SAS = Single Aerial Survey.

[d] Escapement of naturally produced fish upstream of the weir between 3 and 31, July is basis for current SEG.

Table 2.–Current escapement goals, escapements observed from 2007 through 2010, and escapement goal recommendations in 2010 for 12 chum salmon stocks in Lower Cook Inlet, Alaska.

		Escapement Goal		Escapements				
System	Escapement Data[a]	Type (BEG, SEG)	Range	2007	2008	2009	2010	Recommendation[b]
Port Graham River	MFS	SEG	1,450–4,800	1,882	1,802	1,029	1,395	NC
Dogfish Lagoon	MFS	SEG	3,350–9,150	4,919	6,200	4,380	12,703	NC
Rocky River	MFS	SEG	1,200–5,400	1,600	3,763	2,500	1,271	NC
Port Dick Creek	MAS or MFS	SEG	1,900–4,450	2,753	11,774	5,592	2,439	NC
Island Creek	MAS or MFS	SEG	6,400–15,600	3,092	12,935	9,295	3,408	NC
Big Kamishak River	MAS	SEG	9,350–24,000	14,787	4,495	15,026	[c]	NC
Little Kamishak River	MAS	SEG	6,550–23,800	15,569	21,265	4,213	18,414	NC
McNeil River	MAS	SEG	24,000–48,000	21,629	10,617	18,766	10,520	NC
Bruin River	MAS	SEG	6,000–10,250	3,055	17,535	10,071	6,200	NC
Ursus Cove	MAS	SEG	6,050–9,850	20,897	6,502	12,946	11,765	NC
Cottonwood Creek	MAS	SEG	5,750–12,000	12,522	11,561	19,405	15,848	NC
Iniskin Bay	MAS	SEG	7,850–13,700	5,340	20,042	30,821	19,252	NC

[a] MAS = Multiple Aerial Survey, MFS = Multiple Foot Survey.
[b] NC = No Change.
[c] Insufficient data to generate an escapement index in 2010.

Table 3.–Current escapement goals, escapements observed from 2007 through 2010, and escapement goal recommendations in 2010 for 21 pink salmon stocks in Lower Cook Inlet, Alaska.

		Escapement Goal		Escapements[b]				
System	Escapement Data[a]	Type (BEG, SEG)	Range	2007	2008	2009	2010	Recommendation[c]
Humpy Creek	MFS	SEG	21,650–85,550	53,989	90,870	5,207	70,686	NC
China Poot Creek	MFS	SEG	2,900–8,200	6,235	5,086	1,120	2,220	NC
Tutka Creek	MFS	SEG	6,500–17,000	5,664	14,144	3,770	2,141	NC
Barabara Creek	MFS	SEG	1,900–8,950	25,168	16,557	2,583	13,935	NC
Seldovia Creek	MFS	SEG	19,050–38,950	69,405	53,484	14,619	25,886	NC
Port Graham River	MFS	SEG	7,700–19,850	25,595	24,720	13,996	16,586	NC
Port Chatham	MFS	SEG	7,800–21,000	14,451	16,354	25,291	2,992	NC
Windy Creek Right	MFS	SEG	3,350–10,950	32,297	12,491	15,012	6,408	NC
Windy Creek Left	MFS	SEG	3,650–29,950	18,339	64,068	57,263	24,241	NC
Rocky River	MFS	SEG	9,350–54,250	189,992	90,876	173,583	27,045	NC
Port Dick Creek	MAS or MFS	SEG	18,550–58,300	44,170	34,228	41,681	41,090	NC
Island Creek	MAS or MFS	SEG	7,200–28,300	87,235	49,719	44,527	69,525	NC
S. Nuka Island Creek	MAS or MFS	SEG	2,700–14,250	6,645	12,300	19,934	[d]	NC
Desire Lake Creek	MAS	SEG	1,900–20,200	11,820	9,546	73,926	2,978	NC
Bear & Salmon creeks	MFS	SEG	5,000–23,500	NS	NS	NS	NS	Eliminate
Thumb Cove	MFS	SEG	2,350–8,850	NS	NS	NS	NS	Eliminate
Humpy Cove	MFS	SEG	900–3,200	NS	NS	NS	NS	Eliminate
Tonsina Creek	MFS	SEG	500–5,850	NS	NS	NS	NS	Eliminate
Bruin River	MAS	SEG	18,650–155,750	350,420	150,717	1,067,351	40,256	NC
Sunday Creek	MAS	SEG	4,850–28,850	394,797	20,434	106,296	6,607	NC
Brown's Peak Creek	MAS	SEG	2,450–18,800	249,383	17,400	63,605	3,092	NC

[a] MAS = Multiple Aerial Survey, MFS = Multiple Foot Survey.

[b] NS = No Survey.

[c] NC = No Change.

[d] Insufficient data to generate an escapement index in 2010.

Table 4.–Escapements, catches, and total runs (thousands of fish) for 4 pink salmon stocks in Resurrection Bay, 1976–2010.

	Bear/Salmon Ck			Thumb Cove			Humpy Cove			Tonsina Ck			Resurrection Bay (all stocks)		
Year	Esc.	Catch	Tot. Run	Esc.	Catch	Tot. Run	Esc.	Catch	Tot. Run	Esc.	Catch	Tot. Run	Esc.	Catch	Tot. Run
1976	26.9	26.5	53.4	2.0	2.0	4.0	1.4	1.4	2.8	5.7	5.6	11.3	36.0	35.4	71.4
1977	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA		0.0	
1978	18.8	24.1	42.9	2.0	2.6	4.6	0.9	1.2	2.1	1.5	1.9	3.4	23.2	29.7	52.9
1979	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA		0.0	
1980	28.8	123.3	152.1	1.2	5.1	6.3	5.7	24.4	30.1	0.7	3.0	3.7	36.4	155.8	192.2
1981	0.5	7.8	8.3	1.0	15.5	16.5	0.4	6.2	6.6	0.2	3.1	3.3	2.1	32.6	34.7
1982	28.9	82.2	111.1	7.9	22.5	30.4	4.0	11.4	15.4	7.5	21.3	28.8	48.3	137.4	185.7
1983	1.3	2.6	3.9	4.9	9.8	14.7	2.0	4.0	6.0	5.4	10.8	16.2	13.6	27.1	40.7
1984	17.9	71.5	89.4	4.2	16.8	21.0	2.5	10.0	12.5	6.0	24.0	30.0	30.6	122.3	152.9
1985	6.2	6.3	12.5	14.5	14.6	29.1	5.0	5.0	10.0	48.2	48.7	96.9	73.9	74.6	148.5
1986	22.3	21.2	43.5	4.0	3.8	7.8	0.9	0.9	1.8	11.2	10.6	21.8	38.4	36.5	74.9
1987	5.2	5.3	10.5	2.7	2.7	5.4	0.3	0.3	0.6	3.4	3.5	6.9	11.6	11.8	23.4
1988	0.3	0.1	0.4	0.3	0.1	0.4	0.4	0.2	0.6	0.1	0.0	0.1	1.1	0.5	1.6
1989	3.3	0.0	3.3	4.2	0.0	4.2	1.0	0.0	1.0	0.5	0.0	0.5	9.0	0.0	9.0
1990	4.4	0.0	4.4	NS	0.0	NA	3.8	0.0	3.8	1.2	0.0	1.2	9.4	0.0	9.4
1991	15.4	0.0	15.4	3.4	0.0	3.4	NS	0.0	NA	0.3	0.0	0.3	19.1	0.0	19.1
1992	7.6	0.0	7.6	0.4	0.0	0.4	NS	0.0	NA	NS	0.0	NA	8.0	0.0	8.0
1993	6.6	0.3	6.9	5.5	0.2	5.7	0.9	0.0	0.9	3.2	0.1	3.3	16.2	0.7	16.9
1994	34.8	0.0	34.8	10.8	0.0	10.8	2.2	0.0	2.2	7.0	0.0	7.0	54.8	0.0	54.8
1995	38.6	0.0	38.6	9.3	0.0	9.3	1.8	0.0	1.8	0.5	0.0	0.5	50.1	0.0	50.1
1996	8.0	0.0	8.0	9.5	0.0	9.5	3.4	0.0	3.4	0.4	0.0	0.4	21.3	0.0	21.3
1997	6.3	0.0	6.3	4.7	0.0	4.7	2.2	0.0	2.2	0.4	0.0	0.4	13.6	0.0	13.6
1998	13.2	0.0	13.2	21.0	0.0	21.0	1.2	0.0	1.2	2.3	0.0	2.3	37.7	0.0	37.7
1999	7.8	0.0	7.8	9.2	0.0	9.2	4.0	0.0	4.0	0.5	0.0	0.5	21.4	0.0	21.4
2000	35.6	0.0	35.6	8.5	0.0	8.5	1.7	0.0	1.7	6.6	0.0	6.6	52.4	0.4	52.8
2001	3.0	0.0	3.0	3.1	0.0	3.1	0.3	0.0	0.3	2.8	0.0	2.8	9.3	0.0	9.3
2002	2.7	0.0	2.7	3.7	0.0	3.7	1.8	0.0	1.8	6.9	0.0	6.9	15.1	0.0	15.1
2003	4.4	0.0	4.4	5.1	0.0	5.1	2.6	0.0	2.6	5.2	0.0	5.2	17.3	0.0	17.3
2004	1.2	0.0	1.2	4.3	0.0	4.3	1.0	0.0	1.0	3.5	0.0	3.5	10.0	0.0	10.0
2005	34.5	0.2	34.7	8.7	0.1	8.7	14.6	0.1	14.7	9.9	0.1	10.0	67.6	0.4	68.1
2006	9.0	0.0	9.0	5.2	0.0	5.2	1.9	0.0	1.9	6.5	0.0	6.5	22.6	0.0	22.6
2007	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA		0.0	
2008	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA		0.0	
2009	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA		0.0	
2010	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA	NS	0.0	NA		0.0	
Avg. (all yrs)	13.6	10.6	26.4	5.8	2.7	9.2	2.5	1.9	4.9	5.3	3.8	10.0	26.6	19.0	49.5
Avg. (last 10 yrs)	9.1	0.0	9.2	5.0	0.0	5.0	3.7	0.0	3.7	5.8	0.0	5.8	23.6	0.0	23.7
Avg. (last 20 yrs)	14.3	0.0	14.3	7.0	0.0	7.0	2.8	0.0	2.8	3.7	0.0	3.7	27.3	0.1	27.4

Note: NA = Not available, NS = Not surveyed.

Table 5.–Current escapement goals, escapements observed from 2007 through 2010, and escapement goal recommendations in 2010 for 8 sockeye salmon stocks in Lower Cook Inlet, Alaska.

		Escapement Goal		Escapements				
System	Escapement Data[a]	Type (BEG, SEG)	Range	2007	2008	2009	2010	Recommendation[b]
English Bay[c]	PAS, Weir	SEG	6,000–13,500	16,487	11,996	18,176	12,253	NC
Delight Lake[d]	PAS, Weir	SEG	5,950–12,550	43,963	23,933	12,700	23,775	Increase EG to 7,550–17,650
Desire Lake	PAS	SEG	8,800–15,200	10,000	10,700	16,000	6,320	NC
Bear Lake[c]	Weir	SEG	700–8,300	8,421	9,000	9,977	7,964	NC
Aialik Lake	PAS	SEG	3,700–8,000	5,370	4,200	3,100	5,315	NC
Mikfik Lake	PAS, Video	SEG	6,300–12,150	11,190	5,560	15,130	11,330	NC
Chenik Lake	PAS, Video	SEG	1,880–9,300	18,288	11,284	15,200	17,312	Increase EG to 3,500–14,000
Amakdedori Creek	PAS	SEG	1,250–2,600	3,830	3,200	2,160	1,210	NC

[a] PAS = Peak Aerial Survey.
[b] NC = No Change.
[c] 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.
[d] Delight Lake escapements are a combination of weir and aerial survey counts.

Table 6.–Escapement (weir counts), catch, and total run data for Delight Lake sockeye salmon, 1997–2010.

Year	July 1-31 Weir Count	Comm. Harvest	Total Run	Exploitation Rate
1997	16,935	4,056	20,991	19%
1998	7,556	8,598	16,154	53%
1999	13,411	27,517	40,928	67%
2000		16,296	NA	NA
2001	12,635	4,735	17,370	27%
2002	17,655	11,672	29,327	40%
2003	6,708	12,547	19,255	65%
2004	3,842	4,623	8,465	55%
2005	13,700	0	13,700	0%
2006	10,879	1,164	12,043	10%
2007 [a]	40,403	26,442	66,845	40%
2008 [a]	21,333	977	22,310	4%
2009 [a]	5,232	0	5,232	0%
2010[a]	23,505	3,282	26,782	12%
Average	14,907	8,708	23,031	30%
Max	40,403	27,517	66,845	67%
Min	3,842		5,232	0%
Escap. Contrast	11			
n	13		Current SEG[b]	
Exploitation	30%		5.95–12.55 thousand	
Percentiles	25th-75th			
New SEG Lo	7,556		Recommended SEG	
New SEG Hi	17,655		7.55–17.65 thousand	

Note: The weir was not operated in 2000.

[a] Weir escapement values for 2007 through 2010 are not supplemented with aerial survey counts, as they are in Table 5.

[b] Current SEG is based on a combination of peak aerial survey and weir counts.

Table 7.–Comparison of video counts and peak aerial survey counts for Mikfik Lake sockeye salmon, 1998–2010.

Year	Video Count (into Lake)	Peak Aerial Survey (in Lake)	Peak Aerial Survey (Stream wide)	Comments
1998	9,515	2,550	12,630	*No lost video*
1999	11,041	8,930	15,717	Video down 11% of time around peak
2000	10,386	7,650	10,910	Video down 7% of time around peak
2001		2,500	5,350	No video counts
2002		5,170	16,650	No video counts
2003	8,009	3,700	12,830	Video down around peak
2004	14,829	5,480	14,020	Video down 66% of time after peak
2005	6,499	1,120	5,070	Video down 40% of time after peak
2006	14,983	4,500	17,700	Video never down, but late start
2007	10,975	3,900	11,190	Video down after 7/9
2008	9,104	4,400	5,560	*No lost video*
2009	20,965	9,150	15,130	*No lost video*
2010	5,221	1,650	11,330	*No lost video during bulk of run*
Average	11,048	4,669	11,853	
Max	20,965	9,150	17,700	
Min	5,221	1,120	5,070	
Escap. Contrast	4	8	3	Current SEG[b]
n	11	13	13	6.3–12.15 thousand
Percentiles	15th-85th	15th-85th	15th-Max	
New SEG Lo	7,254	2,330	5,518	Recommended SEG
New SEG Hi	14,906	7,906	17,700	No Change

Note: The video was not operated in 2001 or 2002.

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

[b] Current SEG based on peak aerial survey counts from 1976 to 2001 (Otis 2001).

Table 8.–Escapement (weir and video counts), catch and total run data for Chenik Lake sockeye salmon, 1989–2010.

Year	Video Count	Weir Count	Escapements Used for New SEG	Comm. Catch	Total Run	Exploitation Rate	Comments
1989		12,000	12,000	38,900	50,900	76%	
1990		17,000	17,000	70,300	87,300	81%	
1991		10,200	10,200	60,400	70,600	86%	
1992		9,300	9,300	14,400	23,700	61%	
1993		4,000	4,000	24,600	28,600	86%	
1994		800	800	0	800	0%	IHN caused stock collapse
1995		1,100	1,100	0	1,100	0%	stock recovering
1996		3,000	3,000	0	3,000	0%	stock recovering
1997		2,300	2,300	0	2,300	0%	stock recovering
1998-2004			No video/weir counts				stock recovering
2005	12,005	12,771	12,771	47,000	59,771	79%	video down parts of 2 days
2006	NA	8,507	8,507	11,800	20,307	58%	no video count
2007	18,230	17,417	17,417	161,600	179,017	90%	weir down part of 1 day
2008	10,653		10,653	171,300	181,953	94%	lost some video > Jul 31
2009	15,264		15,264	65,700	80,964	81%	no lost video
2010	17,312		17,312	5,471	22,783	24%	no lost video
Average	14,693	8,200	9,442	32,031	40,531	40%	
Max	18,230	17,417	17,417	171,300	181,953	94%	
Min	10,653	800	800	0	300	0%	
Escap. Contrast	2	22	22				
n	5	12	15		Current SEG		
Exploitation Rate			40%		1.9–9.3 thousand		
Percentiles			25th-75th				
New SEG Lo			3,500		Recommended SEG		
New SEG Hi			14,018		3.5–14.0 thousand		

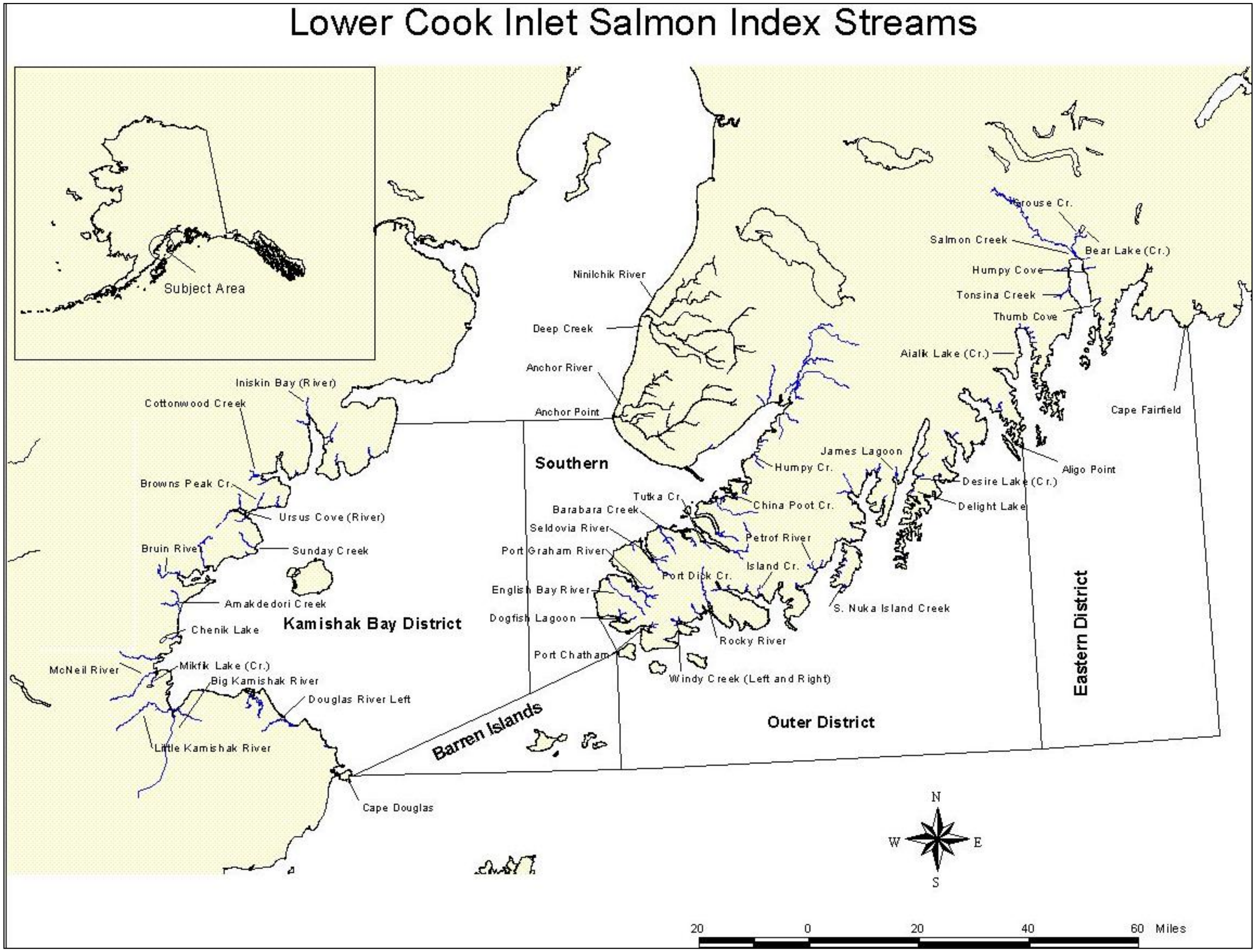

Figure 1.–Lower Cook Inlet commercial fisheries management area, illustrating the locations of salmon-producing streams with escapement goals, by district.

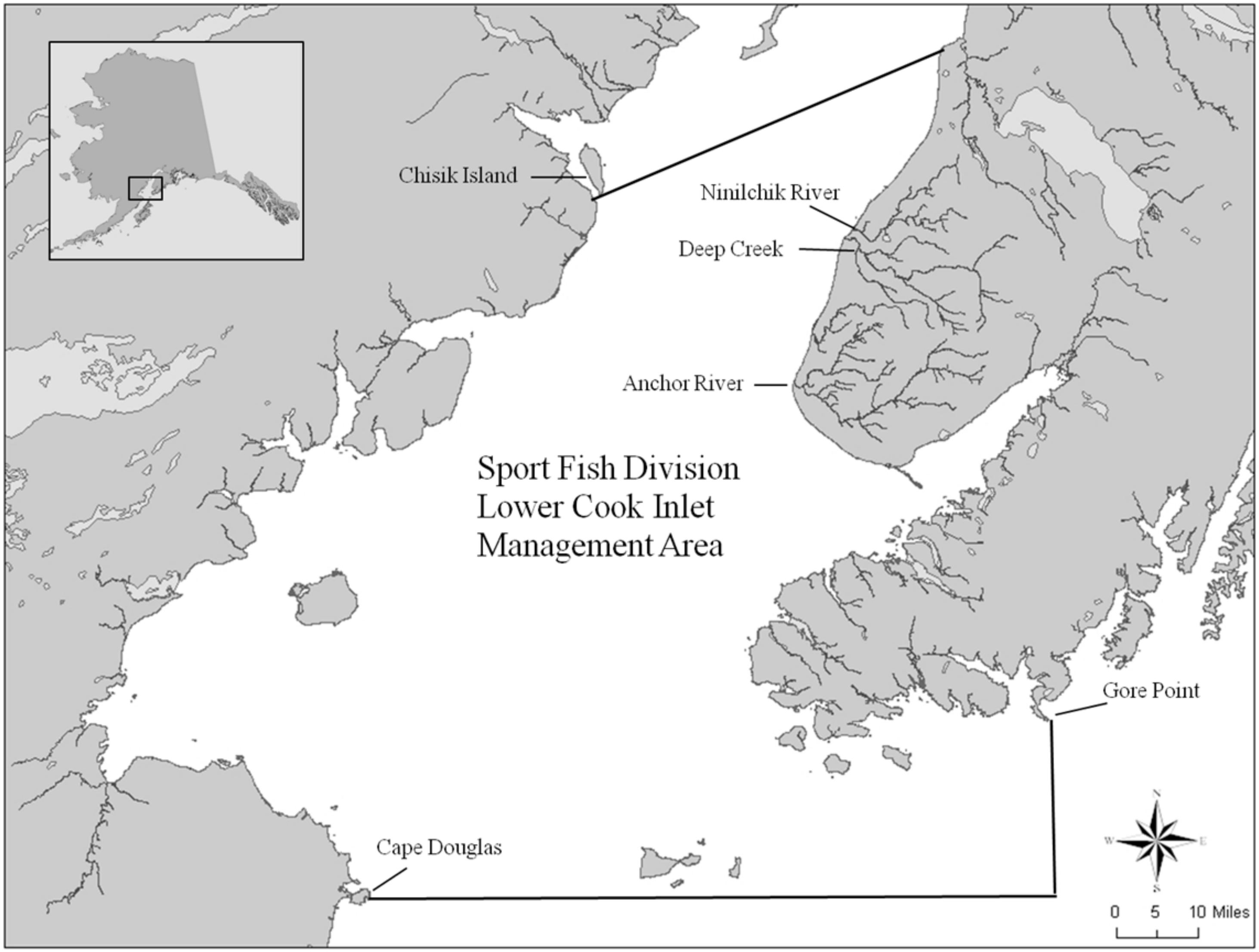

Figure 2.–Lower Cook Inlet sport fisheries management area, illustrating the locations of Chinook salmon-producing streams with escapement goals.

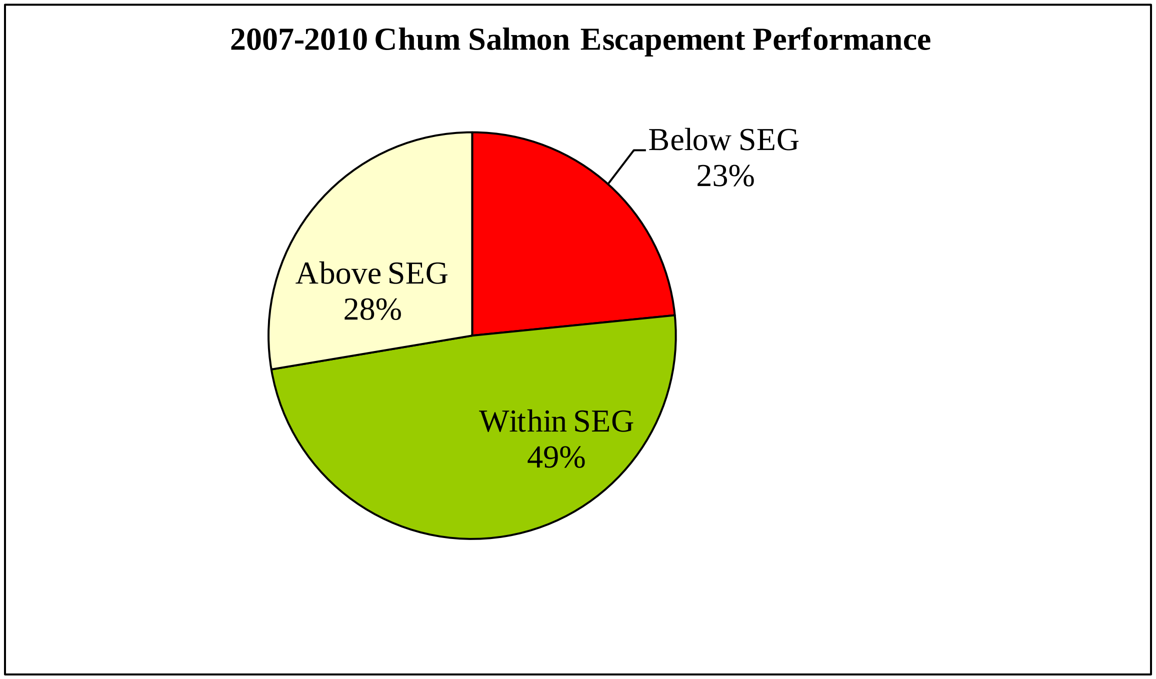

Figure 3.–Lower Cook Inlet chum salmon escapement performance for 12 stocks relative to their current sustainable escapement goal range, 2007–2010.

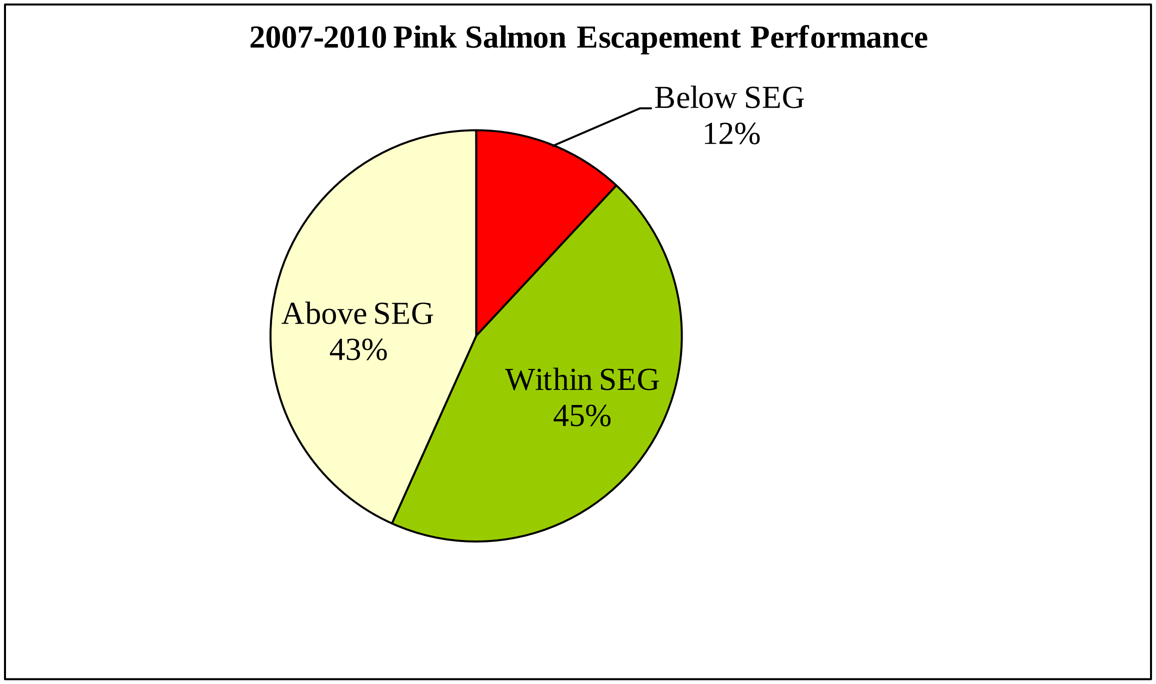

Figure 4.–Lower Cook Inlet pink salmon escapement performance for 21 stocks relative to their current sustainable escapement goal range, 2007–2010.

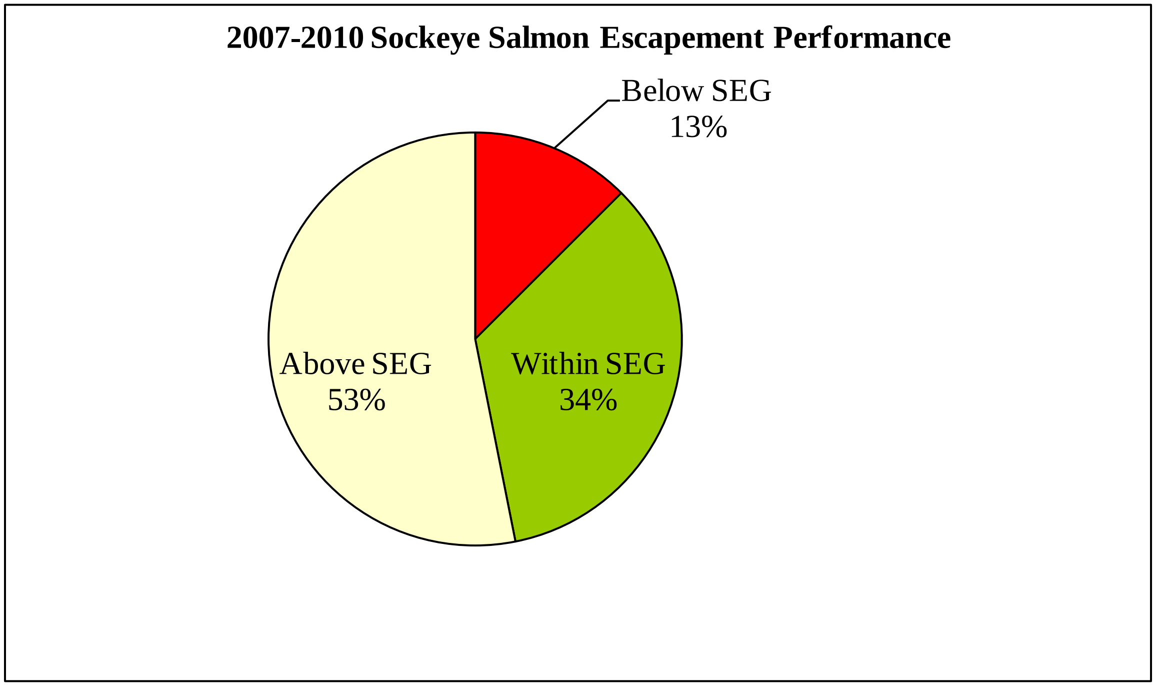

Figure 5.–Lower Cook Inlet sockeye salmon escapement performance for 8 stocks relative to their current sustainable escapement goal range, 2007–2010.

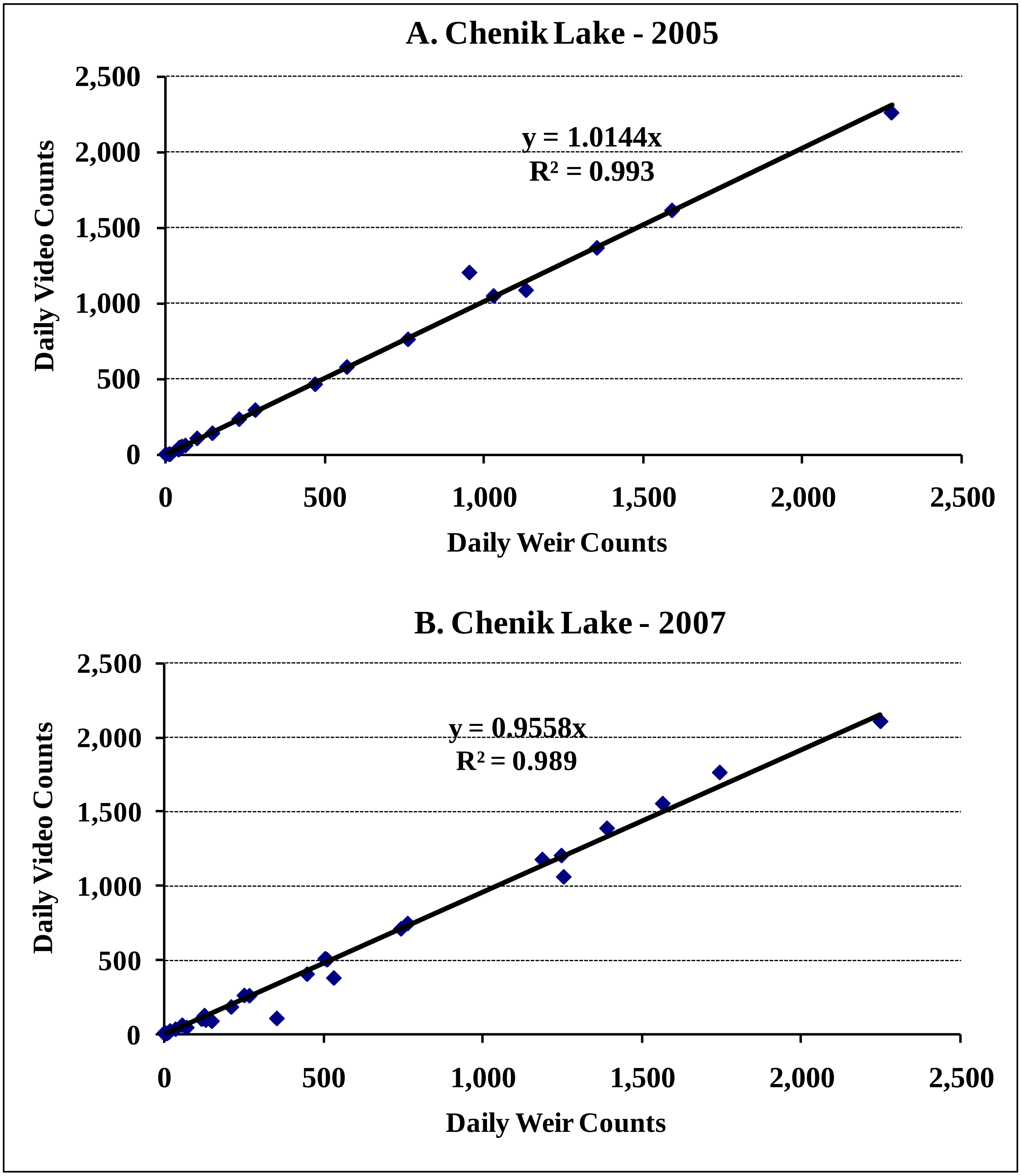

Figure 6.–Comparison of daily weir and video counts of sockeye salmon returning to Chenik Lake in 2005(A) and 2007(B).