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A Review of Escapement Goals for Salmon Stocks in Lower Cook Inlet, Alaska, 2007

by

Edward O. Otis

and

Nicole J. Szarzi

October 2007

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)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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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by

Edward O. Otis
Division of Commercial Fisheries, Homer
and
Nicole J. Szarzi
Division of Sport Fish, Homer

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

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The Division of Sport Fish Special Publications series was established in 1991 for the publication of techniques and procedures manuals, informational pamphlets, special subject reports to decision-making bodies, symposia and workshop proceedings, application software documentation, in-house lectures, and other documents that do not fit in another publication series of the Division of Sport Fish. Since 2004, the Division of Commercial Fisheries has also used the same Special Publication series. Special Publications are intended for fishery and other technical professionals. Special Publications 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,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
3298 Douglas Place, Homer, Alaska 99603-8027, USA
and
Nicole J. Szarzi
Alaska Department of Fish and Game, Division of Sport Fish,
3298 Douglas Place, Homer, Alaska 99603-8027, USA

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ABSTRACT

Following the Alaska Board of Fisheries adoption of two policies in 2000–2001 that affect development of escapement goals, the Alaska Department of Fish and Game (ADF&G) revised all salmon escapement goals in Lower Cook Inlet. Salmon escapements are primarily monitored by single or multiple aerial and/or foot surveys of stream reaches that can be monitored, except for Anchor River Chinook salmon *Oncorhynchus tshawytscha*, monitored by sonar and weir, and Ninilchik River Chinook salmon, monitored by a weir operated during only a portion of the run. 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 salmon, 12 chum salmon *O. keta*, 21 pink salmon *O. gorbuscha*, and 8 sockeye salmon *O. nerka* stocks ADF&G monitors in Lower Cook Inlet. Escapement performance relative to these new goals has been good during the past 4 years, with harvestable surpluses available in 83–97% of the streams during most years. With the exception of 3 streams, ADF&G does not recommend making any changes to the current escapement goals. ADF&G recommends increasing the goal for McNeil River chum salmon to 24,000-48,000 fish, effectively restoring the previous, long-standing goal. Justification for this change was provided by a radiotelemetry study and retrospective analysis of historical escapements that suggests adequately seeding spawning areas upstream of McNeil Falls is the key to restoring McNeil River chum salmon production to levels observed during the 1970s–1980s. The Ninilchik River Chinook salmon sustainable escapement goal should be changed to 550–1,300 based on a longer period of weir operation to more accurately index the true escapement to that system. The development of a new SEG threshold of 5,000 Anchor River Chinook salmon is based on information from full enumeration of the escapement with sonar and weir and is described in a separate report.

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; department) reviews the escapement goals for Lower Cook Inlet (LCI) salmon stocks on a schedule that corresponds to the Alaska Board of Fisheries 3-year cycle for considering area regulatory proposals. This report describes the Lower Cook Inlet salmon escapement goals that were reviewed in 2004 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 the 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 current escapement goals.

Following the adoption of the Alaska Department of Fish and Game's Salmon Escapement Goal Policy in 1992, Fried (1994) documented all the 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 salmon *Oncorhynchus tshawytscha*, 13 chum salmon *O. keta*, 31 pink salmon *O. gorbuscha*, and 8 sockeye salmon *O. nerka*, were considered biological escapement goals.

During 2000 and 2001, the Alaska Board of Fisheries (BOF) adopted two 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 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 due to the absence of stock specific catch estimate; the SEG is the primary management objective for the escapement, unless an optimal escapement or inriver run goal has been adopted by the board, and will be developed from the best available biological information; the SEG will be determined by the department and will be stated as a range that takes into account data uncertainty; the department will seek to maintain escapements within the bounds of the SEG."

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 salmon, 12 chum salmon, 24 pink salmon, and 8 sockeye salmon) that have historically received fishing pressure. The escapement goal of each of these stocks was reviewed in 2001 under the two BOF policies, resulting in the establishment of 47 new sustainable escapement goals (Bue and Hasbrouck *Unpublished*; Otis 2001). Area review of Lower Cook Inlet escapement goals in 2004 (Otis and Hasbrouck 2004) resulted in ADF&G recommendations for, and the BOF adoption of, changes to 4 streams. 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 Hasbrouck 2004). In 2004, ADF&G removed the escapement goals for Little and Big Kamishak river pink salmon because no fishery currently 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.

During the 2007 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 2007, 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 16 January 2007 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 Dickson 2007). The LCI sport fisheries management area also 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 have been monitored by foot survey, aerial survey, or a combination of the two. 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 on a numeric scale that provides information only about the relative level of the escapement. These measurements provide a ranking of escapement magnitude across years but in and of themselves provide no 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 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 Ninilchik River Chinook salmon and Bear 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. LCI staff have also been developing and testing a digital time-lapse video recording system to remotely census fish returns in some small, clear streams (Otis and Dickson 2002). This technology may eventually allow replacement of aerial survey indices on select streams with escapement estimates more appropriate for developing and evaluating biological escapement goals. Dual Frequency Identification Sonar (DIDSON) has been operated in conjunction with a weir to count total Chinook salmon escapement in the Anchor River since 2003. The development of a new escapement goal for the Anchor River based on sonar and weir data is addressed in Szarzi et al. (*In prep.*)

Commercial harvest data are obtained from tallies 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. 2007).

HISTORIC 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 were used to index Chinook salmon escapements. Escapement goals for Deep Creek and Ninilchik and Anchor river stocks were first adopted in 1993 and were 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, management for an escapement near the upper end of the escapement goal range occurred during years when higher abundances of fish reached the plentiful, high-quality spawning habitat available upstream of McNeil Falls.

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

Virtually all 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 Bay. 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 recommended all goals of LCI stocks be changed to sustainable escapement goals (SEGs).

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). To calculate the percentiles, the escapement data were 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 increased, the percentiles used to estimate the SEG range were narrowed, primarily from the upper range, to allow the SEG to include a wide range of escapements. For exploited stocks with a high contrast, the lower end of the SEG range was increased to the 25^{th} percentile as a precautionary measure for stock protection. The percentiles used at different levels of contrast were 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 8–24 July from 1994–2000. 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 mark recovery data, the number of hatchery-stocked fish that passed through the weir could be estimated. The number of naturally produced fish was then estimated by subtracting the estimated number of hatchery fish from the total number of fish observed. Wild fish killed 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 the aerial surveys.

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 salmon production in favor of coho salmon.

RESULTS AND DISCUSSION

We recommend changing the SEG for Ninilchik River Chinook salmon 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 killed for egg takes during the period to better represent the total escapement to the system. We also recommend increasing the SEG for McNeil River chum salmon from 13,750–25,750 to 24,000–48,000 to encourage more production from upriver spawning areas, which have been very lightly utilized during this recent 18-year era of poor adult returns to McNeil River. The following provides additional details on these recommendations and a review of recent salmon escapements relative to the goals developed in 2001.

CHINOOK SALMON

ADF&G recommends the current SEG range of 400–850 for the Ninilchik River (Table 1), based upon wild Chinook salmon counts to the weir operated during the part of the spawning migration between July 8–24, be changed to an SEG range of 550–1,300 wild adult Chinook salmon, based upon live Chinook salmon counts that escape to spawn upstream of the weir from July 3–31 during 1999–2007, to represent a greater proportion of the wild escapement.

From 1999 to 2005, the Ninilchik River Chinook salmon weir was operated throughout the Chinook salmon spawning migration starting in mid-May and ending in early August. During 2003 and 2004, the midpoint of the wild Chinook salmon run was July 4 compared to midpoints between July 11 and 16 for the years 1999–2002 and 2005. In 1999–2005, an average of 36% of the escapement above the weir was counted each year during July 8–24 with a range of 20–48% compared to an average of 65% with a range of 46–81% during July 3–31. Extending the SEG period for the Ninilchik River will encompass more of the variability in run timing and reduce the likelihood of mistaking a low escapement count for late run timing.

The egg take weir operating dates included the period of July 8–24 each year beginning in 1994. After 1999, the egg take weir operation included the period July 3–31, therefore the new SEG is based upon index weir counts from 1999–2007. Although the dates of weir operation encompass the midpoint of the Chinook salmon migration, weir operation is skewed toward the latter part of the return because more ripe Chinook salmon are available for egg-takes later in July.

ADF&G recommends an SEG threshold of 5,000 adult Chinook salmon in the Anchor River based on a full probability spawner recruit model that uses 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. The recommended threshold is based on the point estimate (posterior median) of S_{MSY} from the full probability model.

Continued collection and analysis of stock assessment data for Anchor River Chinook salmon is necessary to evaluate the performance of the recommended S_{MSY} because there are no empirical production data from escapements at or near our estimate of S_{MSY} for this stock. Based on our spawner-recruit analyses, the Anchor River Chinook salmon stock can support more harvest. The difference between the average escapement from 2004–2006 and our proposed escapement threshold is 5,685 fish. Changes to the fishery should be implemented gradually, allowing time for their impact to be evaluated and for more production data to be collected. Szarzi et al. (*In prep*), provides a complete description of the escapement goal analyses conducted for the Anchor River Chinook salmon stock.

Recent Chinook salmon escapements at Deep Creek have been within or above the SEG (Table 1). The 2007 escapement of Deep Creek Chinook salmon was within the SEG.

CHUM SALMON

ADF&G recommends changing only one of the 12 chum salmon goals in Lower Cook Inlet (Table 2). Recent escapements have been sufficient, relative to the current SEGs, to provide a harvestable surplus for most LCI chum salmon stocks. During 2004–2007, only 17% of LCI chum stocks had escapements below the current SEG range, while 52% of chum stocks had escapements above the current SEG range (Figure 2). Low prices, relatively modest returns, and lack of tender service have all contributed to diminished commercial fishing effort, particularly in the Kamishak Bay District. This in turn has contributed to many chum salmon systems realizing escapements above their existing SEG range.

The exception to this general trend is McNeil River. Although McNeil River chum salmon have met or exceeded at least the low end of the current escapement goal range during 3 of the past 5 years and 13 of the past 19 years, it has exceeded the upper end of the range only three times since 1988, despite the lack of commercial fishing effort (Figure 3). Because this contrasts with chum salmon production from other west side Cook Inlet drainages, it suggests a freshwater cause rather than prevailing ocean conditions.

Several hypotheses have been developed to explain the low chum salmon production from McNeil River in recent years, relative to the 1970s–1980s. Principal among them are factors associated with the high seasonal abundance of brown bears (*Ursus arctos*) at McNeil Falls (Figure 4) and their potential to impede chum salmon from reaching quality spawning areas upstream of the falls. McNeil River is a unique system in that it is effectively bisected into two distinct stream reaches by a series of large, step falls created by a fault line through a bedrock section of the river just 2.0 km upstream from the ocean (Figure 5). McNeil Falls represent a difficult obstacle for the upstream migration of chum salmon, making them relatively easy prey for the high density of brown bears that annually frequent the area (Figure 6). Approximately 10 kilometers of spawning habitat exists upstream of McNeil Falls (Figure 7), including two heavily braided sections with abundant upwelling sites that chum salmon favor (Figures 7 and 8; Geist et al. 2002; Maclean 2003). In contrast, less than 2.0 km of river are available to chum salmon downstream of McNeil Falls, not all of which is suitable for spawning (Figure 9). In order for McNeil River to realize its productive capacity for chum salmon, favorable spawning habitats upstream of McNeil Falls need to be consistently reseeded by spawners.

While chum salmon are not as adept as sockeye salmon at leaping vertical barriers, aerial surveys over the past 30 years indicate substantial numbers of fish successfully ascended McNeil Falls in some years. The median number of spawners above McNeil Falls during 1976–1988, an era with sufficient production to provide consistent commercial fishing opportunities was 2,847 (Figure 10). In contrast, the median number of spawners successfully ascending McNeil Falls during 1989–2007, an era with poor production and virtually no harvest opportunities, was 510 (Figure 10). At least three factors likely contribute to the number of Above-Falls (AF) spawners in any given year: 1) fish density below McNeil Falls, 2) river discharge, and 3) the abundance of brown bears at McNeil Falls.

Spawning distribution with pink and chum salmon appears to be at least partially density dependent; higher densities of spawners in the lower river typically encourage more fish to seek less densely occupied spawning areas upstream. This tenet is corroborated each time fish have been observed spawning further upstream in drainages during years with abundant escapements. River discharge may also play a significant role in determining AF escapement, particularly for chum salmon, which are not well known for their ability to ascend challenging vertical and/or velocity barriers. It is likely that chum salmon have a very difficult time successfully ascending McNeil Falls during extremely high flows (velocity barrier) or extremely low flows (vertical barrier). Finally, it is reasonable to assume that the variable abundance of bears at McNeil Falls also plays a role in influencing AF escapement. High concentrations of bears can impede upstream migration of chum salmon by directly killing fish attempting to ascend the Falls and by "chasing" fish back down from holding areas midway up the Falls.

These three variables, and especially the last two, probably interact with one another. Fish are likely to be more vulnerable to bears at very low discharge; when fewer pathways through the falls are open, the fish are more concentrated. Although vulnerability to bears may diminish at very high discharges, the physical barrier created by high velocity flows may impede or completely preclude upstream movement. Fish density below the falls also interacts with discharge and bear abundance. High densities below the falls may cue more fish to attempt to ascend the falls, but if bear densities are high and/or discharge conditions are unfavorable, few fish may make it through. Likewise, lower densities of fish below the falls may not cue fish to attempt to ascend the falls, despite a lack of bears and favorable discharge conditions.

Of the three interacting variables that likely influence AF escapement, we only have the ability to manipulate one, escapement below McNeil Falls. When returns are strong, we can affect inriver escapement via openings and closures to the commercial fishery (e.g., see 1976–1988 in Figure 3). When returns are weak, as in the current era, the commercial fishery is closed and all returning fish are allowed to escape to the river (e.g., see 1989–2007 in Figure 3). Therefore, the McNeil River chum salmon stock will have to recover from its current low production on its own. This is most likely a natural cycle that has occurred throughout history prior to humans being here to observe or influence the peaks and valleys of annual salmon returns or bear densities. The relevant question is, once the run does recover, can we encourage more consistent "seeding" of upriver spawning areas to boost stream-wide production, thereby avoiding lengthy recovery periods in the future? Our historical time series of escapement indices above and below McNeil Falls (Figure 10) suggests that achieving higher AF escapements may require higher inriver escapements than our current SEG (13,750–25,750) recommends. As part of the retrospective analysis conducted to evaluate the McNeil River chum salmon escapement goal, we determined that the average escapement index during 1977–1988, an era with higher AF escapement and sufficient production to provide consistent commercial fishing opportunities, was 30,000 fish. In contrast, the average escapement since 1988, an era with low AF escapement, poor production, and virtually no harvest opportunities, was 18,000 fish. While not conclusive by themselves, these observations corroborate the hypothesis that greater escapement below McNeil Falls encourages greater use of high quality spawning habitats above McNeil Falls, and that more upriver spawning contributes to increased stream-wide production and harvest opportunities.

The missing ingredients to this simple observational analysis are stream discharge and bear abundance data. Unfortunately, we were unable to evaluate the degree to which stream discharge influences escapement above McNeil Falls. Discharge data do not exist for McNeil River and we were unable to find an appropriate proxy dataset. To remedy this, ADF&G recently purchased a remote water level and temperature data logger and deployed it at McNeil Falls in 2007, so the lengthy time series necessary to facilitate discharge analysis is forthcoming.

McNeil River State Game Sanctuary (MRSGS) staff has been recording bear densities at McNeil Falls for over 30 years (ADF&G 2007). Their data show a clear trend of increasing numbers of bears using both the Sanctuary as a whole, and McNeil Falls specifically, until about the mid-late 1990s when bear densities began dropping (Figure 4). Comparing the long-term trends in bear and salmon abundance at McNeil River (Figures 3 and 4) indicate that the decline in chum salmon occurred around the same time the number of bears using the MRSGS reached about 100–120 animals, which might suggest a cause and effect relationship since bears are at MRSGS, in large part, to prey on salmon. However, broadening our perspective to include other west-side Cook Inlet chum salmon stocks, we see that several systems experienced a similar decline in adult returns that began around 1989 (Figure 11). This area-wide phenomenon suggests that prevailing ocean conditions were at least part of the cause for the initial decline in adult chum salmon returns at McNeil River, and not bears alone. Figure 11 also illustrates how most Kamishak area chum stocks recovered and again began experiencing strong returns in about 2000, suggesting ocean conditions returned to those favorable to juvenile chum salmon survival. Because McNeil River chum salmon did not experience increased returns, it suggests a freshwater influence is involved in stalling its recovery. There is strong suspect that the lack of use of abundant upriver spawning areas in the past 19 years is a major cause for the continued low production from McNeil River.

In an effort to better understand factors affecting the freshwater production of chum salmon in McNeil River, ADF&G initiated a cooperative project between the Divisions of Wildlife Conservation and Commercial Fisheries in 2005. Josh Peirce, a graduate student at the University of Alaska Fairbanks (UAF) was hired to implement a 2-year radiotelemetry project to investigate chum salmon streamlife (SL: a key parameter in the area-under-the-curve (AUC) method used to estimate total spawning escapement from periodic aerial surveys), spawning distribution, and bear-induced mortality on pre-spawning fish. A detailed description of the methods and results associated with that study can be found in Peirce (2007). Select project results include: the average streamlife estimate for McNeil River chum salmon was reduced from 17.5 to 13.8 d; on average less than 10% of the total inriver escapement occurred above McNeil Falls, however, >90% of the above falls fish lived long enough to spawn; and >90% of the total escapement was confined below McNeil Falls where half of the fish were killed by bears before they spawned.

These data were used in a retrospective analysis of the 31 year time series of catch and escapement data available for McNeil River chum salmon. Historical aerial survey maps were reviewed to apportion the observed escapements to stream section (above and below McNeil Falls). The AUC model was re-run using the revised SL estimate and an observer efficiency parameter was introduced to convert the escapement index into an abundance estimate. Because some aerial survey years were truncated prior to the end of the run, a run-timing curve was developed from historical catch and escapement data and a model was developed to expand truncated escapement estimates accordingly. Finally, a predation model was developed to estimate the number of pre-spawning fish that were killed by bears stream wide at given escapement levels. The model was based on a combination of 16 years of observations where MRSGS staff recorded hourly counts of salmon removed by bears at McNeil Falls, and our 2-year telemetry study that investigated predation stream-wide. The predation model was used to subtract the number of pre-spawning fish killed by bears from the total inriver escapement estimates derived by aerial survey (using AUC) and estimated the number of actual spawners for each year. These values, along with the total return produced by each parent year, were fed into a Ricker (1975) stock-recruitment model to estimate the number of spawners that produce maximum sustained yield (S_{MSY}). Because we only had age composition data for 8 of the 25 return years in our time series, our brood table was built using the historical average age composition for years in which no age data were available.

After completing the run-timing and predation modeling exercises necessary to conduct a spawner-recruit analysis, S_{MSY} for McNeil River chum salmon was determined to be approximately 27,100 fish. The predation model was then used to determine what inriver escapement level was needed to assure 27,000 spawners. We found that the estimated inriver escapement target of 43,700 fish was virtually identical to the midpoint of the current SEG range (45,000 fish) once the current EG range had been rescaled (23,000–66,000) to account for the new SL and observer efficiency values used in the retrospective analysis. On the surface, this appears to be valid justification to maintain status quo. When applied retroactively, the lower end of the current SEG range has been met 13 of the past 19 years and nearly met 4 of the remaining 6 years (Figure 3). However, despite the acceptable escapement performance relative to the current SEG, seeding of upstream spawning areas has remained inconsistent and total returns have been insufficient for commercial harvest opportunities over this same period (Figures 10 and 3, respectively). Hence, the current SEG is not likely to promote sufficient production from McNeil River to maintain commercial viability once the chum salmon stock recovers on its own and fishing resumes.

We conclude that the "noise" in our data (e.g., observer bias associated with aerial survey estimates, incomplete age composition data to build accurate brood tables, error associated with predation models used to estimate actual spawner abundance, inability to quantify the influence above-falls spawners have on stream-wide production, etc.) makes it very difficult to use a traditional spawner-recruit analysis to estimate S_{MSY} for McNeil River chum salmon at this time. We therefore recommend a simplified approach, a return to the previous, long-standing escapement goal range (20,000–40,000) that was in place prior to adopting the current SEG based on the percentile methodology (Bue and Hasbrouck *Unpublished*). Because that goal was in place while aerial assessments employed outdated AUC methods and SL estimates, we recommend re-scaling the historic goal to account for the new SL factor and AUC model that will be used in future escapement monitoring for McNeil River chum salmon. However, we currently recommend against rescaling the goal to account for observer efficiency until more data are available to improve the estimates of that parameter, and the measurement error associated with it. Thus, the new goal of 24,000–48,000 fish represents an aerial survey based index of total inriver escapement rather than an estimate of spawning escapement. In the future, as more data become available to evaluate the effect discharge and bear predation have on escapement above McNeil Falls and stream-wide production, we plan to revise the goal accordingly.

Pink Salmon

ADF&G recommends no changes to the 21 pink salmon goals (Table 3). Recent pink salmon escapements have been sufficient, relative to the new SEGs, to provide a harvestable surplus for most stocks. During 2004–2007, only 3% of LCI pink salmon stocks had escapements below the current SEG range, while 61% of pink salmon stocks had escapements above the current SEG range (Figure 12). Low prices, relatively modest returns, and lack of tender service have all contributed to diminished commercial fishing effort for pink salmon, particularly in the Kamishak Bay District. This in turn has contributed to many pink salmon systems realizing escapements above the existing SEG range.

Sockeye Salmon

ADF&G recommends no changes to the 8 sockeye salmon goals (Table 4). Recent sockeye salmon escapements have been sufficient, relative to the new SEGs, to provide a harvestable surplus for most stocks. During 2004–2007, only 6% of LCI sockeye stocks had escapements below the current SEG range, while 60% of sockeye stocks had escapements above the current SEG range (Figure 13). Sockeye salmon runs in Lower Cook Inlet are modest in size compared to Upper Cook Inlet, largely due to LCI's limited number and size of accessible lakes, which juvenile sockeye require for rearing. As such, only a few of the larger systems receive consistent commercial fishing effort. Thus, some of the smaller systems entire return escapes into the respective lakes to spawn.

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TABLES AND FIGURES

Table 1.–Current escapement goals, escapements observed from 2004 through 2007, and escapement goal recommendations in 2007 for 3 Chinook salmon stocks in Lower Cook Inlet.

		Escapement Goal		Escapements				
System	Escapement Data	Type (BEG, SEG)	Range	2004	2005	2006	2007	Recommendation
Chinook Salmon								
Anchor River	Sonar/weir	SEG	5,000	12,016	11,095	8,945	9,622	Threshold
Deep Creek	SAS[a]	SEG	350–800	1,075	1,076	507	553	NC
Ninilchik River[b]	Weir	SEG	400–850	416	814	764	532	Increase EG to 550–1,300

Note: NC = no change.

a SAS = Single Aerial Survey.

b Escapement of naturally produced fish through the weir between 8–24 July is basis for current SEG.

Table 2.–Current escapement goals, escapements observed from 2004 through 2007, and escapement goal recommendations in 2007 for 12 chum salmon stocks in Lower Cook Inlet, Alaska.

System	Escapement Data[a]	Escapement Goal Type (BEG, SEG)	Escapement Goal Range	Escapements 2004	2005	2006	2007	Recommendation[b]
Port Graham River	MFS	SEG	1,450–4,800	1,177	743	2,231	1,882	NC
Dogfish Lagoon	MFS	SEG	3,350–9,150	3,617	2,746	5,394	4,919	NC
Rocky River	MFS	SEG	1,200–5,400	17,159	6,060	11,200	1,600	NC
Port Dick Creek	MAS or MFS	SEG	1,900–4,450	8,620	4,848	2,786	2,753	NC
Island Creek	MAS or MFS	SEG	6,400–15,600	15,135	20,666	5,615	3,092	NC
Big Kamishak River	MAS	SEG	9,350–24,000	57,897	25,717	58,173	14,787	NC
Little Kamishak River	MAS	SEG	6,550–23,800	45,342	12,066	42,929	15,569	NC
McNeil River	MAS	SEG	13,750–25,750	11,203	17,411	28,176	13,590	Increase EG to 24,000–48,000
Bruin River	MAS	SEG	6,000–10,250	15,886	21,208	7,000	3,055	NC
Ursus Cove	MAS	SEG	6,050–9,850	15,988	12,176	15,663	20,897	NC
Cottonwood Creek	MAS	SEG	5,750–12,000	16,277	17,914	13,243	12,522	NC
Iniskin Bay	MAS	SEG	7,850–13,700	22,044	16,461	15,640	5,340	NC

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

[b] NC = No Change.

Table 3.–Current escapement goals, escapements observed from 2004 through 2007, and escapement goal recommendations in 2007 for 21 pink salmon stocks in Lower Cook Inlet, Alaska.

		Escapement Goal		Escapements				
System	Escapement Data[a]	Type (BEG, SEG)	Range	2004	2005	2006	2007	Recommendation[b]
Humpy Creek	MFS	SEG	21,650–85,550	28,945	93,756	48,368	53,989	NC
China Poot Creek	MFS	SEG	2,900–8,200	3,335	9,223	7,242	6,235	NC
Tutka Creek	MFS	SEG	6,500–17,000	17,846	133,600	25,824	5,664	NC
Barabara Creek	MFS	SEG	1,900–8,950	5,395	14,440	3,554	25,168	NC
Seldovia Creek	MFS	SEG	19,050–38,950	56,763	98,602	70,045	69,405	NC
Port Graham River	MFS	SEG	7,700–19,850	44,010	69,095	31,173	25,595	NC
Port Chatham	MFS	SEG	7,800–21,000	26,375	44,389	24,210	14,451	NC
Windy Creek Right	MFS	SEG	3,350–10,950	11,974	22,174	17,146	32,297	NC
Windy Creek Left	MFS	SEG	3,650–29,950	23,286	72,031	65,155	18,339	NC
Rocky River	MFS	SEG	9,350–54,250	53,760	198,671	67,840	189,992	NC
Port Dick Creek	MAS or MFS	SEG	18,550–58,300	13,323	122,236	51,500	44,170	NC
Island Creek	MAS or MFS	SEG	7,200–28,300	33,573	26,404	107,683	87,235	NC
S. Nuka Island Creek	MAS or MFS	SEG	2,700–14,250	6,432	11,199	5,100	6,645	NC
Desire Lake Creek	MAS	SEG	1,900–20,200	24,258	45,980	74,774	11,820	NC
Bear & Salmon Creeks	MFS	SEG	5,000–23,500	1,236	34,452	9,033	NA	NC
Thumb Cove	MFS	SEG	2,350–8,850	4,250	8,668	5,205	NA	NC
Humpy Cove	MFS	SEG	900–3,200	990	14,586	1,905	NA	NC
Tonsina Creek	MFS	SEG	500–5,850	3,450	9,922	6,453	NA	NC
Bruin River	MAS	SEG	18,650–155,750	66,494	98,346	515,114	350,420	NC
Sunday Creek	MAS	SEG	4,850–28,850	31,497	116,170	70,037	394,797	NC
Brown's Peak Creek	MAS	SEG	2,450–18,800	18,100	60,983	35,703	249,383	NC

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

[b] NC = No Change.

Table 4.–Current escapement goals, escapements observed from 2004 through 2007, and escapement goal recommendations in 2007 for 8 sockeye salmon stocks in Lower Cook Inlet, Alaska.

		Escapement Goal						
	Escapement	Type		Escapements				
System	Data[a]	(BEG, SEG)	Range	2004	2005	2006	2007	Recommendation[b]
English Bay[c]	PAS, Weir	SEG	6,000–13,500	15,310	8,188	15,454	16,487	NC
Delight Lake	PAS, Weir	SEG	5,950–12,550	7,262	15,200	10,929	43,963	NC
Desire Lake	PAS, Weir	SEG	8,800–15,200	10,700	4,820	18,600	10,000	NC
Bear Lake[c]	Weir	SEG	700–8,300	8,061	10,285	8,338	8,421	NC
Aialik Lake	PAS	SEG	3,700–8,000	10,100	5,250	4,760	5,370	NC
Mikfik Lake	PAS	SEG	6,300–12,150	14,020	5,970	17,700	11,190	NC
Chenik Lake	PAS, Weir	SEG	1,880–9,300	17,006	14,507	13,868	18,288	NC
Amakdedori Creek	PAS	SEG	1,250–2,600	7,200	1,710	300	3,830	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.

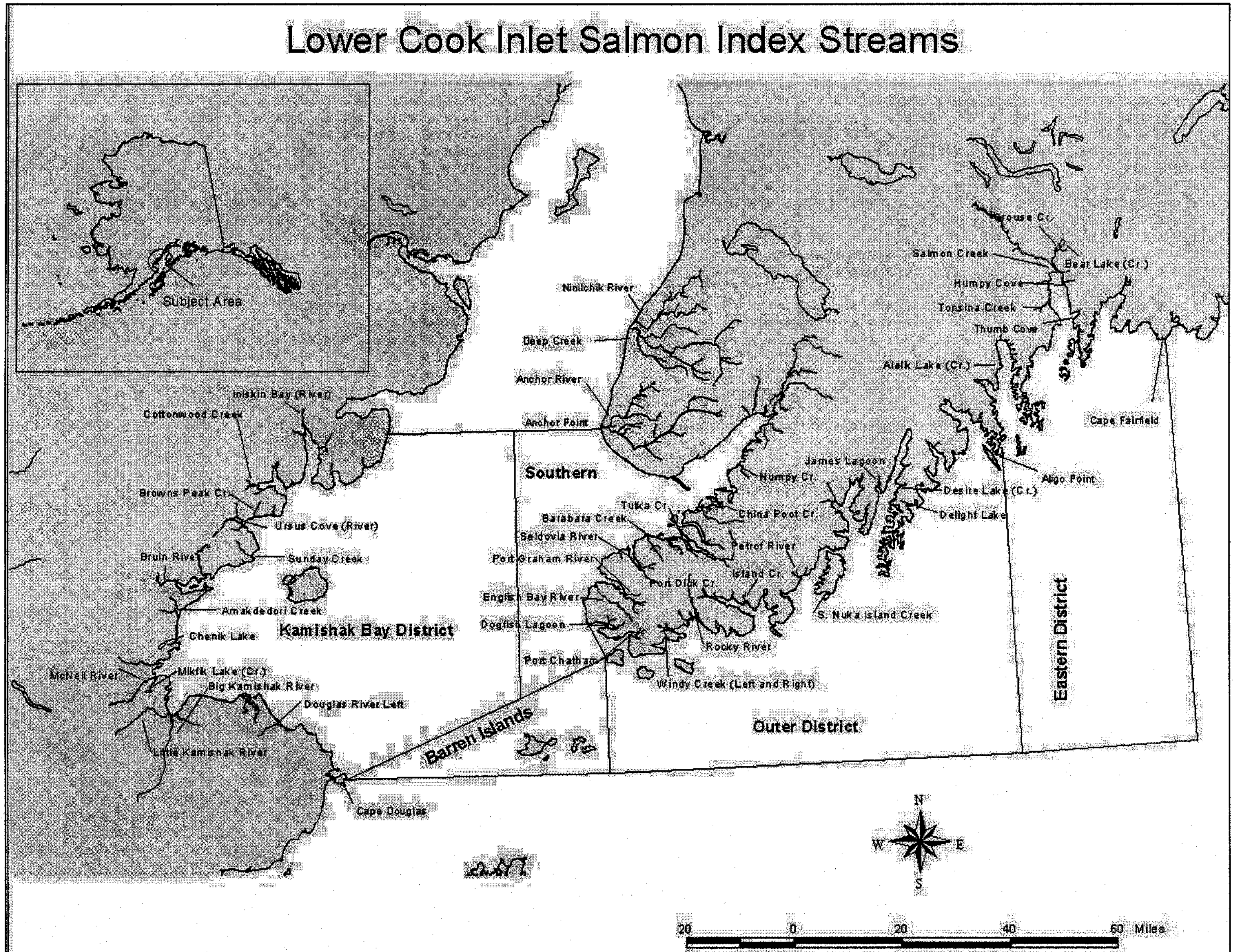

Figure 1.–Salmon producing streams with escapement goals, by district, in the Lower Cook Inlet management area.

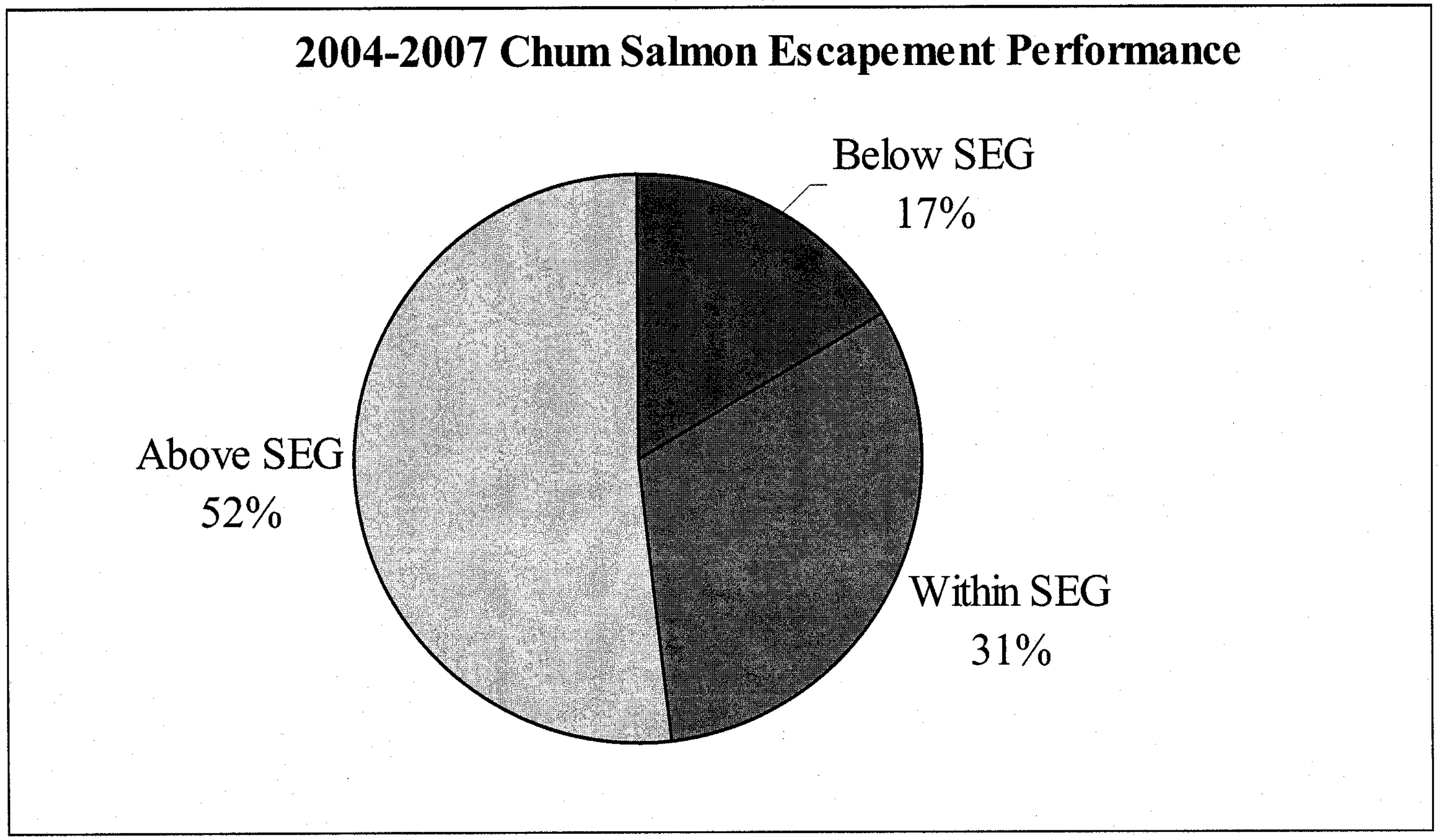

Figure 2.–2004–2007 Lower Cook Inlet chum salmon escapement performance for 12 stocks relative to their current sustainable escapement goal range.

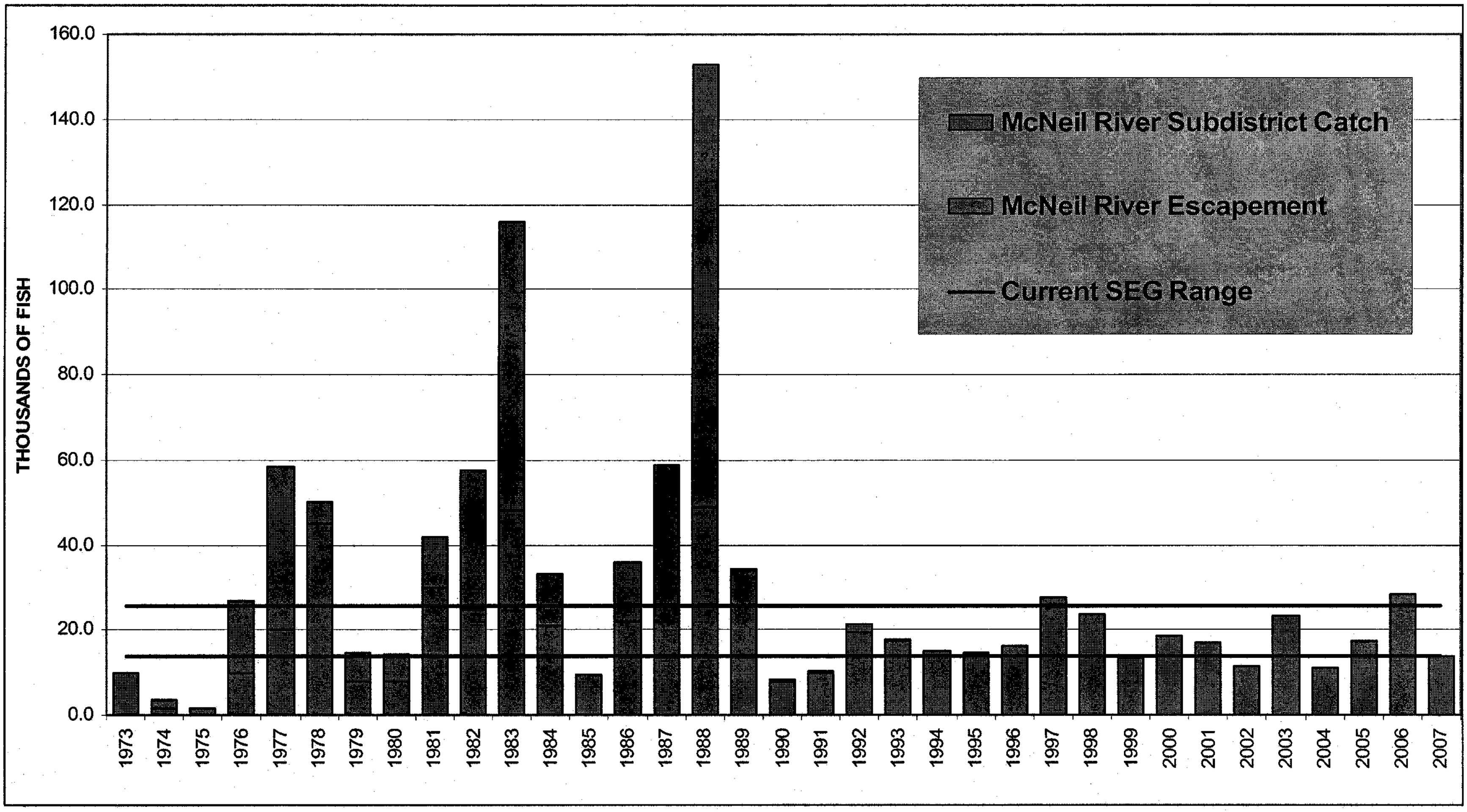

Figure 3.–McNeil River chum salmon historical catch and escapement abundance indices, 1973–2007, relative to the current escapement goal range.

Note: Escapement indices in this figure were estimated using the area-under-the-curve (AUC) method employing the historical stream life (SL) estimate of 17.5 d and an observer efficiency factor of 1.0.

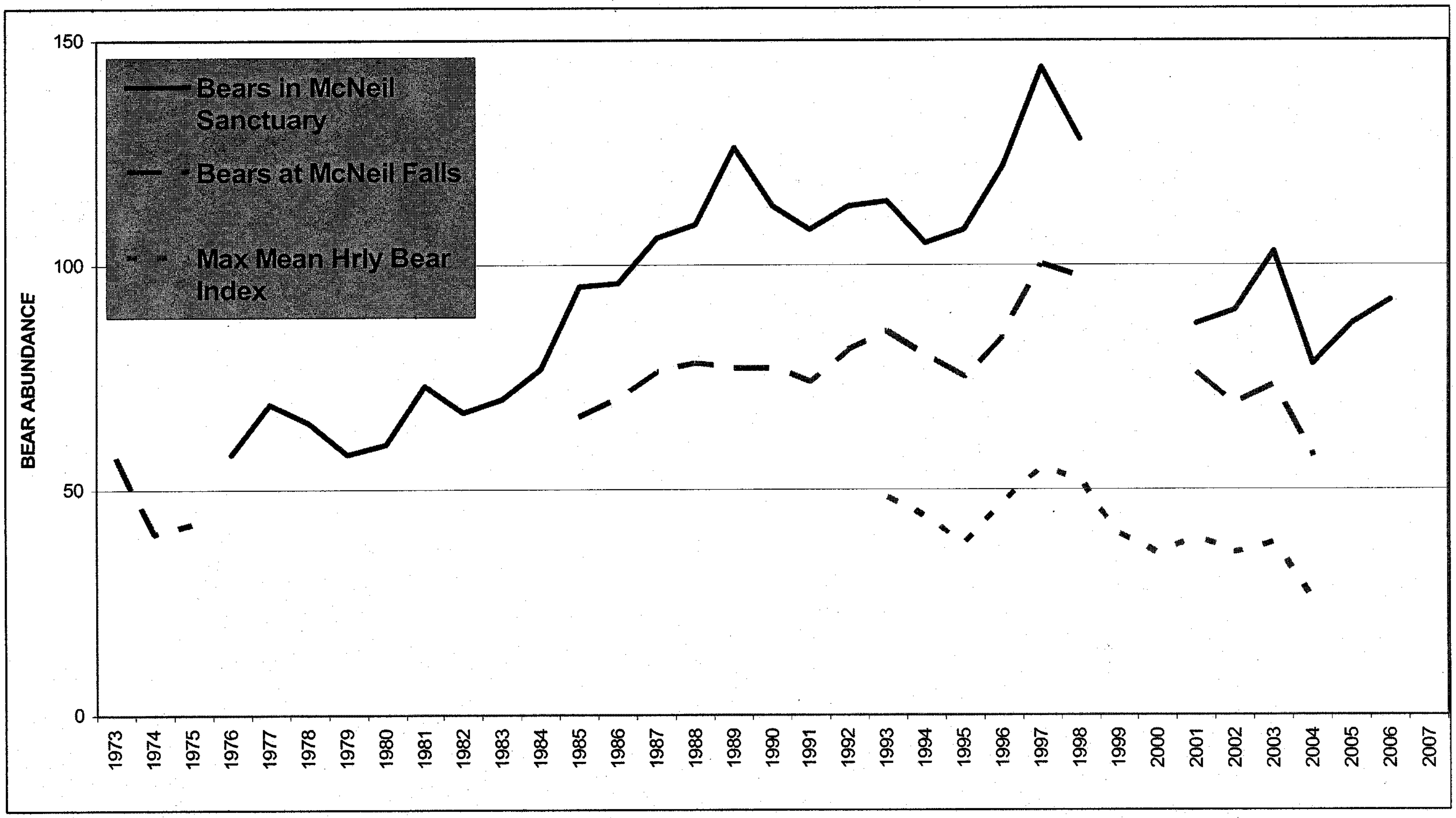

Figure 4.–Historical abundance of brown bears documented within the McNeil River State Game Sanctuary, and specifically at McNeil Falls, 1973–2006.

Source: McNeil River State Game Sanctuary staff, ADF&G Division of Wildlife Conservation, unpublished data.

Figure 5.–Aerial photo of McNeil Falls, located 2 km upstream from the ocean, illustrating physical impediments to chum salmon migration.

Note: for scale, the rock in mid-river is approximately 10 m across; photo by Ted Otis.

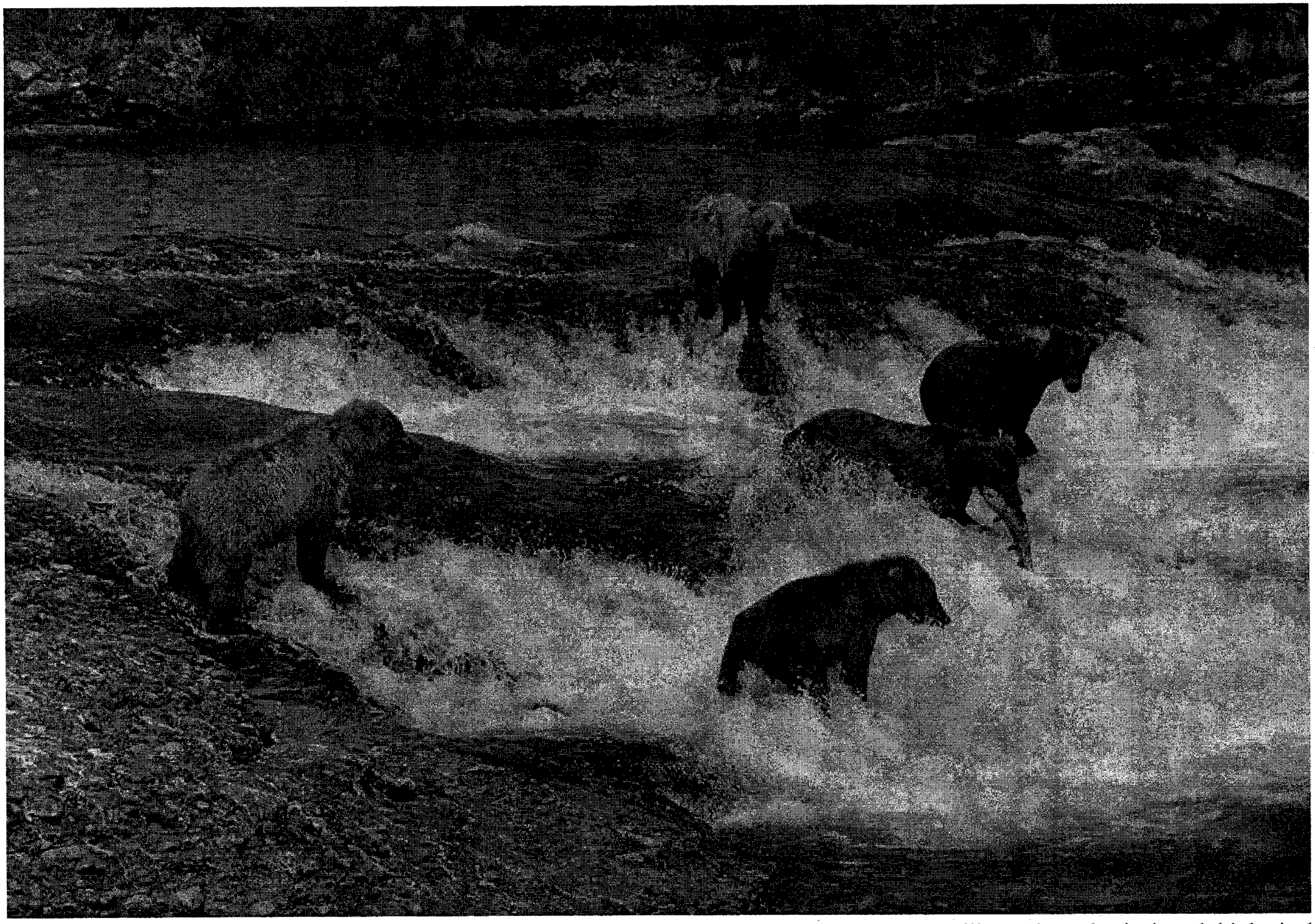

Figure 6.–Ground level photo of McNeil Falls, located 2 km upstream from the ocean, illustrating physical and biological impediments to chum salmon migration.

Note: photo by Mark Wipfli.

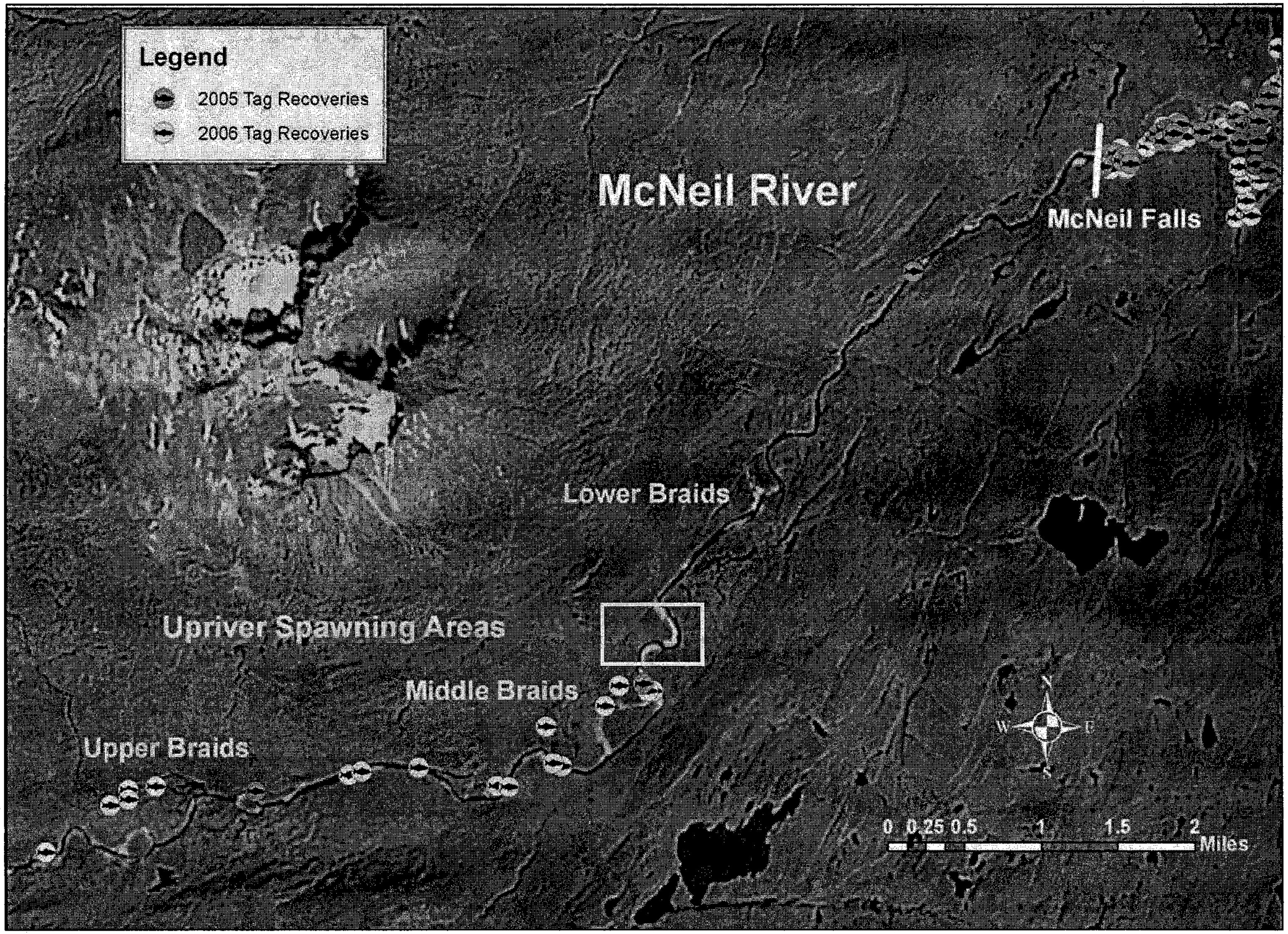

Figure 7.–Satellite image of McNeil River drainage illustrating the extensive spawning habitat available upstream of McNeil Falls.

Note: radiotagged fish that ascended McNeil Falls spawned at locations in the middle and upper braids in 2005–2006. Figure 8 magnifies the area inside the polygon.

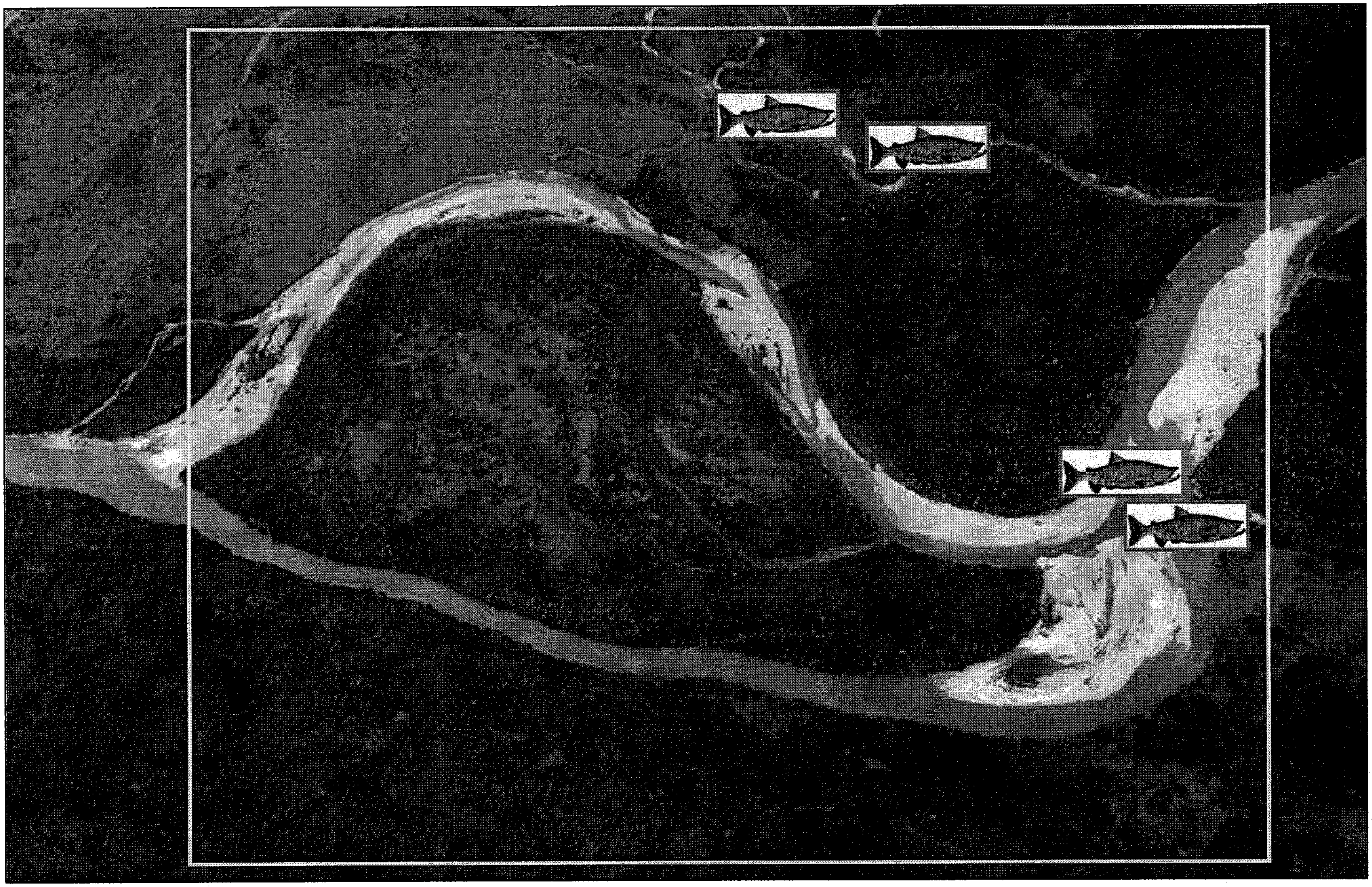

Figure 8.–Aerial close-up of one section of the middle braids where chum salmon selected main and side channels for spawning, sites likely to have groundwater and hyporheic upwelling.

Note: photo by Ted Otis.

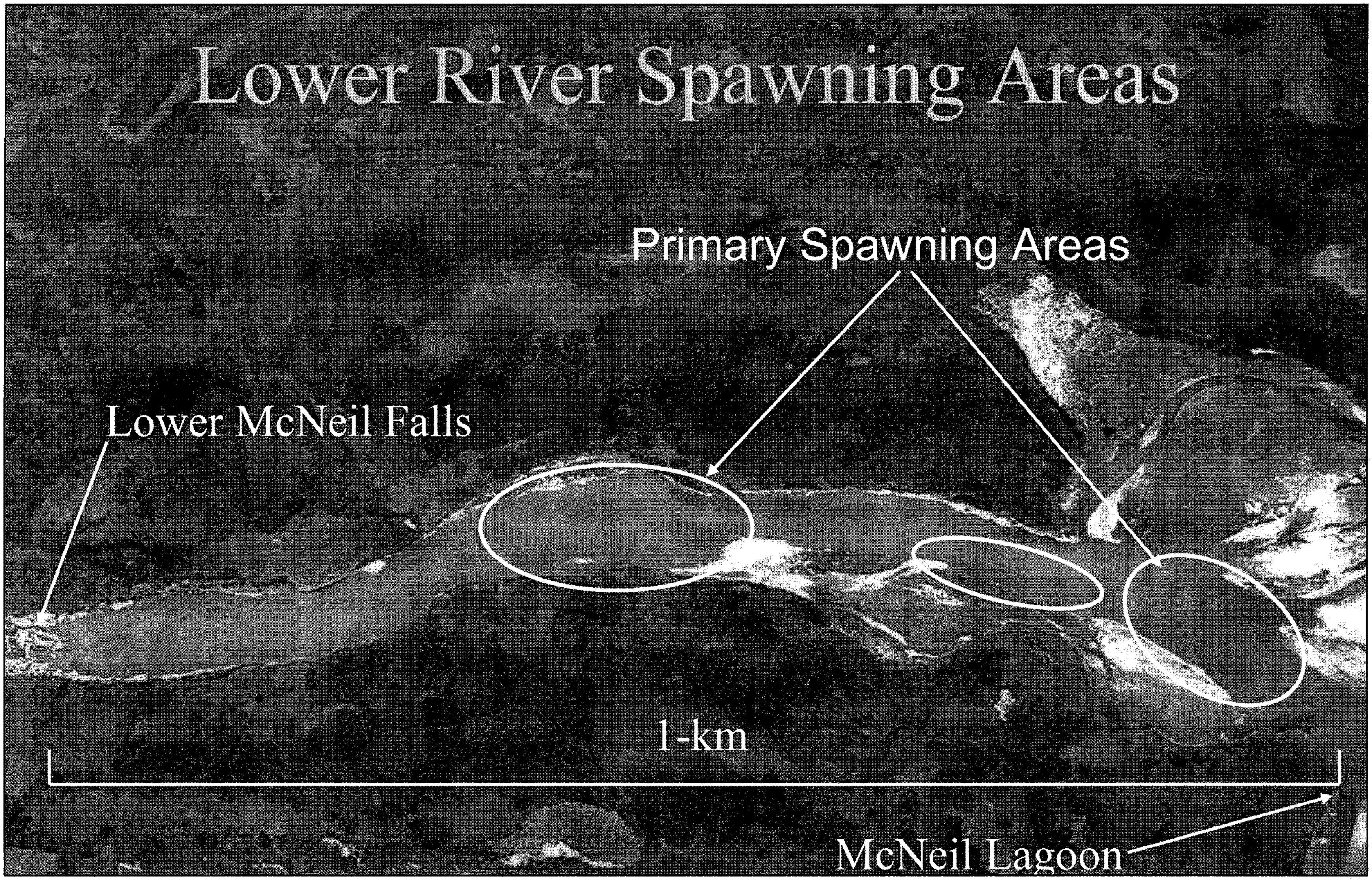

Figure 9.–Aerial photo of lower McNeil River illustrating the limited spawning area available below McNeil Falls.

Note: photo by Ted Otis.

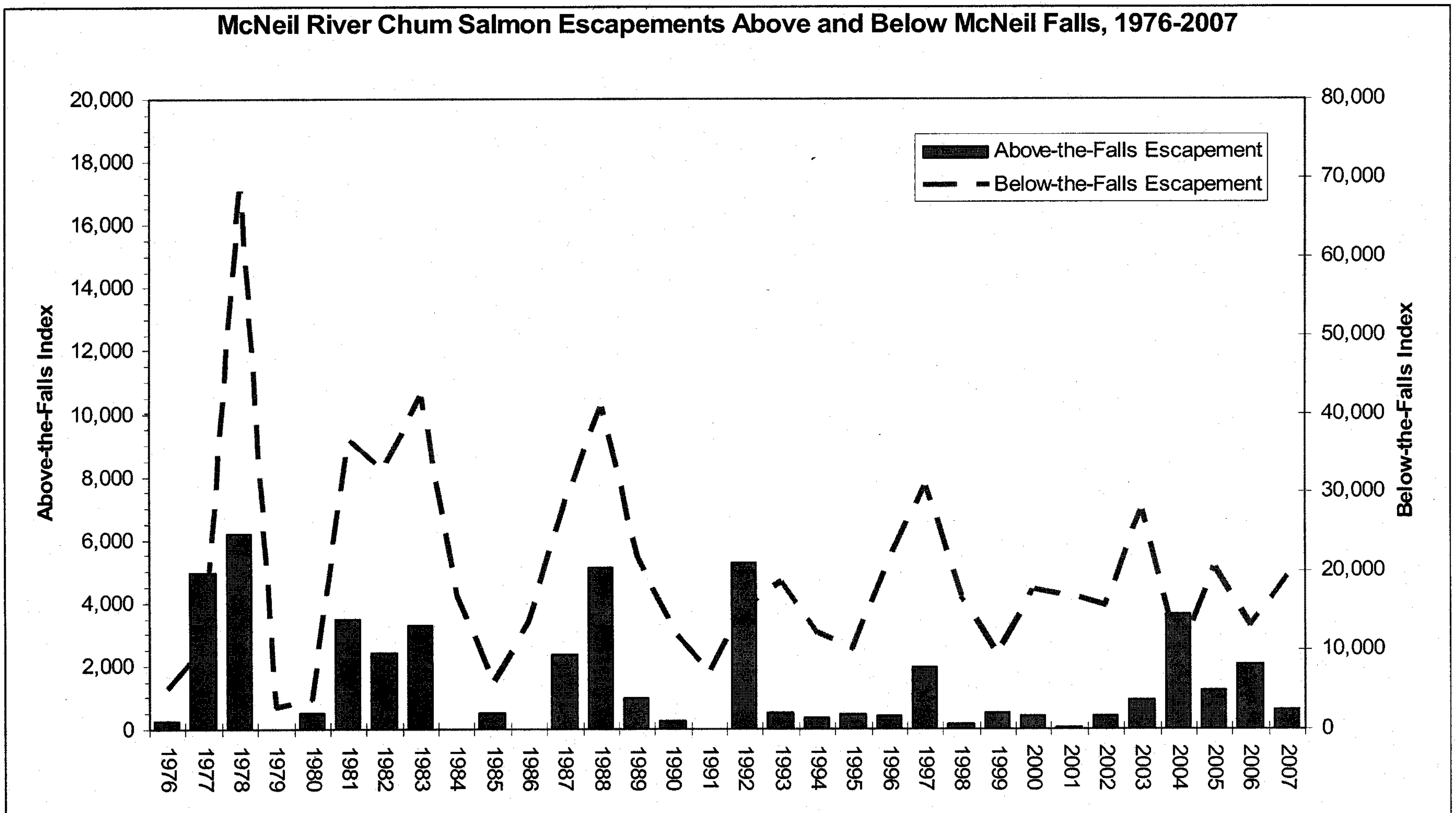

Figure 10.–Annual chum salmon escapement indices above (AF) and below (BF) McNeil Falls, 1976–2007, illustrating lower AF escapements during the past 19 years.

Note: The asterisks (*) denote years when AF escapement indices were not available. Escapement indices depicted in this figure were estimated using the area-under-the-curve (AUC) method employing reach-specific stream life (SL) estimates that were derived from a radio telemetry study (AF=21.9 d, BF=12.6 d). Observer efficiency was assumed to be 1.0.

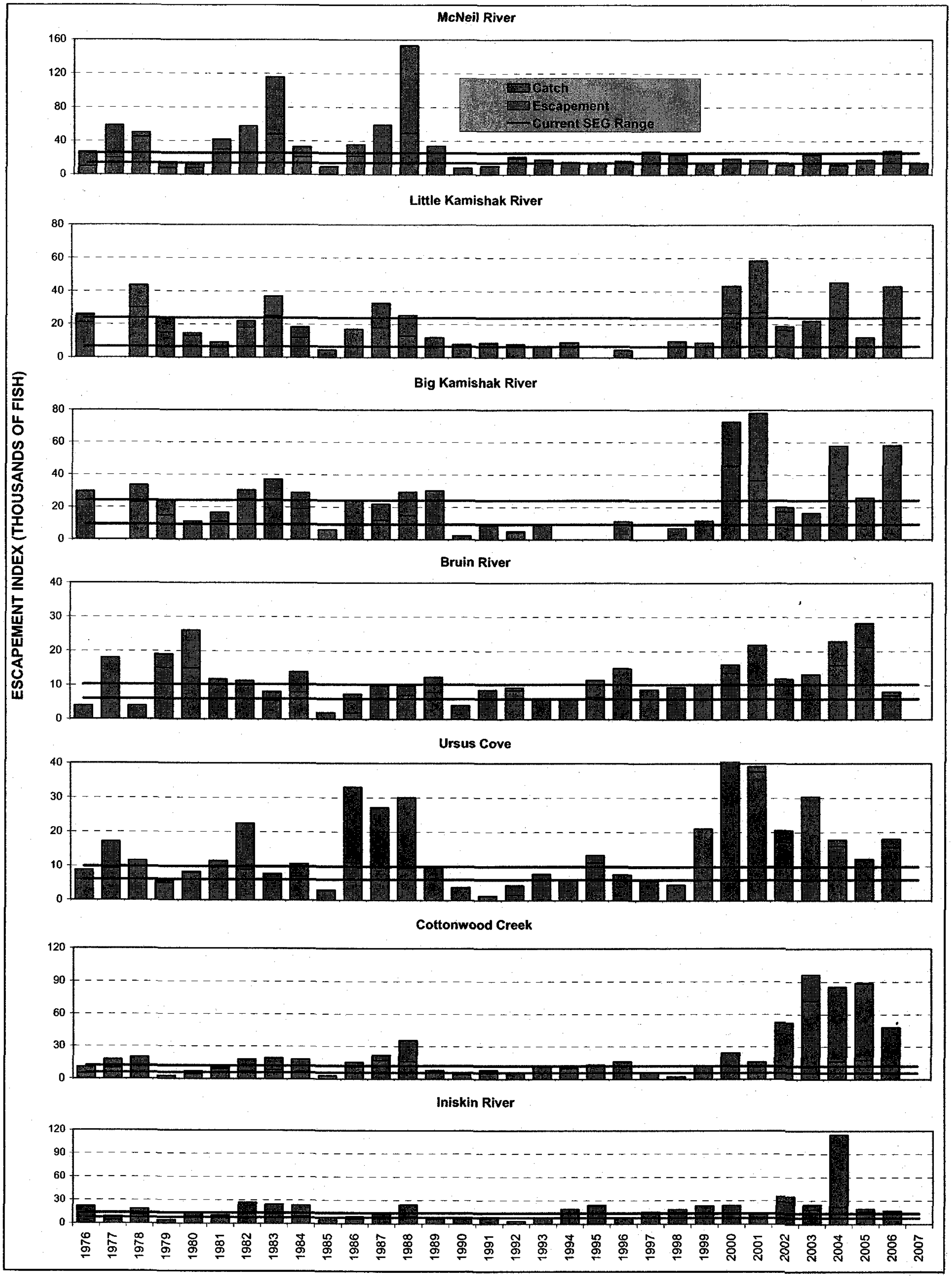

Figure 11.–Kamishak District chum salmon catch and escapement abundance indices, 1976–2007.

Note: Illustrates an area-wide decline in adult returns that began about 1989 and lasted until 1999, after which adult returns increased for all west side Cook Inlet stocks except McNeil River.

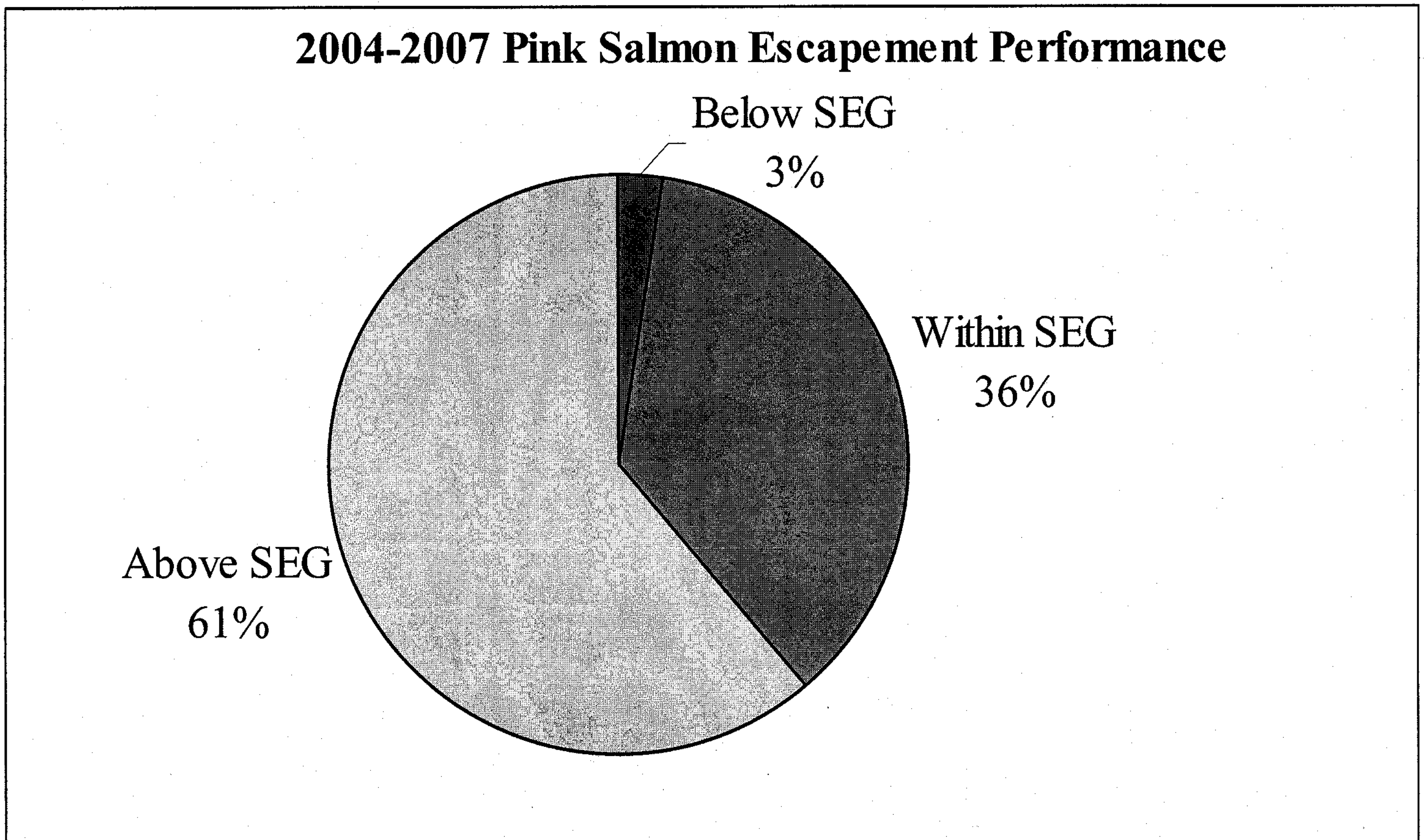

Figure 12.–2004–2007 Lower Cook Inlet pink salmon escapement performance for 21 stocks relative to their current sustainable escapement goal ranges.

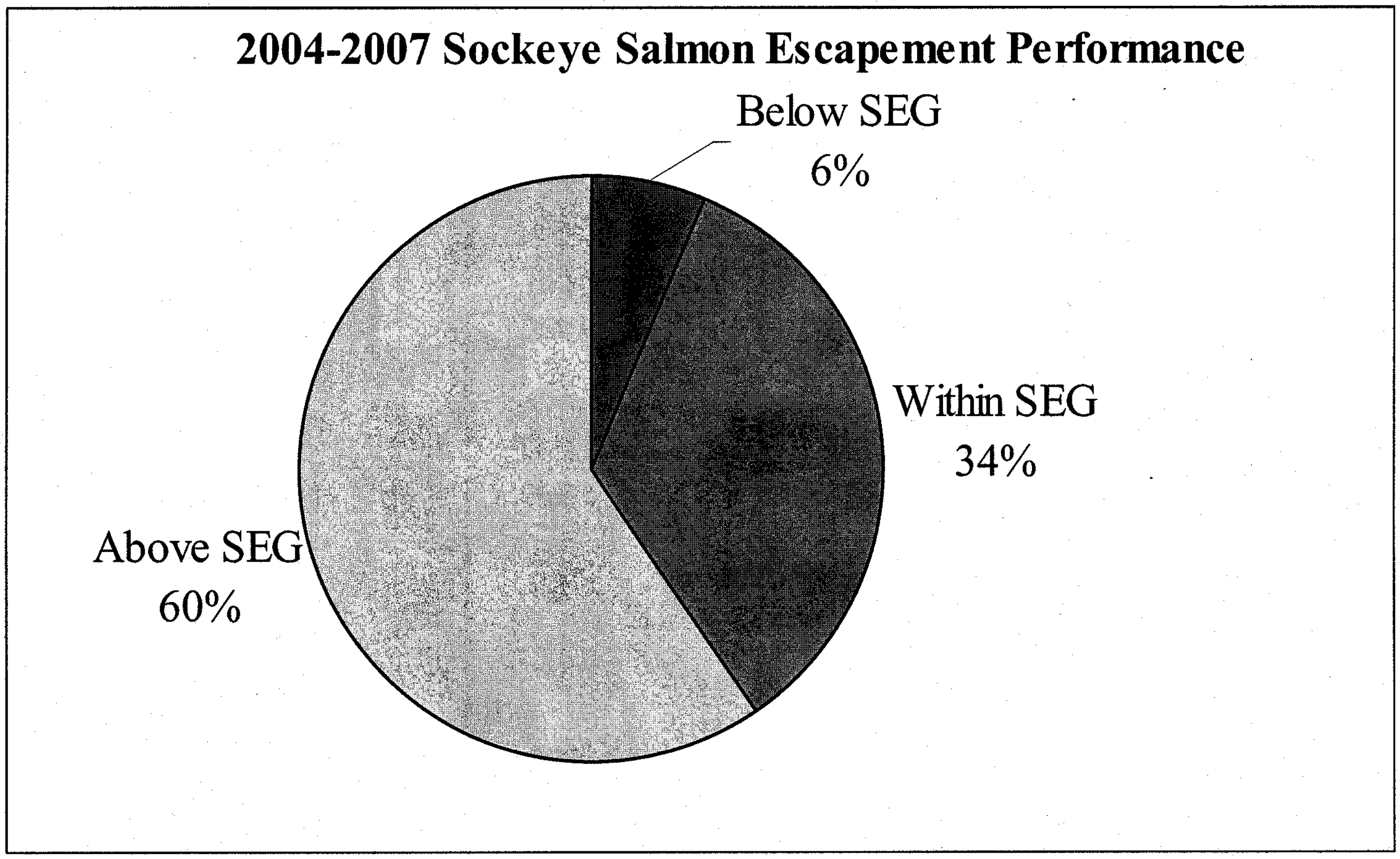

Figure 13.–2004–2007 Lower Cook Inlet sockeye salmon escapement performance for 8 stocks relative to their current sustainable escapement goal ranges.

Fishery Management Report No. 07-55

Recreational Fisheries in the Lower Cook Inlet Management Area, 2005-2007, with updates for 2004

by

Nicole J. Szarzi

Carol M. Kerkvliet,

Charles E. Stock

and

Michael D. Booz

October 2007

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: Fishery Manuscripts, 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)

Measures (fisheries)	
fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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 MANAGEMENT REPORT NO. 07-55

RECREATIONAL FISHERIES IN THE LOWER COOK INLET MANAGEMENT AREA 2005-2007, WITH UPDATES FOR 2004

by

Nicole J. Szarzi,
Carol M. Kerkvliet,
Charles E. Stock
and
Michael D. Booz
Alaska Department of Fish and Game, Division of Sport Fish, Homer

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

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The Division of Sport Fish Fishery Management Reports series was established in 1989 for the publication of an overview of Division of Sport Fish management activities and goals in a specific geographic area. Since 2004, the Division of Commercial Fisheries has also used the Fishery Management Report series. Fishery Management Reports are intended for fishery and other technical professionals, as well as lay persons. Fishery Management Reports 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 regional peer review.

Nicole J. Szarzi,Carol M. Kerkvliet, Charles E. Stock and Micheal D. Booz
Alaska Department of Fish and Game, Division of Sport Fish,
3298 Douglas Place, Homer, Alaska USA

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ABSTRACT

This report is a detailed summary of the recreational fisheries in the Lower Cook Inlet Management area for 2005 to 2007 with estimated angler effort, catch and harvest updated for 2004. Included are a description and historical overview of each fishery, how the fishery is managed, and sport fishery performance and escapement for 2004 to 2007.

Key words: Lower Cook Inlet Management Area, recreational fisheries, Board of Fisheries.

INTRODUCTION

The Lower Cook Inlet Management Area (LCIMA) includes the freshwater drainages on the west side of the Kenai Peninsula south of the Kasilof River drainage to Gore Point, the freshwater drainages on the west side of Cook Inlet from the south end of Chisik Island to Cape Douglas, and the marine waters and beaches of Cook Inlet bounded by these landmarks (Figure 1).

For sport fishery management purposes the LCIMA is often divided into four areas: Central Cook Inlet (CCI) is north of Bluff Point; Lower Cook Inlet (LCI) is south of Bluff Point and west of Kachemak Bay; Kachemak Bay is east of a line from Bluff Point to Seldovia; and West Cook Inlet (WCI) consists of the freshwaters along western Cook Inlet.

Easy access to salt water and popular salmon streams, combined with close proximity to major population centers, attracts large numbers of anglers to the diverse sport and personal use fishing opportunities of the LCIMA. Anglers can target five species of North Pacific salmon (pink *Oncorhynchus gorbuscha*, coho *O. kisutch*, sockeye *O. nerka*, chum *O. keta* and Chinook *O. tshawytscha*). Fisheries for these species occur in fresh and salt water. The major salmon fisheries harvest Chinook and coho near shore in Central Cook Inlet and the adjacent freshwater tributaries, in Kachemak Bay and the salt waters extending to the west. In Kachemak Bay, the Nick Dudiak Fishing Lagoon (Fishing Lagoon) is stocked with salmon by the Alaska Department of Fish and Game, Sport Fish Division (ADF&G, SFD) and is a focal point of anglers fishing from shore. A popular fishery occurs on the area's anadromous and resident stocks of Dolly Varden *Salvelinus malma*. Steelhead/rainbow trout *O. mykiss* support popular catch-and-release sport fisheries. The LCIMA accounts for the largest annual landings of sport-caught halibut *Hippoglossus stenolepis* in Alaska.

The state's largest recreational razor clam *Siliqua patula* fishery occurs on the beaches of the central Kenai Peninsula. Razor clam digging occurs along a 50-mile area of beach between the Kasilof and Anchor rivers on the east side of Cook Inlet. The largest hardshell clam (little neck *Protothaca staminea* and butter clam *Saxidomus giganteus*) fishery in Southcentral Alaska occurs in Kachemak Bay. Shrimp *Pandalus spp.*, Tanner crab *Chionoecetes bairdi*, King *Paralithodes camtschaticus*, and Dungeness crab *Cancer magister* are indigenous to the area, but fisheries for these species are all closed due to low stock abundance.

A small fishery for coho salmon occurs on the west side of Cook Inlet. Western Cook Inlet also hosts small fisheries for chum salmon, halibut, razor clams and several other species of clams.

Most fishing occurs from April to September, but a small number of anglers pursue Chinook salmon October to March.

Fisheries of LCIMA provide recreation for local residents, Alaska residents and a growing number of nonresidents. Fishing-directed tourism is a major segment of the economic base of the LCIMA.

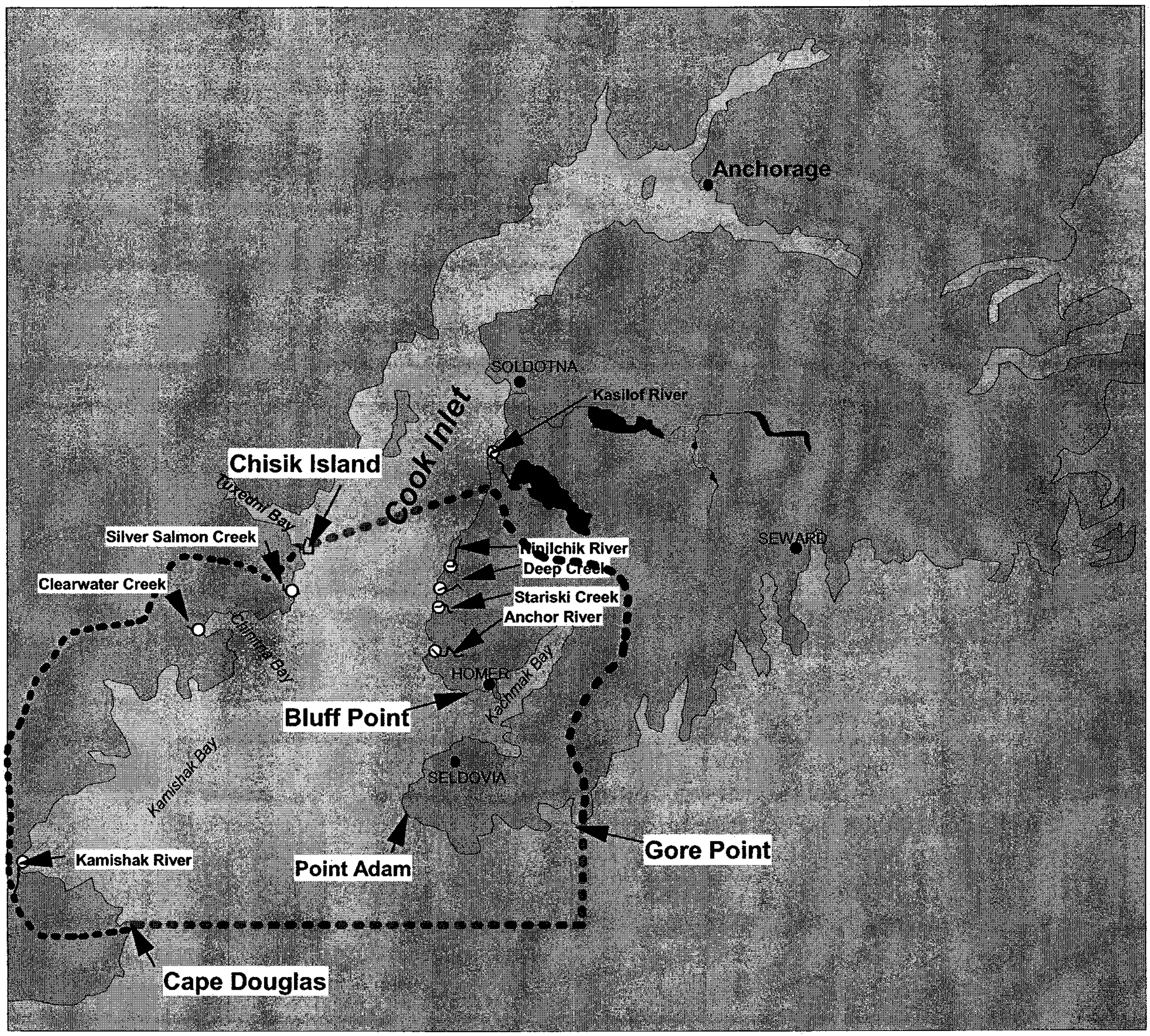

Figure 1.–Lower Cook Inlet Management Area.

Recreational angler effort and harvest in the LCIMA have been estimated using the Statewide Harvest Survey (SWHS) since 1977 (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*). The SWHS is a mail survey that estimates sport fishing effort and harvest annually. Final estimates are available during the summer of the following year. The survey is designed to estimate effort in angler-days and the number of fish caught and harvested by location. Beginning in 1990, the survey was modified to include estimates of catch (release plus harvest) by location. Although harvest and catch are estimated for individual species, the SWHS is not designed to estimate effort directed towards individual species. Creel surveys have been selectively used for fisheries that require more detailed information or inseason management and to validate the SWHS for fisheries of interest. The following summaries of recreational angler effort and harvest in the LCIMA are based on estimates from the SWHS, as are all effort and harvest estimates in subsequent sections, unless noted otherwise. Estimates for 2006 are preliminary and subject to revision.

Sport Fishing Effort

The LCIMA supports the second highest sport fishing effort in Alaska after the Upper Kenai Peninsula Management Area. From 1977 through 2003, the LCIMA accounted for an average of 13.0% of the total statewide recreational effort. During 2006, participation was slightly lower than the historic average (Table 1).

Most LCIMA effort occurs in Central and Lower Cook Inlet. As in 2003, in 2004-2006, slightly more effort occurred in Lower Cook Inlet than in Central Cook Inlet. Previously, except in 1988, more effort occurred in Central Cook Inlet.

Shellfish harvesters accounted for about 13% of the total recreational effort in the area in 2004 through 2006 (Table 1). Their focus was razor and hardshell clams because popular crab and shrimp fisheries are closed.

The dominant sport fisheries in Central Cook Inlet, in terms of participation, are the marine fishery for halibut and salmon, the freshwater fisheries in the Anchor River, Deep Creek and the Ninilchik River, and the razor clam fishery. Most fishing in Lower Cook Inlet occurs in the marine waters for halibut and salmon. A small amount of effort for clams occurs across Kachemak Bay from Homer. Very little freshwater sport fishing occurs in Lower Cook Inlet.

Sport Harvest

The LCIMA boasts the largest halibut fishery in Alaska. More halibut are harvested in the LCIMA than any other fish species. Halibut harvests for the area have generally increased since 1977 (Table 2). An average of approximately 213,200 halibut were harvested in the LCIMA from 2004 to 2006, approximately twice the historic average and nearly 20 % above the previous five-year (1999-2003) average.

Chinook salmon are an important component of the sport harvest from LCIMA waters. Approximately 10% of the statewide Chinook salmon harvest has come from the LCIMA, from 1977-2003 (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*). A similar proportion of the statewide total was taken in 2004 through 2006. LCIMA Chinook salmon harvest peaked at nearly 33,000 in 1993, generally declined through 2002 and has increased annually since 2002 to approximately 23,100 in 2006 (Table 3).

Coho salmon are the predominant salmon species harvested in the LCIMA, in terms of numbers of fish. . Harvests of coho salmon were stable from 1977-1988 and increased sharply in 1989 as stocked coho salmon from a new stocking program began returning to Homer Spit (Table 4). Harvests rose sharply again in 1993 and continued to increase through 2004 when a record of nearly 54,000 coho salmon were harvested. Relatively large harvests since 2001 are the result of good survival of Cook Inlet coho salmon stocks and additional stocked fish to the Homer Spit since 2001. The decline in coho salmon harvest in 2006 is partly the result of a poor return of stocked coho salmon returning to the Nick Dudiak Fishing Lagoon (see Coho Salmon Stocked Fisheries section).

Dolly Varden rank fourth amongst the most commonly harvested fish from the LCIMA and were a fifth of the statewide harvest in 2004 through 2006. LCIMA Dolly Varden harvests in 2004 through 2006 were near the lowest on record but within the range of harvests since the current more restrictive 2 fish bag limits were implemented in 1990 (Table 5) (see Dolly Varden section).

The LCIMA has the largest sport fishery for razor clams in Alaska. Razor clam harvests in 2004 through 2006 were the lowest since 1977 (Table 6). This is likely because diggers avoided young small clams from recent spawning events that currently dominate some popular beaches. The area also supports the largest hardshell clam fisheries north of Southeast Alaska; a variety of crab and shrimp species have been harvested in the LCIMA but currently, the shellfish harvest is dominated by hardshell clams taken from Kachemak Bay beaches (Table 7). Lower Cook Inlet hardshell clam harvests in 2004 and 2005 were within the range of historic harvests but the 2006 harvest was the lowest on record (Table 7).

CHINOOK SALMON FISHERIES

AREA-WIDE OVERVIEW

Area-wide Historical Harvest and Escapement

Saltwater Chinook salmon fishing occurs throughout the LCIMA, mostly from boats fishing within 3 miles of shore. The harvested fish originate in streams from within the LCIMA, other Cook Inlet tributaries and Southeast (SE) Alaska, British Columbia, Washington and Oregon streams (McKinley 1999, Begich 2007a, R. Begich, ADF&G Sport Fish, Soldotna, personal communication). Chinook salmon from streams outside Cook Inlet that are feeding in area saltwaters are caught throughout the year. Cook Inlet Chinook stocks are caught during their spawning migration from April to August.

During April to August in Lower Cook Inlet, the harvest is dominated by stocks of non-Cook Inlet origin (McKinley 1999; Begich 2007a, R. Begich, ADF&G Sport Fish, Soldotna, personal communication). During April to August in Central Cook Inlet, fish from Cook Inlet tributaries are generally more prevalent in the harvest (McKinley 1999; Begich 2007a).

Most of the saltwater Chinook salmon fishing during September through March occurs south and east of a line from the Bluff Point area to the Pt. Pogibshi area.

Cook Inlet stocks migrate along in a corridor within one mile of shore, while non-Cook Inlet stocks are scattered further offshore (McKinley 1999; Begich 2007a). Poor fishing near shore motivates anglers to fish offshore, changing the composition of the harvest in some years from more Cook Inlet fish to more non-Cook Inlet stocks.

Prior to 2002, the saltwater Chinook salmon harvest from Central Cook Inlet was higher than from Lower Cook Inlet and Kachemak Bay, but since 2002, more Chinook salmon have been taken from Lower Cook Inlet and Kachemak Bay (Table 3). This can be partially attributed to the growing popularity of the saltwater troll fishery for non-local "feeder" Chinook salmon.

ADF&G required sport fishing guide businesses and guides to register before fishing in Alaska beginning in 1995. Guides fishing in salt water were required to record their clients' effort, harvest and catches in logbooks beginning in 1998. Chinook harvests from the marine waters of the LCIMA reported by guides are similar in magnitude to estimates of harvest from the SWHS (Table 8) (Howe et al. 2001c, 2001d; Walker et al. 2003; Jennings et al. 2004, 2006a-b).

Chinook salmon have been stocked at a relatively stable level since the mid-1980s at the Nick Dudiak Fishing Lagoon (Fishing Lagoon), Seldovia and Halibut Cove Lagoon. Harvests have been assessed continuously since the inception of the stocking program at the Fishing Lagoon and average 20% of the area-wide marine harvest. During 2004 and 2005, 16% of the marine

Chinook harvest was taken at the Fishing Lagoon. In 2006, the Fishing Lagoon contributed only 9% of the area-wide harvest (Table 3).

LCIMA freshwater Chinook salmon fisheries occur in the Anchor River, Deep Creek and the Ninilchik River, all accessible from the Sterling Highway. The Ninilchik River wild run has been supplemented with stocked fish since 1987. Stariski Creek, also accessible from the Sterling Highway, has Chinook salmon but is closed to fishing due to the small run size. Chinook salmon enter Bradley River, Humpy Creek and the Seldovia River, on the south side of Kachemak Bay, but successful spawning has only been documented in the Bradley River. Chinook salmon in the streams on the south side of Kachemak Bay are thought to be strays from marine stocking programs in Kachemak Bay or to have originated from stray stocked fish. Few Chinook salmon are harvested in West Cook Inlet.

Freshwater harvests have remained fairly stable except during 1991 through 1997 when the Ninilchik River had returns from years with high stocking rates. The proportion of the total LCIMA Chinook harvest that is taken from the Anchor River, Deep Creek and the Ninilchik River combined has declined from nearly 40% in 1978 to a low of 13% in 2005 as saltwater fishing has expanded. The stability of the freshwater fisheries is attributed to the restrictive sport fishing regulations in place since the inception of the fisheries to protect these relatively small-sized streams from overharvest in light of their popularity. More Chinook salmon are harvested from the Ninilchik River than the Anchor River, on average despite the Anchor River being larger because the Ninilchik River is stocked.

Chinook escapements were counted in the Ninilchik River during 1999-2005 and the Anchor River since 2003. Deep Creek Chinook salmon escapement enumeration was attempted in 1997-2000. The Anchor River has by far the largest run.

Area-wide Fishery Management and Objectives

Chinook salmon sport fishing regulations are typically not changed inseason in the LCIMA. Harvests are estimated post-season and harvest guidelines contained in 5 AAC 58.055 Upper Cook Inlet Salt Water Early-run King Salmon Management Plan and 5 AAC 58.060 Lower Cook Inlet Winter Salt Water King Salmon Sport Fishery Management Plan have not been exceeded. The Kenai River Late-Run King Salmon Management Plan (5 AAC 21.359) requirement that the marine Chinook salmon sport fishery in Central Cook Inlet close if the projected Chinook salmon escapement to the Kenai River is less than 17,800 fish has not been invoked.

Limited inseason regulation changes have been made by emergency order to increase fishing opportunity. The Nick Dudiak Fishing Lagoon has been opened to snagging for Chinook salmon annually when stocked fish returning to the Fishing Lagoon mature sexually to the point that they quit biting and cannot be harvested using conventional sport fishing methods by provision 5 AAC 58.030 (d). Fishing seasons for hatchery-produced Chinook salmon in the Ninilchik River have been liberalized to increase the harvest. The Anchor River and Deep Creek Chinook salmon seasons have increased because fish surplus to sustainable escapements have occurred.

CENTRAL COOK INLET SALTWATER CHINOOK SALMON FISHERY

Fishery Description

Most Chinook salmon harvest in Central Cook Inlet is taken along the beach area (approximately 30 miles) between Bluff Point and Deep Creek (Figure 2) during April through early August.

Access to this fishery occurs primarily near the mouths of Anchor River and Deep Creek. Commercial operators provide beach launching and take-out service at Deep Creek and at Anchor Point making it possible to use larger boats and launch all boats at most tide stages. Private boats are also launched at the mouth of the Anchor River and Deep Creek beach. The unstable beach at Deep Creek precludes most private launching or loading of boats except at high tide. Private boats launch at the Anchor River beach at tide levels that expose the sandy beach surface and from a primitive boat launch in the Anchor River estuary at high tide. Boats also launch in the Homer Boat Harbor to access the Anchor Point area.

Anglers generally troll near shore within a few hours of the high tide. Historically, angler effort has been dependent on local weather conditions. Limited boat launching facilities have restricted, and for the most part continue to restrict, the size of vessels that are used. As a result, adverse weather has, on occasion, limited fishing to as little as 30% of the available fishing days in which Chinook salmon are present. Many anglers fish for halibut as well as Chinook salmon.

This recreational fishery is essentially the first harvest of Chinook salmon returning to Cook Inlet tributaries. In the commercial fishery, only drift gillnet fishing is allowed south of Ninilchik. The commercial drift gillnet fishery does not occur until late June when interception of early-run Chinook salmon is minimal.

The fishery targets the mixture of Chinook salmon stocks found in Cook Inlet marine waters. Cook Inlet stocks with early run timing (late April through late June) include the small central Kenai Peninsula drainages (Stariski Creek, Deep Creek, Anchor River, Ninilchik River), and larger drainages in upper and northern Cook Inlet (Kasilof, Kenai, and Susitna rivers) (McKinley 1999, Begich 2007a, R. Begich, ADF&G Sport Fish, Soldotna, personal communication). Cook Inlet stocks with late run timing (late June through early August) include the Kenai River and, to a lesser extent, the Kasilof River. Immature fish (non-spawning fish commonly referred to as "feeders") are harvested throughout the summer and are of non-Cook Inlet origin, including Southeast Alaska, British Columbia, and to a lesser extent Washington and Oregon (McKinley 1999, Begich 2007a, R. Begich, ADF&G Sport Fish, Soldotna, personal communication).

Coded wire tag recovery and maturity data indicate that the high interception rate on Cook Inlet stocks is not focused on a few selected stocks (McKinley 1999, Begich 2007a, R. Begich, ADF&G Sport Fish, Soldotna, personal communication). Rather, tag recovery data indicate that the origin of the harvest of mature fish is of a broader Cook Inlet distribution composed of numerous individual stocks, none of which make up a large component. By far the most abundant stocks in Cook Inlet are those returning to the Susitna River drainage, therefore it is reasonable to assume that their contribution to the Central Cook Inlet fishery is proportionate to their abundance in Cook Inlet. Immature fish harvested in this fishery are mainly non-Cook Inlet origin, including Southeast Alaska, British Columbia, and to a lesser extent Washington and Oregon.

The largest annual marine harvest of the two nearby stocks that were coded-wire tagged, Deep Creek and Ninilchik River hatchery fish, were estimated to be less than 300 and fewer than 200, respectively, during the years that all the returning age classes were tagged (Deep Creek 1998-2000; Ninilchik 1996-2002) (McKinley 1999, Begich 2007a, R. Begich, ADF&G Sport Fish, Soldotna, personal communication). The contribution of the three other wild LCIMA stocks (Anchor River, Stariski Creek, and Ninilchik River wild) was likely low due to similar run sizes and fishing regulations. Marine harvest has remained relatively stable since 1996 and fishery regulations static therefore the contribution of nearby LCIMA Chinook stocks is likely similar to the levels found in the 1996-2002 study.

Maturity sampling of the coded wire tagged fish collected during 1996 through 2002 indicated that mature (spawning) fish taken in the fishery were mainly of Cook Inlet origin and that immature (non-spawning) fish were mainly non-Cook Inlet origin (McKinley 1999, Begich 2007a, R. Begich, ADF&G Sport Fish, Soldotna, personal communication). An estimated average of about 2,600 mature early-run Chinook salmon where the origin could not be determined from coded-wire tags, but presumed to be from Cook Inlet systems, were harvested each year of the study. This indicates that other non-LCIMA Cook Inlet stocks account for most of the early-run marine harvest of mature fish.

The proportion of immature (non-Cook Inlet) fish in samples taken during the 1996-2002 study, ranged between 20% to slightly over 50% of the harvest annually (McKinley 1999, Begich 2007a, R. Begich, ADF&G Sport Fish, Soldotna, personal communication). A majority of mature spawning fish sampled during the 1996-2002 study were harvested within ¾ mile of shore. The majority of fish taken more than ¾ miles from shore were immature fish (non-spawners). It is probable that the proportion of immature Chinook salmon in the harvest continues to vary annually as anglers change fishing locations between nearshore and offshore to maximize fishing success.

Historical Harvest

Anglers began fishing for Chinook salmon in the Central Cook Inlet marine waters in the early 1970s. Fishery participation and harvest remained fairly stable through the late 1980s (Nelson 1995). The fishery expanded in the early to mid 1990s (Table 9). The greatest expansion was in guided angler effort (Table 10) and occurred in waters adjacent to Deep Creek. The increase in the 1990s is attributed to more marketing by the sport fish guiding and tourism industries, availability of commercial boat launching services that accommodate larger vessels, development of sport fishing lodges along Cook Inlet beaches, displacement of anglers from the restricted Kenai River fishery to salt water and increased use of the fishery by Kenai River guides on days when the Kenai River is closed to fishing from boats. High angler success rates reported by the news media also attracted additional participants.

Expansion of the marine fishery in the early 1990s raised concerns about the impact on Cook Inlet Chinook salmon stocks particularly from small local streams and from the Kenai River. A suite of restrictions were implemented during the early-run fishery with passage of 5 AAC 58.055 Upper Cook Inlet Salt Water Early-Run King Salmon Management Plan in 1996 by the Board of Fisheries (see Fishery Management and Objectives section). After 1995, participation and harvest stabilized below their 1995 peak, presumably as a result of the fishery restrictions.

Information about harvest and fishing effort is available from department creel surveys conducted at the Deep Creek access from 1972-1986 and at the Anchor River/Whiskey Gulch access in 1986 (Hammarstrom 1974-1981; Hammarstrom and Larson 1982-1984, 1986; Hammarstrom et al. 1985). Harvest after 1986 was determined by the SWHS.

Participation in the Cook Inlet marine Chinook salmon fishery could not be ascertained after the creel survey ended because the SWHS determines participation by location, not by species, and a major sport halibut fishery occurs in the same area as the Chinook salmon fishery. In 1994 and 1995, because of the rapid expansion of the fishery and a public perception that harvest in this fishery was negatively impacting other Cook Inlet drainage fisheries, a creel survey was conducted at Deep Creek, Whiskey Gulch, and Anchor River (McKinley 1995, 1996) to estimate early-and late-run harvest, total participation in the combined Chinook salmon and halibut fishery, and to verify the SWHS data. Estimates from the SWHS were thought to be more accurate and complete than the creel estimates because of temporal, area and seasonal limitations to the creel survey. Since 1996, the SWHS has requested information from surveyed Central Cook Inlet marine anglers by two time periods: prior to and including June 24 (early run) and after June 24 (late run). This allows the SWHS to generate separate estimates for the early and late runs.

Fishery Management and Objectives

The Central Cook Inlet marine Chinook salmon fishery has been regulated by the Upper Cook Inlet Salt Water Early-Run King Salmon Management Plan, since its adoption in 1996. The plan creates a special harvest area from Bluff Point north to Ninilchik (Figure 3). This area extends 1 mile seaward from the beach. From April 1 through June 30, within this special harvest area, guides cannot fish while guiding clients and an angler cannot fish for any species of fish for the remainder of the day after harvesting a Chinook salmon, but may fish outside the special harvest area.

Three conservation zones, closed to fishing for all species from April 1 through June 30, are located within this special harvest area. These zones extend 1 mile seaward and encompass the area from the mouth of the Ninilchik River to 2 miles south of Deep Creek, 1 mile on either side of Stariski Creek and 2 miles on either side of the mouth of the Anchor River.

A harvest guideline of 8,000 Chinook salmon governs the fishery from April 1 to June 30. If this guideline is exceeded the plan does not specify how the fishery will be restricted to ensure compliance with the guideline harvest level. The harvest reported in the SWHS is the fishery performance measure.

Management of the Cook Inlet marine late-run Chinook salmon recreational fishery north of Bluff Point is addressed in the Board-adopted Kenai River Late-Run King Salmon Management Plan (5 AAC 21.359) because it is assumed that a portion of the harvest is late-run Chinook salmon of Kenai River origin. The plan states that if the spawning escapement in the Kenai River is projected to be less than 17,800 late-run Chinook salmon, the department shall close the recreational fisheries in the Kenai River and in the salt waters of Cook Inlet north of the latitude of Bluff Point to the taking of Chinook salmon.

The projected escapement to the Kenai River has not been less than 17,800 and restrictions to the marine fishery have not been required since adoption of threshold in 1999.

The contribution of local stocks to the early-run marine harvest before the current saltwater regulations were implemented in 1996 is unknown. The impact of the regulations on escapement to the Ninilchik River, Deep Creek and the Anchor River is not apparent from fishery data (see Central Kenai Peninsula freshwater Chinook sections). Some users are concerned that the marine early-run Chinook salmon fishery may impact the early-run Kenai River fishery but the data do not support the belief that Kenai River stocks dominate the harvest but rather that the harvest consists of many stocks both from within and outside Cook Inlet.

No proposals addressed the Central Cook Inlet marine Chinook salmon fishery during the last Board of Fisheries meeting concerning Cook Inlet salmon regulations held in 2004.

Several proposals are before the BOF in November 2007 to liberalize fishing within the special harvest area. These proposals would decrease the closed saltwater area around the mouths of the Anchor River and Deep Creek and Ninilchik Rivers. Another proposal would open the saltwater at the mouth of the Anchor River June 25 instead of July 1.

Fishery Performance in 2004-2007

The 2004 season was exceptionally mild and great fishing was reported during both the early- and late-runs. Anglers reported harvesting more large fish in the nearshore waters in late July, assumed to be late-run Chinook of Cook Inlet origin, than in the recent past. Although good fishing was reported during the early run, the early-run harvest reported in the SWHS was below average (Table 9). The late-run harvest reported in the SWHS was also below average although good fishing was reported during the late-run (Table 9).

Similar to 2004, the 2005 season was characterized by exceptionally mild weather and great fishing was reported during both the early- and late-runs. Anglers reported good fishing in May for Chinook salmon off Bluff Point and north to Stariski Creek, in Central Cook Inlet. It is likely most of the fish were of non-Cook Inlet origin during May because it was early for Cook Inlet stocks to be returning. Reports of good fishing during the early-run were not borne out by harvest estimates from the SWHS, however (Table 9). Anglers reported harvesting more large fish in the nearshore waters in late July, assumed to be late-run Chinook of Cook Inlet origin, than in the recent past. Fishing for feeder Chinook salmon, remained good throughout the summer and supplemented the harvest during lulls between early and late runs of Cook Inlet stocks slowing in August.

In 2006, the weather was more typical of historic patterns with frequent rain. Saltwater Chinook salmon fishing was generally reported as slow during the Cook Inlet stock migration timing except during the latter part of May off Deep Creek. Anglers commonly went farther than a mile offshore where feeders are more abundant to find Chinook salmon. The early-run harvest was the largest since 1998, while the late-run harvest was below average (Table 9).

The 2007 season began with a late, chilly spring. Summer weather brought a few rainy days but most of the days were overcast and chilly broken by periods of a few sunny, warm days. Chinook salmon fishing was generally slow during the Cook Inlet stock migration timing. It was speculated that cool ocean temperatures was the cause of the late migration timing. Anglers commonly went farther offshore and fished deeper where feeder Chinook salmon were more abundant, but had little success there either.

Lower Cook Inlet and Kachemak Bay Saltwater Chinook Salmon Fisheries

Fishery Description

Anglers have fished for Chinook salmon for many years in the waters of Lower Cook Inlet and Kachemak Bay. Effort is concentrated during the summer months, but boat anglers are known to have harvested immature "feeder" Chinook salmon in the off-season during the 1960s or earlier. ADF&G SFD began ongoing Chinook salmon stocking programs for sport anglers in Halibut Cove Lagoon in 1979, the Nick Dudiak Fishing Lagoon (Fishing Lagoon) on the Homer Spit in 1984 and in Seldovia starting in 1987 that created additional fishing opportunity for shore and boat anglers (Figure 4). Anglers generally troll within a mile of shore for Chinook salmon except near stocked locations where they more frequently fish from anchored boats or from shore. Most Chinook salmon fishing takes place from boats.

Information about the origin, age, length, sex and sexual maturity of the Chinook salmon harvest has been collected during formal department sampling programs, from salmon derbies and from heads of fish missing their adipose fins (indicating that the fish might be tagged with a coded wire tag) voluntarily turned in by sport anglers. Sport harvested Chinook salmon caught by boat anglers were sampled by department personnel during the off-season (prior to May and after July) from 1994 through 1996, both early-run (May through June 24) and late-run (June 25 through mid July) summer harvests in 1997 and 1998, and early-run harvests only after 1998 through 2002 (R. Begich, ADF&G Sport Fish, Soldotna, personal communication). Formal sampling of the summer Chinook fishery in Lower Cook Inlet has ended but staff continue to encourage voluntary returns from anglers of Chinook salmon missing their adipose fins. Staff also sample winter fishing derby catches for biological information and recover coded wire tags from fish to determine their origin as time permits.

Winter stocks are thought to be largely composed of non-local stocks because of the lack of coded wire tagged Cook Inlet fish recovered from the fishery; only one tagged Chinook of Cook Inlet origin has been recovered from any source during August through March (R. Begich, ADF&G Sport Fish, Soldotna, personal communication). However, relatively few Chinook stocks of Cook Inlet origin have been tagged and relatively few individual Cook Inlet fish received tags compared to the diversity of stocks outside of Cook Inlet that are the focus of extensive tagging programs.

Coded wire tags recovered from the sport harvest during the summer indicate a mixture of stocks are harvested including hatchery stocks returning to the local stocking projects as well as wild and hatchery stocks returning to Cook Inlet tributaries further north, and a number of stocks of non-Cook Inlet origin. Tagged fish of non-Cook Inlet origin recovered in Lower Cook Inlet and Kachemak Bay have all been from hatcheries in British Columbia, Washington, and Oregon. Sexually immature fish are more predominant in the summer harvest in Lower Cook Inlet and Kachemak Bay than in Central Cook Inlet.

Historical Harvest

The Chinook salmon fishery is difficult to characterize because anglers reporting their harvest in the SWHS often generalize their fishing location and because the survey does not estimate effort by species. Participation and harvests in the area have generally increased (Table 3).

The SWHS questionnaire was modified to provide the estimates of winter harvest beginning in 2002. Estimates of winter harvest have been below the harvest guideline of 3,000 Chinook salmon, although the 2005 estimate of 2,958 was very close (Table 11). Most of the off-season harvest takes place near or south of Bluff Point.

Non-local feeding Chinook salmon from many stocks dominate both the summer and winter harvests south of Bluff Point therefore the fishery does not pose a threat to conservation of Cook Inlet stocks or visiting non-local stocks. The potential harvest of stocks that fall under the strictures of the Endangered Species Act is possible but the likelihood of impacting those stocks is remote.

Fishery Management and Objectives

Boat anglers fishing the marine waters of Lower Cook Inlet catch primarily immature Chinook salmon throughout the year. Immature fish offer opportunity both as a primary target and as an alternative when other fisheries are poor. Although regulated by a yearly limit of five during April through September, no seasonal bag limit is in place during the rest of the year. Additional opportunity is afforded throughout the year by the daily bag and possession limits in Lower Cook Inlet and Kachemak Bay marine waters, which are two Chinook salmon compared to one in the remainder of Cook Inlet salt- (and fresh-) waters. The waters in Lower Cook Inlet and Kachemak Bay open by regulation to snagging on June 24 except in the vicinity of the Nick Dudiak Fishing Lagoon on the Homer Spit (see Stocked Chinook Salmon Fisheries section).

Historically, no inseason management of this fishery occurred. The harvest of Chinook salmon has been unrestricted by a yearly limit or harvest recording requirement during October 1 to March 31 since 1988, except during 2001, when the BOF voted to require harvests during the winter fishery be governed by the five Chinook salmon annual limit, based upon indications that the fishery was growing. The action was rescinded by the BOF in 2002 but they established the Lower Cook Inlet Winter Salt Water King Salmon Sport Fishery Management Plan (5 AAC 58.060) which was implemented early in the winter of 2002. The plan contains a sport harvest guideline of 3,000 Chinook salmon for the waters of the LCIMA south of Bluff Point from October 1 through March 31 and stipulates the harvest will be estimated annually with the SWHS. Any restriction of this fishery necessitated by exceeding the harvest guideline would likely be based on data from previous seasons as no inseason information is available.

Fishery Performance 2004-2007

The Chinook salmon harvest from Lower Cook Inlet and Kachemak Bay was the second highest since 1977 and is partly the result of a strong run of stocked fish to the Nick Dudiak Fishing Lagoon.

The marine weather was typically mild through much of the spring and summer in Lower Cook Inlet in 2005. Fishing for feeder Chinook salmon was excellent during February, March and April in Kachemak Bay. Hotspots included the Seldovia area and Bluff Point. Anglers reported good fishing in May for Chinook salmon off Bluff Point and near Glacier Spit. It is likely most of the fish were of non-Cook Inlet origin during May because it was early for Cook Inlet stocks to be returning. Fishing for feeder Chinook salmon in hotspots remained good throughout the summer and supplemented the harvest during lulls between early and late runs of Cook Inlet stocks. Excellent fishing for feeders was reported into the fall at Bluff Point, Pt. Pogibshi and locations throughout Kachemak Bay.

The 2006 field season kicked off from a cold wintry spring; the last snow fell on the north side of Kachemak Bay on May 19th. Chinook salmon fishing in Lower Cook Inlet and Kachemak Bay followed the typical pattern: prior to the return of Cook Inlet stocks, periods of good fishing alternated with periods of fair to poor success as anglers targeted non-local feeders, fishing success improved during April through July as Cook Inlet stocks migrated through, and became more sporadic as non-local stocks became predominant.

January to May of 2007 saw unseasonably cold weather. The Winter King Salmon Derby conducted by the Homer Chamber of Commerce was rescheduled from March 24 to March 31 because ice in the boat harbor restricted boats from leaving to go fishing. When a rare break in the weather allowed anglers out onto the water, fishing was poor. Except during the migration timing of Cook Inlet stocks, fishing for feeders was poor until mid-August when many small Chinook salmon were reported to be biting.

Stocked Chinook Salmon Fisheries

Early-run Chinook salmon are currently stocked in the Nick Dudiak Fishing Lagoon (Fishing Lagoon) on the Homer Spit, in Halibut Cove Lagoon, and in Seldovia to create "terminal" fisheries meaning salmon returning here will not naturally reproduce because there is no spawning area available. These stocked fisheries are managed so all returning fish are harvested. The department objective for these fisheries is to provide for 25,000 angler-days of annual sport fishing opportunity directed at early-run Chinook salmon on the Homer Spit and in Seldovia Bay and Halibut Cove Lagoon, combined.

Run-timing is from approximately May 9 through mid-July with a peak in mid-June. The average weight of returning adults is 15 to 17 pounds. The broodstock is from the Ninilchik River where adults are artificially spawned and eggs fertilized before the eggs are transported to the Ft. Richardson Hatchery in Anchorage to be reared. The fish are reared for two years in the hatchery before their release as smolt at the saltwater stocking locations.

Smolt are held for up to 5 days after they are stocked and fed by volunteers twice each day. They are held at the saltwater stocking locations, the Fishing Lagoon and Halibut Cove Lagoon, to increase fidelity to the stocking location. The benefits of this practice have not been tested.

Smolt size at stocking was reduced in 2001 to reduce the number of 1-ocean "jacks" in the return to these stocked locations. Anecdotal reports of fewer jacks in the return were not confirmed by the department in the years after stocking size was reduced.

All salmon produced by department hatcheries are marked by altering hatchery water temperatures to produce banding patterns on the salmon otoliths. The banding pattern on the otoliths of salmon stocked in Cook Inlet is unique and different from the pattern on fish stocked in other waters.

Chinook salmon have been sighted in Bradley River, Humpy Creek and Seldovia River, streams not known to have wild Chinook stocks prior to the stocking program. Otoliths extracted from three Chinook salmon caught by department staff in the Seldovia River in 2005 were banded with the pattern of Cook Inlet hatchery-produced Chinook salmon indicating they had strayed in 2005 from a Cook Inlet stocking program.

Commercial, subsistence or personal use fisheries operate in proximity to stocking sites and conflicts over interception of fish stocked for sport use in other fisheries have been addressed by the Board of Fisheries at almost every Lower Cook Inlet meeting.

Nick Dudiak Fishing Lagoon

Early-run Chinook and coho salmon smolt (see the Coho Salmon Fisheries section) are stocked in the Fishing Lagoon on the Homer Spit, located in Kachemak Bay (Figure 4). The Fishing Lagoon was named in 2005 in honor of Nick Dudiak, the ADF&G biologist who initiated the stocking programs for sport anglers in Kachemak Bay. It is commonly known as the "Fishing Hole." Most sport fishing effort on stocked salmon in Kachemak Bay and Lower Cook Inlet is directed at the Fishing Lagoon. The major goal of the program is to meet the summer demand for more sport fishing opportunities along the Kenai Peninsula road system without compromising wild runs. The majority of the return is harvested by recreational anglers.

The success of this fishery resulted from the combined efforts of the department, the City of Homer, and the South Peninsula Sportsmen's Association to promote the project, improve the Lagoon itself, implement the fishery and promote the fishery. These three entities were co-recipients of the American League of Anglers and Boaters Sport Fish Management Award for best project in the nation in 1990.

The Fishing Lagoon was enlarged in 1994 by the City of Homer. In 1999, a handicapped ramp was added and the berm and entrance channel were hardened with riprap. ADF&G contributed $380,000 of the $1.2 million estimated project costs for the handicapped ramp and hardening.

Early-run Chinook salmon have been stocked by the department in the Fishing Lagoon since 1984 (Table 12). From 1984 until 1993, the brood stock for the early-run came from Crooked Creek, a tributary to the Kasilof River. Between 1993 and 1999, adults were collected from the Fishing Lagoon and spawned in the hatchery to produce the smolt stocked there. Since 2000, Chinook salmon from the Ninilchik River have been artificially spawned and reared to produce the early run to the Fishing Lagoon. The goal is to stock 210,000 early-run Chinook salmon smolt and produce 6,500 returning adults all of which are available for harvest in the recreational fishery. The average size of the adult return is 15 to 17 pounds.

Late-run Chinook salmon smolt were stocked from 1992 through 1999 by the department creating a popular fishery because fish up to 50 pounds were reported being caught. The original brood stock for the late run was Kasilof River Chinook salmon; brood stock was collected from adults returning to the Homer Spit from 1994 through 1998. The program was discontinued in 1999 when insufficient numbers of sexually mature adults were available for egg takes. A personal use salmon set gillnet fishery (see Coho Salmon section) also intercepted late-run Chinook salmon. Anglers continue to request that this program be revived, but artificial spawning of the original Kasilof River late-run stock is no longer approved because run size in the Kasilof River is unknown and sustainability could be jeopardized by harvesting sufficient broodstock to recreate a run to the Fishing Lagoon.

When the Chinook stocking program was first initiated, Chinook salmon smolt were artificially imprinted to a chemical at the Elmendorf Hatchery. This same chemical was dispensed from several drip stations anchored along the Spit to attract imprinted adult Chinook salmon returning from previous years' releases. The majority of the returning Chinook salmon came back to the Fishing Lagoon instead, where they were held in pens prior to release. As no fresh water is present, the fish apparently imprint to some unique characteristic of the Fishing Lagoon, therefore the use of drip stations was discontinued.

The first significant harvest of stocked early-run Chinook salmon occurred in 1987 (Table 13). Annual early-run Chinook salmon harvests from shore during 1988 through 2006 have ranged from 993 to 4,068. The contribution to the harvest of anglers fishing from boats near the Spit shoreline is difficult to assess because anglers are imprecise about reporting their harvest location, but it may approach 1,000 fish in some years.

The Homer Spit stocked salmon sport fishery is not specifically addressed in a regulatory management plan. Since 1989, regulations have prohibited snagging while salmon can be caught using conventional angling methods, but have allowed a snag fishery by emergency order when salmon become sexually mature and can no longer be caught by non-snagging methods. Snagging dates are determined by staff observation that surplus fish are available and that these fish are no longer "on the bite", usually in late June or early July. Snagging ends a few days after it opens when most surplus early-run Chinook salmon have been harvested. This management scheme has been applied to the other salmon species stocked in the Lagoon except for the early-run coho salmon stock that overlaps with the onset of the late coho salmon run. Through 1994, snagging was permitted at the Fishing Lagoon and the nearby area beginning on June 24. Snag opening dates in the Fishing Lagoon area have been more variable since 1994 (Appendix A2).

Public compliance with emergency orders has been deteriorating. Anglers developed a technique using a weight following a single hook, referred to as "tight lining," that is technically legal, but results in fish being snagged in the mouth but also in other body parts. The technique has increased the incidence of snagging-related complaints by the public and snagging citations by enforcement personnel. During 2001, the use of weighted hooks and weights following hooks was restricted by emergency order during snagging closures to lessen the incentive for anglers to snag and keep fish during the period when the fish are still biting (Appendix A1). The restriction produced a change from the use of weights following the hook to the use of bobbers following the hook to snag salmon in the mouth. Coincident with the increasing popularity of tight lining, noticeably fewer fish are taken when the Fishing Lagoon is opened to snagging. At the November 2007 meeting, the Board of Fisheries will address a public proposal intended to eliminate the practice of snagging fish by tight lining and bobber snagging by prohibiting the use of any gear following the hook.

In April 2004, the Alaska Legislature passed HB 98 giving the BOF authority to establish restricted seasons and areas necessary for persons less than 16 years of age to participate in sport fishing. At the November 2004 meeting, the BOF passed a public proposal to allow only youths under 16 years of age to fish along an area designated by the department in the Homer Spit Enhancement Lagoon on the third Saturday in June and the first and third Saturdays in August. Youth fishing days have become more popular as public awareness of their existence has grown.

Halibut Cove Lagoon

Early-run Chinook salmon are stocked in Halibut Cove Lagoon, located approximately 10 miles across Kachemak Bay from the Homer Spit (Figure 4). This is formerly the site of the Halibut Cove Lagoon Saltwater Rearing Facility, established in 1973 by the former Fisheries Rehabilitation, Enhancement and Development Division (FRED) of ADF&G, where all five species of Pacific salmon were reared experimentally for varying periods of time. Since 1979, the Lagoon has served only as a Chinook salmon imprinting, rearing and release site.

The annual stocking goal through 2006 was 105,000 early-run Chinook salmon smolt, to produce a run of approximately 3,000 adult fish. From 2001-2006 the number of fish stocked averaged about 109,000 (Table 12). The stocking goal was reduced to 50,000 smolt in 2007. The reduction was the result of reallocation of Chinook rearing space in SFD Anchorage hatcheries to rainbow trout after loss of the heat source resulted in longer use of hatchery space for trout rearing. This reduction is temporary until completion of a new hatchery facility in Anchorage, anticipated for about 2011.

Access to the fishery is via boat. It provides fishing opportunity in a beautiful and remote setting. Anglers fish from the Alaska State Park (ASP) dock or from anchored vessels near the dock. A limited amount of trolling occurs in greater Halibut Cove at the mouth of the lagoon channel.

Sport effort, harvest and catch in Halibut Cove Lagoon have not been estimated with the SWHS since 2000 because of uncertainty caused by anglers who were misreporting their fishing location as the lagoon when they fished elsewhere (halibut were reported harvested in the lagoon which is unlikely because of the shallow entrance and limited presence of prey species). The Chinook salmon fishery is relatively small with harvests likely less than 1,000 fish most years.

Snagging is prohibited in Halibut Cove Lagoon until June 24 when Kachemak Bay and Lower Cook Inlet open to snagging by regulation. On this date the fish are maturing and angler efficiency using non-snagging techniques is dwindling.

This stocked return is subject to a commercial set gillnet fishery adjacent to the Lagoon from the first Monday in June until September 30. The commercial set gillnet fishery harvest of Chinook salmon in the Halibut Cove Subdistrict has ranged from 321 in 2006 to 1,400 in 1989, averaging 650 fish annually from 1984 through 2006 (Hammarstrom and Dickson 2007). The number of Chinook salmon harvested in the commercial fishery is estimated from fish tickets.

There are no biological concerns associated with the management of this fishery. The incidental commercial Chinook salmon harvest is of concern to some recreational anglers. The BOF considered and rejected public proposals in 1992 and 1998 that would have reduced the commercial harvest of stocked early-run Chinook salmon returning to Halibut Cove Lagoon.

In November 2004, the BOF changed the start of the commercial set gillnet fishery season in the Southern District from the first Monday in June to a start date no earlier than June 1, to be opened by emergency order. The BOF directed the department to establish the start of the season so that no change in allocation between the commercial and sport fisheries would occur compared to preceding years. Commercial harvests have been below the historical average since 2005 and the commercial fishery regulations have not been adjusted (Hammarstrom and Dickson. 2006, Hammarstrom and Dickson 2007).

Current regulations compromise the department's ability to achieve the harvest objective in the sport fishery because not all Chinook salmon produced are available to the recreational angler.

If the department seeks to maximize fishing opportunity in the region, stocking small fisheries such as Halibut Cove Lagoon may be discontinued to provide for new fisheries where more anglers can be served. An ADF&G SFD goal to provide a diversity of fishing experiences is satisfied by the stocked fishery in this beautiful, remote yet accessible location.

Seldovia

Seldovia is located approximately 15 miles southwest of the Homer Spit across Kachemak Bay (Figure 4). Chinook salmon smolt were first released in the Seldovia Harbor in 1987 to create a new sport fishery. The release site was moved to upstream of a dam in Fish Creek, a small tributary to Seldovia Slough, in 2000 to increase the fidelity of fish to the release location.

The full complement of ocean age classes has returned since 1991. This is a terminal harvest fishery where all fish are intended for harvest and none spawn at the stocking location.

The annual stocking goal through 2006 was 105,000 early-run Chinook salmon smolt, to produce a run of approximately 3,000 adult fish. Number of smolt stocked averaged about 102,000 from 2001-2006 (Table 12). For the same reason that stocking was reduced to Halibut Cove Lagoon, a reallocation of hatchery space to rainbow trout rearing, the stocking goal for Seldovia was reduced to 50,000 smolt in 2007. Also, like Halibut Cove Lagoon, this reduction is temporary until completion of a new hatchery facility in Anchorage, scheduled for completion in about 2011.

Access to Seldovia is via boat and plane; the Alaska State Ferry docks regularly in Seldovia and scheduled air service fly to Seldovia daily.

Estimation of sport angler participation, harvest and catch in Seldovia with the SWHS was discontinued in 2001 in an effort to improve estimates of harvest from broader geographical regions of the management area by combining estimates from small fisheries. Prior to 2001, the largest reported harvest was 600 in 2000. Estimates were thought to be conservative because fewer than 30 respondents to the survey reported fishing in Seldovia some years, rendering the estimates inaccurate.

A subsistence set gillnet fishery for salmon was created in Seldovia Bay by the BOF during its 1995 meeting. The harvest of Chinook salmon was limited to 200 fish to avoid impacting the stocked Chinook fishery in Seldovia Bay. The annual possession limit is 20 Chinook per household. The fishery is opened for two 48-hour periods per week from April 1 to May 30 and one 36-hour period each of the first 2 weekends in August. The BOF adopted a proposal extending the April/May period by 10 days to May 30 at their February 1998 meeting. The highest reported subsistence harvest was 189 Chinook salmon in 2000 and the lowest was 12 reported in 2006 (Hammarstrom and Dickson 2007).

A commercial set gillnet fishery harvests Chinook salmon in Seldovia Bay. Much of this harvest is likely composed of enhanced Chinook salmon returning to Seldovia. Commercial harvests averaged 40 fish prior to stocking from 1984 through 1988 (Hammarstrom and Dickson 2007). Since 1991, when the run consists of all age classes of stocked fish, the average annual commercial harvest has been 283 and ranged from 57 in 2007 to 770 in 1991 (Hammarstrom and Dickson 2007, L. Hammarstrom, ADF&G Commercial Fisheries Division, Homer, personal communication).

In November of 2004, the BOF changed the start of the commercial set gillnet fishery season in the Southern District from the first Monday in June to a start date no earlier June 1, to be opened by emergency order. The BOF directed the department to establish the start of the season so that no change in allocation between the commercial and sport fisheries would occur compared to preceding years. Since the 2005 fishing season, commercial harvests of Chinook salmon in Seldovia Bay have been below the 1991-2004 average of 330 and commercial fishery regulations have not been adjusted (Hammarstrom and Dickson 2007, L. Hammarstrom, ADF&G Commercial Fisheries Division, Homer, personal communication).

Support for the stocked Chinook salmon fishery from the local community is strong although numerous complaints have been lodged about snagging violations prior to the June 24 regulatory opening. Complaints have also arisen over the practice of snagging and wasting wild chum salmon that return to the Seldovia Slough after the Chinook salmon run is over. Snagging is legal because the slough is salt water but the waste of fish is not. It may be necessary to close the slough to snagging at the conclusion of the Chinook salmon return to prevent snagging of other fish species. Although not a consideration in managing this fishery, the incidental commercial and subsistence Chinook salmon harvest is of concern to some recreational anglers.

Current regulations compromise the department's ability to achieve the objective that all Chinook salmon produced be available to recreational anglers.

The fishery is small relative to most other stocked saltwater terminal fisheries in Southcentral Alaska. As with the stocked early-run fishery in Halibut Cove Lagoon, if new salmon stocking projects are identified, their costs and benefits will be weighed against those of existing projects. Smaller fisheries provide diversity but provide opportunities for fewer anglers, and therefore may be a lower priority.

FRESHWATER CHINOOK SALMON FISHERIES

Fishery Descriptions

Three streams in the LCI management area are open to sport fishing for Chinook salmon: Anchor River, Deep Creek and Ninilchik River (Figure 2). All three fisheries are on the road system. The Sterling Highway crosses the lower reaches of the streams and developed access and camping facilities are located on or near each river. Anglers can easily access the entire 2-mile open fishing area. Run timing of Chinook salmon in these streams is approximately early May through late July with a peak in early June.

The streams have pass-through fisheries for salmon, including Chinook salmon, where only the waters from the mouth upstream approximately 2 miles are open for fishing and the spawning areas located upstream of two miles are permanently closed to salmon fishing. The streams have historically been open to the harvest of wild Chinook salmon only on weekends and the Mondays following those weekends in late May and early to mid-June although fishing time on the Ninilchik River has been liberalized to increase the harvest of hatchery-produced Chinook salmon stocked there. Chinook salmon spawning occurs above the fishery from mid-July through August in each stream.

The Anchor River watershed is approximately 225 square miles in size and about 114 miles of the river have been identified as habitat for anadromous fish. The Deep Creek watershed is approximately 211 square miles in size; 106 miles of the river contain anadromous fish species. Water levels and water clarity in the Anchor River and Deep Creek are variable due to their length, relatively steep gradient and drainage morphology that includes 1,000-foot cut banks of loose substrate. Harvest success is related to water depth, flow rate and clarity during fishery openings. Typical spring conditions find both Deep Creek and Anchor River high and muddy for the first and second Chinook fishery openings, respectively, and generally flow subsides and clarity improves during the second and third Chinook fishery opening, respectively.

The Ninilchik River drainage covers 135 square miles and drains low altitude wetland habitat. Anadromous fish species have been found in 52 miles of the river. Water conditions on the Ninilchik River are generally less turbid than on the Anchor River and Deep Creek and fishing conditions are good throughout the Chinook salmon fishery. The Ninilchik River is stocked by ADF&G SFD with approximately 50,000 hatchery-produced Chinook salmon annually. Hatchery-produced Chinook salmon can be recognized by the missing adipose fin (fleshy fin on the back immediately preceding the tail). The timing of hatchery fish in the fishery estimated from harvest sampling is variable. Run-timing of hatchery fish to the eggtake weir located approximately 4 miles upstream is approximately 10 days later than timing of wild fish.

The following sections detail historic Chinook salmon harvests and escapements through 2003 and the fishery management and objectives, and the fishery performance from 2004 through

2007 for Anchor River, Deep Creek and Ninilchik River. Open season and bag and possession limits for each stream are described in fisheries performance section.

Historical Harvest

The historic Chinook salmon harvest average and harvest range (1977-2003) has varied between streams (Anchor River =1,286, Deep Creek = 951, and the Ninilchik River = 1,721; Tables 14-16) and within a given stream: (Anchor River range = 578 – 2,787, Deep Creek = 182 – 2,503 and the Ninilchik River = 420 – 5,316). Harvest variations between streams are attributed to differences in stock size, with the Anchor River supporting the largest wild stock fishery, and supplementation of the Ninilchik River wild stock boosting the harvest there. Harvest variation within a given stream is primarily attributed to changes in fishing regulations, angler effort and river conditions during fishery openings. Harvest success is related to the water depth, flow rate and clarity during fishery openings.

In the early 1970s, the Anchor River, Deep Creek, and Ninilchik River were the major Chinook salmon fisheries in Southcentral Alaska. The only other Southcentral Chinook salmon fishery of consequence occurred in the marine waters adjacent to Deep Creek. In the late 1970s and early 1980s, other Chinook salmon fisheries developed on the Kenai Peninsula and in northern Cook Inlet and effort in LCIMA freshwater declined (Figure 5). In the early 1990s, participation stabilized in the Anchor River and Deep Creek while harvest increased. At the same time, both participation and harvest increased in the Ninilchik River. The increases in harvests in the 1990s were the result of efforts to increase fishing opportunity in the Anchor River and Deep Creek with the addition, in 1989, of a 3-day Chinook salmon opening in the Anchor River and in Deep Creek. The return of the first major year class of stocked fish to the Ninilchik in 1991 bolstered harvest and effort there. The lower Kenai Peninsula Chinook salmon fisheries remain popular; but fisheries in the Kenai and Kasilof rivers, the Homer Spit, and Susitna River drainage streams now have more participation and harvest.

Anchor River and Deep Creek

Since fishery restrictions to the Anchor River and Deep Creek were implemented in 1996, harvest, catch and participation have been relatively stable in these streams (Figure 2, Tables 14-15). However, aerial escapement counts of Anchor River Chinook salmon were below the Sustainable Escapement Goal (SEG) range of 750 to 1,500 fish, in effect beginning 2001, in four of six consecutive years between 1996 and 2001 (Table 17), despite the fishery restrictions in 1996, resulting in change of the regulatory fishery openings by the BOF from five to four 3-day weekends beginning in 2002. This action was in effect during 2002 and 2003 but did not coincide with a significant decrease in the Anchor River Chinook salmon harvest compared to 2001.

In 1997, there was an uncharacteristically early completion of snowmelt runoff and clear weather that resulted in low, clear water and good fishing conditions for all weekend fishery openings in both the Anchor River and Deep Creek.

In 1998 through 2002 more typical conditions of high muddy water occurred during some or all of the fishery openings. Deep Creek was opened for a fourth weekend in 2001 (Appendix A1) because high muddy water during the 3 regulatory weekend openings prevented anglers from catching fish.

Two flood events occurred in the fall of 2002; both of magnitudes in excess of any event recorded or known in the previous 100 years. The first flood event occurred as the result of heavy rainfalls during October 22 and October 23; the second followed heavy rains on November 22. The channels of the lower 50% of the Anchor River and 90% of Deep Creek were heavily eroded and extensive rechannelization of both rivers occurred based on post-flood surveys of the drainages. Additionally, flood waters tore out or damaged bridges, culverts and roads throughout the LCIMA.

Water was lower than normal throughout the 2003 Chinook salmon fishery but water conditions were less than ideal at Deep Creek because dark water, presumably caused by silt deposition from the 2002 fall floods, prevailed during the first and second weekends allowing only one day of fair Chinook salmon fishing during the second weekend opening. The Anchor River was low and clear in 2003 and fishing was reported as good to excellent. Stream levels dropped early in spring of 2004 and remained low for most of the season.

Ninilchik River

The department stocking program of the Ninilchik River began in 1987 to protect wild Ninilchik River Chinook salmon from overharvest and to respond to the increasing popularity of sport fishing on the Kenai Peninsula by providing additional fishing opportunity. Approximately 180,000 Chinook salmon smolt of Ninilchik River origin were stocked annually from 1988-1994 which resulted in an approximate 3.4-fold increase harvest as the dominate year class returned from the large numbers of smolt releases in 1991 (Table 16, Figure 5).

Increased fishing opportunity was provided by extending the season with emergency orders from 1991 through 1996 (Appendix A1), which generally opened the fishery beginning on Saturday of the fourth weekend and extended the open fishing period through the following Monday (Appendix A1). In 1995 and 1996, the Ninilchik was opened for an additional 14 and 10 days after the regulatory weekend openings (Appendix A1). Emergency openings were triggered by foot survey counts upstream of the fishery to the weir of 500 or more Chinook salmon. Poor visibility or fewer than 500 fish upstream from the fishery at the conclusion of the third weekend would have resulted in more conservative measures.

To evaluate the stocking program, the contributions of hatchery-reared Chinook salmon were assessed from creel surveys from 1991 through 1993 (Boyle et al. 1993; Balland et al. 1994; Marsh 1995). The estimated percents of the hatchery-reared Chinook salmon in the harvest in1991, 1992, and 1993 were 77%, 57% and 50%, respectively. Inriver harvest samples in 1994, 1995, and 1996, the estimated percent of hatchery-reared Chinook salmon was 45%, 50%, and 50% respectively (Marsh 1995, L. Marsh ADF&G Sport Fish Division, Soldotna, personal communication).

Concerns about unsustainable harvests of wild Chinook salmon in the Ninilchik River, negative hatchery-wild smolt interactions, straying of hatchery fish, and unintended taking of eggs from untagged hatchery-produced Chinook salmon for future stocking, resulted in a reduction in stocking levels from approximately 180,000 to 50,000 in 1995. At the same time, the percentage of coded wire tagged hatchery smolts was increased from approximately 20% to 100%. The average annual estimate of effort between 1998 and 2003 was approximately 40% of the average annual effort during the years of returns from the high stocking years, 1991-1997 (Figure 5, Table 16). After 1997, when most returning year classes were from the lower stocking rate, average harvests declined by more than half (Figure 5, Table 16).

Run timing differences with hatchery reared Chinook salmon returning to the eggtake weir later than wild fish, created concerns that fishery openings were targeting wild rather than hatchery-produced Chinook salmon (Begich 2006b). To address these concerns, the department sampled the inriver harvest in 2000 and 2001 and estimated that the percentage of hatchery produced fish in the harvest was 49% to 51% respectively, which was similar to 1991-1996 estimates even though hatchery returns were smaller because of the reduction in stocking levels (Begich 2006b, Balland and Begich *In prep*). When it was observed that the seasonal proportion of hatchery produced fish at the weir was much lower than 50%, it was evident that the fishery was not missing the hatchery component.

The eggtake weir was operated throughout the Chinook salmon escapement beginning in 1999 to estimate the magnitude and run timing of wild and hatchery stocks returning to the river (Table 18). In 2001, the high incidence of hatchery fish harvest samples, plentiful numbers of fish in the lower river between the weir and the area open to fishing and weir counts comparable to the ample escapement on the same date the previous year, justified an extension of the sport fishery for a 4th weekend, June 16 through June 18, by emergency order. The estimated contribution of hatchery fish to the fourth weekend's harvest increased to 62%, and was significantly different from the first through third weekends (Balland and Begich *In prep*).

The fishery was extended by emergency order in both 2002 and 2003 to provide more harvest opportunity on hatchery-produced fish and reduce their escapement (Appendix A1). In 2002, the river was opened to harvest of only hatchery-produced fish, downstream of the Sterling Highway bridge from June 15-17 (Appendix A1). The emergency order in 2003 was more aggressive than in 2001 or 2002 because a significant number of hatchery-produced fish still escaped the fishery despite the emergency openings in both 2001 and 2002 (Table 18). In 2003, the entire river was opened to the retention of hatchery-produced fish only from June 14-June 30, after the 3 regulatory weekends were past (Appendix A1). Despite the longer opening, 425 hatchery-produced escaped the fishery.

Harvest and effort has been relatively stable since 1998, even with subsequent fishery liberalizations by emergency order to harvest surplus hatchery fish (Figure 5, Table 16).

Historical Escapement

Chinook salmon escapement to the LCIMA streams has been assessed since 1962. Prior to 1974, fixed-wing aircraft were used in tandem with foot surveys. After 1973, helicopters were used in concert with foot surveys. The escapement to these streams was indexed by counting salmon from the air along a standard section of each river where the majority of spawning was thought to occur and counting a standard subsection of flown area by foot. If the foot survey count was higher than the aerial count for that subsection, the aerial count for the whole stream was expanded by the difference between the aerial and foot survey counts in the subsection. If the aerial count was higher for the subsection, the aerial count of the entire stream was used as the escapement index. Foot surveys were discontinued after 1995 as a cost savings because trends in foot survey counts mirrored trends in aerial counts and because foot survey counts added an additional source of variability in estimating the true escapement to the LCIMA streams. Since the foot surveys were discontinued, only aerial counts have been used to index escapement (Table 17).

Chinook salmon BEGs of 950 for Deep Creek, 1,790 for the Anchor River and 830 for the Ninilchik River were adopted in 1993. In 1998, these BEGs were rescaled based on historical aerial survey counts alone and the relationship of the aerial survey counts to sport fishing harvests. The BEG range for the Anchor River was set at 1,050 to 2,200 Chinook salmon; for 400 to 950 for Deep Creek , and 500 to 900 for the Ninilchik River.

Escapement goals for salmon stocks in Cook Inlet were reevaluated in 2001 (Bue and Hasbrouck *Unpublished*) after the Policy for Management of Sustainable Salmon Fisheries (5 AAC 39.222) and the Policy for Statewide Salmon Escapement Goals (5 AAC 39.223) were adopted into regulation by the BOF in 2000. A set of standard criteria was developed to set escapement goal ranges for stocks where total returns cannot be enumerated, based on the performance of salmon stock dynamics where total returns are known. The 25th to 75th percentiles of annual 1976-2000 helicopter aerial escapement counts at Deep Creek and Anchor River were established as the new SEG ranges for those streams. The actual escapement goal range values for the Anchor River and Deep Creek were set at 750-1,500 and 350-800, respectively.

Aerial escapement counts for the Ninilchik were too poor in quality to base management decisions on. In 2001, the lower end of the Ninilchik River Chinook salmon SEG range was established as the 15th percentile of the 1994 through 2000 estimates of wild Chinook salmon passage to the egg take weir during July 8-24 (Bue and Hasbrouck *Unpublished*); fish killed at the weir for spawning were not subtracted. The upper end of the range was set at the maximum observed wild Chinook salmon escapement to the weir during July 8-24 from 1994 through 2000 (Table 19). This approach established an SEG range of 400 to 850 wild Chinook salmon.

Anchor River

Six of 12 escapement index counts in the Anchor River from 1989 to 2001 were below the SEG range of 750 to 1,500 fish and four of six consecutive years between 1996 and 2001 were below the SEG range (Table 17). During the BOF meeting in November 2001, in response to the guidelines established in the Sustainable Salmon Fisheries Policy, the BOF designated Anchor River Chinook salmon as a stock of "management concern" defined in the policy as "a concern arising from a chronic inability, despite use of specific management measures, to maintain escapements for a salmon stock within the bounds of the SEG, BEG, OEG, or other specified management objectives for the fishery" (5 AAC 39.222 (f) (21)). The regulatory fishery openings were reduced from five to four 3-day weekends beginning in 2002.

In 2003, a Dual Frequency Identification Sonar (DIDSON) was installed upstream of the fishery and just downstream of the confluence of the North and South forks of the Anchor River. Based on counts from the sonar between 30 May to 9 July, at least 9,238 Chinook salmon were estimated to have migrated upstream in the Anchor River during the count period in 2003 (Table 20) (Kerkvliet et al. *In prep*). The count represented a minimum estimate for several reasons: 1) counting was initiated well into the migration; and 2) species discrimination is not yet reliable with sonar and the estimate represents the net upstream count after downstream migrating fish, including emigrating rainbow/steelhead trout are subtracted. Sonar counts revealed the inaccuracy of Anchor River aerial survey counts; 680 Chinook salmon were counted from the air in 2003 (Table 17). The aerial count area is on a section of the South Fork, the North Fork of the Anchor River supports only a small fraction of the Anchor River Chinook spawning escapement. It is likely that less than 10% of the Chinook salmon that returned to the Anchor River were harvested in 2003.

The DIDSON was installed and operational at the Anchor River May 15, 2004 (Table 20). On June 9 when river levels lowered, a complete resistance board floating weir was installed to continue escapement monitoring. The floating weir was removed September 13. Based on DIDSON and weir counts, the escapement of Chinook salmon in the Anchor River was approximately 12,016 (Kerkvliet et al. *In prep*). An emergency order was issued on June 21, 2004 extending the Chinook salmon fishery for another 3-day weekend (Saturday, June 26 through Monday, June 28) after approximately 7,000 Chinook salmon were estimated to have passed upstream of the Anchor River sonar/weir site (Appendix A1).

Deep Creek

Aerial index counts of Chinook salmon escapement to Deep Creek have been within or above the SEG range, established in 2001, since 1998 (Table 17). This improvement coincides with the fishing restrictions and with years of high turbid water during some or all of the fishery openings. We are currently unable to determine the actual escapement to Deep Creek or the maximum harvest level that will maintain escapement levels. From 1997 through 2000, a weir was operated in Deep Creek to enumerate and collect biological samples from Chinook and coho salmon (Begich 2002, 2006a; Begich and Evans 2005; King and Breakfield 1999, 2002). High water during late May and early June prevented timely installation in 1998-2000 and counting of a significant portion of the run. In 1997, a significant number of fish escaped past the weir without being sampled. Although we are unable to determine the actual escapement to Deep Creek or the maximum harvest level that will maintain escapement levels, weir counts in 1997 and 1999 of 1,732 and 2,055 are likely the closest to the actual escapement (King and Breakfield 1999, Begich 2002). Instream exploitation rates estimated from those counts were 41% and 24%, respectively, and are likely maximum estimates because escapement is underestimated. The number of spawners in 1997 and 1999 were at or above the level thought to achieve stable long-term production in Chinook salmon populations (McBride et al. 1989). Our inability to fully enumerate the Chinook salmon return to Deep Creek with the weir has precluded evaluation of aerial index counts. The current level of exploitation is likely sustainable, assuming weir counts represent minimum escapement levels.

Concerns that the relatively small Chinook stock from Deep Creek was being overharvested in the marine fishery were alleviated when marine harvest estimates of Deep Creek fish from coded wire tag recoveries were fewer than 300 each year from 1998 through 2000 (McKinley 1999, Begich *In prep*, R. Begich, ADF&G Sport Fish, Soldotna, personal communication). The estimated stray rate of Ninilchik River hatchery-produced Chinook salmon into Deep Creek was found to be minimal based upon data collected at the Deep Creek weir (King and Breakfield 1999, 2002; Begich 2002; Begich and Evans 2005).

Ninilchik River

The counts of Chinook salmon through the Ninilchik River weir during July 8 through July 24 did not achieve the lower end of the SEG range established in 2001, in 1997 and 2003 (Table 19). It is likely that the early arrival of Chinook salmon to the Ninilchik River resulted in the SEG not being met in 2003 and barely met in 2004. During 2003 and 2004, the midpoint of the Chinook salmon run was July 4 compared to midpoints between July 11 and 16 for the years 1999-2002.

Wild and hatchery Chinook salmon escapement to the Ninilchik River was successfully censused at the weir in 1999 through 2005 (Begich 2006b, 2007; Balland and Begich *In prep,* and Kerkvliet *In prep*, C. Kerkvliet, Sport Fish Biologist, ADF&G, Homer, Alaska; personal communication). The wild and hatchery composition of the harvest in 2000 and 2001 was approximately 50%, estimated from harvest sampling (Begich 2006b, *B*alland and Begich *In prep*). Approximately 35% of the instream run of wild Chinook salmon was harvested in 2000 and 33 % of the total instream run of wild Chinook salmon was harvested in 2001 (Table 18). This exploitation rate is within the range that other Alaskan Chinook salmon stocks sustain. Due to variability in the aerial counts caused poor water clarity, aerial counts were suspended after 2001 because it was unlikely that their relationship to actual escapement could be determined.

Fishery Management and Objectives

The overall objective is to manage the wild Chinook salmon stocks of the Anchor River and Deep Creek and the Ninilchik River naturally produced fish by regulation to provide sustainable and predictable fisheries. Specific objectives have been established for these stocks.

Objective for the Anchor River is:

1. Determine a BEG that maintains the population at a level to ensure sustained yield.

The objective for Deep Creek is:

1. Ensure, through appropriate management and research programs, that the spawning escapement index does not decline below levels necessary to ensure sustained yield. This number is the SEG, which is 350-800 for Deep Creek.

Objectives for the Ninilchik River are:

1. Ensure that annual wild Chinook salmon escapement upstream of the eggtake weir in the Ninilchik River falls within SEG range, established in 2007, of 550-1,300 during July 3-31.
2. Ensure that the historical age and sex composition are not significantly altered by supplemental production.
3. Stock 50,000 Chinook salmon smolt into the Ninilchik River, which yield a 3% survival or 1,500 returning adults.
4. Provide approximately 2,500 additional angler-days of participation for Chinook salmon at the Ninilchik River during June.

Historically, the Anchor River and Deep Creek have been managed by regulation because the fisheries occurred in late May and June when water conditions were often too high and turbid to visually or physically count fish in these streams. The Ninilchik River fishery has been extended by emergency order based mainly on inseason counts made by foot upstream of the fishery (Appendix A1).

The sport fisheries for wild Chinook salmon in the Anchor River, Deep Creek and Ninilchik River have been consistently and heavily restricted by regulation throughout most of their history. The open area for salmon fishing has been limited to the lower drainage from the mouth upstream approximately 2 miles since 1960. Fishery openings have occurred only on weekends and the following Mondays since 1978. The number of weekend openings has remained at three in the Ninilchik since 1978. A fourth weekend opening was added at Deep Creek and at the Anchor River in 1977 and a fifth in 1989. The current daily bag and possession limit of one fish over 20 inches was established in 1961. The annual limit was increased from two to five fish in 1979, and remains at five in the Ninilchik River.

Anchor River and Deep Creek

A suite of changes were made to the sport fishing regulations governing Deep Creek and the Anchor River and the adjacent marine fishery in 1996, because of below average aerial escapement counts to these two streams, particularly Deep Creek, during the immediately preceding years. Besides restriction of the marine fishery of Central Cook Inlet (see Central Cook Inlet Saltwater Chinook Salmon Fishery section for a more detailed description of the marine restrictions), the Chinook salmon fishery in Deep Creek was reduced from five weekends to three, and the combined seasonal bag limit in Deep Creek and the Anchor River was reduced from five to two Chinook salmon 16 inches or larger. In both the Anchor River and Deep Creek, an angler could no longer fish for the remainder of the day after harvesting a Chinook salmon. The spawning areas of Anchor River, Deep Creek, Stariski Creek and the Ninilchik River were closed to all fishing until August 1 to protect spawning Chinook salmon from catch-and-release mortality.

Aerial escapement index counts of Chinook salmon spawning in the Anchor River were mostly less than the SEG goal of 750-1,500 despite the measures taken in 1996 and the Anchor River fishery was restricted by regulation from 5 to 4 3-day weekend openings in 2002. A fifth 3-day weekend opening was restored to the fishery in 2005 after the total estimated escapement from sonar and sonar/weir counts was revealed to be much higher than expected from aerial index counts. The fifth weekend was added before Memorial Day, based upon a public BOF proposal.

The Anchor River and Deep Creek have rarely been liberalized inseason by emergency order in the past. Deep Creek was opened for a fourth 3-day weekend in 2001 after high water during all three regulatory weekends discouraged anglers from fishing because water conditions were so poor. The Anchor River was reopened for a fifth 3-day weekend in 2004 by emergency order based on low harvest rates, projected escapement from sonar/weir counts, and expected harvest.

Use of sonar in conjunction with a weir in the Anchor River has allowed enumeration of Chinook salmon throughout their migration period for the first time. The department conducted a spawner-recruit analysis using all the available data and found that approximately 5,000 adult Chinook salmon must spawn in the Anchor River to sustain maximum yields to the river over time (Szarzi et al. 2007). The department is proposing this number as the sustainable escapement goal (SEG) threshold for the river. A threshold is proposed rather than a range because the small amount of total escapement data results in uncertainty about what production will result from escapements between current levels and 5,000. The Anchor River Chinook salmon stock can support more harvest based on the proposed SEG threshold. The difference between the average escapement from 2004-2006 (Table 20) and the proposed threshold is 5,685.

The implication of an escapement goal threshold for management is that the fishery can not be liberalized inseason because the department may only increase bag and possession limits and liberalize methods and means of harvest by emergency order when total escapement of a species is projected to exceed the escapement goal. Rather regulations will be changed through the Board of Fisheries process as more data accumulates with which to evaluate the escapement goal and the impacts on effort, harvest and catch of new fishery regulations are known.

In November 2007, the BOF will consider a host of regulations proposed by the public to liberalize the Anchor River and adjacent marine waters . The proposed regulation changes include: 1) extend the Anchor River weekly Chinook salmon openings from 3 to 5 or 6 days; 2) remove the regulatory 3-day weekend before Memorial Day weekend and add a 3-day weekend at the end of the current openings; 3) increase the annual limit from two to five Chinook salmon 20 inches or greater; 4) allow anglers to continue fishing in the Anchor River after harvesting a Chinook salmon; 5) change the date restrictions in the Upper Cook Inlet Salt Water Early-Run King Salmon Management Plan end from June 30 to June 24; and 6) reduce the closed area in the saltwaters adjacent to the Anchor River mouth during April 1 to June 30 from 2 miles north and south from the mouth to one mile north and south of the mouth.

Public proposals before the BOF in 2007 regarding Deep Creek would: 1) liberalize the annual limit from two to five; 2) allow anglers to continue fishing in the Anchor River after harvesting a Chinook salmon; 3) reduce the closed fishing area in the saltwaters adjacent to the Deep Creek mouth during April 1 to June 30 by one or two miles.

Aerial index counts of Chinook salmon escapement have been within or above the SEG range of 350-800 have been achieved or exceeded under the current regulations. The escapement has not chronically exceeded the SEG range over a four to five year period therefore a "management concern" as specified in the Sustainable Salmon Fisheries Policy (5 AAC 39.222 (f) (21)) does not exist and liberalization of Deep Creek is not advised.

Ninilchik River

Changes to the Ninilchik River regulations are recent and focus on maximizing the harvest of hatchery-produced fish. In 2005, the bag limit of Chinook salmon 20 inches or longer increased from one to two, only one of which could be a wild fish. In conjunction with the bag limit increase for hatchery fish, anglers were prohibited from cleaning or disfiguring a Chinook salmon in any manner that prevented determination whether the fish was wild or hatchery-produced (hatchery-produced fish have their adipose fin clipped before release).

The Ninilchik River Chinook salmon fishery was extended inseason by emergency order for both wild and hatchery stocks during years when high stocking levels produced large runs in 1991-1996 based on foot surveys conducted upstream of the fishery (Appendix A1). During 2001, a year that eggtake weir operations were extended to encompass the entire spawning migration period, the Ninilchik River was opened for a fourth 3-day weekend to the harvest of both wild and hatchery-produced Chinook salmon, based upon projected weir counts. Otherwise fishing time was extended only for the harvest of hatchery fish (Appendix A1) (Kerkvliet et al. *In prep*).

At the 2007 BOF meeting, the department is proposing a season for hatchery-produced Chinook salmon from Memorial Day weekend through December 31. A member of the public has proposed a similar regulation with the season for hatchery produced Chinook salmon extending from Memorial Day weekend through July 15. The public also is proposing to reduce the bag limit to one fish 20 inches or longer. A surplus of both hatchery and wild fish warrants liberalization of the harvest for hatchery fish; wild stocks can sustain the small increase in hooking mortality from catch and release by anglers seeking hatchery-produced fish.

Fishery Performance and Escapement 2004-2007

Szarzi and Begich 2004a, 2004b and Szarzi et al. *In prep.-b* contain a detailed overview of the 2004 field season. In 2005, stream levels dropped early in the spring but periodic rains beginning in mid-June caused water levels to regularly fluctuate for most streams, typical of historic patterns. In 2006, river levels were colder in May than the previous two years, and the river level was higher. Chinook salmon runs into Anchor River, Deep Creek and the Ninilchik

River were later than usual, likely due to colder than typical water temperatures in May. Toward the end of Memorial Day weekend, fishing picked up on all three streams and was excellent for the remaining regulatory openings. Chinook salmon runs were later than usual in 2007. Cool marine temperatures may have contributed to the delay.

The following describes the sport fisheries on the Anchor River, Deep Creek, and Ninilchik River from 2004-2007.

Anchor River

In 2004 through 2006, the historic harvest trend shifted from the Anchor River harvest being generally lower than the Ninilchik, to the Anchor River having a higher harvest than the Ninilchik (Tables 14 and 16). The average Anchor River harvest (1,462) and catch (5,075) for 2004-2006 are close to the historical average of 1,286 and 4,420 respectively during 1997-2003.

In 2004, an emergency order was issued on June 21 extending the Chinook salmon fishery for a fifth 3-day weekend (Saturday, June 26 through Monday, June 28) after approximately 7,000 Chinook salmon were estimated to have passed upstream of the Anchor River sonar/weir site. The emergency order marked a transition to basing decisions for managing Anchor River Chinook salmon on sonar/weir escapement counts.

The BOF approved a public proposal to add an additional 3-day weekend opening before Memorial Day weekend that was implemented in 2005. Fishing in 2005 was reported as good to excellent throughout the Chinook salmon fishery with river conditions low and clear for the first four openings but high for the fifth. Some anglers reported the best fishing they had had in years.

High water resulted in poor fishing during the first two open periods in the Anchor River in 2006. Fishing improved during the remaining three as high spring flows abated somewhat.

Chinook salmon fishing success was fair to excellent in 2007 and peaked during the third opening for anglers. Fishing pressure was low for the first and second openings and fair to high for all other openings on the Anchor River. River conditions were high and muddy for the first opener and gradually improved to low and clear by the fifth one.

Low river levels in July cause hundreds of Chinook salmon to remain in the lower reach of the river, when the fishery opened on July 1 to fishing for Dolly Varden and salmon (other than Chinook salmon). During this time, the department received many complaints of Chinook salmon being caught and taken on the Anchor River. The department posted additional "No Chinook Salmon Fishing" signs to reduce the Chinook salmon catch and recommended anglers fish near the mouth of the river where there were more Dolly Varden and pink salmon and fewer Chinook salmon. Department staff confiscated two harvested Chinook salmon during this period.

From 2004-2007, Anchor River Chinook salmon escapement was counted in the mainstem using sonar in the mid-May when river levels were high and with a full-weir once spring flows subsided (Table 20). Helicopter index counts were also collected each year (Table 17). The average Chinook salmon escapement estimate was 10,423 and ranged from 8,945 in 2006 to12,016 in 2004 (Table 20). Aerial index counts averaged 766 and ranged from 651 to 899 during 2004-2007 (Table 17). There was no relationship in the trends between sonar/weir count and aerial escapement counts. In 2004, a weir was also operated on the North Fork of the Anchor River and 1,919 Chinook salmon were counted which represented 16% of the total escapement. Fifty percent of the Anchor River Chinook salmon escapement was counted by June 6 in 2004, June 7 in 2005, and June 8 in 2006. Based on harvest estimates and escapement counts, the average annual harvest rate for 2004-2006 was 11.8%.

There was no apparent impact from the 2002 floods on returning fish, although adverse affects of the flood may account for the slightly lower proportion of ocean-age 2 fish in the escapement in 2006 (Kerkvliet and Burwen *In prep*).

Deep Creek

At Deep Creek, angler effort decreased, from 10,575 in 2004 and 10,182 in 2005, to 7,187 in 2006 (Table 15). Decreased angler effort may explain the decrease in Chinook salmon harvest, from 823 in 2004 and 642 in 2005, to 451 in 2006. Catch (1,830) in 2006 was similar to 2004 and 2005.

In 2005, the Memorial weekend opening (May 28 to 30) was reported as good for Chinook salmon with a lot of space to fish because of the low numbers of anglers.

In 2006, fishing pressure was described as light for Chinook salmon. On the Memorial Day opening weekend, fishing was initially slow but then improved at the end of the opening. The remaining opening weekends were described as excellent.

River conditions were high and muddy for the first Chinook salmon fishery in 2007 and contributed to the poor fishing success reported by anglers. Fishing pressure was light on Deep Creek during the Chinook salmon fishery openings and success was fair to good for the second and third openings. Anglers reported Deep Creek Chinook salmon were smaller than usual.

Each year, aerial survey index counts of the Chinook salmon escapement in Deep Creek were all above the lower range of the SEG of 350 (Table 17). However, the index counts in 2004 (1,075) and 2005 (1,076) were about twice as high as the 2006 count (507) and were above the upper SEG range of 800. The lower escapement count in 2006 may be partially attributed to a lower return from the two-100-year floods that hit LCI streams in October and November in 2002. The floods may have reduced the survival of eggs, fry, and pre-smolt life stages, with the highest impact on the 2002 brood year caused by disturbing eggs and pre-emergent fry. Adverse affects of the flood may account for the lower number of fish counted 2006 and 2007 (Table 17).

Ninilchik River

The average harvest and catch from 2004-2006 were slightly below the historical average from 1977-2003 but similar to the average since returns from reduced stocking levels have dominated the escapement (1998-2006) (Table 16).

In 2004, the Ninilchik River was opened by emergency order to the harvest of hatchery-produced Chinook salmon 7 days per week beginning on May 29 to provide fishing opportunity and to reduce escapement of hatchery-produced Chinook salmon (Appendix A1). Even with the added fishing time, effort was low during the week and following the regulatory weekend openings and hatchery-reared Chinook salmon represented approximately 26% of the total weir count (Table 18).

The regulation passed by the BOF in 2004 increasing the bag and possession limit to two, only one of which could be wild, went into effect in spring of 2005. Approximately 17% of the total weir count were hatchery-reared Chinook salmon (Table 18).

In 2006, the season for hatchery-reared Chinook salmon was extended by emergency order from June 14 to July 14, based upon Department sampling that encountered harvestable numbers of hatchery fish in the fishery during the final regulatory opening, but again, effort was low during the emergency order period and 19% of the weir counts during July were hatchery-reared.

Excluding jack (ocean age-1) Chinook salmon, the overall hatchery-produced percentage of the total Chinook salmon harvest in 2006, estimated from department samples during the three regulatory weekends, was 30% and ranged from 24% to 34% for all three weekends. There was no significant difference in the proportions of hatchery fish in the estimate from each weekend (Booz and Kerkvliet *In prep*).

In 2007, weekly beach seine surveys were conducted from mid-May through mid-July in the area open to sport fishing to estimate the hatchery-produced percentage in the sport fishery area. The mean hatchery-produced percentage was 15% and ranged from 0% to 28% for all surveys. The last survey was conducted on July 11 and the hatchery-produced percentage was 21%.

In 2004 and 2005, the Ninilchik River weir was operated in mid-May to early August to census the total escapement and to conduct egg takes for supplementation (Table 18). In 2004, the run timing of Chinook salmon at the weir was early. The run was later in 2005. The total weir count in 2005 of 2,703 was the highest since the first total count in 1999. The average freshwater exploitation (2004 and 2005) on the Ninilchik River run was approximately 35% (Table 18) and was within the range of exploitation rates from 1999-2003 of 29-46%.

In 2006 and 2007, the weir was operated only in July to early August.

In 2004, the run timing of Chinook salmon at the weir was early and the weir count during the SEG period (July 8-24) of 416 wild Chinook salmon was only slightly above the lower boundary and egg take goals (Table 19). Run timing was later in 2005 and 2006, and weir counts during the SEG periods of 814 and 764, respectively, were near the upper boundary. The number of wild Chinook salmon counted through the weir in 2007 (532) fell near the lower bounds of the SEG range (400-850). The reduced escapement in 2007 may be explained by the prolonged king salmon run observed in other Lower Cook Inlet area streams so more fish escaped upstream before and after weir operation. Additionally, the educational fishery Chinook salmon harvest within one mile of the Ninilchik River mouth increased from an average of 143 during 2001-2006 to 365 in 2007 due to an increase in the 2007 harvest quota.

The SEG range of 400-850 for the Ninilchik River, based upon wild Chinook salmon counts between July 8-24 during 1994-2000, was changed in 2007 to an SEG range of 550-1,300 adult Chinook, based upon live Chinook salmon counts that escape to spawn upstream of the weir from July 3-31 during 1999-2007, to represent a greater proportion of the wild escapement. Extending the SEG period for the Ninilchik River encompasses more of the variability in run timing and reduces the likelihood of mistaking a low escapement count for late run timing.

The new SEG range of 550-1,300 has been met each year during that period except in 2007. The 2007 wild Chinook salmon escapement of 545 fish; five fish below the lower end of the goal range. (Table 19). The reduced escapement might be explained by the prolonged Chinook salmon run observed in other Lower Cook Inlet area streams so more fish than usual escaped upstream of the weir before and after operation. The middle 50% of the cumulative Anchor River Chinook salmon run in 2007 was 17 days longer than the 2004 through 2006 average. Also, the educational fishery Chinook salmon harvest from within one mile of the Ninilchik River mouth increased from an average of 143 during 2001-2006 to 365 in 2007 due to an increase in the 2007 harvest quota (see Educational Fisheries section).

COHO SALMON FISHERIES

AREA-WIDE OVERVIEW

Area-wide Historical Harvest and Escapement

Coho salmon are harvested from freshwater tributaries on the east and west sides of Cook Inlet. Freshwater harvests mostly come from the eastern Central Cook Inlet tributaries, Anchor and Ninilchik rivers and Deep and Stariski creeks. Saltwater coho salmon fishing occurs primarily along the eastern Cook Inlet shoreline, because of easy access from the road system to harvestable numbers of fish.

Coho salmon harvest in the LCIMA has increased approximately five-fold since it was first estimated in 1977 from approximately 7,000 to over 46,000 fish (Table 4). Most of the increase has occurred in the salt waters of Lower Cook Inlet and Kachemak Bay. Part of the increased coho salmon harvest in Lower Cook Inlet and Kachemak Bay is the result of a stocking program begun at the Nick Dudiak Fishing Lagoon on the Homer Spit in 1989 and augmented with a second stock in 2001.

Historically, the streams in Central Cook Inlet supported over 50% of the area's coho salmon harvest most years until 2001 when the first coho returned from the stocking program to the Nick Dudiak Fishing Lagoon (Table 4). These streams contributed only 20% on average to the area harvest in 2004 -2006. The harvest at Nick Dudiak Fishing Lagoon has grown to about 30% of the area total and the average harvest from the remainder of Lower Cook Inlet and Kachemak Bay is approximately 33% of the total.

Coho salmon headed for Cook Inlet tributaries are first encountered by anglers fishing the salt waters off the southern tip of the Kenai Peninsula in early July. These early arrivals are thought to be destined for tributaries in Northern Cook Inlet. Local stocks arrive at Central Cook Inlet stream mouths and begin their spawning migrations in mid- to late July. The migration is mostly over by mid-September. Coho salmon spawning migrations into Kachemak Bay tributaries are thought to be a little later than the run timing of Central Cook Inlet stocks. Coho salmon tend to hold in the salt water near natal stream mouths or in the lower reaches of streams until rain raises the stream water level, then to immigrate en masse. Peak daily fish counts at the Anchor River weir have exceeded 4,000 during high water.

Coho salmon escapement monitoring of important stocks in the LCIMA has occurred periodically using weirs and foot or aerial surveys. Coho salmon escapement was enumerated in the Anchor River from 1987-1989 and in 1992, at a weir operated to count Dolly Varden and steelhead in some years (Table 21; Larson 1990; Larson 1993; Larson and Balland 1989; Larson et al. 1988), and since 2004 (Table 20; Kerkvliet and Burwen *In prep;* Kerkvliet et al. *In prep*; C. Kerkvliet, Sport Fish Biologist, ADF&G, Homer; personal communication). Anchor River coho salmon runs are extremely variable, the lowest escapement of 2,409 was counted in 1987, the highest in 1989 20,187 (Table 21). Counts since 2004 have averaged 10,778 and ranged from 5,728 in 2004 to 18,977 in 2005 (Table 20). The count in 2005 is incomplete because the weir washed out in high water before the end of the migration.

A floating weir was operated in Deep Creek from 1996 through 2001 (Table 22; Begich 2002, 2006a; Begich and Evans 2005; King and Breakfield 1999, 2002). Deep Creek coho salmon escapement ranged from 1,537 in 1997 to 6,164 in 2001 and averaged 3,193 fish annually over the six years the weir was operational (Table 22). Coho salmon escapement to the Fox River is enumerated by periodic aerial flights in one of its few small clearwater tributaries, Clearwater Slough. Coho salmon escapement to some small streams in West Cook Inlet near Chinitna Bay has been estimated with periodic aerial and foot surveys including; Clearwater Creek, Fitz Creek, Shelter Creek and Silver Salmon Creek.

Area-wide Fishery Management and Objectives

There are no sport fishery management plans for LCIMA coho salmon stocks. Area coho salmon sport fishery regulations specify seasons, gear, open areas and bag and possession limits. In 1999, the Board of Fisheries reduced the historic coho salmon bag and possession limits for all Cook Inlet fresh waters from three to two fish and for all Cook Inlet salt waters from six to two fish. The exceptions were freshwaters south of the West Forelands, including the west side of the LCIMA, where the limits remained three, and the Nick Dudiak Fishing Lagoon where the limits remained six. The action was initiated by ADF&G SFD to protect coho salmon stocks after low runs throughout Cook Inlet.

The only inseason management action for wild coho salmon occurred in 1997 and restricted the daily bag and possession limits temporarily in the freshwaters of Central and Northern Cook Inlet from three to one fish per day and was the result of an inlet-wide shortfall in coho returns. Late-season coho salmon numbers increased in Central Cook Inlet streams and the emergency order was rescinded there (Appendix A1). The coho salmon fishery in the Nick Dudiak Fishing Lagoon is opened to snagging almost annually by emergency order, after the immigrating fish have matured sexually to the point they are no longer striking at lures (Appendices A1 and A2). Otherwise the Fishing Lagoon is closed to snagging for coho salmon.

CENTRAL COOK INLET FRESHWATER COHO SALMON FISHERIES

Fishery Description

The Anchor and Ninilchik rivers and Deep and Stariski creeks all support popular coho salmon fisheries. Run timing is approximately mid-July through September with a peak in late August or early September. These stocks are all early-run fish (compared to the Kenai River which supports a late-run that returns in September). Spawning occurs upstream of the mouth 2 miles throughout most of the remainder of these drainages. Coho salmon spawn in a variety of habitat types that include narrow shallow areas with a gravel bottom and seem to favor areas with groundwater upwelling. The majority of the juvenile fish rear in freshwater for two years before leaving as smolt. Most mature adults return to local streams after spending only one year in saltwater feeding. Returning coho salmon generally mill in the saltwater near the mouth and the lower freshwater reaches when river levels are low and then migrate upstream after rains cause river levels to rise.

The Sterling Highway crosses the lower reaches of the Anchor River, Ninilchik River, Deep Creek and Stariski Creek and developed access and camping facilities are located on or near each river. Anglers can easily access the entire 2-mile open fishing area. Fishing success varies by time of day and river levels. In general, successful anglers fish the relatively brief period immediately after sunrise and just before darkness. During peak flows, angler success is in the Anchor River and Deep Creek is generally low because the rivers are muddy.

Of the four watersheds, Stariski Creek is the smallest (draining approximately 52 square miles and with about 30 river miles as habitat for anadromous fish). The upper Stariski Creek drainage forms long meanders as is flows through low lying wetlands, straightens as it gets closer to the intertidal area, then again forms long meanders as it runs parallel to the shore before it flows into Cook Inlet. The Anchor River, Deep Creek and the Ninilchik River watersheds are described in the Freshwater Chinook Salmon Fisheries section.

The following sections detail historical coho salmon harvests and escapements through 2004 and fishery management and objectives, and fishery performance from 2004 through 2007.

Historical Harvest and Escapement

The Anchor River, Deep Creek, Ninilchik River, and Stariski Creek support the major freshwater coho salmon fisheries in the LCIMA. A marine fishery at the mouths of these streams harvests an unknown number of these stocks. The average annual coho salmon harvest (1977-2003) has varied between streams (Anchor River (2,487), Deep Creek (1,338), Ninilchik River (800), and Stariski Creek (263) (Tables 14-16, Table 23) and within a given stream: (Anchor River (1,021-4,033), Deep Creek (306-2,651), Ninilchik River (88-2,980), and Stariski Creek (25-1,168). Harvest variations between streams are attributed to differences in stock size, with the Anchor River return generally being the largest (except in 1985, 1996, and 1999 when the harvest from Deep Creek was higher). Annual differences in harvest from a given stream are primarily attributed to changes in water depth, flow rate and clarity conditions rather than variations in run strength between years.

Harvests from the Anchor River, Deep Creek and the Ninilchik River generally increased over from 1977 through 2003 (Tables 14-16). The annual harvest from Stariski Creek generally was stable and relatively low with an average harvest of 263, with one exception in 1998 when the harvest was 1,168 (Table 23). Fewer than 30 respondents to the SWHS have reported fishing in Stariski Creek each year since the inception of the survey, therefore the harvest estimates can only be used to indicate trends in harvests; the large spike in estimated harvest in 1998 is likely inaccurate.

The large run and resulting emergency order extending the Anchor River 9 days and opening an additional 5 miles of stream in the South Fork did not coincide with a significant increase in harvest in 1989 (Table 14). Nor did the emergency order restricting the bag and possession limits and prohibiting bait in 1997 result in a decrease in harvests compared to 1996 and 1998. The regulatory bag limit reduction from 3 to 2 starting in the summer of 2000 did not result in stabilization or reduction of the sport harvest from the Anchor River, Deep Creek or the Ninilchik River through 2003; the average combined harvest of the four roadside fisheries from 2000 to 2003 was about 23% higher than the average combined harvest during 1977-1999 (Table 14). Also, the average harvest for each roadside stream was higher from 2000 to 2003 than the average harvest for each individual stream during 1977-1999.

The coho salmon escapement to the Anchor River was opportunistically counted at a floating weir designed to count immigrating Dolly Varden from 1987-1995 (Table 21; Larson and Balland 1989; Larson et al. 1988; Larson 1990-1995, 1997). The Dolly Varden weir was located approximately 1 mile from the river mouth. During four years (1987-1989 and 1992) when steelhead trout were also enumerated, the operating dates overlapped the run timing of coho salmon and a complete count of coho salmon escapement was made. The highest coho salmon escapement to the Anchor River (20,187, Table 21) was counted in 1989. In comparison, the escapements in 1987, 1988, and 1992 averaged 3,270. The inriver exploitation in 1989 was much lower (12%) than the other years when exploitation ranged from 33% to 45%.

In 2004, the mainstem Anchor River Chinook salmon weir operation was expanded to include counting coho salmon. The 2004 coho salmon escapement was 5,728 (Table 20). A weir was operated in the North Fork as well (see Freshwater Chinook Salmon Fisheries section). Based on the mainstem and North Fork weir counts, 88% of the coho salmon counted at the mainstem weir used the South Fork to spawn. Stream conditions in 2004, were characterized as low and warm in August. During September 2-3, the river rose and approximately 78% of the total coho salmon escapement in 2004 was counted during the high water event.

Escapement counts of Deep Creek coho salmon arose from a smolt abundance study that was initiated in 1995 (Bendock 1995, 1996). In the first phase of the study, smolt were captured, coded-wire tagged, adipose fin clipped then released. Smolt were tagged from 1995-1997, and again in 2000-2003 (Table 22; King and Breakfield 1998, 1999, 2002; Begich 2002, 2006a; Begich and Evans 2005). In the second phase of the study, the proportion of coded wire tags was estimated from returning adults. Returning adults were initially captured in nets in 1996. From 1997-2001, coho salmon were counted throughout their migration at a floating weir installed approximately 2.5 miles upstream from the mouth. In 2003 and 2004, nets were again used to sample the adult returns to estimate smolt abundance and marine survival.

Weir counts of coho escapement Deep Creek ranged from 1,537 in 1998 to 6,164 in 2002 (Table 22). The peak of the Deep Creek coho salmon run ranged from August 17 in 1998 to August 26 in 1997 (King and Breakfield 1998, 1999, 2002; Begich 2002, 2006a; Begich and Evans 2005). Passage rates of coho salmon were later in 1997 than 1998, with 76% of the run having passed the Deep Creek weir by September 1 in 1997 versus 97% of the run counted by September 1 in 1998. Escapement counts were similar sized in 1997 and 1998 (1,537 and 2,267 respectively).

Deep Creek coho salmon smolt abundance estimates ranged from about 20,000 to 57,700 (Table 22). The estimated marine survival rates for coho salmon smolt in 1996, 1997, and 2001 were 8.1%, 17.8% and 20.8% respectively (Table 22).

The Deep Creek weir was also used to detect coho salmon strays from Nick Dudiak Fishing Lagoon. In 1998 and 1999, smolt released in the Fishing Lagoon were marked with an adipose fin clip. No strays from the Fishing Lagoon were detected at the Deep Creek weir from the fish examined in the escapement (Begich 2002, 2006a; Begich and Evans 2005).

The inriver exploitation of coho salmon in Deep Creek averaged 40% from 1997 to 2002 (Table 22). The 1999 regulation that lowered the coho salmon bag and possession limits from three to two coincided with a lower average inriver exploitation from 2000 to 2003 of 35% compared to the average annual exploitation rate from 1997 to 1999 of 49%.

Annual variability in run size may be less in Deep Creek than the Anchor River based on weir data (Table 20, Table 22). The fluctuations in daily coho salmon counts through the Anchor River weir linked to river levels were much greater in the Anchor River than in Deep Creek (King and Breakfield 1998, 1999, 2002; Begich 2002, 2006a; Begich and Evans 2005, Kerkvliet et al. *In prep*).

Fishery Management and Objectives

These roadside streams have pass-through fisheries for salmon, including coho salmon, where only the waters from the mouth upstream approximately 2 miles are open for the Anchor River, Ninilchik River, and Deep Creek, and approximately 1 mile is open for Stariski Creek. The rivers are permanently closed to all salmon sport fishing above the open areas. These streams are open from July 1 for the rest of the year to fishing for salmon other than Chinook salmon. On September 1, only unbaited single hooks are allowed. The daily bag and possession limit is two coho salmon. The spawning areas upstream of the fishery are permanently closed to all salmon fishing.

The coho salmon sport fishery regulations have remained unchanged since 1999 when the bag and possession limit was reduced from three to two fish. No proposals have come before the Board to change the current regulations since 1999.

There has been little inseason management of these coho salmon fisheries throughout their history. An emergency order increasing the open area upstream of the traditional fishery for nine days was issued in 1989 to provide harvest opportunity on the exceptionally large run that year. In 1997, coho salmon sport fish bag, possession and tackle were restricted, Inlet-wide by emergency order, because returns were perceived as poor.

Fishery Performance and Escapement 2004-2006

The average coho salmon harvest from 2004 through 2006 varied between streams: Anchor River averaged 4,539, Deep Creek averaged 2,094, Ninilchik River averaged 2,412, and Stariski Creek averaged 348 (Tables 14-16, Table 23). In 2004, a record harvest of 10,656 from the four streams, combined, and a record harvest of 3,425 fish was taken from the Ninilchik River. The harvest from the Anchor River was the highest of the road side streams every year during 2004-2006.

In 2005, low water caused coho salmon to hold near the mouth of the Anchor River through mid-August making fishing better at the mouth than inriver. Then periodic rains caused water levels to fluctuate bringing several surges of coho salmon upstream during high water. Fishing gradually improved as coho salmon began immigrating into the river later in August and into September when substantial numbers of coho salmon moved upstream.

In 2006, coho salmon fishing in the Anchor River was reported to be excellent for an extended period as regular rain showers caused higher flows throughout August bringing pulses of fish into the river in contrast. In 2006, many more anglers fished for coho salmon in the LCI road system streams than normal, as they sought fishing opportunity away from the flooding in the Mat-Su river valleys.

In 2007, coho fishing was good to excellent near the mouth of the river especially during morning tide changes. As the coho salmon run began to build in late August and early September, and when river levels were low, fish lingered in pools in the lower 2 miles of the river rather than move further upstream. During this time, the number of steelhead trout in the lower river also began to build. Department staff received several reports of steelhead misidentified as coho salmon being killed. Also, department staff stopped on angler from killing a steelhead that was misidentified as a coho. The department responded by posting signs to help anglers distinguish steelhead trout from coho salmon and reminders that steelhead trout must be released, and requested the State Troopers to increase enforcement of fishing regulations in the area.

Run size differences from 2004 to 2007 (escapement counts for 2005 and 2006 are detailed below) do not explain harvest variation. Run strength in 2004 was lower than in 2005 and 2006 yet the 2004 harvest was higher.

Coho salmon escapement to LCIMA streams is currently only counted in the Anchor River. The coho salmon escapements in 2005 and 2006 are partial counts because high water washed out the weir while high numbers of fish were still being counted. Despite missing part of the run, counts in 2005 (18,977) and 2006 (10,181) were still higher than the 2007 escapement (8,226) (Table 20) (Kerkvliet and Burwen *In prep;* Kerkvliet et al. *In prep*).

In 2005, when the weir washed out on September 9, the last daily count was 842. Before the weir washed out on August 19 in 2006, the last daily count was 423 and the cumulative count was 6,889. Another 3,292 fish were counted during August 22-24, 2006 by sonar until the sonar was removed because of another surge of water. The 2006 escapement count would likely be similar to the 1989 (Larson 1990) or 2005 escapement counts if the weir had operated into September.

Most of the escapement in 2005 (72%), 2006 (91%) (Kerkvliet and Burwen *In prep;* Kerkvliet et al. *In prep*), and 2007 (89%) was counted when river levels were high, and in only 4 or 5 days. In 2007, the run timing of coho salmon at the weir was much later than in 2004 through 2006. The later run timing at the weir was attributed to fish holding due to low water. Once river levels rose and fish began to pass through the weir, many of the fish were maturing and few were bright.

The exploitation of the 2005 and 2006 run was estimated to be less than 20% and 28%, respectively, because part of the runs were not counted due to high water. In comparison, the inriver exploitation in 2004 was 43%.

LOWER COOK INLET AND KACHEMAK BAY COHO SALMON FISHERIES

Fishery Description

Most sport fishing for coho salmon in Lower Cook Inlet and Kachemak Bay occurs in salt water. Anglers target a mixture of Cook Inlet stocks from boats in Lower Cook Inlet. Kachemak Bay stocks predominate in the harvest near and east of the Homer Spit and most anglers fish from shore in Kachemak Bay for coho salmon stocked in the Nick Dudiak Fishing Lagoon. Boat anglers troll or mooch herring, flies or lures (jig) for coho salmon. Shore anglers cast flies or lures or drift eggs or herring.

The Fox River, at the head of Kachemak Bay, is thought to be the major producer of wild coho salmon in the Kachemak Bay and Lower Cook Inlet. Recreational shore and boat anglers have historically targeted these fish as they migrate close to shore past the tip and along the eastern side of Homer Spit.

Only a small amount of fishing occurs in the freshwaters of Lower Cook Inlet and Kachemak Bay. The Fox River is remote and access is difficult and other coho salmon runs are small. Sport fishing has historically occurred on Clearwater Slough, a small tributary to the Fox River. Silver Creek, the Seldovia River and Pt. Graham River along with several other small tributaries that enter the south side of Kachemak Bay also support small coho salmon harvests.

A personal use set gillnet fishery targets mixed coho salmon stocks of Kachemak Bay from near Bluff Point to near the Fox River on the north side of the Kachemak Bay and on the south side of Kachemak Bay from Fox River to Jakolof Bay. A limited commercial fishery harvests coho salmon; primarily in eastern Lower Cook Inlet and in Kachemak Bay. Commercial fishing occurs on coho salmon stocks in West Cook Inlet, primarily in Kamishak Bay.

Historical Harvest and Escapement

The annual average sport harvest of coho salmon in Lower Cook Inlet and Kachemak Bay combined was stable, at about 1,500-2500 fish from 1978-1988 (Table 4). The first return of stocked coho salmon to the Nick Dudiak Fishing Lagoon in 1989 doubled the harvest. Annual coho salmon sport harvests have generally increased since 1989 to approximately 30,000. Inter-annual harvest trends have occurred and have generally been similar from the Fishing Lagoon and the remainder of Kachemak Bay and Lower Cook Inlet.

Wild coho salmon escapement in the Lower Cook Inlet and Kachemak Bay has been regularly monitored only in the Fox River tributary, Clearwater Slough. Aerial counts were first made in 1969 and have ranged between 125 in 1997 and 3,023 in 2001 and averaged 850 through 2003 (L. Hammarstrom, Commercial Fisheries Biologist, ADF&G, Homer; personal communication). Significant numbers of coho salmon are only viewable at the Slough confluence with Fox River so the usefulness of the survey is limited. The Fox River may have experienced the low runs observed in other Cook Inlet tributaries in 1997 (L. Hammarstrom, Commercial Fisheries Biologist, ADF&G, Homer; personal communication).

Fishery Management and Objectives

Management of sport coho salmon fisheries in Lower Cook Inlet and Kachemak Bay is relatively non-controversial. There is little focused harvest on wild stocks returning to tributaries in the area by either sport or commercial fisheries.

One allocative issue centers around the personal use coho salmon set gillnet fishery in Kachemak Bay which targets a mixture of wild stocks primarily bound for the Fox River drainage at the head of Kachemak Bay and stocked fish bound for the Nick Dudiak Fishing Lagoon. The coho salmon gillnet fishery dates back prior to statehood and was alternately regulated as a personal use fishery and a subsistence fishery until 1995, when it acquired personal use status for the final time. The fishery extends along the shoreline from near Homer to Jakolof Bay, with some closed areas at stream mouths and sensitive wildlife habitat. The guideline harvest range is 1,000-2,000 fish and is based on the average harvest prior to stocking. The BOF lowered the guideline beginning in 1999, because discontinuation of coho salmon stocking projects at Caribou Lake and Fritz Creek, on the north Kachemak Bay shoreline near the head of the bay, was threatening to focus the gillnet fishery too much on wild stocks.

Allocation of coho salmon that return to the Nick Dudiak Fishing Lagoon between set gillnetters and sport anglers, has been debated since the advent of the stocking program at the Fishing Lagoon, because set gillnet catches were increasingly from Homer Spit until 1999. The proportion of the total effort taken in the personal use fishery on the Homer Spit adjacent to the Fishing Lagoon peaked in 1999 at 60% and the proportion of personal use coho salmon harvest in 1998 at 70% (L. Hammarstrom, Commercial Fisheries Biologist, ADF&G, Homer; personal communication). Late-run Chinook salmon stocked in the Fishing Lagoon that returned from 1996-2001 were additional incentive for set gillnet users to move near the Fishing Lagoon.

Approximately 32% and 34% of the stocked coho salmon returning to the Enhancement Lagoon during 1999 and 2000 were coded wire tagged and adipose fin-clipped as smolt. The contribution of hatchery-produced coho to the personal use set gillnet fishery on the east side of the Homer Spit was estimated; the number sampled without adipose fins from the personal use harvest was expanded by the fraction tagged at the hatchery as smolt. Of the 499 coho salmon examined during the four 48-hour personal use fishing periods in 1999, 402 or 81% were estimated to be of hatchery origin (Table 24). The proportion of hatchery fish was significantly different during all the openings and higher during the last two openings than the first two. In 2000, 675 coho salmon were examined during the two fishing periods the fishery was open and 608 or 90% were estimated to be fish stocked in the Enhancement Lagoon. The number of hatchery fish in the harvest was higher during the second opening than the first. It was previously thought that the wild return to the Fox River occurs later than the enhanced return.

Effort and coho salmon harvest in the personal use fishery on the Homer Spit has declined steadily since 1998-1999 and now focuses on the north shore of Kachemak Bay.

A public proposal has been submitted to the BOF for consideration at the fall 2007 meeting to move the boundary of the set gillnet fishery 1,000 yards away from the Fishing Lagoon area.

Fishery Performance and Escapement 2004-2007

The highest sport harvest of coho salmon from Lower Cook Inlet and Kachemak Bay combined was nearly 36,500 coho salmon in 2004 (Table 4). The lowest harvest since 1999, from both areas combined was in 2006. Both the high and the low harvests are related to the strength of runs to the Nick Dudiak Fishing Lagoon.

Aerial index counts of coho salmon escapement in Clearwater Slough since 2004 were above the average of nearly 1,000 except in 2005 (L. F. Hammarstrom, Commercial Fisheries Biologist, ADF&G, Homer; personal communication). Aerial counts were 2,800 fish in 2006 and 2,900 fish in 2007 and, near the record of 3,023 in 2001.

Stocking Program

ADF&G SFD has stocked coho salmon in the Nick Dudiak Fishing Lagoon since 1988 (Table 12). The objectives of that program are to:

Objective 1: Annually stock 120,000 coho smolt in the Homer Spit Enhancement Lagoon, which will return approximately 6,000 adult fish, all of which are available for harvest in the recreational fishery.

Objective 2: Generate 10,000 angler-days of sport fishing opportunity directed at stocked coho salmon in Kachemak Bay.

The source of the original coho salmon run to the Nick Dudiak Fishing Lagoon was Bear Lake, in the Salmon Creek drainage about 10 miles north of Seward. Coho salmon from this stock begin to arrive at the Fishing Lagoon around the first of August and the run peaks during the third or fourth week in August and continues until mid-October. The fish begin to sexually mature in mid-September. The stock is thought to have a slightly earlier run timing than wild coho salmon returning to lower Cook Inlet tributaries.

The demise of the late-run Chinook salmon run to the Fishing Lagoon after 1999, prompted the department to seek an alternate stock to provide fishing opportunity during the time between the early-run Chinook and the coho return. Loss of opportunity in late July and early August provided by late-run Chinook salmon, combined with complaints about the interception of stocked fish in the personal use set gillnet fishery led the department to replace the Bear Lake coho salmon stock with the earlier returning Ship Creek coho salmon stock. The Ship Creek coho stock returned closer to the peak tourist season and therefore provide more angler opportunity. While the opportunity to harvest coho salmon in July and early August was welcomed, the loss of opportunity in August and September was not. Interested citizens and department personnel began cooperating to raise funds to rear the Bear Lake stock at the Cook Inlet Aquaculture (CIAA) operated Trail Lakes Hatchery so both early- and late- run coho salmon would return to the Enhancement Lagoon.

The year 2001 was the last stocking of coho salmon of Bear Lake origin reared by department hatcheries and the first time coho salmon of an earlier run timing stock from Ship Creek in Anchorage were released by the department in the Fishing Lagoon. Fundraising each year since 2001 has covered expenses for Cook Inlet Aquaculture Association to rear and stock late-run coho salmon of Bear Lake origin. Since 2002, both early and late coho salmon runs have returned to the Fishing Lagoon.

Beginning in 2001, angler counts were conducted at regular intervals in the vicinity of the Fishing Lagoon from August 15 through September 15 to monitor the response of the sport fishery to the different coho salmon stocks. The counts take place during the daylight when fishing effort peaks as the water is first pouring over the sill into the Lagoon. The new early-run coho salmon stock has proven to be very popular – much more angler effort occurs during this run than was attracted by the late Chinook salmon run that ended.

In both 2005 and 2006, the Bear Lake coho salmon smolt contracted, and were treated for, bacterial kidney disease (BKD). High mortality occurred in smolt stocked in 2005 and virtually none of them returned as adults to the Fishing Lagoon in 2006. In 2006, nearly 325,000 treated smolt were released in the Fishing Lagoon in good condition. The return in 2007 was smaller than expected and effort was similar to runs from average stocking levels.

All salmon produced by department hatcheries are now marked by altering hatchery water temperatures to produce banding patterns on the salmon otoliths. The banding pattern on the otoliths of salmon stocked in Cook Inlet is unique and different from the pattern on fish stocked in other waters. Limited sampling in LCIMA wild salmon streams has occurred to ascertain that straying is not occurring from department stocking programs.

From 1984 through 1994, fingerling coho salmon were stocked in Caribou Lake, located approximately 20 miles northeast of Homer. Caribou Lake stocks mixed with wild stocks bound primarily for the Fox River at the head of Kachemak Bay and were targeted by both personal use and sport fishers. In 1990, the BOF established a personal use dip net fishery in Fox Creek, the tributary that joins Caribou Lake to Kachemak Bay. This location provided a terminal harvest area for coho salmon stocked in Caribou Lake because fish were stopped by a barrier falls from returning to the lake. A personal use dip net fishery first occurred in Fox Creek in 1991. Coho harvests in the dip net fishery from 1991 through 1997 were small, with a low level of participation. No stocked coho salmon returned to Fox Creek after 1997. The dip net fishery was closed by emergency order during the season in 1997 and in 1998 to prevent the harvest of wild coho salmon present in Fox Creek, and the handling of non-target species. The BOF closed the fishery by regulation during their meeting in November 1998.

WEST COOK INLET FRESHWATER COHO SALMON FISHERIES

Fishery Description

Coho salmon are widely distributed in WCI freshwaters where they spawn in a variety of freshwater habitats. Coho salmon begin to enter streams in this area to spawn in late July and continue their immigration through mid-September. The exact location and duration of spawning for each stock is unknown. There is little research directed on coho salmon in this area because there is relatively low sport and commercial fishing effort. The small fisheries that do occur are remote, low yield and it is expensive to participate in them. Access is by plane, helicopter or boat, and anglers are typically guided. Facilities to house anglers overnight are few. In the fisheries south of Chinitna Bay, participants are mostly guided anglers flown in and out daily from the Lake Iliamna area.

The largest coho salmon sport fisheries occur in Silver Salmon Creek and the Kamishak River (Table 25). Silver Salmon Creek is located mid-way between Tuxedni and Chinitna bays (Figure 1). Aside from the private lodge properties, the drainage is contained within the borders of Lake Clark National Park. Access is by airplane or boat. Most anglers are housed in one of three sport fishing lodges that are located in the immediate vicinity of the mouth of Silver Salmon Creek. Additional day-use access to the fishery occurs via regular air service from the communities of Soldotna and Homer that lands on the beach adjacent to the creek.

The Kamishak River flows into the southern end of Kamishak Bay. Several sport fishing operations from the Lake Iliamna area moor boats in the Kamishak River and fly clients in and out of the Kamishak drainage, daily. Guides transport clients by jet boat up the Kamishak River or to the Little Kamishak River and Strike Creek nearby to fish.

Other fisheries in the tributaries to Kamishak Bay, Amakdedori Creek and the Douglas River, are accessed most commonly by plane or helicopter. Anglers have been observed fishing in these remote rivers but runs here are thought to be relatively minor in size compared to the run to Kamishak River.

Clearwater and Shelter creeks are small tributaries to Chinitna Bay where sport fishing for coho salmon occurs regularly. The number of encampments that house anglers fluctuates; up to four have been active.

Commercial fishers harvest coho salmon in WCI set net and drift gillnet fisheries. The harvests are currently well below the historic average due to low prices but are above recent levels because a 1996 regulatory closure of the commercial fishery after August 9 was repealed by the BOF for the 2005 field season in the marine waters outside Chinitna Bay and including waters adjacent to Silver Salmon Creek (Shields 2006). Commercial fishing WCI now closes by emergency order.

During August 2001, a court decision rejected Alaska Native land claims to approximately 50 miles of the WCI coastline. The disputed land claims were concentrated mostly in the area from Tuxedni Bay to Kamishak Bay. Jurisdiction of these lands now pending appeal will be under the National Park Service. Prior to the decision, land status, access restrictions as well as boundaries of Park Service, private and native claim properties were uncertain. The recent court ruling will likely provide clear land access definitions and easier public access to these sport fisheries. Therefore, it is expected that effort in these remote fisheries will grow.

Historical Harvest and Escapement

Information concerning WCI coho salmon sport fisheries comes from the SWHS, which provides estimates of sport fishing effort, catch and harvest of coho salmon in many WCI tributaries. However, because of the relatively small number of anglers participating in the survey and corresponding low number of surveys returned by anglers who fish these tributaries, many coho salmon fisheries do not appear annually in the survey and others appear even more sporadically. Information regarding the fisheries is also available from anecdotal reports from anglers, inseason observation of selected fisheries by the department staff, harvest reports required of guides fishing in the McNeil Game Sanctuary and stream surveys of selected tributaries to index coho salmon spawning escapement.

The catch and harvest reported in the SWHS since 1997 is trending upwards in Silver Salmon Creek (Table 25). For the first time, annual catch estimates during 2000-2003 were consistently over 2,000 and harvests were near or above 1,000 coho salmon. In 2003, the reported catch of 7,377 coho salmon was comparable in magnitude to the catches reported for LCIMA's largest fishery on the road system, the Anchor River (Table 14).

The estimated sport fishing effort and harvest of coho salmon reported from the Kamishak River in the SWHS has been relatively small and stable while catch has varied presumably with abundance of coho salmon in the return (Table 25). Departmental observation of the Kamishak River coho salmon fishery during 1999 and 2000 identified that anglers practice catch-and-release, but also attempt to take a three-fish daily bag limit before the end of the fishing day. Thus, as documented by SWHS, release is prevalent in this fishery and catch is likely proportionate to instream abundance.

Amakdedori and Douglas River, have appeared occasionally in the SWHS since 1983. Small numbers of anglers report fishing these streams and the estimates reported by the SWHS are inexact. However, the annual participation, catch and harvest on these small stocks has remained low with no increasing trend. Similar to the Kamishak River the majority of coho salmon caught are released.

Clearwater and Shelter creeks are small tributaries to Chinitna Bay where the harvest and effort is also reported sporadically in the SWHS, and estimates are inaccurate due to the small number of respondents. However, the low number of respondents indicates a minimal level of angler effort, and harvest estimates suggest that the magnitude of harvest is low at both locations. For instance, estimated harvests reported for Shelter Creek are typically fewer than 40 fish, while harvest reported at Clearwater intermittently since 1989 averaged 87 coho salmon. At present harvest trends for these systems are not discernable by the SWHS. Periodic observations by the department and anecdotal information from guides indicate that angling activity is low.

During 2000 and 2001, the department conducted foot survey counts of coho salmon on an index area of the Clearwater Creek, as well as interviews of anglers and lodge operators. Although counts of coho salmon decreased from 873 in 2000 to 355 during 2001, the 2001 count did not accurately portray the magnitude of the run as coho salmon were very numerous in the lower intertidal portions of the creek and could not be counted. In addition, lodge operators indicated that coho were late in returning to the creek and anglers were having good fishing success.

The index area of the Silver Salmon Creek was counted on foot August 27, 2002. A total of 1,806 coho salmon were observed and additional 929 coho salmon were observed in a lower fork that had not previously been counted for a total of 3,380 coho salmon. Concentrations of fish were also noted in the lower tide-water sections of the river where poor visibility into the water prevented counting. Silver Salmon Creek Lodge and Alaska Homestead owners both reported a good return to Silver Salmon Creek in 2002 with coho salmon arriving earlier than normal on about July 7. Silver Salmon lodge also reported good numbers of coho salmon at Shelter Creek, a tributary approximately 8 miles south of Silver Salmon Creek along the west Cook Inlet shoreline.

Lodge owners at Silver Salmon Creek reported runs appeared to be strong in 2003 and 2004 and fishing was excellent.

Commercial Fisheries Division (CFD) has counted coho salmon incidentally during their August aerial chum salmon escapement surveys of Silver Salmon Creek since 2000 and Shelter Creek in 2000 and 2001 (L. F. Hammarstrom, Commercial Fisheries Biologist, ADF&G, Homer; personal communication). Peak aerial counts of coho salmon in Silver Salmon Creek ranged from 630 in 2003 to 6,900 in 2000. Shelter Creek peak coho salmon counts were 4,500 in 2000 and 1,060 in 2001.

CFD conducts aerial counts of chum salmon in Chinitna Bay systems annually during late July through mid-August. Surveys attempt to coincide with peak instream abundance of chum and not coho salmon. Furthermore, it is difficult to differentiate between chum and coho salmon during aerial surveys when both species are present. Therefore, Sport Fish Division conducted foot survey counts of coho salmon at Clearwater Creek and the Chinitna River during 2000-2002 to determine spawning distribution and escapement in these interconnected tributaries. Additionally, department personnel observed angling activity at these systems. The majority of coho salmon spawned in Clearwater Creek where the number counted during the ground survey was 3,061 in 2000, 938 in 2001 and 427 in 2002. In 2000, 3 coho salmon were counted during ground surveys of the Chinitna River, 169 in 2001 and 0 in 2002. The 2002 ground survey was conducted on September 2 and 3. No coho salmon were counted on an aerial survey of Clearwater Creek and Chinitna River flown by CFD staff on August 26, 2002.

Fishery Management and Objectives

No regulatory management plan specifically addresses the coho salmon fisheries of WCI; they are managed by regulation. The daily limits for salmon, except Chinook salmon, 16 inches or more in length, are three per day and six in possession. The bag and possession limits for Chinook salmon less than 20 inches and other salmon less than 16 inches in length are 10 per day and 10 in possession. Only unbaited artificial lures may be used from August 15 through May 15. The McNeil River is closed to fishing.

Prior the 1980s, all flowing waters (except portions of McNeil River) from the southern tip of Chisik Island to Cape Douglas were open to fishing the entire year. Bait was prohibited from September 1 through December 31. The bag limit for coho salmon was three daily and in possession.

Many of the regulatory restrictions in place for WCI coho salmon sport fisheries are the result of public proposals during the 1990s to reduce hooking mortality of coho salmon and other species. The bait prohibition was extended to September 1 through May 15 by the BOF in 1994. At the 1999 BOF meeting, a January 1 through September 30 season was established for coho salmon and bait restrictions were increased to July 15 through May 15 to encompass the July arrival of coho salmon to west side tributaries. Area restrictions included limiting the fisheries at Clearwater and Shelter creeks within Chinitna Bay to the lower 1-mile section of each creek.

Public proposals to lower the daily bag limit and restrict tackle to artificial single hook lures south of the North Forelands and to restrict a portion of Silver Salmon Creek to fly-fishing only were not passed by the BOF in January 2005.

Lack of escapement data and uncertainty about the extent of coho salmon mortality from the sport fisheries in the tributaries of WCI make it unclear if hooking mortality is a problem or is likely to be as effort on these streams continues to increase. Information about harvest and participation is only adequate to gauge trends and relative magnitude on a broad scale and not actual amounts, but harvests are relatively small and appear to be stable. As these fisheries grow, we may not be able to detect when harvests are no longer sustainable.

Fishery Performance and Escapement 2004-2007

The annual average angler effort and harvest and catch of coho salmon in Silver Salmon Creek and the Kamishak River during 2004-2006 were all higher compared to the historic averages (Table 25). In Silver Salmon Creek, coho salmon harvests during 2004-2006 continued to be near or above 1,000 annually, but catches were above 5,000 and the highest reported catch of 10,902 occurred in 2004. Angler effort during 2004-2006 was in the range of effort estimates since 2000. The highest reported catch and harvest estimates from Kamiskak River are for 2004 and 2006. Estimates of angler effort for the Kamishak River during 2004-2006 are among the highest reported. Coho salmon catches in Silver Salmon Creek are comparable to catches in the largest coho salmon fishery in the LCIMA, the Anchor River (Table 14).

Coho salmon were counted in Silver Salmon Creek and Shelter Creek on August 12 and August 19 in 2005. The high count was 1,830 in Silver Salmon Creek and 630 in Shelter Creek on August 12. The streams could not be surveyed adequately on August 25 due to fog.

The NPS conducted a creel census to estimate coho salmon sport harvest and effort and attempted to count the escapement of coho salmon in Silver Salmon Creek in 2005. Results of the creel census were not available at the time this report was completed. High water damaged the video equipment before the counts were complete (D. Young, National Park Service Fisheries Biologist, Iliamna; personal communication.

DOLLY VARDEN FISHERIES WITH AN EMPHASIS ON ROADSIDE FISHERIES

AREA-WIDE OVERVIEW

Area-wide Historical Harvest and Abundance

Dolly Varden are the most common, widely distributed, and complex sport fish in the LCIMA. They spawn during autumn and overwinter in numerous drainages. Adults that survive spawning return to Cook Inlet during spring and forage before returning to fresh water during mid-summer. Adults exhibit intertributary spawning as well as overwintering behavior, i.e. a fish may spawn and overwinter in Anchor River one year and spawn and overwinter in another freshwater system the next year. Juveniles become smolt and migrate to Cook Inlet to forage and often return to a different drainage during mid-summer, where they remain to overwinter. Their prolonged freshwater residence makes them available to sport anglers throughout much of the year.

Peak harvest typically occurs during July to mid-August. This period coincides with the return of Dolly Varden to fresh water as they follow in the salmon to feed on eggs and overlaps migration period of abundant pink and chum salmon. Dolly Varden run timing is between returns of Chinook salmon and coho salmon and provides opportunity in roadside streams with small pink and chum salmon returns. Incidental harvest of Dolly Varden occurs in the Cook Inlet marine recreational Chinook salmon fishery during June through early July and in nearly all freshwater salmon sport fisheries of the LCIMA. Hence, Dolly Varden are important to the LCIMA because they add diversity to the fishing experience by being available concurrent to fisheries for other species and provide directed sport fishing opportunity when little opportunity is available.

Historically, Dolly Varden contributed the most fish to LCIMA freshwater sport fish harvests (Table 5). Daily bag limits were 20 fish from 1960-1968, 10 fish from 1969–1983 and five fish between 1984 and 1990.

Area-wide Fishery Management and Objectives

No Dolly Varden fisheries in the LCIMA are specifically addressed in a regulatory management plan but rather by regulations governing methods, means, time and area. Criteria for establishing special management areas for Dolly Varden on the Kenai Peninsula (5 AAC 56.014) were adopted in 1999. Special Dolly Varden fisheries have not been created in the LCIMA to date.

ROADSIDE DOLLY VARDEN FISHERIES

Fishery Description

Dolly Varden provide harvest opportunity in roadside streams during July to mid-August. They are ubiquitous in nearly every stream along the road system but many streams have barriers to saltwater and resident fish do not attain sizes attractive to anglers. Road system streams, Anchor and Ninilchik rivers and Deep and Stariski creeks, offer the greatest opportunity to catch Dolly Varden.

Harvest and Abundance

Historically the Anchor River supported the largest fishery with other roadside systems including Deep Creek, Ninilchik River and Stariski Creek also supporting fisheries. Declines in harvest at Anchor River from 21,364 fish in 1979 to just 2,735 in 1987 were mirrored by declines in harvest at the other streams (Table 26). Declines in harvest were assumed to reflect stock abundance declines. In 1987, a study was initiated in the Anchor River to: (1) assess abundance by counting fish at a weir, (2) identify overwintering areas through tagging and recapture, and (3) determine the age structure of the population. Weir counts of Dolly Varden at the Anchor River declined from 19,062 in 1987 to 10,427 by 1990 (Table 21). Other major findings of the study indicated that immediate stock concerns were best served by controlling harvests targeting individual spawning stocks, and by protecting overwintering populations. Furthermore, due to the multifaceted life history behavior of the species, it was thought that low inriver abundance could result from numerous out-of-system factors. Management goals therefore focused on stopping and reversing the population decline of the numbers of returning Dolly Varden at Anchor River, maintaining fishing opportunities for Dolly Varden, and meshing regulations for Dolly Varden with concurrent fisheries of other species. Consequently, the BOF adopted a department proposal during the 1990 BOF cycle reducing the Dolly Varden bag and possession limit from five to two fish.

The Dolly Varden harvest has stabilized since 1990 as compared to harvest prior to 1990 (Table 26). For instance, harvest at Anchor River has averaged 1,428 fish and ranged from 662 to 2,821 fish, while harvests from 1977 through 1989 averaged 9,689 and ranged from 1,476 to 21,364 fish. Prior to 1990 Anchor River accounted for 81% of the harvest followed by Deep Creek (9%), Ninilchik River (7%) and Stariski Creek (4%). Since 1990, but the proportion of the total taken from the Anchor River is lower (72%) and more of the total harvest now comes from Deep Creek (19%). The proportion from Stariski Creek has declined to 1%.

The Anchor River salmon weir operated since 2004, allows small Dolly Varden to pass uncounted through the weir pickets. Although the Dolly Varden that enter the live box of the weir are counted, the Dolly Varden counts are considered an index count. The total number of Dolly Varden counted in 2004 was 7,846 (Table 20). Peak counts occurred in the third week of July.

Fishery Management and Objectives

The fisheries are open from the mouth to approximately 2 miles where regulatory markers are posted on the Anchor River, Deep Creek, and the Ninilchik River in May and June during the Chinook salmon weekend openings (see Chinook Salmon Fisheries section). On July 1, the fishery opens again in the lower two miles of the Anchor River, Ninilchik River, and Deep Creek and on Stariski Creek upstream to the Sterling Highway Bridge (approximately 1 mile). Then on August 1 the upstream areas of the rivers open for the rest of the season. The daily bag and possession limit is two. Beginning September 1 only unbaited, single hook, artificial lures are allowed.

A proposal by the public to open the Anchor River upstream of the forks to fishing on July 15 with barbless hooks was not passed by the BOF at their meeting in November 2004 to protect spawning Chinook salmon.

Fishery Performance 2004-2006

Recent catch and harvest information indicates the LCIMA roadside Dolly Varden fishery has become primarily a catch and release fishery. Catch may be an indicator of run strength, and if so, indicates fluctuations in annual run size with no decreasing trend (Table 26). The portion of the run handled by anglers at the Anchor River is likely high, as the 2000 catch estimate of over 20,000 fish approximates the highest weir count at Anchor River for this species (Table 21). Catch-and-release mortality of Dolly Varden in LCIMA tributaries is not known. Production of roadside stocks is probably commensurate with the existing habitat. Overexploitation of these stocks is not likely under the current regulations. Dolly Varden in Southeast and Kodiak, Alaska show an affinity to overwinter in freshwater systems containing lakes. Tributaries of the LCIMA with headwater lakes that are in relatively close proximity to roadside Dolly Varden populations are few and include Packers Lake, English Bay Lakes and Tustumena Lake. It is not known to what extent local roadside stocks use these systems for spawning and overwintering. The extent of the coastal distribution of Dolly Varden originating in local roadside tributaries remains unknown.

The count of Dolly Varden captured in the Anchor River salmon weir live box was 5,719 in 2005, 234 in 2006 and 1,268 in 2007 (Table 20). Peak count occurred the second week of July in 2005, and around July 20 in 2007. In 2006 Dolly Varden counts were low during the weir operation. However on August 24 when sonar was used for 3 days after the weir washed out, large schools of Dolly Varden were observed moving upstream.

STEELHEAD TROUT WITH AN EMPHASIS ON ROADSIDE FISHERIES

AREA-WIDE OVERVIEW

Area-wide Historical Harvest and Abundance

The steelhead trout is a seagoing rainbow trout. Steelhead and rainbow trout aren't physically different but look subtly different at various times during their life cycles. Juvenile steelhead trout change appearance from rainbow trout only just prior to when they smolt just prior to migrating from freshwater, when they loose their parr marks and become silvery. Adults returning to freshwater are initially more silver than resident rainbows but quickly loose their sheen and are indistinguishable from rainbow trout in color but generally have are more fusiform in shape. Juvenile steelhead trout generally rear 2 to 3 years in freshwater but may stay only 1 year or as long as 4 years in freshwater before migrating to saltwater.

Summer run steelhead trout are rare in Alaska and are found only in a few streams in Southeast. Steelhead overwinter in freshwater streams, and spawn in April and May. Unlike salmon, steelhead can spawn more than once. After spawning, some fish die and others emigrate to the ocean in the spring and early summer. Emigrating steelhead are also referred to a kelts. Steelhead trout often spawn more than once, and fish over 28 inches are usually repeat spawners. Rarely, steelhead will return to a freshwater stream within a few months of having spawned, but most repeat spawners spend at least one winter in the sea between spawning migrations.

Rainbow/steelhead trout presence in LCIMA fresh waters has been confirmed only in the Anchor and Ninilchik rivers and Deep and Stariski creeks.

Area-wide Fishery Management and Objectives

Trout management is guided by the Criteria For Establishing Special Management Areas for Trout (5 AAC 75.013). The policy was adopted by the department in 1986 to provide future Boards, fisheries managers, and the sport fishing public with: (1) management policies and implementation directives for area rainbow and steelhead trout fisheries, (2) a systematic approach to developing sport fishing regulations that includes a process for rational selection of waters for special management codified in 5 AAC 75.013, and (3) recommended research objectives. This Policy was adopted by the BOF in October 1998 and became effective in the spring of 1999. There are no special management areas or management plans for rainbow/steelhead trout in the LCIMA.

No in season management of trout has occurred in the LCIMA. Trout populations are managed by regulation. In all freshwaters waters of the LCIMA north of the latitude of Point Adam (Figure 1) the annual limit for rainbow/steelhead trout is 2. The freshwater daily bag and possession limits for rainbow/steelhead trout are 2 in flowing waters or 5 in ponds and lakes; only fish may be greater than 20 inches. The Anchor and Ninilchik river and Deep and Stariski creek drainages are exceptions to these regulations.

In the salt waters north of a line from Point Adam to Cape Douglas, rainbow/steel head may not be retained. South of that line, the saltwater daily bag and possession limits are one rainbow/steelhead 20 inches or greater and there are no limits for rainbow/steelhead trout under 20 inches.

Roadside Steelhead Fisheries

Fishery Description

The Anchor River, Ninilchik River, Deep Creek and Stariski Creek support popular rainbow/steelhead trout fisheries. Steelhead studies in LCIMA occurred on the Anchor and Ninilchik rivers but life history data are currently available only for the Anchor River stock. Thus, information on life history characteristics of Anchor River steelhead trout serve as an example of life history behavior typical of all LCIMA stocks. The steelhead stocks are exclusively defined as fall-run fish that enter fresh water as adults as early as July and into November, spawn from April to May and emigrate after spawning during May and June (Larson and Balland 1989, VanHulle 1985, ADF&G 1990). Anchor River studies in 1989 and 1990 found about 19% of the spawning steelhead population are repeat spawners (Larson and Balland 1989, ADF&G 1990, Larson 1993). Larson and Balland 1989 found a majority of sampled steelhead spent 3 years in freshwater as juveniles before emigrating. Fish that reared for 2 and 4 years were also sampled. The rainbow/steelhead trout fisheries have been catch and release only since 1989. In the spring anglers catch steelhead trout during the Chinook salmon openings. In the fall, the fishery is more directed for steelhead trout.

Historical Harvest, Catch and Stock Assessment

According to catch data, implementation of the catch-and-release regulation has served to maintain and possibly increase steelhead stock levels in LCIMA roadside tributaries (Table 27). Beginning in 1989, the annual estimated steelhead catch in the Anchor River exceeded the average annual stock size, thought to approximate 1,500 fish. Furthermore, the estimated annual catch of steelhead at the Anchor River has been more than twice the approximate stock size since 1996 with the 2000 catch estimate of 8,693 fish nearly six times the approximate stock size. These estimates indicate that the number of steelhead in the run has likely increased and that anglers handle a large portion of the run. Furthermore, estimates may also indicate that a large fraction of the population is being exposed to multiple hooking. Catches in the other systems have also increased. At Deep Creek and Ninilchik River, where stock size is believed to be smaller than the Anchor River, the estimated catch also indicates a large portion of the runs is being caught and released by anglers. In general, hooking induced mortality can occur directly from a hook wound or indirectly through a hook injury, stress and induced diseases. Delayed hooking mortality estimates for steelhead were estimated in the range of 0 to 6% (Reingold 1975; Caverhill 1977; Pettit 1977; Hooten 1988). However, these studies were not based on multiple hooking. Taking into account the current regulations that complement mandatory catch-and-release, particularly the unbaited single hook and prohibition of removal from the water, there is little reason to suspect that mortality is considerably higher for LCIMA steelhead.

Beginning in 2002, the Ninilchik River weir was also used to capture and enumerate post-spawn steelhead emigrating to the ocean. The steelhead assessment is a cooperative effort between the U.S. Geological Survey of Alaska and the Division of Sport Fish. In 2002, 449 steelhead were counted at the weir; 82 were surgically implanted with either an acoustic or archival tag. In 2003, a total of 416 steelhead were captured, of which a total of 80 were implanted with either an acoustic or archival tag (C. Zimmerman, Fisheries Biologist, USGS, Anchorage; personal communication). A Passive Integrated Transponder (PIT) tag was implanted at the time of surgery to enhance the recovery of tagged steelhead. None of the 82 steelhead equipped with tags in 2002 were recovered in 2003. Several of both types of tags were recovered from 418 emigrating steelhead counted in 2004. The emigrating steelhead counts for 1999, 2000, 2001 2002, 2003 and 2004 were 335, 278, 293, 449, 416 and 418, respectively and averaged 364 fish from 1999 through 2004.

Fishery Management and Objectives

These are currently catch-and-release fisheries. Retention is prohibited and fish may not be removed from the water. Only unbaited, single hook, artificial lures are allowed September 1 through December 31. Other restrictions control allowable fishing time and area open to fishing. During the Chinook salmon season, Deep Creek, Anchor and Ninilchik rivers are open to fishing from salt water to approximately 2 miles upstream only on weekends only beginning Saturday of the weekend before Memorial Day (Anchor River) or Memorial Day weekend (weekends include Monday). The Anchor River is open for five consecutive weekends while Deep Creek and Ninilchik River are open for three consecutive weekends. Fishing the lower sections of each stream resumes July 1. Stariski Creek has no Chinook salmon fishery and the lower section does not open to fishing until July 1. The entire drainage of each stream opens to fishing beginning August 1 and continues through December 31.

The conservative regulatory framework for LCIMA steelhead evolved over a period of nearly two decades during which angler participation and harvest in the steelhead fishery were generally increasing and numbers of returning steelhead enumerated each fall at a weir in place at the Anchor River were declining. Specifically, in 1977 the bag and possession limit was two steelhead trout daily with no seasonal limit. The season was closed from May 1 to June 30. By 1984, the bag and possession limit had been reduced to one fish daily, a seasonal limit of two fish was imposed and a harvest record required. Beginning in 1984 fishing was permitted only from July 1 through December 31. From 1984 through 1988, bait was prohibited after September 15. On October 7, 1988 the Anchor River steelhead trout fishery was closed by emergency order for resource conservation as the number of steelhead counted through the weir was judged to be insufficient to support an inriver fishery. The current regulatory scheme became effective beginning in the 1989 season.

Fishery Performance 2004-2006

Stream conditions when steelhead trout were outmigrating during 2004-2007 are detailed in the Freshwater Chinook Salmon section of this report. Stream conditions during their immigration are detailed in the Freshwater Coho Salmon section.

The average catch from 2004 through 2006 (Anchor River (3,586), Deep Creek (2,318), Ninilchik River (632), and Stariski Creek (53) (Table 26) was near historical levels indicating that catch and release regulations are maintaining steelhead populations in these roadside fisheries.

The count of downstream migrating steelhead through the Ninilchik River weir in 2005 was 681, nearly 250 fish above the highest count during 1999-2004 (C. Zimmerman, Fisheries Biologist, USGS, Anchorage; personal communication). The Ninilchik weir was not operated during the steelhead outmigration after 2005.

The counts of steelhead that were passed upstream of the Anchor River weir from 2004 to 2007 were 20, 107, 4, and 313 respectively (Table 20; Kerkvliet and Burwen *In prep;* Kerkvliet et al. *In prep;* Larson 1990; Larson 1993; Larson and Balland 1989).

Run timing of emigration of steelhead trout in May and June from 2004 to 2006 based on beach seine catches upstream of the sonar/weir site on the Anchor River indicates the emigration of steelhead extends through mid-June. The peak emigration of steelhead trout from the Ninilchik River occurred during the last week in May through the first week in June based on weir counts.

OTHER SALMON FISHERIES

OVERVIEW

Fishery Description, Harvest and Escapement

Pink salmon are present in virtually every freshwater drainage in the LCIMA and are a popular target of sport anglers. Pink salmon returns peak during odd numbered years in Cook Inlet. Commercial fisheries target pink salmon and escapement of numerous area pink salmon stocks is monitored with aerial surveys (Hammarstrom and Dickson 2007). The largest runs are produced in West Cook Inlet and Port Dick on the outer Kenai Peninsula coast, but significant runs to Humpy Creek attract the most anglers.

The average annual pink salmon sport harvest for the entire LCIMA between 1977 and 2006 was only 5,016; the average catch was 13,100 annually, during 1990-2006, when catches are available, and ranged from 7,200 to nearly 21,000 (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*). An average of 70% of the harvest and 90 % of the catch comes from salt water; most from Kachemak Bay. The freshwater streams in Central Cook Inlet support a pink salmon fisheries also. Together, the highest reported catch from these streams was approximately 5,000 pink salmon in 2004 (Tables 14-16, Table 23).

Sockeye play a minor role in LCIMA sport fisheries. The English Bay drainage in Lower Cook Inlet, has the only significant sockeye salmon run in the eastern portion of the area, with escapements of 8,000 to 22,500 reported at the weir operated since 1994 (Hammarstrom and Dickson 2007). The runs in Mikfik and Chenik drainages have the only important West Cook Inlet stocks; aerial escapement counts of Mikfik range from 5,400-12,800 while Chenik aerial counts range between 800 and 17,000 (Hammarstrom and Dickson 2007). Most sockeye salmon harvested are taken in the stocked terminal saltwater fishery in China Poot Bay. A few are hooked incidentally when anglers fish for Chinook and coho salmon in saltwater and some are taken from the freshwaters in Central Cook Inlet (Tables 14-16, Table 23). The sockeye salmon sport harvest has been stable, averaging 3,812 annually from 1977-2006 with a range of 1,206 in 1990 to 7,972 in 2001 (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*).

Fishery Management

Fisheries for pink and sockeye salmon are managed by regulation. In season regulation changes are rare and have only occurred in association with stocking projects to achieve brood stock goals for pink salmon at Tutka Bay Lagoon Hatchery. The personal use dipnet fishery in China Poot Bay has been extended in the past to harvest surplus sockeye salmon before the season was lengthen by the Board of Fisheries.

Stocked Fisheries

China Poot Bay Sockeye Salmon

Leisure Lake, also known as China Poot Lake, is located across Kachemak Bay in a southeasterly direction from the Homer Spit (Figure 4). The lake has been stocked with an average of 1.7 million juvenile sockeye salmon fry since 1984 to supplement the commercial catches in Kachemak Bay. The project was initiated by ADF&G but was transferred to Cook Inlet Aquaculture Association (CIAA). Due to the presence of barrier falls upstream from the intertidal area of China Poot Creek, adult sockeye salmon returning to Leisure Lake are harvested in a terminal fishery. The terminal harvest area has provided excellent opportunities for anglers and personal use dipnetters. A personal use fishery occurs along 200 yards of China Poot Creek between the intertidal area and the barrier falls, and the sport fishery occurs along an expanse of intertidal mud flats in China Poot Bay. The harvest reported in the SWHS peaked at 8,605 in 1995, the last year, the information is available. Annual sport harvests from China Poot Bay are less than 1,200 and average 250.

Virtually all of the sport and personal use fishing originally took place on property owned by the Seldovia Native Association. This land was included in a parcel that was being offered for sale to the State of Alaska for inclusion in Kachemak Bay State Park. When this purchase was not approved by the Legislature, the Association initially planned to prohibit trespass. An agreement for the 1990 season was reached between the department, Seldovia Native Association, and the Kachemak Bay Heritage Land Trust. The Land Trust is a nonprofit group interested in preserving natural areas and easements in Kachemak Bay. Land Trust members sold voluntary seasonal use permits for a $5 fee with proceeds being earmarked for access purchase. In 1991 and 1992 it was reported that anglers fished from private property even though the property was "posted." In 1993 the lands adjacent to the creek were purchased by the state; access to the fishery is no longer an issue.

Until 1995, the personal use season was July 1 through July 31. In some years, sockeye salmon continued to enter China Poot Creek after the close of the season. Harvest of these fish was accomplished by extending the fishery by emergency order through early August. The decision to extend the season was determined by index counts of sockeye salmon present in the stream in late July. Extended openings for personal use dip netting were held by department emergency order in August of 1983-1985, 1989, and 1994 to completely harvest fish that had entered China Poot Creek. The BOF extended the season through August 7 in 1995 to maximize the opportunity to harvest stocked sockeye salmon while minimally impacting wild pink salmon that spawn in China Poot Creek and no inseason extensions have been required since.

When changes were made to the Cook Inlet personal use regulations the prohibition on the harvest of other salmon species in the China Poot personal use dip net fishery was deleted erroneously. At the November 2001 meeting the Board of Fisheries reinstated the regulation that all salmon species besides sockeye salmon may not be possessed or retained.

Conflicts occasionally occur in China Poot Bay between commercial seiners harvesting sockeye salmon for cost recovery and sport anglers. SFD regulation publications and weekly fishing reports contain advisory's to the anglers to yield to commercial cost recovery operations in China Poot Bay.

Sockeye salmon stocking project in Leisure Lake and other locations in Lower Cook Inlet and Kachemak Bay are in question as CIAA searches for a brood source. Conflicts over the use of Tustemena Lake, in the Kasilof drainage, as a brood source due to its protected status within the Kenai National Wildlife Refuge threatened this project in 2004. Hidden Lake, located in the Kenai River drainage upstream of Skilak Lake, was chosen as an alternative brood source for 2004-2010. After 2010, it is hoped that the return in development at Tutka Bay Lagoon Hatchery will be successful and support Kachemak Bay sockeye salmon stocking projects.

Tutka Bay Pink and Sockeye Salmon

Tutka Bay Lagoon, located across Kachemak Bay approximately 9 miles south of Homer Spit (Figure 4), is the site of Tutka Bay Lagoon Hatchery, which operated there from 1975-2004 to enhance commercial pink and sockeye salmon fisheries. Broodstock from Tutka Bay Lagoon Creek were spawned and their offspring reared in the hatchery from 1975-2003 and sockeye salmon broodstock from Tustemena and Packers lakes were remotely spawned and the progeny experimentally reared at the hatchery in 1991 and 1994-1997.

A small salmon fishery evolved in Tutka Bay near the mouth of the lagoon and in Tutka Bay Lagoon itself around the hatchery-produced pink salmon that returned until 2006. The small, 35 acre lake-like lagoon, is only accessible through a narrow intertidal channel during the high tide period. Pink salmon entered Tutka Lagoon and staged for several weeks prior to moving into Tutka Bay Lagoon Creek to spawn. This staging period offered an excellent opportunity to effectively sport fish. As many as 40 boats and 150 anglers could be observed fishing in the lagoon during a single high tide period at the peak of the migration. All intercepting fisheries were closed during years of low return to ensure sufficient numbers of fish were present to provide brood stock for the hatchery. The sport fishery was liberalized in season to take advantage of a surplus of stocked pink salmon in 1997.

Conflicts between commercial fishers conducting cost recovery and anglers were reported in 2001.

Cook Inlet Aquaculture Association has begun to develop a sockeye return to Tutka Bay Lagoon through a remote release program at that location with the first adult return of stocked sockeye salmon occurring in 2007. If successful, the run will provide broodstock for ongoing Lower Cook Inlet enhancement projects at Leisure, Hazel and Kirschner lakes that support commercial fisheries and, incidentally, support sport and personal use sockeye salmon fisheries in China Poot Bay.

At the meeting in 2007, the Board of Fisheries will address two proposals, one to close 100 yards around the net pens to protect brood stock and a second to close the entire lagoon to use of sport and personal use salmon fishing gear.

SHELLFISH FISHERIES

AREA-WIDE OVERVIEW

The beaches on the east side of central Cook Inlet support the largest fishery for razor clams in the Alaska. Southcentral Alaska's largest hardshell clam fishery occurs in Kachemak Bay for little neck *Protothaca staminea* and butter clam *Saxidomus giganteus* . Once thriving fisheries for king crab *Lithodes* sp, Dungeness crab, Tanner crab *Chionoecetes bairdi* and shrimp in Kachemak Bay are now closed because of low abundance . Other mollusks such as cockles

Clinocardium sp. and *Serripes* sp., softshell clams Family Myidae, tritons *Fusitriton oregonensis*, sea urchins Class Echinoidea, and sea cucumbers *Parasthichopus californicus* are harvested in small amounts.

Area-wide Historical Harvest and Abundance

The non-commercial king crab fishery has been closed since 1985. Incidental catches of king crab in department Tanner crab trawl surveys conducted since 1991, number in the single digits for most years since 1994, except 1997. The trawl survey does not target king crab habitat specifically but it is likely survey catches reflect population trends of king crab.

The non-commercial shrimp fishery closed in 1997. Shrimp stocks remain mostly at extremely low levels since 1993, in a department small mesh trawl survey that has been conducted periodically since 1975 (Goldman et al. *In prep.*; Gustafson 1995, 1996; Gustafson and Bechtol 1994, 1998, 2000-2001, 2005).

Both king crab and shrimp fisheries are anticipated to remain closed for indeterminate time into the future because there is little evidence of a recovery in their population size.

The fisheries and population trends for Tanner and Dungeness crab, razor and hardshell clams are detailed in the sections that follow.

Area-wide Fishery Management and Objectives

There are currently no management plans for Dungeness crab, king crab or shrimp and no criteria for opening the non-commercial fisheries on these species. When stocks show signs of recovery triggers for opening non-commercial fisheries will need to be developed that sustain stocks and provide harvest opportunity. The management objectives and tools for Tanner and Dungeness crab, razor and hardshell clams are detailed in the sections that follow.

RAZOR CLAMS

Fishery Description

The Kenai Peninsula razor clam *Siliqua patula* sport fishery occurs primarily on the sandy beaches along a 50-mile area on the east side of Cook Inlet between the Kasilof River and the Anchor River (Figure 6). Razor clam presence in the beach is signaled by a dimple in the sand made when the clam retracts its neck and/or moves deeper into the sand.

Razor clams may be dug on any minus tide; however, tides lower than -2.0 feet on the northern beaches and -3.0 on the southern beaches are preferred. On the northern beaches these tides occur about 65 days annually while on the more southern beaches the average number of days this species is available to the sport digger declines to about 35.

The average length of razor clams increases from north to south along the eastside beaches (Szarzi et al. *In prep.-a*). Razor clams live to a maximum age of approximately 13 years. The average age at mortality is approximately 8.

Every 4 to 7 years a new year class of clams is particularly abundant either because of favorable environmental conditions or because they can from a large parent year class (Szarzi et al. *In prep.-a*). As these strong year classes grow into the size when they are regularly encountered by diggers, the prevalence of small clams in the beach can give the impression to diggers that harm has come to the population because there are no larger-sized clams, when actually, the presence of small clams is a sign of the population successfully replenishing itself.

Historical Harvest and Abundance

Information about the razor clam fishery is available from the SWHS and research and management programs conducted annually since the mid 1960s (D. Nelson, Alaska Department of Fish and Game, Homer, unpublished data; Szarzi 1991; Athons 1992; Athons and Hasbrouck 1994; Szarzi et al. *In prep.-a*).

Average annual participation was approximately 32,000 digger days and annual harvest averaged nearly 1.0 million razor clams from 1977-2003 (Table 6). Participation and harvest peaked in 1994 when 48,500 digger days were spent digging 1.2 million razor clams. Since 1994, participation and harvest have declined overall. The proportion of the total harvest taken at Clam Gulch peaked in 1979 (Table 28) and declined as the Ninilchik beach became more popular for clam digging. Ninilchik beach grew in popularity until 1995 when digging effort shifted toward Clam Gulch and other beach areas again through 2003.

Fully exploitable size is assumed to be 80 mm (4 inches) (Szarzi 1991) and is attained by clams after approximately four winters of life. Abundance of exploitable clams at a beach section in the Clam Gulch area ranged from 6.8 to 16.0 million during the years that abundance was estimated (Table 29). Recruitment of a strong year class occurred in 1999. In 2004, few older clams and many small clams signaled the demise of older year classes and the advent of a new young age class. At Ninilchik Beach, a strong year class became evident in department surveys in 1989, and recruited into the fishery in 1991 and 1992. By 2001, this year class had mostly died or been harvested, with a resulting decline in abundance. The harvest has remained stable resulting in increasing exploitation rates in 1998 and 2001; the exploitation rate is currently approximately 19% at Ninilchik. A new strong year class began recruiting into the fishery in 2003. Exploitation rates on most other beaches have not been estimated but the harvest from these beaches is relatively low (Table 29).

Fishery Management and Objectives

The razor clam fishery is currently regulated by bag, possession and gear limitations. The razor clam bag limit was 30 from 1959 until 1962, when it was increased to 60. In 1960, a sport fishing license was required and a seasonal closure from July 10 through August 31 was implemented. . The seasonal closure was repealed in 1968. Also in 1968, the bag limit was amended to the "first 60 clams dug" (D. Nelson, Alaska Department of Fish and Game, Homer, unpublished data). A possession limit was adopted in 1994, the first significant regulatory change in more than 20 years. In 2000, the daily bag limit was lowered to 45 clams and the possession limit to two daily limits (90 clams) based on public reports of wastage related to the bag limit of 60. In 2003, the BOF passed a public proposal to reinstate the 60 clam daily bag limit and increase the possession limit to two daily bag limits (120 clams).

Currently, there is no closed season but winter weather conditions and night-time low tides preclude most digging during October through February.

The relatively high exploitation rate at Ninilchik is cause for alertness there and population trends will be monitored closely. Better methods for determining razor clams ages are needed so managers can predict population trends better and to anticipate changes in advance.

Fishery Performance 2004-2007

The average annual harvest during 2004-2006 of 461,572 is approximately half the 1977-2003 average of 925,609 despite only a small decline in average annual effort between the two periods (Table 6). The overall decline in harvest since the peak in 1994 has continued through 2005, when the lowest harvest in the history of the SWHS, 427,016 was reported. The reported for 2006 of 438,482 is only slightly higher than the lowest harvest reported in 2005. Coincident with the low harvests is a dramatic shift of diggers away from approximately the 25 mile length of beach around Clam Gulch between Cohoe Beach and just north of Ninilchik to Ninilchik and other southern beaches (Table 28). The low harvest and the shift of diggers in 2005 and 2006 occurred because a new year class grew into harvestable size in the beaches north of Ninilchik in 2004 at the same time abundant older clams died. Poor growth of the young clams in 2005 and 2006 resulted in a shortage of clams big enough to be considered worth eating and many calls from diggers concerned about the health of the population. The lack of large clams at Clam Gulch persisted in 2007 along with calls from concerned diggers. While the demise of large clams and the poor growth of the new year class is unprecedented in the history of the assessment program, new recruits with more normal (faster) growth are evident in department samples from Clam Gulch in 2007 collected to estimate clam length and age and average clam size is expected to increase at a faster rate as these recruits age.

HARDSHELL CLAM

Fishery Description

The beaches of lower Cook Inlet support commercial and noncommercial (sport and personal use) hardshell clam fisheries. In regulation, "hardshell" clam, refers to Pacific littleneck *Protothaca staminea* and butter clams *Saxidomus giganteus*. The commercial fishery targets primarily Pacific littlenecks. Non-commercial diggers also target butter clams. The commercial fishery occurs on beaches certified for commercial digging by the Department of Environmental Conservation on the south side of Kachemak Bay (Figure 7) between Bradley River and Barabara Point.

All beaches in lower Cook Inlet are open to the taking of clams for sport and personal use. However, the harvest is almost entirely from the Kachemak Bay area, especially Sadie Cove, China Poot, Jackalof and Kasitsna bays and the east side of the Homer Spit (Figure 7).

Littleneck and butter clams are found in bays, estuaries and open coastlines in the LCIMA from +5 to -5 feet around mean lower low tide (0ft). They are encountered in a variety of beach gravel sizes with littlenecks preferring gravel beaches with more mud content. Littleneck clams typically inhabit the upper 6-8 inches of the substrate and occasionally to depths of 8 inches while butter clams are encountered to depths of 1 ft.

Littleneck clams up to 16 years of age have been found in Southcentral Alaska. A littleneck clam around 1.5 inches length in Southcentral Alaska may be 8 to 10 years old

Historical Harvest and Abundance

Estimates of noncommercial effort and harvest have been available from the SWHS for Kachemak Bay, since 1981 (Table 7). Effort is for all shellfish species harvested at a particular location, rather than for effort directed at individual species. Harvests are reported as "gallons of clams", with approximately 120 Pacific littleneck clams comprising a gallon, and one gallon equal to approximately 8.5 pounds.

A shellfish permit, required of diggers from 1997 through 2002, provided a second source of statistics concerning noncommercial harvest, effort, and harvest location but was discontinued because of bias caused by to non-compliance of the permit requirement by non-local diggers. (The permit was required in 2003 but entry and analysis of the 2003 permit data did not occur). Digger distribution is currently determined by aerial flights that apportion digger counts by beach area where they were seen digging.

The estimated hardshell clam harvest in Kachemak Bay and Lower Cook Inlet ranged from 5,135 gallons in 1982 to 29,163 gallons in 1996 and averaged 13,318 gallons from 1981-2003 (Table 7). A dramatic decline in effort occurred in 1998 (Table 7), probably as a result of the closure of the Dungeness crab recreational fishery. Annual hardshell clam harvest estimates remained variable but did not reach as high as prior to the crab closure.

The department clam assessment tool is surveys to estimate clam abundance in locations important to the fisheries (Szarzi et al. *In prep.-a*). Survey effort has been focused on littleneck clams. Butter clams have also been collected but are likely under-represented in samples because their habitat extends deeper into the substrate than littleneck clams. Dating from 1990, they were typically conducted on commercial beaches or locations with suitable clam habitat. Since 1999, the survey was modified so includes long-term trends in clam abundance and sustainable yield, mean annual biomass, size-at-age, and substrate composition. New areas were incorporated including locations where noncommercial diggers concentrate. The harvest of littleneck clams from the south side of Kachemak Bay in all fisheries was likely less than 20% of the biomass of legal sized clams in 2000 and 2001. It was less than 10 % in all locations where department abundance sampling occurs except China Poot Bay (28%) and Jakolof Bay (13%) (Szarzi et al. *In prep.-a*).

Legal-sized littleneck clam abundance at a popular recreational beach in China Poot Bay averaged 337,000 during 1999-2002 and ranged from 209,000 to 437,600. Between 2002 and 2003, estimated legal-sized littleneck clam abundance at the China Poot Bay beach (Figure 7) declined from 286,063 to 51,836 (Szarzi et al. *In prep.-a*). The decline was a much larger magnitude than could be accounted for by harvest. A large decline occurred between surveys conducted in 2002 and in 2004 on the lightly harvested beach in the vicinity of China Poot Bay between Grewingk River and Mallard Bay, further indicating the decrease had an environmental rather than human source. Butter clam abundance at the China Poot Bay beach remained stable and averaged 424,680 each year during 1999-2003 (Szarzi et al. *In prep.-a*). Butter clams are found deeper than littleneck clams, indicating the environmental agent to the decline could have been temperature related.

Fishery Management and Objectives

This fishery is addressed in the Southern District Hardshell Clam and Mussel Fishery Management Plan (5 AAC 38.315). The management plan mandates the annual noncommercial harvest not exceed 160,000 hardshell clams in Kachemak Bay.

Harvest may only occur by hand, or with a rake or shovel. The commercial and noncommercial minimum lengths of 1.5 inches for littleneck clams and 2.5 inches for butter clams were and bag and possession limits of 1,000 littleneck clams and 700 butter clams were adopted in 1994. The size limits allow clams to reach reproductive maturity before harvest. The bag limits facilitate the enforcement of commercial closures by removing the incentive for commercial harvesters to dig during commercial closures.

Nonresidents can participate under sport fishing regulations while residents can participate under either sport or personal use regulations. Bag/possession limits under sport regulations can not be added to the bag/possession limits allowed by personal use regulations and vice versa. T

The sport regulations are liberal enough that they have had little or no effect on the daily harvest by noncommercial users, A guideline harvest level of 160,000 lb was established for the noncommercial fishery in 1997 based on the average harvest in the fishery from 1981–1995. The permit requirement instated in 1997 was suspended in 2004 and was rescinded by the BOF in 2006. Compliance with the permit acquisition and recording by diggers was poor due to lack of enforcement. Local diggers were more likely to obtain permits than non-local diggers and had different harvest patterns than non-locals, therefore statistics from permits were not accurate. No BOF actions have been directed at the hardshell clam fisheries since 1997.

To date, no emergency orders have been required to manage the lower Cook Inlet noncommercial hardshell clam fishery inseason.

Few tools are available to manage the fishery. Harvests aren't available by beach although beaches have different characteristics and likely different sustainable yields. The composition of the harvest is unavailable so exploitation of a species cannot be estimated. Sustainable exploitation rates are unknown. Estimates of abundance are imprecise so it is difficult to determine the magnitude of population change between years.

Fishery Performance 2004-2006

The average annual hardshell clam harvest of 8,167 for 2004-2007 is lower that the average of 13,929 for 1981-2003 (Table 7). The annual harvests in 2004 and 2005 were within the range of harvests from 1981-2003 but the 2006 was the lowest on record. The reason for this is not known but may be the result of low precision of the estimated harvest.

TANNER CRAB

Fishery Description

The Tanner crab fishery occurred primarily in the deep waters west of the Homer Spit. Tanners may live to an estimated maximum age of 14 years and legal sized crabs vary from 2 to 4 pounds. Due to the depth where they are found (up to 1,200 feet) and size of these crabs, large heavy pots are required to harvest them along with mechanical pullers to raise and lower the pots. The gear requirements limit fishery participation. The fishery is currently closed because the low stock size can't support any harvest.

Historical Harvest and Abundance

Noncommercial harvest data are available from the SWHS beginning in 1981 (Table 7) and from shellfish permits starting in 1996 until the fishery was closed in 2002 (Table 7, Table 30). SWHS estimates of noncommercial Tanner crab harvest in most years are significantly lower and more variable than estimates obtained from shellfish permits. This may be the result of imprecision in harvest estimates because of the small number of respondents to the SWHS that fished for Tanner crab. Noncommercial Tanner crab harvests reported on permits are probably more accurate than SWHS estimates because permit compliance it thought to be high. The average annual noncommercial harvest estimated from permits from 1996 to 2000, was about 15,400 crab (Table 7, Table 30) with a bag and possession limit of 20. The bag limit restriction to five resulted in an estimated harvest in 2001 of 6499. The fishery closed early in the season in 2002 and the harvest reported on permits was 1,148.

The commercial Tanner crab fishery began in the mid-1960s in the Southern District as incidental harvest to red king crab *Paralithodes camtschaticus* (Davis 1982). Fishing effort directed at Tanner crab increased during the 1970s when price and demand increased, and fishing effort quickly expanded to other Cook Inlet districts. The commercial fishery was the primary harvester of Tanner crab. The commercial Tanner crab fishery on the outer Kenai Peninsula coast closed in 1990. A commercial fishery was prosecuted in Kachemak Bay and eastern Lower Cook Inlet until it was closed in 1995 after the department trawl surveys estimated that insufficient numbers of crab were available to support a commercial fishery (Trowbridge and Goldman 2006). The fishery remains closed.

Tanner crab harvest data are available since 1968 (Trowbridge and Goldman 2006). Average annual harvest in the Southern District (Kachemak Bay area) approximated 1.2 million pounds or about 480,000 crab.

From the 1970s to 1990, pot surveys were used to index crab abundance in Kachemak Bay and Lower Cook Inlet. Trawl surveys have been used annually since 1990 to estimate absolute abundance of Tanner crab (Table 31). Tanner crab stocks in all surveyed districts have been at low abundance levels since the early 1990s. Estimates of Tanner crab abundance in the Southern District declined sharply in 1994. Large numbers of juvenile crab were captured in 1999 and 2001-2003 surveys. The survey in 2004 did not capture a significant number of the 2001-2003 recruits in older size classes but the trawl net was misadjusted during the survey and may have resulted in the gear missing small sized crabs to a greater extent than it normally does.

Fishery Management and Objectives

The BOF passed the Tanner Crab Harvest Strategy for Area H (5 AAC 38.408) (Cook Inlet and North Gulf Coast waters) in March of 2002. The plan covers sport fisheries in salt waters west of the longitude of Cape Puget and commercial and personal use fisheries in salt waters west of the longitude of Cape Fairfield. The plan includes harvest rates that vary in relation to stock abundance estimates, stock abundance thresholds below which fisheries would remain closed and gear restrictions. The plan stipulates if the estimate of legal males from the department trawl survey in Kachemak Bay equals or exceeds the maximum sustainable yield (MSY) stock size of 1.0 million crab, the stock may be harvested in aggregate among commercial and recreational users at an annual exploitation rate of 25% of estimated legal male abundance. If the legal male population equals or exceeds the minimum stock threshold of 500,000 crab for a commercial fishery but is less than MSY stock size, the stock may be harvested in aggregate among commercial and recreational users at an annual exploitation rate of 15% of estimated legal male abundance.

A commercial fishery will not occur if commercial harvests would drive the population below the minimum stock threshold. It is assumed that as the allowable aggregate harvest rate increases, the commercial proportion of the harvest will increase because of relatively low efficiency of noncommercial users.

When estimated legal male Tanner crab abundance, including fishery removals, is less than 500,000 crab, no commercial harvest will occur. The noncommercial exploitation rate will be 10% when the 5-year average stock size is less than 500,000 legal male crab. When the 5-year mean of estimated legal male Tanner crab population abundance is less than 100,000 crabs, or the most recent three estimates are less than 100,000 crab, or the most recent abundance estimate is less than 50,000 crab, the noncommercial fisheries will be closed. The 5-year average is used to provide fishery stability amid high annual crab abundance variability.

When the management plan was adopted the non-commercial fishery was still open. Regulations adopted by the Board at its January 1993 meeting protect this species during its molting season were in place and included that only male Tanner crab could be taken only from July 15 through March 15, except that in Kachemak Bay east of a line from Anchor Point to Point Pogibshi male Tanner crab could be taken from July 15 through December 31 and again from January 15 or the beginning of the commercial Tanner crab season (whichever was later) through March 15. The daily non-commercial bag and possession limits were five crab. And no more than two pots could be fished per vessel. After the trawl survey in summer of 2002, the stipulations in the management plan were invoked and the non-commercial fishery closed due to the low trawl survey catch in Kachemak Bay.

Fishery Performance 2004-2007

The non-commercial fishery remains closed due to low stock abundance estimated by department trawl surveys. A substantial increased in estimated Tanner crab abundance from Kamishak Bay trawl surveys in 2006 and evidence of recruitment to the population in Kamishak Bay (K. Goldman, Commercial Fisheries Biologist, ADF&G, Homer) have led the Department to propose guidelines in the Tanner Crab Harvest Strategy to open the non-commercial fishery in waters west of Kachemak Bay, including on the outer coast of the Kenai Peninsula. Currently, regulation of areas outside Kachemak Bay is based on Tanner crab abundance in Kachemak Bay; when Kachemak Bay is closed, the remainder of Cook Inlet is closed and if Kachemak Bay opens, all Cook Inlet opens.

Recent increases in abundance of Tanner crab in Kachemak Bay and eastern Cook Inlet spell hope for opening non-commercial fisheries there.

Dungeness Crab

Fishery Description

Dungeness crab were taken in pots, primarily in Kachemak Bay east of the Homer spit. Dungeness crabs are found primarily on sandy or muddy substrates in salt or brackish water at depths usually shallower than 45 feet. Dungeness pots are lightweight and can be deployed and retrieved by hand. The fishery is currently closed because the low stock size can't support any harvest.

Historical Harvest

Sport and personal use shellfish harvest and effort estimates are available from the SWHS since 1981 (Table 7). Estimates of crab harvest and effort for Kachemak Bay and Cook Inlet are also available from shellfish permits, required beginning in 1996 (Table 30). Although hardshell clam fishery statistics from permits were biased for clams (see clam fishery section), Dungeness harvest reported on permits is fairly close to harvests obtained by the SWHS (Table 7, Table 30) and are therefore assumed to be unbiased, although the compliance of permitees by area of residence has not yet been tested for crabbers reporting on shellfish permits.

The noncommercial harvest averaged nearly 21,000 crab (44,100 pounds) through 1994 (Table 7), and then dropped by more than half to nearly 9,000 crab (18,900 pounds) from 1995 until the fishery was closed in 1998. Most of the Dungeness crab harvest reported on permits occurred in Kachemak Bay east of the Homer Spit, fewer were caught west of Homer Spit (Table 30), and the remainder was taken in Cook Inlet and from outer Gulf Coast waters.

Effort for all shellfish species combined in Kachemak Bay and lower Cook Inlet from 1981 through 1997 averaged approximately 14,800 days of fishing (Table 7). Effort was reported on permits as trips in 1996 rather than the number of people who fished. A total of 2,896 trips were made for crab in 1996 (Table 30). Analysis of individual permits reveals that only Dungeness crab were caught on 55% of those trips. Both trips and days fished were recorded on permits in 1997. Approximately 4,250 days of effort reported on permits were spent crabbing in 1997 (Table 30). People who caught only Dungeness crab accounted for approximately 20% of the effort for crab, whether effort was measured in days fished or trips. Approximately 15% of the effort was attributed to persons who caught both Dungeness and Tanner crabs. The remainder was people who caught only Tanner crab or caught nothing. Effort directed at Dungeness crab in areas that remained open to fishing was insignificant after Kachemak Bay was closed to Dungeness fishing in May of 1998.

Commercial harvest data for Dungeness crab are available since 1961 (Trowbridge and Goldman 2006). The commercial fishery was the primary harvester of Dungeness crab with a historical average harvest in the Southern District of about 612,000 pounds (Trowbridge and Goldman 2006), equating to about 290,000 crab annually (the average weight of one crab is estimated to be 2.1 pounds).

The department conducts periodic Dungeness crab pot survey in the shallows (4 to 60 feet in depth) on the north side of Kachemak Bay to monitor changes in stock status (Table 32). The pot survey indexes abundance but does not provide a means to estimate total abundance. In 1993, a dramatic decline in the department pot survey catch occurred. Estimates of Dungeness crab abundance from incidental catches in the department Tanner crab trawl survey have also been low except in 2001. when over 500 juvenile Dungeness crabs were n abundant catch of juvenile crab in the catches of all male Dungeness crab declined from 317 in 1990 to fewer than 20 crab since 1997 (Table 32). Department trawl surveys have typically caught more sublegal than legal Dungeness crab. The larger catches of juvenile crabs caught in 2001 have not persisted in recent surveys, and the surveys in 2002-2003 confirmed that populations are at low levels over a broader range (R. Gustafson, Commercial Fisheries Biologist, ADF&G, Homer; personal communication).

Fishery Management and Objectives

Dungeness crab populations are presently at low levels of abundance in lower Cook Inlet, and all commercial, sport and personal use fisheries are closed. The sport and personal use fisheries for Dungeness crab in lower Cook Inlet were closed by emergency order in 1991, but reopened from 1992 to 1998. In May 1998, Kachemak Bay was closed to sport and personal use fisheries by emergency order because the continued poor catches of Dungeness crab in department pot surveys indicated that sport and personal use harvests could be affecting the maintenance and recovery of the stock. The fishery remained closed by emergency order until the BOF closed it by regulation in 2000. Prior to the closure, Dungeness crab seasons in Kachemak Bay were from July 15 through December 31, and from January 15 or the beginning of the commercial Tanner crab season, whichever was later, through March 15. The bag and possession limit was 5 male crabs with a minimum carapace width of 6.5 inches. Pots, ring nets, diving gear, hooked or hookless hand lines or hands were legal harvest methods in the non-commercial fishery. The commercial Dungeness fishery in Kachemak Bay and eastern Lower Cook Inlet was closed by emergency order beginning in 1991 (C. E. Trowbridge, Alaska Department of Fish and Game, Homer, personal communication), although the remainder of Cook Inlet and the outer Coast remained open. Commercial Dungeness fishing was closed in all Cook Inlet areas by Board action in 1997.

There is currently no management plan for Dungeness crab and no criteria for opening the non-commercial fishery.

Fishery Performance 2004-2007

Due to the low numbers of Dungeness crab numbers in department pot surveys, last conducted in 2000 and continued low incidental catches of Dungeness crab in department trawl surveys, the fishery remains closed. A spike in the number of juvenile and female Dungeness crab in the trawl survey catch in both 2006 and 2007 (R. Gustafson, Commercial Fisheries Biologist, ADF&G, Homer; personal communication) is an encouraging sign that Dungeness crab abundance may be increasing. Persistence of significant numbers of juvenile Dungeness crabs in the trawl survey in 2008 would justify a Dungeness crab pot survey to index abundance. The results of the pot survey would indicate if the population could support any harvest.

COOK INLET RECREATIONAL HALIBUT FISHERIES

FISHERY DESCRIPTION

Pacific halibut are distributed along the continental shelf from California to the Bering Strait near Nome, Alaska (IPHC 1987). They are primarily demersal, living on or near the bottom, and prefer water temperatures in the range 3-8° C. During the summer, adult halibut are found primarily on deep banks, on the edges of gullies, on the lower continental shelf and upper continental slope, at depths from 30-300 m (IPHC 1987; Trumble et al. 1993). Sport harvest is concentrated in shallower nearshore waters of the upper continental shelf where the density of fish is lower. In winter, adult halibut move to deeper water on the upper continental slope in the 300-600 m depth range.

They are the largest of all flatfishes, reaching over 3 m (9 feet) in length and over 318 kg (700 lb). Maximum age recorded is 55 years for males and females. Age of maturity and fecundity of female halibut have changed over time (Schmitt and Skud 1978). Growth also has changed markedly over time (Clark 1996). Fifty percent of females now reach sexual maturity at about 11 years of age, or 88 cm (35 in), compared with 12-13 years and 125 cm (49 in) during the 1980s (Parma 1997). Once mature, halibut are believed to spawn every year (Trumble et al. 1993).

Migration of mature halibut is limited mainly to movements from summer feeding areas to winter spawning areas and back again. Tagging data indicate that these movements can be quite extensive (Skud 1977). Juvenile halibut between 2 and 6 years of age migrate mostly to the east and south, against the counter-clockwise flow of currents in the Gulf of Alaska. This movement counteracts the westward flow of eggs and larvae to maintain the distribution of the stock (Trumble et al. 1993).

In the LCIMA, there are two relatively distinct sport fisheries for halibut: Central Cook Inlet (CCI) and Lower Cook Inlet (LCI). The main access points in CCI include boat ramps and beach launch sites at Deep Creek, Ninilchik and Anchor Point. The CCI fleet fishes primarily the east side and central portion of Cook Inlet about as far south as the latitude of the Homer Spit. Harvest of halibut has been reported as far north as Bishop Creek and the mouth of the Kenai River, but the harvest is negligible north of Ninilchik. There is also a small harvest on the west side of Cook Inlet, mostly from charter boats originating on the east side or from lodges on the west side. The Homer harbor is the major access point for the LCI fishery, with smaller numbers of boats also originating from Seldovia and numerous private docks and clusters of vacation and permanent homes on the south side of Kachemak Bay. Boats based in Homer fish primarily in outer Kachemak Bay, in the central waters of Cook Inlet sometimes overlapping with the CCI fleet, south to the Barren Islands and Shuyak Island, and east to Port Dick. Vessels making overnight trips may venture farther to the east or south. Most of the Cook Inlet harvest occurs from May to September, with the CCI fishery waning by late August.

The recreational halibut fishery is vital to the economy in the Cook Inlet area. Halibut fishing draws vast numbers of tourists and local derbies raise money for community projects and organizations (Denny 1990). In 1986, guided and unguided anglers spent an estimated $18.5 million in Southcentral Alaska (excluding Kodiak area waters) in pursuit of halibut, and indicated a willingness to pay an additional $25 million to ensure the continued availability of halibut fishing opportunity (Jones & Stokes 1987). In a separate study, the Homer halibut charter fishery generated an estimated $9.1 million in gross income and the equivalent of 64 year-round jobs in the Homer economy in 1986 (Coughenower 1986). The most recent estimates indicate that about $19.3 million was spent in Alaska by Cook Inlet halibut charter boat clients in 1998, with $15 million of that spent in the Cook Inlet area (NPFMC 2001, page 71).

HISTORICAL HARVEST AND ABUNDANCE

The Statewide Harvest Survey (SWHS) is used as the basis of all charter and private sport harvest estimates presented in this report for halibut. Halibut harvest data was also required to be reported in charter logbooks from 1998 through 2001, but there were discrepancies between logbook harvest and SWHS estimates of charter harvest on the order of 12-42% each year (harvest reported in the logbook was greater). As a result of these discrepancies, the Alaska Dept. of Fish and Game (ADF&G) decided to discontinue collection of halibut data in the logbook beginning in 2002. That decision was eventually rescinded however, and beginning in 2006 mandatory recording of the number of halibut kept and released was once again a requirement. Harvest by charter and non-charter anglers has been estimated by the SWHS since 1986 for all Kenai Peninsula fisheries, but not for the west side of Cook Inlet. Since 1995, harvest in the West Cook Inlet reporting area has been estimated by user group and merged with the CCI and LCI estimates.

Collectively, the Cook Inlet fisheries constitute the largest discrete recreational halibut fishery in the world. Estimated harvest increased in stair-step fashion from 13,500 fish in 1977 to 218,700 fish in 2005, the highest harvest on record for halibut in the LCIMA (Table 2). Cook Inlet fisheries have accounted for 64-82% of the total Southcentral Alaska sport halibut harvest since

1990 and 44%-60% of the statewide sport harvest (in number of fish) during the period 1990-2006. In 2006, the estimated Cook Inlet sport harvest biomass was 3.24 million lb (209,442 fish).

Growth in the CCI halibut fishery was due largely to an increase in the guided component. As of the late 1980s the CCI fishery was dominated by non-charter anglers (Table 33). The charter harvest component increased from 9% to 50% during the period 1989-1994 as many Kenai River guides moved to the Deep Creek-Ninilchik area to circumvent restrictions in the early-run Kenai River Chinook salmon fishery. In addition, the CCI saltwater fishery offered opportunities to harvest halibut as well as Chinook salmon, and catch rates were reportedly high (Nelson 1995). Ninilchik was about an hour less driving time than Homer from Anchorage, and the boat ride to the fishing grounds was often shorter or smoother. Development of beach access during the early 1990s and use of tractors to launch boats at any tide stage also facilitated development of the guided fishery during that period.

Harvest in the LCI fishery has consistently exceeded that of the CCI fishery. Harvest has been quite variable, but averaged about 95,000 fish per year until 2003 when it began to gradually climb to a record harvest in 2005 (Table 2). The charter portion of the harvest has remained relatively stable at about 60-65% most years.

Halibut management agencies typically describe halibut fishery removals using net weight (headed and gutted) in pounds as the standard unit (net weight = 0.75 round weight). Harvest in pounds, or harvest biomass, is estimated by multiplying numbers of fish by estimates of average weight for each user group obtained through sampling of the recreational harvest. Average weight is estimated from length measurements using a length-weight relationship (Clark 1992). These estimates ranged from 1.08-1.45 million lb for CCI and 1.33-2.01 million lb for LCI during the period 1995-2002 (Meyer 2003, 2006).

Harvest estimates do not include catch-and-release mortality. Recreational anglers in Cook Inlet released 45-50% of the halibut they caught during the years 1998-2002. The IPHC assumes a mortality rate of 3.5% for halibut caught on longline gear using circle hooks and released in excellent condition (Kaimmer and Trumble 1998). Circle hooks are the predominant terminal gear in Cook Inlet. Not all sport-caught halibut are released in excellent condition, but on the other hand, there is no soak time associated with sport gear. Assuming the 3.5% mortality rate, an additional 4,450-6,570 halibut died each year between 1998 and 2002. Therefore, total sport removals in Cook Inlet (in number of fish) were about 1.6-1.8% higher than the harvest estimates. Although some large halibut are released by anglers for conservation reasons, it is believed that most released fish are smaller than fish that are retained. The difference in harvest biomass, therefore, is likely to be even less.

Since 1982 the International Pacific Halibut Commission (IPHC) has been estimating stock size using an age-structured model. Each year the IPHC updates the time series of commercial catch, survey catch, age composition, and other data and re-assesses the stock. There have been numerous changes to the model since the mid-1990s, mostly dealing with specification of survey selectivity (based on length or age). The changes were made in response to a long term decline in growth rate that reduced vulnerability to harvest and caused underestimation of recruitment. With each succeeding year, changes in the assessment model have resulted in increased estimates of historical biomass. An entirely new model was developed for the 2003 assessment that modeled abundance by sex, parameterized selectivity differently, and accounted for changes in the ageing method (Clark and Hare 2006).

In December 2006 the IPHC announced that recent information from tagging programs indicated that the halibut stock is more migratory than previously assumed. As a result they assessed the stock using a coastwide model, and apportioned the overall biomass among regulatory areas based on relative catch rates in the longline survey and bottom habitat area (Clark and Hare 2007). The coastwide assessment was not used to set catch limits for 2007, largely because of objections to the apportionment method used. The closed-area assessment indicated a biomass in IPHC Regulatory Area 3A (Kodiak to Cape Spencer) at the end of 2006 of about 159 M lb. The biomass has been on a downward trajectory since the late 1990s, the result of relatively weak recruitments and lower growth rates in recent years.

FISHERY MANAGEMENT AND OBJECTIVES

Halibut are managed in state and federal waters primarily by federal agencies, the IPHC and the North Pacific Fishery Management Council (NPFMC, or Council). The IPHC was established in 1923 by a convention between Canada and the United States. The IPHC conducts research on halibut biology and population dynamics throughout the range of the stock, determines the harvest strategy, and sets allowable levels of harvest annually in each of ten regulatory areas. The NPFMC was one of eight regional fishery councils created under the Magnuson Fisheries Conservation and Management Act of 1976. The NPFMC is responsible for allocation of the halibut resource in state and federal waters among competing user groups. Although the State of Alaska does not have direct management authority for halibut, the state has an active role in the Council process. The Magnuson-Stevens Fisheries Conservation and Management Act, amended 1996, provides that the Commissioner of ADF&G (or designee) is a voting member of the NPFMC.

Other agencies are involved in halibut management. The National Marine Fisheries Service (NMFS) writes regulations to convert Council motions to law, and is responsible for implementation and enforcement of federal regulations. The Alaska Board of Fisheries (BOF) can adopt federal halibut regulations, and can also adopt state regulations that may impact halibut fisheries as long as those regulations are not specifically for halibut and do not conflict with federal regulations.

ADF&G Sport Fish Division collects information on the recreational harvest and provides it to federal management agencies. This is done through the region-wide halibut and groundfish harvest monitoring (port sampling) program, which was begun in 1991 (Meyer 1992, 1993, 1994; Meyer 1996; Meyer 2003; Meyer 2006). Sampling of the sport harvest and interviews with anglers and charter captains in the LCIMA are conducted in the Homer harbor, and at the Anchor Point and at the Deep Creek beaches from mid-May through the end of August or early September.

The State of Alaska does not have direct management authority over halibut in Alaska waters. The 1953 Halibut Convention, as amended by the 1979 Protocol, mandates that the IPHC manage the stock on the basis of optimum yield (McCaughran and Hoag 1992). The term "optimum yield" is not explicitly defined in the Halibut Convention, but is commonly interpreted to imply consideration of food production, recreational opportunity, protection of the ecosystem, and other social and economic benefits. In addition to the management goal of optimum yield, the IPHC strives to maintain high, stable yields with a low risk of stock collapse (IPHC 1987; page 40).

The ADF&G objective with respect to halibut management is to provide the agencies (IPHC, NPFMC, and BOF) with the best possible information regarding the recreational halibut fishery, so that management and allocation decisions can be made that optimize the social and economic benefits of the fishery to the State of Alaska. The sport fishery is regulated throughout Alaska using daily bag and possession limits and a closed season.

The IPHC first adopted regulations for the sport fishery in 1973, at the request of the State of Alaska and the NMFS. The BOF adopted the IPHC regulations for the sport fishery in 1975. Between 1975 and 1988 there were a number of changes to the regulations, including changes to the open season and bag and possession limits. In 1988 the BOF adopted an IPHC regulation that prohibits cleaning or disfiguring halibut in a manner that prevents determination of the number of fish caught or possessed.

Neither the IPHC nor Alaska halibut sport fishing regulations have changed since 1988. The bag limit remains at 2 fish daily, the possession limit is 4 fish, there is no minimum size, and other special regulations regarding cleaning and possession of sport and commercial-caught fish apply statewide. Bag and possession limits are found in 5 AAC 58.022. Halibut special regulations apply statewide and are found in 5 AAC 75.070. State statutes regarding licensing for sport fishing (AS 16.05.340-430) also apply to the sport halibut fishery. Rules governing charter registration and logbooks are found in statewide sport fishing regulations, 5 AAC 75.075-076.

Over the years, halibut sport harvest has grown unconstrained by catch quotas such as those placed on the commercial longline fishery. Individual fishing quotas (IFQs) were implemented for the commercial longline fishery in 1995, providing fishermen a percentage share of the longline quota. Sport harvest is currently taken off the top of the total allowable harvest before the commercial quota is set. As a result, long-term increases in the sport harvest have caused allocation conflicts between commercial and sport user groups which date back to the early 1990s.

Many years of deliberations among stakeholders eventually led the NPFMC to pursue the adoption of policies designed to resolve these halibut allocation conflicts on a permanent basis. Chief among these was the adoption of a guideline harvest level (GHL) that went into effect in September 2003, and a plan to incorporate the charter fleets in Southcentral and Southeast Alaska into the existing IFQ program. The IFQ plan, once implemented, would replace the GHL. The NPFMC revisited that decision in December 2005, largely because of concerns over recency of the data that would be used to award quota shares. The NPFMC then passed a motion that replaced the IFQ program with a suite of alternatives for management of the charter fleet, including a moratorium, limited entry, direct allocation, and another IFQ program that incorporated recent fishery entrants. In March 2007 the NPFMC passed a motion to implement a moratorium on halibut charter boats and set a Control Date of December 9, 2005. The moratorium is expected to be in place by 2009 at the earliest.

The Area 3A sport charter boat fishery is currently managed under a GHL of 3.65 M lb. If the GHL is exceeded, the NPFMC can initiate a process to identify and implement control measures. The GHL was exceeded in 2004 by 0.5%, and in 2005 by 1.1% and consequently the Council approved an analysis of alternatives designed to bring the Area 3A charter fleet under the GHL in subsequent years. Although the 2006 harvest in Area 3A dipped slightly and was essentially right at the GHL, efforts to control future harvests were already underway. Final decisions on the proposed alternatives were to have been decided during the Council meeting of October 2007, but in light of lower halibut harvest in 2006 those decisions were postponed until October of 2008 when another year of data would be available to assess harvest trends.

The history and issues associated with regulation of the sport fishery, as well as the history of the GHL and IFQ decision process, are summarized in greater detail in Meyer and Stock (2002).

Changes in halibut growth rates and exploitable biomass, changes in stock assessment procedures, and allocation conflicts all underscore the need for continuing recreational halibut harvest monitoring by ADF&G.

FISHERY PERFORMANCE 2004-2006

As of January 2004 the exploitable biomass of halibut in Area 3A was believed by the IPHC to be at an intermediate level of about 146 million pounds and on a downward trajectory, which was attributed to relatively weak recruitments through most of the 1990s. Growth rates are also much lower than they were 20 years ago, so fish are smaller at age and therefore less vulnerable to the fishery (Clark and Hare 2004).

Even though the exploitable biomass is on a downward trajectory throughout Area 3A, sport harvest of halibut in the LCIMA has continued to climb. The record harvest of 2005 surpassed the previous record in 2000 by nearly 20,000 fish. Although the 2006 harvest dropped and was nearly the same as the 2004 harvest, three year averages for the most recent time periods (2001-2003 compared with 2004-2006) shows an increase of over 30,000 fish. This sharp increase in the harvest coincides with proposals and actions by the NPFMC to regulate the sport charter industry, and may be a reflection of increased participation in the fishery by those who feared they might be precluded from doing so had they not started fishing prior to implementation of an IFQ plan, or a moratorium. While IFQ plans are still being reviewed by the NPFMC, a moratorium on new entrants has already been adopted with a Control Date of December 9, 2005. Presumably, the number of participants in the sport charter halibut fishery will now be stabilized at 2005 levels, and the total charter harvest will stabilize somewhat as well.

Other factors may have been at least partly responsible for observed increases in the guided sector harvest in 2004 and 2005. For example, in 2004 it was assumed that extensive wildfires in the interior of the state induced many vacationers, resident and non-resident alike, to spend relatively more time fishing from coastal ports while seeking relief from widespread, persistent smoke. In 2005, unusually good weather and favorable seas for much of the tourist season provided particularly good fishing conditions and were thought to be the reason for the spike in halibut harvest throughout Area 3A that year. Conversely, 2006 exhibited more typical weather patterns and the number of days when charter vessels were able to access the best fishing areas was greatly reduced compared to the previous year. Also in 2006, a sharp increase in the price of fuel probably reduced the overall number of anglers who either did not want to incur the extra expense of traveling to reach their port of departure, or they did not want to pay the increased cost of a charter trip, or both. Finally, it is possible that prospective new entrants in the charter halibut fishery may have been dissuaded from starting their new business in 2006 because the Control Date for the moratorium had already passed.

Halibut harvest from the unguided sector of the sport fishery has remained relatively stable in the LCIMA for the past decade. However, as the NPFMC regulatory package regulating the charter fishery for halibut becomes fully implemented in the coming years, it is possible there will be an upward trend in the level of participation in the unguided sector.

COOK INLET SPORT ROCKFISH FISHERY

FISHERY DESCRIPTION

At least 30 species of rockfish, genus *Sebastes*, inhabit the Gulf of Alaska. Fourteen species have been identified in the recreational harvest from the LCIMA since 1991, but three species—black, dusky, and yelloweye rockfish—typically make up over 90% of the harvest.

Rockfishes are categorized into three assemblages based on habitat preferences (Table 34). Species within each assemblage are biologically similar. The pelagic shelf assemblage consists of species that inhabit waters of the continental shelf and typically exhibit midwater schooling behavior. All appear "bass-like" in appearance and are commonly referred to as "black bass" or "sea bass." Black and dusky rockfish are the primary pelagic shelf species in the Cook Inlet sport harvest. Formerly there were two forms of dusky rockfish, including a nearshore, typically smaller "dark" form, and an offshore, deeper-dwelling "light" form. These forms are combined in this report, although Orr and Blackburn (2004) have recently recognized them as two species, the dusky and dark rockfish. The demersal shelf assemblage consists of species that inhabit the continental shelf and are typically associated closely with bottom habitat. They are usually solitary or occur in small groups. Yelloweye rockfish are the most frequent demersal shelf species in the Cook Inlet recreational catch, but quillback, canary, tiger, and China rockfish are also occasionally taken. Finally, the slope assemblage includes bottom-dwelling species typically found in deep trenches or the offshore waters of the continental slope. Rougheye and shortraker rockfish are typical slope species found in Cook Inlet but are rarely harvested in the sport fishery. For purposes of managing the recreational fishery, however, only two assemblages are defined in sport regulations (5 AAC 75.995): pelagic and non-pelagic. The pelagic assemblage includes black, dusky, dark, widow, yellowtail, and blue rockfish, and the non-pelagic assemblage includes all other species.

Most rockfishes are characterized by extreme longevity. Maximum age for some species exceeds 100 years (Munk 2001). Maximum ages and lengths observed in the Cook Inlet sport harvest vary considerably among species (Table 34). The oldest rockfish observed in the Cook Inlet sport harvest since 1991 was a 100-year-old yelloweye. Ages of most black rockfish taken in the sport fishery are in the range 7-25 years, compared with 5-40 years for dusky rockfish and 15-60 years for yelloweye rockfish (Meyer 2000). Although slope species do get very old, most of the slope rockfish taken in the sport fishery are juveniles and are relatively young.

Rockfishes have low instantaneous rates of natural mortality (M), a trait that is necessarily associated with longevity. Low natural mortality rates indicate low productivity, meaning that allowable levels of harvest are small relative to the stock size, and stocks will be extremely slow to recover if overfished. Natural mortality estimates are available only for selected species: Estimates of annual natural mortality rates used in recent stock assessments were 14-24% for black rockfish in Washington (Wallace and Tagart 1994; Wallace et al. 1999), 2-4% for yelloweye rockfish from Oregon to Southeast Alaska (O'Connell et al. 2003), and 9% for dusky rockfish (Lunsford et al. 2003).

Tagging studies suggest that pelagic rockfishes move around more than demersal species, and that several species have a high degree of site fidelity. In one study, nearly 1,900 tagged black rockfish were recaptured out of over 52,000 fish tagged off the Washington coast. Of these, 62% were recaptured at or near their release site, and 79% within 10 miles of their release site (F. Wallace, Washington Department Fish and Wildlife, 1996, personal communication). In a

Southeast Alaska study, displaced yellowtail rockfish returned to their capture site from as far away as 22.5 km, some after displacement to other schools of the same species and some after 3 months in captivity (Carlson and Haight 1972). Yelloweye rockfish in Southeast Alaska were recaptured in the same area they were tagged up to 3 years later (O'Connell 1991). In another study, all recaptured copper and quillback rockfish and 63% of recaptured black rockfish were recovered at or near their tagging site up to 2.5 years after tagging (Mathews and Barker 1983). Mathews and LaRiviere (1987) noted that demersal species had small home ranges and were more likely to return to high-relief rocky areas than low-relief areas.

Rockfishes mate and fertilize eggs internally. Eggs incubate and hatch within the ovaries, and larvae are born when only a few millimeters long. Female rockfishes are believed to release a single brood annually. Timing of maturation, fertilization, and birth have not been rigorously estimated for black, yelloweye, or dusky rockfish in the Gulf of Alaska. The age at which 50% of fish are mature has been estimated at 7-10 years for black rockfish (ADF&G unpublished estimates), 11 years for dusky rockfish (Lunsford et al. 2003), and 18 (male) to 22 (female) years for yelloweye rockfish (O'Connell et al. 2003).

All *Sebastes* have unvented swim bladders and sustain embolism and other decompression trauma injuries when brought to the surface from depths greater than about 15 m. This life history trait results in high bycatch mortality in sport and commercial fisheries, complicates management, and is an obstacle to efficient stock assessment.

The State of Alaska has management authority for all recreational rockfish fisheries in state waters as well as federal waters of the Exclusive Economic Zone (EEZ). State regulations apply in the EEZ because the NPFMC's Gulf of Alaska Fishery Management Plan does not address any recreational groundfish fisheries. Section 306 of the Magnuson-Stevens Fisheries Conservation and Management Act, amended in 1996, allows the state to regulate sport vessels in federal waters in the absence of a plan for the sport fishery.

Most rockfish are caught in state waters (within 3 nautical miles of shore) on the east side of Cook Inlet and around the Barren Islands. The directed fishery for rockfish is extremely small; most rockfish are taken incidentally to fishing for other species or while targeting rockfish only after fishing for other species. Interview data gathered in Central and Lower Cook Inlet during the three-year period 2004-2006 show that nearly all pelagic and non-pelagic rockfish were harvested by anglers that reported targeting halibut, bottomfish, or bottomfish and salmon (Table 35).

The economic value of the recreational rockfish fishery in Cook Inlet is unknown. As is the case with effort, the economic value of rockfish fishing is not entirely separable from halibut because most of the harvest is incidental to halibut fishing.

HISTORICAL HARVEST AND ABUNDANCE

Estimates of harvest in Cook Inlet have risen from about 2,000-4,000 rockfish (all species) per year in the late 1970s to around 11,500 in 2005 (Table 36). Harvest averaged about 5,400 fish over the period from 1994 to 2003, but has increased significantly since then. Average harvest during the period from 2004 to 2006 was over 10,200 fish. The Cook Inlet harvest has made up 7-13% of the Southcentral Region recreational rockfish harvest since 1990. In numbers of fish, the charter component has accounted for 0-96% of the Central Cook Inlet harvest and 26-56% of the Lower Cook Inlet harvest since 1986 (Table 37). Black and dusky rockfish are regularly caught in outer Kachemak Bay, either as a target species or incidental to halibut or salmon fishing. All species regularly occurring in the LCIMA are taken along the outer Kenai Peninsula coast, and around the Chugach Islands.

The accuracy of rockfish harvest estimates from the SWHS is questionable. The biggest concern is with the magnitude of estimated harvest in the Central Cook Inlet fishery (Anchor Point and northward). Harvest in this fishery has been estimated at 200 to 1,900 fish per year since 1986 (Table 37). From 1995 to 2001, however, only one rockfish was reported harvested in over 4,500 vessel-trip interviews. It is unknown whether this estimated rockfish harvest was made up of other species such as sculpins or greenlings that were misidentified as rockfish, or rockfish that were actually taken in Lower Cook Inlet and reported in Central Cook Inlet by SWHS respondents. Only since 2002 has interview data from Anchor Point indicated that some of those anglers are harvesting rockfish from Lower Cook Inlet waters.

Harvest biomass (pounds round weight) has been estimated since 1991 by integrating SWHS and port sampling data from Homer (Table 38). Estimates were computed as the product of SWHS estimates of the number of fish harvested, the proportion of harvest by assemblage, and the average weight by assemblage. Assemblage composition and average weight were obtained from port sampling in Homer. Total harvest has ranged from 18,700 lb in 1991 to 71,900 lb in 2005. Pelagic rockfish have a lower average weight, and as a result, make up a larger percentage of the harvest in number than by weight.

Because rockfish are caught incidental to other fisheries, most of them are released. The numbers of rockfish released each year in Cook Inlet generally exceed the number retained (Figure 8). The magnitude of the release component is important because of the potential for high immediate or delayed mortality. Release mortality has not been estimated but is believed to be higher for non-pelagic species than for pelagic species, primarily because pelagic species generally inhabit shallower waters and are more often caught in salmon troll fisheries. Rockfish caught in less than 15 m of water generally have a high probability of survival when released. Port sampling interview data collected in Homer since 1995 show that pelagic species made up 95-100% of the rockfish released each year.

There are not at present any widely applicable fishery-independent methods available to assess rockfish stocks exploited in nearshore waters of Southcentral Alaska. Line transect counts from manned submersibles have been used in Southeast Alaska to assess the demersal rockfish fishery (O'Connell et al. 2003) but these surveys are expensive and difficult to apply over large areas. For the time being, annual monitoring of recreational and commercial harvest composition is the most cost-effective method of looking for changes in stock status.

Fishery Management and Objectives

The department manages the sport rockfish fishery in state and federal waters on the constitutionally mandated sustained yield principle. Within this principle, the Division of Sport Fish seeks to optimize social and economic benefits, and where possible, to provide expanded opportunity to participate in diverse fisheries. The department and the BOF have attempted to take a conservative approach to management of rockfish fisheries in Cook Inlet and the rest of Alaska. Sport bag limits have been reduced during the last decade in recognition of the failure of other Pacific rockfish fisheries (see below) and the life history variables that make rockfish susceptible to overharvest. More restrictive bag limits have been set for the longer-lived and less productive non-pelagic species to discourage targeted harvest, while still allowing for retention of incidental catch. Seasons or size limits for rockfish have not been implemented because of mortality from decompression trauma. Along with regulation changes, efforts have been made to educate anglers regarding the risks and consequences of rockfish overharvest, and to foster fishing practices that avoid bycatch and waste in the sport fishery.

Harvest of pelagic species, however, continues to increase in some fisheries due to increases in effort or declines in other target species. It is unknown whether the bag limits, combined with management measures for commercial and subsistence fisheries, are adequate to maintain these fisheries for the long term. The projected decline in halibut stocks and moratorium on halibut charter boats is anticipated to result in more targeting of rockfish in the sport fishery. In addition, implementation of individual quotas for charter boats may result in increased targeting of rockfish by charter operators that do not qualify for quota share.

The sport rockfish fishery in Cook Inlet was unregulated until 1973 when the BOF adopted limits of 10 fish daily and 10 in possession for the Cook Inlet-Resurrection Bay Saltwater Area. In 1989 the BOF revised the Cook Inlet-Resurrection Bay Area bag limit to five rockfish per day, 10 in possession. In 1995 the BOF approved an ADF&G proposal to limit harvest of non-pelagic (demersal and slope) species, recognizing the relative difference in productivity between these groups. Even though increasingly conservative steps have been taken to curtail harvest and manage bycatch and waste, it is unknown whether these efforts are providing optimum yield or adequately protecting rockfish populations.

The current regulations, effective since 1996, include a year-round season, daily bag limit of 5 rockfish per day and possession limit of 10 rockfish, of which no more than 1 daily and 2 in possession may be non-pelagic species. Bag and possession limits, special restrictions, and state authority in the EEZ are found in area regulations in 5 AAC 58. The terms "rockfish," "non-pelagic rockfish," and "pelagic rockfish" are defined in statewide regulations, 5 AAC 75.995. Charter operators are required to report the numbers of pelagic and non-pelagic rockfish kept and released daily in logbooks, and those regulations are outlined in 5 AAC 75.076.

The status of rockfish stocks in Cook Inlet is for the most part unknown. Because this is mostly an incidental fishery, little has been invested in rockfish research in Lower Cook Inlet. Virtually nothing is known of fish movement or stock structure, no analytical stock assessment has yet been done, there is substantial uncertainty in the harvest estimates, and catch and release mortality is unknown. No index of relative abundance, such as catch per unit effort (CPUE), has been developed using fishery data. This is partly because fishery CPUE for rockfish tends to be hyperstable, or remain high as the stock declines, and partly because most rockfish are taken incidentally, so there is no measurement of effective effort. No surveys have been conducted in Cook Inlet in order to obtain a fishery-independent estimate of relative abundance. Information on locations and quantity of rockfish habitat, and spatial or depth distribution by species are also lacking.

There are, however, rudimentary indicators of the condition of the rockfish stock(s). Despite a steady growth in recreational harvest, there is no obvious trend in the average length or average weight of black, dusky, or yelloweye rockfish harvested in the sport fishery (Figure 9). In addition, there is broad representation of ages in the black and yelloweye rockfish harvest, and no obvious truncation of these distributions due to excessive harvest over time (Figure 10). Therefore, if past levels of harvest have exceeded surplus production, they have not done so by a large amount.

Age composition data do show, however, that relatively large year classes are the exception. The 1991 year class of black rockfish was relatively large, but the previous large year class to recruit was at least 10 years earlier. Recruitment variability is common in rockfish, and reinforces the principle that allowable levels of harvest have to take natural variability into account, and that fisheries should be managed to maintain a diversity of age groups in the population in order to buffer the natural variability in production.

Overfishing is by far the primary management concern for rockfish. These concerns are largely based on rockfish life history characteristics such as extreme longevity, relatively late age at maturity, high recruitment variability, and susceptibility to mortality from decompression trauma (Leaman and Beamish 1984; Munk 2001; Parker et al. 2000). Many species recruit to the fishery before reaching sexual maturity, and fisheries develop on the standing stock rather than on the surplus production. Removal of the older spawning stock reduces spawning biomass, further inhibiting population recovery.

Substantial declines in rockfish abundance have been documented from California to Alaska over the last 40 years. Pacific ocean perch, bocaccio, canary rockfish, darkblotched rockfish, widow rockfish, cowcod, and yelloweye rockfish are declared overfished by federal managers and are under rebuilding plans off the west coast (NMFS 2004). No federally managed rockfish stocks in Alaska are declared overfished, but most species are not assessed. Foreign fleets overfished Pacific ocean perch in the Gulf of Alaska during the 1960s (Bracken 1986) and off the coast of British Columbia during the period 1965-1974 (Archibald et al. 1983). While Pacific ocean perch are recovering, many other rockfish stocks in British Columbia have experienced heavy commercial and recreational fishing since the mid-1980s and rockfish in the Strait of Georgia are considered to be over-utilized and declining (DFO 2000). The copper rockfish population in the main basin of Puget Sound has declined over the last four decades with overharvesting considered a major factor (NMFS 2001).

Given the difficulties and failures of rockfish management elsewhere, Alaskan rockfish stocks are not immune to overexploitation. Despite the restrictions that have been progressively placed on sport and commercial rockfish fisheries in Southcentral Alaska, the department still lacks much of the information needed to assess stock status and the effectiveness of these management measures.

Because rockfish are taken as bycatch in other directed fisheries and suffer high mortality from decompression trauma, management actions taken in other fisheries can directly affect rockfish management. With implementation of the commercial IFQ fishery for halibut in 1995, it was suspected that many boats would fish halibut closer to port, raising harvest and unreported discards of nearshore rockfishes. Whether this occurred is a topic of debate. It is usually impractical or politically difficult to control rockfish bycatch in target fisheries for other species that are relatively more abundant, have higher rates of surplus production, or are economically more important.

Incorporation of the sport charter fleet into the existing halibut IFQ program would be expected to result in increased levels of targeting of rockfish. Charter vessels that do not qualify for adequate halibut quota share and those that wish to maximize the value of their halibut quota are expected to satisfy customer demand with rockfish and other state-managed species.

The number of management options for rockfish fisheries is limited, primarily because of the limitations put on assessment and management by mortality from decompression trauma. This mortality prevents or complicates conventional assessment methods, results in underestimates of fishery removals, and prevents implementation of traditional management measures such as seasonal or area closures, size limits, and gear limits.

Marine protected areas (MPAs), and marine reserves (areas closed to all removals) in particular, are a promising potential management tool to provide for sustained yield of long-lived marine fishes such as rockfish (Pitcher 1997; Yoklavich 1998). The American Fisheries Society recommends establishment of marine reserves for rockfish management, and recognizes that they should have specific goals and should undergo periodic evaluation (Parker et al. 2000). Murray et al. (1999) recommend establishing reserve networks, or groups of relatively small, strategically placed closed areas. Reserves and reserve networks have numerous potential benefits over traditional management tools (Bohnsack et al. 2004).

There are potential drawbacks to implementing marine reserves as a management tool for any species. Many commercial and recreational user groups are opposed to the loss of fishing area and are skeptical of the potential benefits (Bee 2000;Crow 2000). Shipp (2004) argues in favor of traditional fishery management tools for most major exploited fish stocks, but does acknowledge that reserves could be beneficial in rebuilding overfished stocks that are not too mobile, and where bycatch mortality of non-targeted species is excessive. Punt and Methot (2004) point out that if reserves are successful and result in local concentrations of increased abundance, this will pose new challenges for stock assessment. Most stock assessments assume a relatively even distribution of the stock. One often overlooked aspect of implementing a reserve system is that effort and harvest are concentrated in the remaining open waters and need to be reduced, at least initially, in order to maintain current levels of exploitation.

The use of marine reserves as a management tool for rockfish in Alaska was suggested many years ago for rockfish management in Southeast (Bracken Unpublished) and Southcentral Alaska (Vincent-Lang 1995a, 1995b). More recently, several BOF proposals from the public called for establishment of marine reserves to protect rockfish and other long-lived marine species. This led to the formation of the ADF&G Marine Protected Areas Task Force in November 2001. The task force released a report to the BOF in July 2002 that outlined recommendations for a public process of dealing with MPA proposals (ADF&G 2002). This report also included discussion of marine protected area programs outside of Alaska, including descriptions of regulatory frameworks and evaluations of existing reserves. After considerable public comment, the BOF decided to adopt an MPA policy. ADF&G staff drafted a policy and submitted it to the BOF in December 2002. In March 2003, the BOF put all work on MPAs on hold indefinitely, citing new BOF appointments due to a change in administration, and a demanding meeting schedule, as impediments to further work. The BOF has not addressed the issue of MPAs since.

FISHERY PERFORMANCE 2004-2006

Cost effective, fishery independent surveys for rockfish in the LCIMA and the Gulf of Alaska are not presently available. Instead, the fishery dependent SWHS has been used since 1977 to estimate the recreational harvest, catch, and effort for the primary species of interest, including rockfish. Recreational harvest biomass (pounds round weight) has also been estimated since 1991 by integrating SWHS estimates of the number of fish taken and estimates of species composition and average weight by species assemblage from port sampling (Table 38).

Rockfish harvest in 2004 from Lower Cook Inlet was estimated at 9,756 fish, about 2000 fish more than the previous year, and the highest harvest on record for this fishery. As noted in the halibut section of this report, efforts by the NPFMC to contain the charter halibut harvest by adopting a GHL, an IFQ plan, and a moratorium on new entrants to the fishery probably influenced the level of participation by charter vessels operating out of Homer. As participation in the halibut fishery increased, harvest for all groundfish species went up, including rockfish. Recreational anglers targeting halibut or any combination of bottomfish frequently will retain rockfish when they are caught and consider them a bonus to their bag limit of halibut. Also, once a vessel targeting halibut has achieved their bag limit, they will often specifically target rockfish for a portion of their trip.

The recreational harvest of rockfish in the Central Cook Inlet fishery in 2004 was 577 fish. This level of harvest was well within the normal range for that fishery. Anglers departing from the beaches of Anchor Point and Deep Creek primarily fish in waters with few rockfish present and are nearly exclusively targeting halibut and salmon. The few rockfish that are incidentally caught are mostly black or dusky rockfish, are not retained.

The estimated rockfish harvest in Lower Cook Inlet in 2005 was 11,607 fish, another record harvest and an increase of nearly 2000 more fish than the previous year. Participation in the fishery was at a peak. Continued interest and concerns among charter vessel operators about an IFQ plan, a proposed vessel moratorium, and GHL issues were all hotly debated throughout the summer, and by the end of 2005 preliminary SWHS estimates indicated the GHL for halibut had again been exceeded, and a moratorium was in place. In conjunction with the high level of interest among those wanting to get into the fishery before it was "shut down" to new entrants, favorable weather and calm seas allowed unusually easy access to a large portion of the Lower Cook Inlet fishing area. While halibut was the primary target for the vast majority of those anglers, the harvest of rockfish, both targeted and incidental can be attributed to more angler days of effort.

An increase in harvest was also observed in the Central Cook Inlet fishery, although total harvest was still only a modest 840 fish.

There was a decrease in the total rockfish harvest in both the Central and Lower Cook Inlet fisheries in 2006. Much less favorable weather during the months of June through August kept both guided and unguided vessels closer to port and put a damper on fishing activity regionwide. Also, with the halibut charter moratorium in place, the sense of urgency on the part of new entrants to get into the fishery may have diminished somewhat.

COOK INLET RECREATIONAL LINGCOD FISHERY

FISHERY DESCRIPTION

Lingcod are distributed from the Alaska Peninsula south to Baja California (Cass et al. 1990). In Cook Inlet, they are common along the outer Kenai Peninsula from Gore Point to the Chugach Islands and around the Barren Islands, and occasionally juveniles are found in Kachemak Bay and as far north as Anchor Point. While adult lingcod can be found to depths of 400 m, they more typically inhabit nearshore rocky reefs from 10-100 m (Cass et al. 1990).

Lingcod are moderately long-lived, although they are a relatively fast growing, productive species. Lingcod in Southcentral Alaska commonly reach lengths of 130 cm and weights of 23 kg (50 pounds). Maximum age is 25 years (Munk 2001) but most lingcod taken in the Cook Inlet fishery are 8–20 years old. Growth is relatively rapid, with males and females reaching lengths of 50-60 cm by age 4 (Meyer 1992). Natural mortality has not been rigorously estimated anywhere in Southcentral Alaska, but methods based on life history parameters (Alverson and Carney 1975; Pauly 1980; Hoenig 1983) provide estimates of annual natural mortality in the range 16%-19% for females and 13%-23% for males (unpublished data).

Age and length at maturity are not well documented in Alaska. In a study in Southeast Alaska, 50% of females were mature at about 83 cm (Gordon 1994). Age and length at maturity in British Columbia lingcod ranges from 3-5 years or 61-75 cm for females and 2 years and 50 cm for males (Cass et al. 1990). Fecundity increases with both size and age.

The exact timing of lingcod spawning and egg development in Southcentral Alaska is unknown. The nesting period extends to late April through May in Southeast Alaska (O'Connell 1993). Females choose nest sites between 2 and 97 m in depth (Cass et al. 1990; O'Connell 1993) and deposit their eggs in crevices in rocky areas with strong tidal currents or wave action. After spawning, females return to deeper water leaving the male to guard the nest for the next 5 to 11 weeks. Nest guarding is essential to protect the eggs from predatory invertebrates and fish (Low and Beamish 1978), and aggressive males are especially vulnerable to capture during the nest-guarding period. Newly hatched larvae are approximately 7–10 mm long (Cass et al. 1990). Initially, they are relatively passive and move with surface ocean currents, but eventually sink to the bottom in kelp or eelgrass beds. As the fish grow they move from nearshore habitats to flat-bottomed areas, and finally to rocky habitats similar to those preferred by adults.

Results of tagging studies have indicated the majority of adult lingcod are fairly sedentary and do not wander far from their home reef (Barss and Demory 1989; Jagielo 1990). Some tagged individuals do appear to move considerable distances however, and have been recovered over 50 kilometers from their original tagging location (Mathews and LaRiviere 1987; Jagielo 1990). Some studies have indicated there is a general seaward pattern to these movements, perhaps in association with the end of the spawning and nesting period.

The sport fishery is the primary source of removals in the LCIMA. Most lingcod are caught in state waters, around the Barren Islands and along the Kenai Peninsula coast south of Point Pogibshi. Sublegal-size fish are also reportedly caught occasionally by salmon trollers in portions of Kachemak Bay and in Cook Inlet near Anchor Point. Very few anglers target lingcod exclusively, and as with rockfish, most lingcod are taken by anglers targeting other species or targeting lingcod in conjunction with other species. Lingcod was the target species for only two of 1,706 vessel-trip interviews from Homer during the period 2004-2006, and 93% of the lingcod harvest was by anglers targeting halibut or bottomfish.

The economic value of the recreational lingcod fishery in Cook Inlet is unknown. As with rockfish, the economic value of lingcod is not separable from halibut because most of the harvest is incidental to halibut fishing.

Historical Harvest and Abundance

The status of the lingcod population in Cook Inlet is unknown. There is no stock assessment, no proven index of abundance, and considerable uncertainty regarding the sport harvest estimates. Some basic fishery information may provide clues to stock status, however. The estimated average weight increased from about 23 lb in 1993, the first year with a minimum size limit, to over 30 lb in recent years. This increase could be due to a lack of recruitment, but this is not apparent in the estimates of age composition from the sport harvest (Figure 11). Instead, it appears there has been a broad range of age classes represented in the harvest and fairly consistent recruitment. The strong 1989 year class continued to contribute to the harvest even as 17-year-olds in 2006.

As with rockfish, estimates of recreational lingcod harvest from the SWHS are questionable. Concerns center on potential misreporting of other species as lingcod, and misreporting the area of harvest. According to the SWHS, Central Cook Inlet has accounted for up to 40% of the total Cook Inlet harvest (Table 39) but very few lingcod have been documented by ADF&G port samplers or creel survey crews stationed at Deep Creek and Anchor Point during May-August every year since 1994. The SWHS is believed to overestimate the percentage of lingcod harvest taken by non-charter anglers in Lower Cook Inlet. For the period 1995-2002, SWHS estimates show that non-charter anglers accounted for an annual average of 34% of the Lower Cook Inlet harvest. On the other hand, the estimate from port sampling interview data is only 12%. Part of the problem may be that anglers are reporting charter harvest in the unguided section of the SWHS questionnaire. Anglers may also be confusing Pacific cod *Gadus macrocephalus* with lingcod. It is unknown to what extent the problems are caused by misidentification or misreporting of the area fished.

Fishery Management and Objectives

The department manages the sport lingcod fishery in state and federal waters on the constitutionally mandated sustained yield principle. Within this principle, the Division of Sport Fish seeks to optimize social and economic benefits, and where possible, expand opportunities to participate in diverse fisheries. Lacking a comprehensive stock assessment, ADF&G and the BOF have adopted a precautionary approach for management of the sport lingcod fishery. In Cook Inlet the approach includes a conservative bag limit, a minimum size limit designed to allow fish to spawn prior to harvest, and closed seasons to protect spawners and nest-guarding males. The department is working toward a comprehensive stock assessment for lingcod that will incorporate the available time series of harvest information from sport and commercial fisheries, including age and size data, and provide estimates and strategies for optimizing harvest.

The Cook Inlet recreational lingcod fishery was unregulated before 1987. In that year the BOF established a daily bag and possession limit of 2 lingcod for the Cook Inlet-Resurrection Bay Saltwater Regulatory Area in response to concerns over increased harvest, mainly in the Seward area. In 1992 the BOF adopted a suite of regulatory measures for the entire Cook Inlet-Resurrection Bay Regulatory Area, again largely in response to declining recruitment of lingcod in the North Gulf fishery (Meyer 1992; Vincent-Lang and Bechtol 1992). Changes that applied to the Cook Inlet portion (waters west of Gore Point) included: (1) establishing a closed season of January 1-June 30 to protect spawning and nest-guarding lingcod, (2) establishing a minimum size limit of 35 inches total length, and (3) specifying that lingcod may only be landed by hand or with a landing net.

In 1995, the state extended its regulatory authority for sport fisheries into federal waters of the EEZ off Alaska through an emergency regulation. Section 306 of the Magnuson-Stevens Fisheries Conservation and Management Act, amended 1996, allows the state to regulate sport vessels in federal waters in the absence of a plan for the sport fishery. In 2003 the restriction on the use of gaffs for lingcod was lifted with passage of a statewide gaffing regulation.

Current regulations in the LCIMA include an open season of July 1-December 31, a bag and possession limit of two lingcod, and a minimum size limit of 35 inches (28 inches with the head removed). Only marine fishes that are not regulated by bag or size limits may be used for live bait. Anglers may gaff only legal-size lingcod that they intend to harvest during the open season. Charter operators are required to report the number of lingcod kept and released daily in logbooks. Bag and possession limits, special restrictions, and state authority in the EEZ are found in area regulations in 5 AAC 58. Regulations outlining ADF&G Emergency Order authority, gaffing and waste, and the charter logbook program are outlined in 5 AAC 75.

Given the lack of stock status information, management concerns center around whether current levels of harvest are sustainable, whether the current regulations represent an optimal harvesting policy, and the potential effects of other fishery changes on future lingcod harvest.

Although there are no clear signs of overfishing in Southcentral Alaska, lingcod stocks are vulnerable to overfishing and have been overfished elsewhere. Lingcod in Washington, Oregon, and California are considered overfished, and the fishery was managed under a 10-year rebuilding program (PFMC 2004). Lingcod in the Strait of Georgia, British Columbia, are at such low levels that the commercial fishery was closed in 1991 and the recreational fishery was closed to retention in 2002 (DFO 2004).

The current regulations for lingcod were put into place during the early 1990s as a precautionary approach. At the time, relatively little data were available to describe the spawning and nest-guarding season or to analyze the effectiveness of the minimum size limit. Much of that information has not yet been collected, especially in the northern Gulf of Alaska. It is unknown whether the current size limit optimizes natural reproduction or whether a different size limit would be more appropriate.

Recent increases in sport harvest of lingcod were anticipated and raise concerns for overfishing. Increases in effort and harvest are expected to continue as a result of improved access and development in Southcentral Alaska, and resulting population increases.

Changes in the halibut fishery are also likely to affect the lingcod fishery. As with rockfish, incorporation of the Area 3A charter fleet into the existing halibut IFQ program could increase lingcod harvest by charter vessels that do not qualify for adequate halibut quota share, and by those that wish to maximize the value of their halibut quota by satisfying customer demand with lingcod and other species. In addition, if halibut stocks decline as projected due to weak recruitments, anglers are expected to increase targeting of alternate species.

The current harvest assessment program is effective at characterizing the lingcod harvest in the recreational fishery and provides a basis for evaluating the effects of regulatory proposals (Stock and Meyer 2005). Primary objectives for this program include: estimation of age, length, and sex composition, as well as spatial distribution of effort and harvest.

Data sources are being gathered and summarized to begin the process of an analytical assessment, and that process should continue. One of the first steps should be development of a standardized index of abundance. Several potential data sources for this index should be evaluated, including interview data, charter logbook data, IPHC longline survey data, and NMFS trawl survey data. The assessment should include summaries of the sport and commercial removals, spatial distribution of harvest, and age, length, and sex composition of the harvest. Existing information can be analyzed to estimate growth, natural mortality, and other assessment inputs.

The assessment should include an analysis of the effectiveness of the current 35-inch minimum size limit. It concentrates harvest on the largest, and most fecund females, and was implemented without a thorough analysis of long-term effect on population dynamics. This may require a field project to estimate maturity as a function of age and size.

As with rockfish, there is considerable uncertainty regarding the sport harvest estimates. The SWHS estimates should be evaluated using all available data to either justify them or make recommendations for improvement.

A fishery-independent index of abundance, such as that from a survey, is highly desirable. A reliable index could be used for management in the absence of a stock assessment, or could be used to tune an age or size structured assessment model. Because lingcod don't move much and are generally found in easily-identified rocky habitat, the fishery can maintain stable catch rates even as abundance declines. Work is needed to develop survey methods that provide for an unbiased index of abundance. The minimum size limit of 35 inches also precludes the use of fishery data as an index of recruitment and no data are available on the sizes of released fish. A survey would provide catch data on the sublegal portion of the population that may give insight on future recruitment.

As with rockfish, estimates of lingcod habitat are needed to evaluate spatial harvest data and may be helpful for interpreting stock assessment results, modeling alternative harvest strategies, and designing future research.

Recent Fishery Performance

Harvest estimates from the SWHS are available since 1990. Annual sport lingcod harvest in Cook Inlet ranged from a low of about 1,100 fish in 1995 to a high of about 3,300 fish in 2005 (Table 39). From 1993 until 2003 the harvest was variable but stable around an average of 1,700 fish per year. Since 2003 however, total recreational lingcod harvest has significantly increased. For the period from 2004 through 2006 the average harvest has grown to around 3200 fish, nearly double the previous 10 year average. Cook Inlet has accounted for 15-28% of the total Southcentral Region lingcod harvest since 1991. Guided anglers accounted for an estimated 6-100% (average 60%) of the Central Cook Inlet harvest (in numbers of fish) and 36-80% (average 65%) of the Lower Cook Inlet harvest each year (Table 40).

Harvest biomass (lb round weight) has been estimated for the sport fishery since 1992 by multiplying average weight estimates from harvest samples at Homer by the SWHS estimates for all of Cook Inlet. Harvest biomass ranged from about 29,000 to 105,000 pounds during the period 1992-2006 (Table 41).

Most of the lingcod caught in Cook Inlet are released, either because they are not a species of interest, they are sublegal-size fish, or the season is closed. The number of lingcod released annually from 1990 to 2006 in Cook Inlet ranged from 3,500 to 11,700 fish, representing 63%-83% of the catch (Figure 12). Lingcod do not have a swim bladder and are not subject to barotrauma when caught in deep water. Release mortality has not been estimated in Alaska sport fisheries but is believed to be low because many lingcod are caught on circle hooks in the halibut fishery and because released lingcod are quite hardy (Davis and Olla 2002; Parker et al. 2003). Albin and Karpov (1998) estimated the mortality rate for lingcod caught on rod and reel with single J-hooks and treble hooks, and held in aquaria, at about 4%.

ACCESS PROJECTS

BACKGROUND OF THE SPORT FISHING ACCESS PROGRAM

The Division of Sport Fish sport fishing access program coordinates and implements projects to improve access to fisheries by boating and non-boating anglers. The funding is derived from a combination of state and federal sources, including sport fishing license sales and a federal excise tax on sport fishing equipment and motorboat fuel. The federal funding source is the result of the Federal Aid in Sport Fish Restoration Act (also known as "Dingell-Johnson") and the Wallop-Breaux amendment made to the Act in 1984.

The primary beneficiary of each access project that involves Federal Aid funding must be the recreational boater or sport fishing public. A minimum of 15% of the Federal Aid funds allocated to the state is mandated to be used for recreational boating access projects. Federal Aid funds cannot be used for projects that support subsistence and personal use fisheries due to Alaska resident status restrictions placed on these fisheries and the type of fishing gear used (subsistence and personal use gear do not fit under the federal definition of sport fishing gear). Federal Aid funds cannot be used to support commercial user groups because commercial fishermen are exempt from the federal taxes that support the program. Federal Aid funds pay for approximately 75% of eligible access projects. The remaining 25%, called the state match, must be made up of non-federal funds or assets.

A variety of sport fishing access projects have been accomplished in the Lower Cook Inlet Management area since 1995. In 1995, a grant proposal was written to research and potentially purchase approximately 84 acres of land at or near the mouth of the Anchor River to provide access to sport anglers and recreational boaters. The purchase was denied because the appraised value of the property was lower than the owner's selling price and the department cannot spend more than the appraised fair market value for any property using Federal funding. Recently, The Nature Conservancy, a non-profit organization dedicated to the protection of land and water, submitted a proposal through ADF&G to the National Coastal Wetlands Conservation Grant Program to purchase the property. Notification of acceptance of the appraisal will occur in October 2001.

In 1996, the department cooperated with the Department of Natural Resources (DNR), Division of Parks and Outdoor Recreation (DPOR) to fund the fabrication and installation of two public mooring buoys in Halibut Cove Lagoon. The buoys became property of DNR in 1999. In 1997 additional funds were added to the original agreement for the construction and installation of two additional mooring buoys in Tutka Bay. The department is no longer funding mooring buoy related projects due to liability and maintenance concerns.

Handicapped accessible ramps and landings were installed inside Homer Spit Enhancement Lagoon in 1999 to allow full accessibility to the sport fishery. The parking area adjacent to the ramps and a trail to an accessible toilet facility near the lagoon were paved. DNR and Alaska Department of Transportation and Public Facilities (ADOTPF) were cooperators through grants. Also in 1999, the seaward banks of the lagoon were hardened to reduce maintenance costs and to provide winter storm protection for the upgrades inside the lagoon. Hardening of the outer banks of the fishing lagoon and protection of the channel leading into the lagoon were accomplished with funds from the Federal Aid in Sport Fish Restoration Program and ADOTPF.

The department cooperated with the City of Homer to construct an additional fish cleaning table, carcass trailer, an industrial fish waste grinder and building to house the grinder during 2000 and 2001 because the amount of fish waste being dumped by the City was exceeding United States Environmental Protection Agency (EPA) limits. The fish cleaning facility was operational beginning in June 2001 and the City is now in compliance with EPA regulations.

Construction of three new, accessible, plumbed restrooms located at the top of the load & launch ramps (2 toilet unit), at the top of the Ramp 4 (7 toilet unit) and Ramp 6 (7 toilet unit) transient mooring floats in the Homer Boat Harbor started in late summer of 2004 and was completed.

Maintenance projects paid for by the department that relate to sport fishing access include annual upkeep of the road to the beach at Whiskey Gulch. During the summer of 1999, the road was graded and brushed along the edges near the entrance, widened at the top of the bluff, and drainage culverts were installed on both sides. The existing roadbed materials were replaced on the road up the bluff with more stable roadbed materials and a drainage culvert was installed in the streambed at the base of the bluff road.

CURRENT PROJECTS SPORT FISHING ACCESS PROJECTS

A request was received from the Homer Port Director to replace the dilapidated wood-supported fish cleaning tables at the top of Ramp 4 located at the Homer Boat Harbor in 2004. In December of 2005 the grant agreement period for the renovation of the Ramp 4 fish cleaning tables was extended to 2007 and the funding amount was increased by ~ $60K. The project was completed late in the summer of 2007 with the roof and asphalt apron in place, photo cell operated lights installed and working, painting, landscaping, and plumbing complete and operational.

In addition, the Ramp 6 (northeast of the top of the load & launch ramps) Homer Harbor fish cleaning facility renovation was completed in the summer of 2007 including addition of the carcass trailer and a roof with lexan panels for natural illumination, plumbing and painting. A fish carcass trailer was added for this cleaning station. The City of Homer contributed additional funds (~$20K) to complete Ramp 6 renovations and supplied City crews as a labor force for both projects.

Also in 2004, the Port Director also asked for help funding some type of lighting for the Fishing Lagoon cleaning tables. Anglers have complained about difficulties seeing to clean fish at night after the later tide stages.

A Kenai Peninsula Superintendent of State Parks request for help to address vehicle/boat trailer traffic and parking problems related to the boat tractor launch at the Anchor River State Recreation Site was addressed with a FY08 CIP Request in the fall of 2006 fall which included the Anchor River Tractor Launch Improvements (~$220K). It was approved by the Statewide Access Program Coordinator and submitted to and approved by the Legislature. This will be a cooperative project with DPOR with ADF&G utilizing access program funds for the parking lot and turn-around design and construction.

In the summer of 2006, a custom fish cleaning table was constructed (~$950) on-site in ADF&G maintenance shop in Palmer for Halibut Cove Lagoon. Transportation and installation was coordinated with DPOR. Annual maintenance contracts for amenities presently are; Whiskey Gulch (~$2.72K/year), Ninilchik (~$4.31/year) for portable-latrine rental and pumping services and Ninilchik Scenic Overlook Site (~$10K) for a cooperative project with DPOR for O&M of the site.

Removal of the broken wire gabion "mattresses" that were originally installed for slope stabilization adjacent to the Deep Creek boat ramp and their replacement with articulated concrete matting was completed during the spring of 2002. Interpretive display signboards were also be constructed/installed at the boat launch as part of this project. The ramp was completely removed by floodwaters in the fall of 2002 and currently there is no plan to replace the ramp.

Funding is being sought to construct stairways to access the Seldovia Slough at the ends of the Seldovia Slough bridge for sport anglers to descend to the water more easily and to eliminate trespassing on property adjacent to the fishery.

The department sought additional public easements to the eastside Cook Inlet beaches for public access to clam digging and angling north of the Ninilchik River through development of existing public easements, or lease or purchase and improvement of easements currently in private ownership. Funding is inadequate to cover the estimated costs of these alternative.

Annual installation and pumping of portable toilets and refuse service at Whiskey Gulch and Ninilchik River is paid for by access funds. DPOR is given $10,000 annually for operation and maintenance of the Ninilchik wayside.

Vehicles and camper trailers were abandoned at Whiskey Gulch in 2007. While researching ADF&G's authority to penalize the owners, it was discovered that DNR is presently the official property owner. DNR is drafting a transfer document for ADF&G to become the property manager owner.

LAND PURCHASES

Large sections of the watersheds of the road accessible streams and many remote streams on the central and lower Kenai Peninsula are privately owned. Private land owners are becoming less tolerant of trespass, particularly as subdivision of large tracts of private property occurs, and access for fishing is decreasing. The ADF&G has limited options for protecting public access through land purchase or easement dedication. Several private non-profit organizations are based on the lower Peninsula that purchase land or protect it from development through easements. Public access for sport fishing can be an outcome of agreements between private landowners and these non-profit agencies, but habitat protection is the priority. Access for sport fishing in the central lower Kenai Peninsula will be sharply reduced in the future without further public land acquisition or easements.

The department has been actively involved in land protection efforts on the Anchor River. Through the Exxon Valdez Trustee Council, the state successfully acquired a 20-acre parcel just downstream of the Sterling Highway (Elliot), and another 60-acre parcel just upstream (Thorne/Crowser). Three additional acquisitions (Knol-37 acres; Thompson-61 acres; Nakata-5 acres) are in the final stages of completion. All of these parcels will be managed by ADF&G. In cooperation with The Nature Conservancy, ADF&G also obtained and is administering a National Coastal Wetland Conservation Grant to purchase approximately 75 acres of estuarine wetlands and barrier beach near the mouth of the Anchor River. These and future purchases are expected to provide lasting benefits for Pacific salmon, steelhead trout and Dolly Varden that migrate, spawn and rear throughout the river. These efforts are also intended to ensure that angler access is maintained on the Anchor River, which is one of the most popular sport fishing streams in Southcentral Alaska.

EDUCATIONAL FISHERIES

BACKGROUND

The objectives for educational fisheries are specified in 5 AAC 93.235 as "educating persons concerning historic, contemporary, or experimental methods for locating, harvesting, handling, or processing fishery resources." Standards, general conditions, and requirements of the educational fishery program are outlined in 5 AAC 93.200-235. The Federal Court initially ordered educational fisheries while litigation was underway regarding issues surrounding rural preference for subsistence uses in Alaska and in Cook Inlet. Nelson et al. 1999 outlines the legal and political events surrounding conflicts over subsistence rights in Alaska that pertain to the creation of educational fisheries on the Kenai Peninsula.

HISTORY OF LCIMA EDUCATIONAL FISHERIES

The first educational fishery permit granted in the LCIMA was issued to the Ninilchik Traditional Council (NTC) in 1993 (Nelson et al. 1999). The goal of the NTC educational fishery was to teach and preserve the cultural and traditional subsistence way of life as well as provide food for the Elders and others in need. They were the lone applicant for a permit from 1993 through 1996. Permit stipulations in 1993 allowed a saltwater harvest of 2,000 salmon; not more than 100 could be Chinook and 250 coho salmon (Table 42). Only 50 Chinook salmon could be taken prior to July 21. An additional 50 could be taken beginning July 21 if the Chinook salmon spawning escapement to the Kenai River was projected above 22,300. The fishing area extended north 1 mile from near the Ninilchik River and ¼ mile from shore. Gear was limited to a single 10-fathom gillnet. Regular harvest reporting was required along with a season summary 10 days after the completion of the season. Virtually the same permit requirements were in place in 1994 through 1997 with a few alterations. Beginning in 1996, 100 Chinook salmon could be taken prior to July 21 and 50 thereafter if the Kenai River escapement goal was met. The duration of the permit expanded each year until 1996; since then fishing has been allowed from May 1 until October 31. A very limited freshwater fishery was permitted on the Ninilchik River downstream of the Sterling Highway Bridge beginning in 1995 using traditional methods. After 1995, the freshwater harvest was limited to no more than 30 Chinook and 20 coho salmon. The annual harvest in the educational fishery is reported in Table 43.

In 1998, a group of NTC members formed a new organization, the Ninilchik Native Descendents (NND), and requested a separate permit with similar goals of passing on traditional knowledge and providing food for needy tribal members. Initially, one permit was granted to both organizations jointly with the same stipulations as in the past. This was not acceptable to the NTC. The NND fished upon receiving the joint permit while the NTC members did not fish until they were granted a separate permit. Since the two groups represented the same constituents that had been served in the past by one permit, two permits were issued and the allocation normally granted to the NTC was divided in half between them. Each permit allowed the taking of 1,000 salmon. No more than 50 Chinook salmon could be harvested in total, with 25 taken before July 21, and no more than 125 coho salmon in total. No more than 15 Chinook and 10 coho salmon could be taken during the limited freshwater fishery. The remaining terms of the permits were the same as in the past. Each permitee was allowed their own net.

After the permits had been issued, the NTC asked that they be allowed an additional 20 Chinook salmon, the number caught by the NND before separate permits were granted, for a total of 70 prior to July 21. The NTC permit was amended to allow the taking of 18 additional Chinook salmon because they had taken 52, two more than the amount allotted them at the time of their request for additional fish. The NTC also requested an additional 25 coho salmon but were refused. Their coho salmon allocation was thought to achieve the educational purposes stipulated in the permit; coho salmon harvests in previous years had not exceeded 119 in total. The educational fishery was closed July 28 through August 2 because sockeye returns to the Kenai River were projected to be under the goal.

Both the NTC and NND applied for and received permits in 1999. The stipulations of the two permits were the same as in 1998. The NTC requested an additional 50 Chinook salmon on May 25 after they harvested their initial quota of 50. The additional harvest was approved because they would not meet their educational goals otherwise and the additional allocation was not thought to negatively impact the Chinook salmon resource or other fisheries. Both organizations exceeded their allocation of Chinook salmon in early July and were requested to cease their harvest of Chinook until after July 20. No further Chinook salmon were reported harvested.

The educational fishery permits issued in 2000 contained the same stipulations and quotas as initially granted in 1998. The fishery proceeded without inseason changes.

In 2001, the NTC was allowed the use of an additional net, at their request, to better attain their quota of sockeye salmon. The NND requested an additional 25 Chinook salmon prior to July 21, for a total of 75 during that period, to provide educational opportunities for an anticipated increase in participants to the program. The Chinook salmon quota of both groups was increased prior to July 21 to 75; the increase to the NTC was to allow them to achieve their quota of sockeye salmon and better achieve their educational goals.

Since 2001, the educational fishery permit of the NTC has allowed the use of a second net after June 10. Despite requests from both the NTC and NND for more fish, the harvest quotas in 2002 for each group were 75 Chinook salmon prior to July 21 and 25 thereafter if the Kenai River spawning escapement goal was projected to be met. No more than 125 coho salmon could be taken by either group. Each group's freshwater quota from the Ninilchik River was no more than 10 king salmon or 15 coho salmon taken over four 3-day periods. Salmon harvests were below harvest quotas.

A new organization in Ninilchik requested an education permit in 2003: Ninilchik Emergency Services (NES). They wished to conduct classes in July and requested a permit for July 1 through August 15. The group was allocated 250 salmon including no more than 50 coho salmon and 25 Chinook salmon. Chinook salmon could be taken after July 20 only if the Kenai River run projection was above the spawning escapement goal. Due to poor weather on scheduled class days only one student participated in the NES program during one day. Salmon quotas for the NTC and NND, adjusted to accommodate the requested harvest by the NES, were 850 for each group. No more than 100 of the group's 850 salmon could be Chinook salmon or 100, coho salmon. The restriction on harvest of Chinook salmon after July 20 was the same as in previous years. The same freshwater restrictions applied as in previous years. For April, NND were granted use of a 20 foot long gillnet with a mesh size not to exceed 2 inches to catch no more than 1,000 herring *Clupea pallasi* or hooligan *Thaleichthys pacificus*. Salmon harvests were well below harvest quotas. No fishing occurred for herring or hooligan.

In 2004, permits with the same stipulations as in 2003 were granted to the three Ninilchik organizations. An addition permit was requested from the Seldovia Village Tribe (SVT) for a fishery in Seldovia, July 15 through July 21, during a youth camp. The standard gillnet gear was permitted and the harvest of 70 salmon: no more than 50 pink salmon, 20 chum salmon and 20 sockeye salmon. The harvest of 15 Dolly Varden was permitted. The harvest was nine pink salmon and one chum salmon.

EDUCATIONAL FISHERIES IN THE LCIMA 2005-2007

In 2005 and 2006, educational fishery permits with similar stipulations 2003 were issued for salmon in the Ninilchik area to the NTC, NND and NES. The NND hooligan limit was removed in 2006 and herring were no longer permitted because opportunity to harvest herring was provided in Cook Inlet personal use regulations. NES did not fish in 2006 or 2007.

The Seldovia Village Tribe permit stipulations for 2005 and 2006 were similar to 2004 except their season was July 6-15 and they were authorized an additional fishing day in Seldovia on June 30.

The reported total harvests of all permittees during 2005 and 2006 fell well within the limits of their educational fishery permits.

In 2007, Chinook, coho and salmon saltwater limits were increased for the NTC and NND. Educational fishing opportunity was provided to the NTC in the Kasilof River for the first time. The NTC met their Chinook salmon quota of 300 (Table 43). Late reporting and misinterpretation of permit stipulations by NTC resulted in a harvest 428 coho salmon, an accidence of their coho salmon quota of 300.

The Anchor Point Veterans of Foreign Wars applied for an educational fisheries permit in 2007 and was permitted to conduct an educational fishery approximately 1.5 miles north of the Anchor River. The gear and gear specifications were the same as for the Ninilchik area permitees. Their fishing season was August 15-31. Their quota was 160 salmon no more than 80 of which could be coho salmon and 80 sockeye salmon.

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TABLES AND FIGURES

Table 1.–Angler days of effort expended by recreational anglers fishing Lower Cook Inlet Management Area waters, 1977-2006.

	West Cook Inlet		Central Cook Inlet			Lower Cook Inlet and Kachemak Bay			Management	Percent	
	Salt	Fresh	Saltwater	Saltwater	Freshwater	Saltwater	Saltwater	Freshwater	Area	of	Alaska
Year	Water	Water	Finfish	Shellfish	Finfish	Finfish	Shellfish	Finfish	Total	State	Total
1977			57,611 [a]		55,706	46,827 [a]			160,144	13.4	1,198,486
1978			64,429 [a]		74,378	59,128 [a]			197,935	15.4	1,286,063
1979	880		65,677 [a]		77,027	64,656 [a]			208,240	15.3	1,364,739
1980	928		63,481 [a]		63,273	57,078 [a]			184,760	12.4	1,488,962
1981	972		25,538	31,298	59,648	67,894	25,391		210,741	14.8	1,420,772
1982	1,501		29,718	31,954	49,687	61,315	15,712		189,887	11.7	1,623,090
1983	707	1,739	45,337	31,470	52,721	91,229	20,334	3,844	247,381	14.3	1,732,528
1984	1,673	652	53,955	30,013	53,320	72,441	25,162	2,243	239,459	12.8	1,866,837
1985	1,942	970	55,435	32,652	63,464	63,272	16,732	1,024	235,491	12.1	1,943,069
1986	2,562	399	66,377	33,486	63,132	74,781	21,755	2,231	264,723	12.8	2,071,412
1987	810	903	80,565	25,427	71,191	104,602	20,710	2,569	306,777	14.2	2,152,886
1988	3,989	782	54,799	30,998	50,260	127,748	13,306	2,339	284,221	12.3	2,311,291
1989	2,136	1,474	62,503	22,693	44,583	98,922	9,594	2,180	244,085	10.8	2,264,079
1990	2,406	1,140	82,881	29,427	61,718	133,938	10,342	4,068	325,920	13.3	2,453,284
1991	2,287	1,187	83,988	32,012	60,052	118,015	6,690	1,613	305,844	12.5	2,456,328
1992	2,526	989	93,175	44,537	67,710	127,971	15,727	2,575	355,210	14.0	2,540,374
1993	3,064	2,534	85,460	40,376	70,330	140,302	13,753	2,155	357,974	14.0	2,559,408
1994	4,151	900	111,560	48,546	70,085	143,033	18,187	3,071	399,533	14.7	2,719,911
1995	4,254	2,239	121,936	42,220	55,785	156,222	17,682	3,717	404,055	14.5	2,787,670
1996	2,753	1,865	73,229	29,943	37,797	116,089	11,584	802	274,062	13.7	2,006,528
1997	2,819	1,551	81,602	28,343	38,435	114,998	9,263	1,003	278,014	13.4	2,079,514
1998	2,403	937	68,965	26,636	35,766	99,481	3,926	752	238,866	12.9	1,856,976
1999	2,336	1,887	75,790	36,278	48,263	107,623	9,149	695	282,021	11.3	2,499,152
2000	3,344	1,414	84,602	37,755	48,895	122,613	11,445	1,097	311,165	11.8	2,627,805
2001	2,275	744	73,577	32,642	38,252	108,426	8,090	1,900	265,906	11.8	2,261,906
2002	2,120	1,638	65,204	34,406	38,468	120,892	7,439	572	270,739	12.0	2,259,091
2003	1,220	2,487	56,969	25,328	37,080	132,586	5,836	716	262,222	11.8	2,219,398
2004	2,304	1,619	65,968	30,178	42,392	137,910	6,641	931	287,943	11.6	2,473,961
2005	1,984	2,255	68,393	32,835	40,396	154,229	6,415	771	307,278	12.5	2,463,929
2006	NA	2,260	65,745	24,474	34,351	134,827	6,704	747	269,108	11.7	2,298,092
Averages											
1977-2003	2,242	1,354	69,791	32,976	55,075	101,188	13,818	1,960	270,569	13.1	2,075,984
2004-2006	2,144	2,045	66,702	29,162	39,046	142,322	6,587	816	288,110	11.9	2,411,994

Source: Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication).

[a] Includes shellfish.

Table 2.–Historical recreational harvest of Pacific halibut in Cook Inlet waters, 1977-2006.

Year	Lower Cook Inlet [a]	Central Cook Inlet [b]	West Cook Inlet [c]	Total Cook Inlet	StatewideTotal
1977	9,416	4,050	d	13,466	23,244
1978	20,756	4,821	d	25,577	37,085
1979	20,479	6,518	d	26,997	47,705
1980	21,808	8,177	d	29,985	64,658
1981	29,294	9,427	d	38,721	74,212
1982	28,851	10,681	d	39,532	92,358
1983	36,623	23,503	d	60,126	117,042
1984	37,747	23,455	d	61,202	124,950
1985	41,450	21,198	510	63,158	127,634
1986	41,943	42,072	1,072	85,087	160,885
1987	44,380	33,039	869	78,288	145,829
1988	91,688	44,321	1,192	137,201	225,106
1989	73,892	51,739	1,224	126,855	229,016
1990	90,380	56,397	1,685	148,462	247,202
1991	86,405	60,423	1,576	148,404	266,523
1992	81,430	60,670	984	143,084	264,943
1993	92,057	67,826	2,507	162,390	313,147
1994	88,260	79,775	2,725	170,760	329,046
1995	86,832	81,322	e	168,154	325,188
1996	105,968	81,807	e	187,775	350,220
1997	105,646	88,270	e	193,916	380,256
1998	94,209	85,153	e	179,362	350,464
1999	86,239	69,264	e	155,503	332,657
2000	107,736	93,991	e	201,727	403,280
2001	94,864	87,618	e	182,482	365,539
2002	93,625	73,398	e	167,023	350,809
2003[f]	112,386	77,708	e	190,094	402,862
2004	125,595	86,107	e	211,702	482,550
2005	133,147	85,548	e	218,585	500,048
2006	124,823	84,619		209,442	462,855
Averages					
1977-2003	67,569	49,875		117,975	227,847
2004-2006	127,855	85,425		213,243	481,818

Source: Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication.

[a] Cook Inlet salt waters east of the center of Cook Inlet, south of Anchor Point including Kachemak Bay and Gulf Coast waters west of Gore Point.

[b] Cook Inlet salt waters east of the center of Cook Inlet and north of Anchor Point.

[c] Cook Inlet salt waters west of the center of Cook Inlet and from the Susitna River south to Cape Douglas .

[d] Halibut information was not requested in the SWHS West Cook Inlet questionnaire before 1985.

[e] After 1994 the West Cook Inlet estimates were apportioned and included in the Central and Lower Cook Inlet subareas.

[f] Estimates for subareas within Cook Inlet had not been apportioned by the publication date of this report.

Table 3.–Chinook salmon harvest in Lower Cook Inlet Management Area waters, 1977-2006.

	West Cook Inlet			Lower Cook Inlet and Kachemak Bay			Central Cook Inlet			
				Salt Water	Salt Water					
	Salt	Fresh		Stocked	Other		Salt	Fresh		Area
Year	Water	Water	Total	Locations	Locations	Total	Water	Water	Total	Total
1977					970	970	4,470	2,670	7,140	8,110
1978					816	816	4,800	4,358	9,158	9,974
1979	10		10		1,034	1,034	4,070	4,109	8,179	9,223
1980					431	431	1,636	1,510	3,146	3,577
1981	95		95		1,145	1,145	2,711	3,196	5,907	7,147
1982	189		189		1,963	1,963	3,836	2,749	6,585	8,737
1983	41		41		2,664	2,664	2,832	3,294	6,126	8,831
1984	75		75	537	1,559	2,096	4,613	2,407	7,020	9,191
1985	50		50		883	883	6,256	1,904	8,160	9,093
1986	112		112	665	439	1,104	4,174	2,462	6,636	7,852
1987	29		29	1,738	452	2,190	5,125	2,489	7,614	9,833
1988	171		171	8,222	1,472	9,694	6,018	2,548	8,566	18,431
1989	183	58	241	3,486	899	4,385	5,487	2,182	7,669	12,295
1990	23		23	3,513	1,123	4,636	6,719	3,583	10,302	14,961
1991	149		149	2,786	775	3,561	6,883	5,997	12,880	16,590
1992	166	9	175	2,602	2,978	5,580	8,609	8,389	16,998	22,753
1993	141		141	7,007	4,400	11,407	11,725	9,543	21,268	32,816
1994	328	19	347	3,985	6,154	10,139	9,272	8,064	17,336	27,822
1995	164	76	240	5,508	3,642	9,150	11,283	5,087	16,370	25,760
1996	181		181	3,592	3,509	7,101	7,092	4,770	11,862	19,144
1997	371	133	504	4,000	3,591	7,591	8,926	6,075	15,001	23,096
1998	117		117	2,584	3,417	6,001	7,682	2,775	10,457	16,575
1999				3,638	3,605	7,243	6,386	4,095	10,481	17,724
2000	93	207	300	3,028	3,628	6,656	6,074	4,449	10,523	17,479
2001	55	21	76	2,835 [a]	3,715	6,550	4,948	2,881	7,829	14,455
2002	28		28	2,621 [a]	5,300	7,921	3,889	2,384	6,273	14,222
2003	72	37	109	4,059 [a]	6,394	10,453	4,303	3,238	7,541	18,103
2004	13		13	4,068 [a]	8,103	12,171	5,553	3,624	9,177	21,361
2005	46	92	138	2,810 [a]	11,128	13,938	4,866	3,416	8,282	22,358
2006	NA			2,092	8,287	13,938	5,989	3,174	9,163	23,101
Averages										
1977-2005	116	72	142	3,426	3,149	5,499	5,874	3,914	9,788	15,431
2000-2004	52	88	105	3,322	5,428	8,750	4,953	3,315	8,269	17,124

Source: Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication.

[a] Halibut Cove Lagoon and Seldovia harvests no longer assessed individually; includes only Homer Spit shore angler harvest estimates.

Table 4.–Coho salmon harvest in Lower Cook Inlet Management Area waters, 1977-2006.

	West Cook Inlet			Lower Cook Inlet and Kachemak Bay			Central Cook Inlet			
				Saltwater	Saltwater					
	Salt	Fresh		Stocked	Other		Salt	Fresh		Area
Year	Water	Water	Total	Locations	Locations	Total	Water	Water	Total	Total
1977					4,749	4,749	557	1,900	2,457	7,206
1978					2,137	2,137	503	3,231	3,734	5,871
1979	50		50		2,633	2,633	387	3,707	4,094	6,777
1980	69		69		1,748	1,748	405	3,603	4,008	5,825
1981	48		48		2,149	2,149	918	4,255	5,173	7,370
1982	755		755		2,148	2,148	639	3,105	3,744	6,647
1983	62	1,872	1,934		2,408	2,408	860	2,401	3,261	7,603
1984	125	773	898		1,397	1,397	972	2,881	3,853	6,148
1985	124	747	871		1,232	1,232	734	5,262	5,996	8,099
1986	78	302	380	245	1,193	1,438	1,467	2,132	3,599	5,417
1987	127	706	833	459	994	1,453	1,986	4,111	6,097	8,383
1988	18	764	782	200	1,328	1,528	1,109	4,602	5,711	8,021
1989	251	875	1,126	1,439	1,766	3,205	888	5,682	6,570	10,901
1990	110	375	485	1,272	2,540	3,812	1,274	4,430	5,704	10,001
1991	63	1,144	1,207	3,822	3,604	7,426	1,365	5,528	6,893	15,526
1992	283	567	850	1,109	2,540	3,649	1,270	3,886	5,156	9,655
1993	177	1,579	1,756	5,823	4,186	10,009	2,190	6,962	9,152	20,917
1994	65	443	508	5,355	3,866	9,221	3,478	6,971	10,449	20,178
1995	1,018	1,979	2,997	5,367	3,418	8,785	2,020	4,786	6,806	18,588
1996	702	3,502	4,204	9,060	6,233	15,293	2,788	5,572	8,360	27,857
1997	32	722	754	6,091	4,905	10,996	2,793	3,264	6,057	17,807
1998	158	697	855	6,672	6,402	13,074	1,795	6,425	8,220	22,149
1999	235	885	1,120	3,890	5,629	9,519	2,425	7,564	9,989	20,628
2000	440	1,264	1,704	7,067	5,903	12,970	3,136	6,765	9,901	24,575
2001	483	2,232	2,715	11,015	11,273	22,288	5,301	5,766	11,067	36,070
2002	665	1,289	1,954	14,508	18,264	32,772	5,807	7,684	13,491	48,217
2003	173	2,511	2,684	18,531	10,300	28,831	2,865	8,585	11,450	42,965
2004	410	2,225	2,635	21,009	15,457	36,466	4,237	10,656	14,893	53,994
2005	182	1,845	2,027	15,075	16,187	31,262	3,541	9,234	12,775	46,064
2006		1,667	1,667	4,450	9,975	14,425	3,418	8,278	11,696	27,788
Averages										
1977-2003	252	1,201	1,262	5,663	4,257	8,032	1,849	4,854	6,703	15,904
2004-2006	296	1,912	2,110	13,511	13,873	27,384	3,732	9,389	13,121	42,615

Source: Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication.

Table 5.–Dolly Varden harvest in Lower Cook Inlet Management Area waters, 1977-2006.

	Lower Cook Inlet			Central Cook Inlet			
Year	Salt Water	Fresh Water	Total	Salt Water	Fresh Water	Total	Area Total
1977	4,137		4,137	603	11,437	12,040	16,177
1978	2,866		2,866	325	22,418	22,743	25,609
1979	3,218		3,218	382	27,808	28,190	31,408
1980	3,917		3,917	164	13,156	13,320	17,237
1981	4,212		4,212	313	18,403	18,716	22,928
1982	3,606		3,606	526	12,484	13,010	16,616
1983	3,997	1,678	5,675	493	18,871	19,364	25,039
1984	1,659	312	1,971	237	7,595	7,832	9,803
1985	2,324		2,324	243	8,826	9,069	11,393
1986	2,172	306	2,478	15	5,367	5,382	7,860
1987	1,358	380	1,738	379	3,911	4,290	6,028
1988	2,819	218	3,037	200	3,802	4,002	7,039
1989	2,083	343	2,426	382	1,848	2,230	4,656
1990	1,522	176	1,698	61	3,811	3,872	5,570
1991	1,393	275	1,668	246	1,983	2,229	3,897
1992	1,804	378	2,182	205	3,097	3,302	5,484
1993	1,720	172	1,892	150	1,506	1,656	3,548
1994	1,516	216	1,732	311	2,034	2,345	4,077
1995	737	154	891	285	2,102	2,387	3,278
1996	1,765	586	2,351	171	2,162	2,333	4,684
1997	1,541	706	2,247	378	2,178	2,556	4,803
1998	1,790	115	1,905	297	3,854	4,151	6,056
1999	774	209	983	288	1,671	1,959	2,942
2000	1,045	695	1,740	491	2,605	3,096	4,836
2001	1,019	195	1,214	422	2,131	2,553	3,767
2002	580	114	694	196	1,158	1,354	2,048
2003	1,265	356	1,621	117	1,539	1,656	3,277
2004	1,089	230	1,319	166	1,193	1,359	2,678
2005	524	158	682	440	945	1,385	2,067
2006	775	194	969	282	1,217	1,499	2,468
Averages							
1977-2003	1,974	355	2,246	292	6,370	6,663	8,909
2004-2006	1,000	318	1,318	278	1,725	2,004	3,321

Source: Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication.

Table 6.–Razor clam harvest in Lower Cook Inlet Management Area waters, 1977-2006.

Year	Participation (Digger-days)	Harvest	Clams/Digger day
1977	25,393	871,247	34
1978	29,750	896,667	30
1979	30,323	966,677	32
1980	31,494	771,603	25
1981	31,298	829,436	27
1982	31,954	963,994	30
1983	31,470	978,720	31
1984	29,963	1,044,307	35
1985	32,652	1,070,265	33
1986	33,486	1,124,728	34
1987	25,427	979,020	39
1988	30,998	1,171,308	38
1989	22,693	832,155	37
1990	29,427	950,974	32
1991	32,012	1,166,787	36
1992	44,537	1,156,034	26
1993	40,364	946,766	23
1994	48,546	1,271,174	26
1995	42,220	1,158,107	27
1996	29,943	814,360	27
1997	28,343	829,841	29
1998	26,636	643,612	24
1999	36,278	750,447	21
2000	37,755	842,270	22
2001	32,642	640,633	20
2002	34,406	767,780	22
2003	25,361	568,662	22
2004	30,177	519,217	17
2005	32,835	427,016	13
2006	24,766	438,482	18
Averages			
1977-2003	32,033	925,609	29
2004-2006	29,259	461,572	16

Source: Harvest and participation were determined by creel survey through 1976 and by the Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication) since that time.

Table 7.–Shellfish harvest in Lower Cook Inlet Management Area waters, 1977-2006.

Year	Participation All Species (angler-days)	King Crab (numbers)	Dungeness Crab (numbers)	Tanner Crab (numbers)	Shrimp (gallons)	Hardshell Clams (gallons)	Razor Clams (numbers)	Other Shellfish (numbers)
1981	25,391	6,178	22,928	4,320	7,117	8,132		38,560
1982	15,712	1,981	9,956	4,234	5,009	5,135		1,782
1983	20,334	409	15,083	3,084	3,577	16,110		2,633
1984	25,162	62	15,113	2,332	2,419	8,891	37,476	349
1985	16,732	closed	29,530	3,502	3,260	10,334	16,205	2,982
1986	21,755	closed	34,217	7,926	4,771	20,212	40,937	128
1987	20,710	closed	51,279	8,988	7,788	23,577	25,855	9,080
1988	13,306	closed	32,053	4,669	2,090	26,597	18,374	3,474
1989	9,594	closed	10,075	closed	1,199	18,195	15,954	13,015
1990	10,342	closed	7,034	closed	2,038	11,821	21,701	11,707
1991	6,690	closed	closed	1,142	613	10,476	7,963	1,513
1992	15,727	closed	10,050	4,165	1,547	9,993	11,358	13,327
1993	13,753	closed	15,198	9,206	656	8,350	10,692	7,995
1994	18,187	closed	19,155	9,648	2,087	13,279	13,974	2,384
1995	17,682	closed	8,957	10,936	1,654	20,311	14,669	7,708
1996	11,584	closed	6,428	12,053	301	29,163	6,089	1,327
1997	9,263	closed	5,905	11,357	closed	9,426	1,997	882
1998	3,926	closed	closed	16,763	closed	12,431	4,030	
1999	9,149	closed	closed	17,045	closed	7,971	4,524	216
2000	11,445	closed	closed	19,672	closed	14,697	7,275	992
2001	8,090	closed	closed	6,499	closed	13,141	3,838	1,620
2002	7,439	closed	closed	3,574	closed	12,047	7,887	2,163
2003	5,836	closed	closed	closed	closed	10,074	7,241	1,925
2004	6,641	closed	closed	closed	closed	8,399	6,412	1,372
2005	6,415	closed	closed	closed	closed	11,625	3,677	1,874
2006	6,704	closed	closed	closed	closed	4,480	16,010	1,448
Averages								
1981-2003	13,818		18,310	8,056	2,883	13,929	13,902	5,716
2004-2006	6,587					8,168	8,700	1,565

Source: Harvests were estimated from the Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication), except Tanner crab harvests 1996-2002 which are summaries of reported harvest on returned shellfish permits.

[a] July 12 reduced bag limit from 15 to 5.

[b] August 3 closed fishery.

Table 8.-Comparison of charter logbook data and Statewide Harvest Survey marine Chinook salmon guided angler harvest in the LCIMA, 1998-2006.

Year	Charter logbook (reported harvest)	Statewide Harvest Survey (estimated harvest)
1998	4,245	5,478
1999	4,180	4,688
2000	4,304	4,422
2001	3,560	4,780
2002	3,954	3,694
2003	4,710	4,347
2004	5,867	6,958
2005	6,722[a]	6,644[b]
2006	4,708[a]	6,543[b]

Source: Statewide Harvest Survey (Howe et al. 2001c-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, In prep.; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication).

[a] Includes charter crew harvest.

[b] Preliminary.

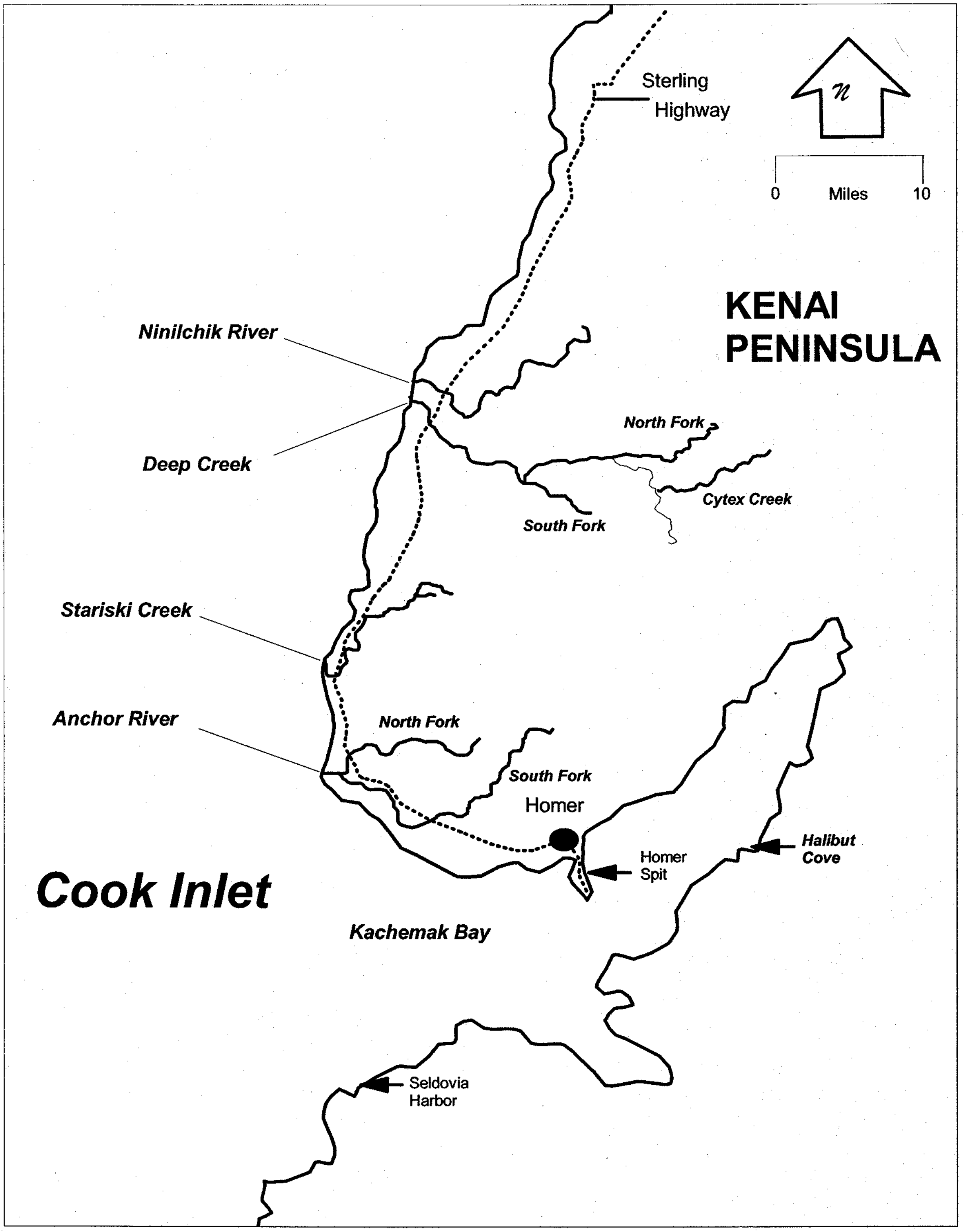

Figure 2.–Lower Kenai Peninsula road system streams.

Table 9.-Central Cook Inlet marine early- and late-run Chinook salmon sport fishery harvest and effort, 1972-2006.

Year	Chinook Harvest Early-run	Late-run	Total
1972	1,000	1,250	2,250
1973	519	491	1,010
1974	500	100	600
1975	540	345	885
1976	5,495	1,382	6,877
1977	4,617	366	4,983
1978	2,669	2,693	5,362
1979	3,088	1,164	4,252
1980	521	747	1,268
1981	2,363	170	2,533
1982	2,497	1,173	3,670
1983	1,000	1,707	2,707
1984	2,386	835	3,221
1985	5,087	1,731	6,818
1986	3,106	676	3,782
1987	3,613	1,512	5,125
1988	4,243	1,775	6,018
1989	3,863	1,616	5,479
1990	4,694	1,964	6,658
1991	4,824	2,019	6,843
1992	5,996	2,509	8,505
1993	8,136	3,404	11,540
1994	6,850	2,296	9,146
1995	8,230	2,673	10,903
1996	4,702	2,006	6,708
1997	5,646	2,850	8,496
1998	5,783	1,680	7,463
1999	4,907	997	5,904
2000	4,773	1,026	5,799
2001	3,671	860	4,531
2002	3,368	427	3,795
2003	4,042	200	4,242
2004	3,880	1,539	5,419
2005	3,746	1,040	4,786
2006	5,035	898	5,933
Average	3,834	1,389	5,223

Source: 1972-1986 from creel survey (Hammarstrom 1974-1981; Hammarstrom and Larson 1982-1984, 1986; Hammarstrom et al. 1985); 1987-2006 data from Statewide Harvest Survey (Mills 1988-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, In prep.; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication).

Notes: Harvest was apportioned 70.5% to the early run and 29.5% to the late run for 1987-1993, based on estimates from onsite creel surveys from 1972-1986. Early-run percentages of total harvest for 1994 and 1995 were 74.9% and 75.48% respectively, based on creel survey (McKinley 1995, 1996). Beginning in 1996, the Statewide Harvest Survey has generated separate estimates for the early (prior to and including June 24) and late (after June 24) runs. Table numbers may not necessarily match those of the SWHS summaries because different site groupings were used for this report; all Boat sites north of Bluff Point to Ninilchik were used.

Table 10.-Early- and late-run Chinook harvests of guided and unguided anglers, Central Cook Inlet, 1986-2006.

	Early run			Late run			Total		
Year	Unguided	Guided	Total	Unguided	Guided	Total	Unguided	Guided	Overall
1986	2,719	168	2,888	1,138	71	1,208	3,857	239	4,096
1987	3,268	345	3,613	1,368	144	1,512	4,636	489	5,125
1988	4,026	217	4,243	1,684	91	1,775	5,710	308	6,018
1989	3,611	252	3,863	1,511	105	1,616	5,122	357	5,479
1990	4,186	508	4,694	1,752	212	1,964	5,938	720	6,658
1991	3,031	1,794	4,824	1,268	750	2,019	4,299	2,544	6,843
1992	3,624	2,372	5,996	1,516	993	2,509	5,140	3,365	8,505
1993	4,548	3,588	8,136	1,903	1,501	3,404	6,451	5,089	11,540
1994	3,809	3,042	6,850	1,276	1,019	2,296	5,085	4,061	9,146
1995	4,225	4,004	8,230	1,373	1,301	2,673	5,598	5,305	10,903
1996	2,464	2,238	4,702	1,099	907	2,006	3,563	3,145	6,708
1997	2,989	2,657	5,646	1,656	1,194	2,850	4,645	3,851	8,496
1998	2,600	3,183	5,783	1,164	516	1,680	3,764	3,699	7,463
1999	2,598	2,309	4,907	624	373	997	3,222	2,682	5,904
2000	2,613	2,160	4,773	457	569	1,026	3,070	2,729	5,799
2001	1,457	2,214	3,671	559	301	860	2,016	2,515	4,531
2002	1,621	1,747	3,368	204	223	427	1,825	1,970	3,795
2003	1,827	2,215	4,042	89	111	200	1,916	2,326	4,242
2004	1,631	2,249	3,880	764	775	1,539	2,395	3,024	5,419
2005	1,746	2,000	3,746	669	371	1,040	2,415	2,371	4,786
2006	2,212	2,823	5,035	398	500	898	2,610	3,323	5,933

Source: 1986 from creel survey (Hammarstrom and Larson 1986a); 1987-2006 data from Statewide Harvest Survey (Mills 1988-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, In prep.; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication).

Notes: Harvest was apportioned 70.5% to the early run and 29.5% to the late run for 1987-1993, based on estimates from onsite creel surveys from 1972-1986. Early-run percentages of total harvest for 1994 and 1995 were 74.9% and 75.48% respectively, based on creel survey (McKinley 1995, 1996). Beginning in 1996, the Statewide Harvest Survey has generated separate estimates for the early (prior to and including June 24) and late (after June 24) runs. Table numbers may not necessarily match those of the SWHS summaries because different site groupings were used for this report; all Boat sites north of Bluff Point to Ninilchik were used.

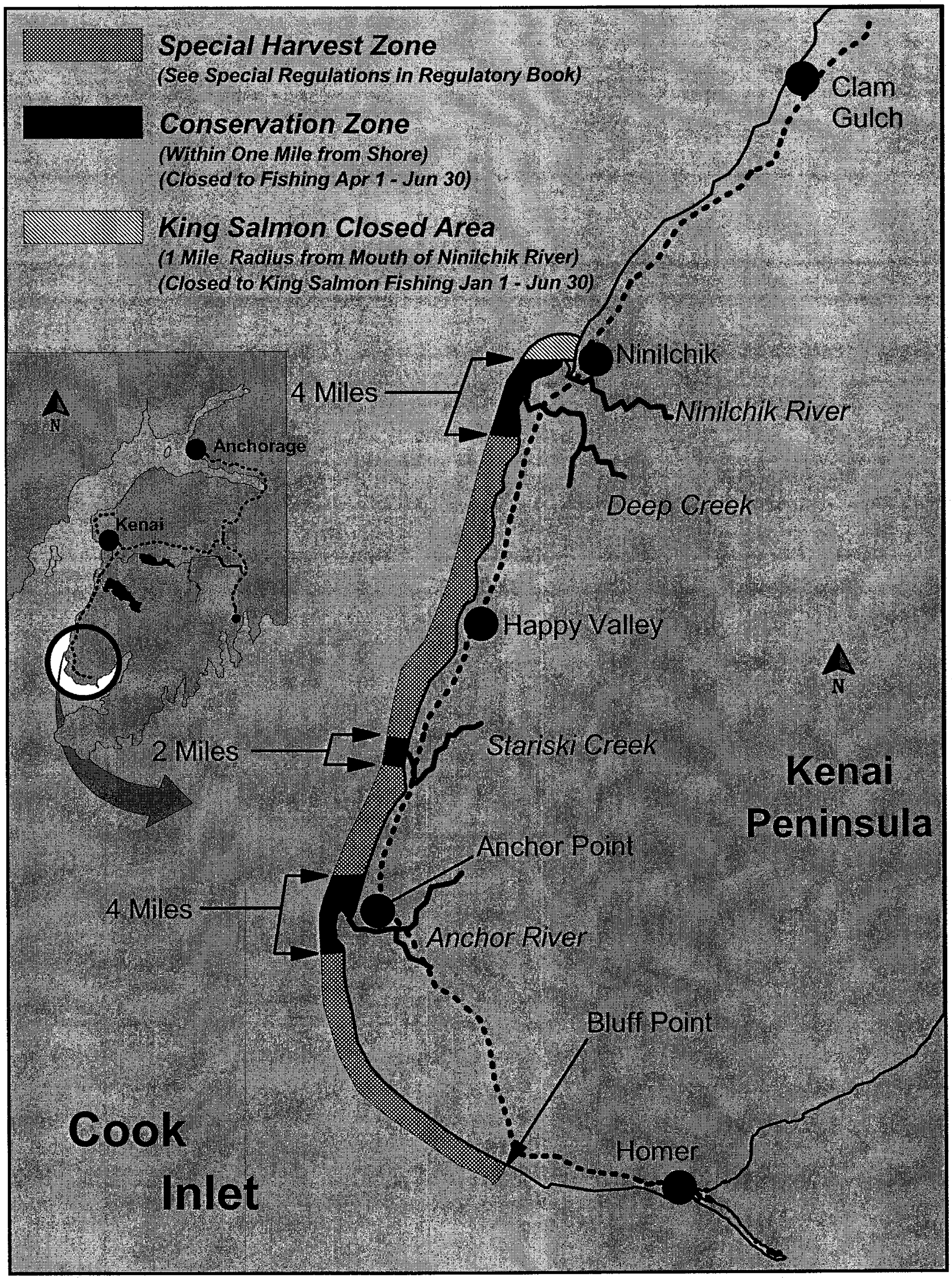

Figure 3.–Central Cook Inlet regulatory zones.

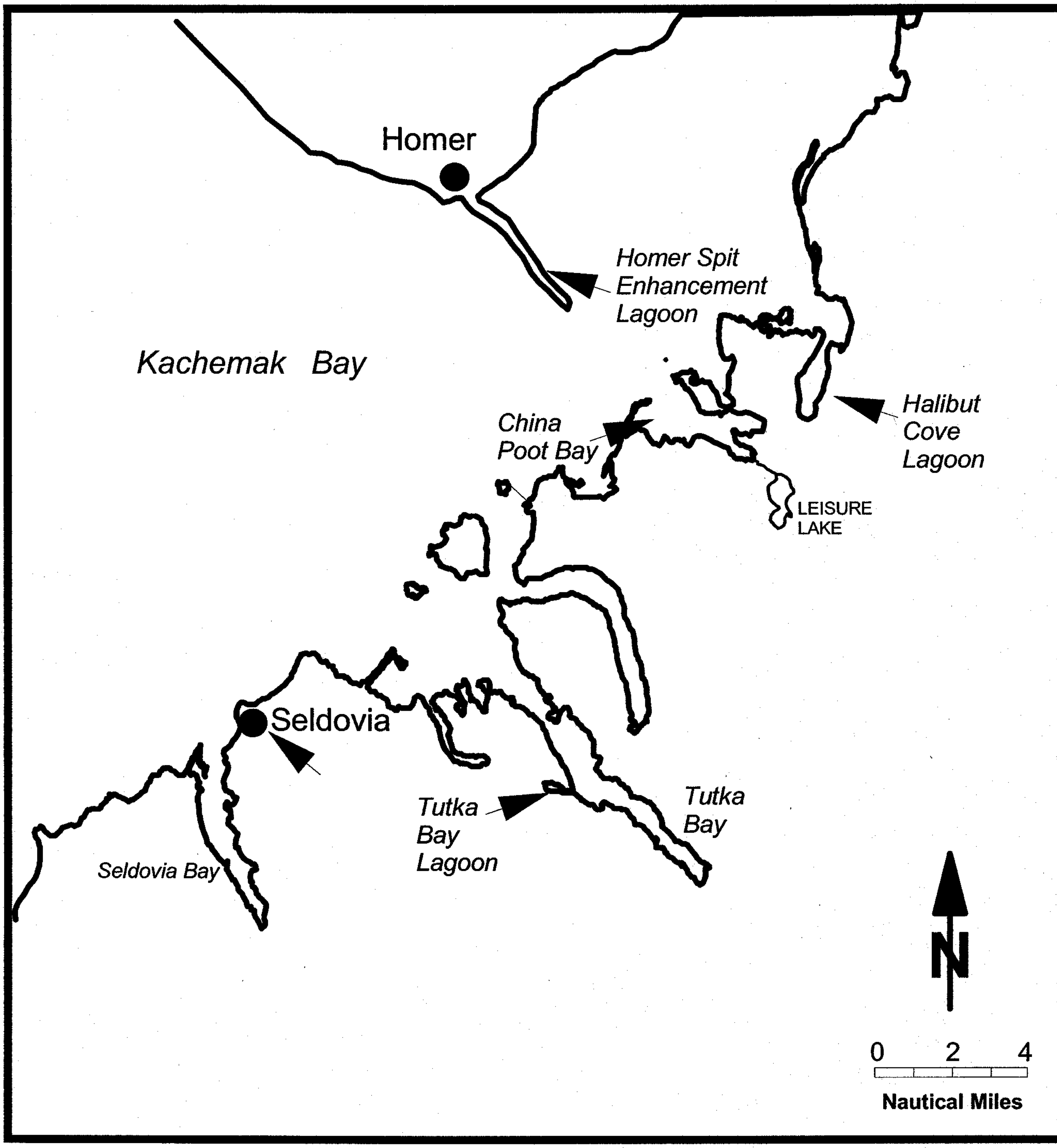

Figure 4.–Saltwater stocking locations in Kachemak Bay and Lower Cook Inlet.

Table 11.-Chinook salmon harvested in Lower Cook Inlet and Kachemak Bay during October-March, 2002-2006.

Year	Guided	Unguided	Total
2002	204	1,219	1,423
2003	289	1,515	1,804
2004	419	1,650	2,069
2005	412	2,546	2,958
2006	153	1,334	1,487
Average	295	1,653	1,948

Source: Jennings et al. 2006a-b, 2007, In prep.; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication.

Table 12.-Salmon smolt releases to terminal fisheries in Kachemak Bay, 1974-2007.

	Homer Spit				Halibut Cove Lagoon	Seldovia	
Release Year	Early-run Chinook	Late-run Chinook	Early-run Coho	Late-run Coho	Early-run Chinook	Early-run Chinook	Late-run Coho
1974					3,872		
1975					3,463		
1976					16,183		
1977					48,907		
1978					126,306		
1979					305,145		
1980					260,295		
1981					76,472		
1982							
1983					200,900		
1984	88,753				84,000		
1985	152,226				98,000		
1986	103,946				101,331		
1987	103,860				94,100	80,420	
1988	219,572			62,550	93,874	111,435	
1989	212,737			153,844	115,682	108,300	
1990	210,087			122,945	112,458	98,525	
1991	190,915			100,029	92,363	91,592	
1992	227,125	126,130		100,570	117,850	112,935	
1993	212,292	100,000		116,129	100,228	106,497	
1994	163,963	156,873		156,213	98,872	107,246	
1995	216,026	123,048		110,701	37,577	116,165	
1996	204,085	108,204		149,685	97,729	118,274	
1997	217,733	100,933		232,146	78,133	103,757	
1998	177,730	112,100		130,219	65,893	69,461	
1999	163,170	59,611		129,602	79,221	74,057	
2000	219,984			122,338	83,277	68,114	
2001	208,062		100,280	124,762	106,719	102,793	
2002	190,026		95,648	120,707	106,279	83,045	
2003	206,292		222,735 [a]	105,000 [b]	106,844	107,521	
2004	168,644		130,243	110,000 [b]	103,771	88,682	
2005	220,822		125,707	91,485 [b,c]	112,521	114,984	
2006	224,053		125,216	324,200 [b,c]	117,549	113,974	113,800 [b,c]
2007	226,972		127,244	100,600 [b]	54,560	54,276	

[a] Includes 100,000 coho diverted from Bird Creek because of highway construction.
[b] Purchased from CIAA with non-Fish and Game funding source.
[c] Treated for BKD

Table 13.-Shore-based harvest and angler participation for enhanced Chinook pink and coho salmon stocks at the Nick Dudiak Fishing Lagoon, 1987-2006.

	Chinook Salmon Harvest[a]			Pink Salmon Harvest[c]	Coho Salmon Harvest	Total		
Year	Early run	Late run[b]	Total			Harvest	Catch	Days Fished
1987			833			833		
1988			5,275	1,819		7,094		20,282
1989			1,956	3,856	1,439	7,251		16,758
1990			2,027	697	1,272	3,996	5,001	22,751
1991			1,634	647	3,822	6,103	6,150	11,495
1992			1,406	485	1,109	3,000	3,442	8,440
1993			4,997	1,836	5,823	12,656	14,821	28,290
1994			2,607		5,355	7,962	10,495	30,221
1995			4,266		5,367	9,633	12,344	36,451
1996	933	1,423	2,356		9,060	11,416	19,094	24,315
1997	1,512	1,450	2,962		6,091	9,053	14,257	23,197
1998	1,051	805	1,856		6,672	8,528	11,929	15,093
1999	1,753	688	2,441		3,890	6,331	8,730	19,448
2000	1,223	789	2,012		7,067	9,079	14,021	23,227
2001	1,371	1,164	2,535		11,015	13,550	15,699	18,516
2002	2,621		2,621		14,508	17,129	23,460	24,981
2003	4,059		4,059		18,531	22,590	33,087	28,380
2004	4,068		4,068		21,009	25,077	33,101	32,185
2005	2,810		2,810		15,075	17,885	17,944	28,097
2006	2,092		2,092		4,450	6,542		21,043
Average	2,136	1,053	2,741	1,557	7,864	10,285	15,223	22,798

Source: Statewide Harvest Survey (Mills 1988-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, In prep.; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication).

[a] Early-run fish only prior to 1993 when 1-ocean late run fish were first available. Early and late run harvests estimated separately beginning in 1996.

[b] Stocking program discontinued in 2000; last return occurred in 2004. Beginning in 2002 the SHS no longer assessed the late-run.

[c] Stocking program discontinued; last return was in 1993.

Table 14.-Angler participation and harvest and catch of Chinook, coho, pink and sockeye salmon; Dolly Varden; rainbow trout and steelhead trout, Anchor River, 1977 - 2006.

	Chinook Salmon		Coho Salmon		Dolly Varden		Rainbow/Steelhead		Pink Salmon	Sockeye Salmon	Angler-Days of
Year	Harvest	Catch	Harvest	Catch	Harvest	Catch	Harvest	Catch[b]	Harvest	Harvest	Effort
1977	1,077		1,339		9,222		2,099		27		31,515
1978	2,109		1,559		17,357		2,305		139		42,671
1979	1,913		4,006		21,364		1,782		18		44,220
1980	605		2,649		10,948		1,186		339		33,272
1981	1,069		2,949		15,271		928		11		34,257
1982	718		2,379		10,375		698		161		24,709
1983	1,269		1,395		17,277		1,605		252		28,881
1984	998		1,135		5,599		985		249	167	26,919
1985	672		2,239		7,716		475		124	224	31,715
1986	1,098		1,021		3,914		520		136	39	34,938
1987	761		2,010		2,735		643		54	1,263	39,045
1988	976		2,219		2,746		200		109	109	24,356
1989	578		2,635		1,476			2,066	115	136	19,145
1990	1,479	4,119	2,782	4,666	2,821	11,441		1,978	163	136	28,829
1991	1,047	2,540	3,169	3,980	1,409	14,433		2,349	125	152	22,187
1992	1,685	4,506	2,267	4,850	2,532	18,303		2,720	92	66	24,028
1993	2,787	6,022	4,003	6,657	1,031	9,719		4,156	98	45	29,338
1994	2,478	3,890	3,360	5,136	1,574	13,305		4,035	79	82	27,856
1995	1,475	3,545	3,080	5,141	1,537	10,957		2,232	47	94	25,888
1996	1,483	6,594	1,762	4,025	963	17,189		7,570	78	218	16,016
1997	1,563	5,289	1,636	4,017	1,575	17,467		3,103	321	165	17,020
1998	783	2,443	2,386	3,949	2,105	16,195		3,878	7	174	14,310
1999	1,409	6,903	1,780	3,807	1,061	17,076		3,920	54	174	21,184
2000	1,730	5,200	2,604	4,807	1,903	20,469		8,693	123	127	22,971
2001	889	2,415	2,960	6,327	1,652	11,980		3,045	11	61	19,195
2002	1,047	4,103	3,830	7,510	662	11,419		3,501	124	52	19,245
2003	1,011	4,311	3,999	12,133	1,124	18,305		3,409	68	504	17,482
2004	1,561	5,561	4,383	10,194	736	15,052		3,710	146	11	20,452
2005	1,432	5,028	5,314	11,639	675	6,820		2,524	69	156	20,079
2006	1,394	4,637	3,920	7,634	909	13,059		4,525	112	54	17,254
Averages											
1977-2003	1,286	4,420	2,487	5,500	5,480	14,876	1,119	3,777	116	199	26,711
2004-2006	1,462	5,075	4,539	9,822	773	11,644		3,586	109	74	19,262

Source: Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication).

[a] Catch first reported in SWHS during 1990.

[b] Rainbow/steelhead trout caught and released. Retention of this species is prohibited. 1989 catch estimates from unpublished Statewide Harvest Survey data.

Table 15.-Angler participation and harvest and catch of Chinook, coho, pink and sockeye salmon; Dolly Varden; rainbow trout and steelhead trout, Deep Creek, 1977 - 2006.

	Chinook Salmon		Coho Salmon		Dolly Varden		Rainbow/Steelhead		Pink Salmon	Sockeye Salmon	Angler-Days of
Year	Harvest	Catch	Harvest	Catch	Harvest	Catch	Harvest	Catch	Harvest	Harvest	Effort
1977	425		306		1,330		569		109		11,399
1978	804		1,383		3,046		498		294		13,872
1979	703		362		2,027		263		9		12,560
1980	182		478		1,028		236		321		8,796
1981	604		464		1,382		248		11		10,127
1982	791		366		1,247		239		293		12,149
1983	1,154		545		1,112		315		42		13,505
1984	761		1,197		973		311		112	318	15,760
1985	249		2,301		850		179		37	187	19,802
1986	944		588		306		688		52	52	17,354
1987	604		1,050		72		85		18	191	16,734
1988	777		1,528		219		291		72	182	12,115
1989	843		2,254		333			409 [a]	28	117	13,414
1990	1,411	3,625	1,111	2,039	708	3,862		1,291 [a]	35	165	23,567
1991	1,776	3,947	1,290	1,710	287	2,480		425 [a]	50	876	17,048
1992	1,379	3,045	737	1,239	401	2,941		740 [a]	46	378	15,226
1993	2,503	7,058	1,722	2,790	145	1,423		1,448 [a]	81	145	19,535
1994	2,379	4,174	1,895	2,970	377	3,437		1,156 [a]	25	141	18,357
1995	1,161	2,470	1,014	1,636	301	1,325		520 [a]	180	87	12,727
1996	886	2,426	2,313	3,818	615	4,346		1,079 [a]	21	55	9,629
1997	1,249	2,574	1,115	1,943	276	2,409		384 [a]	106	252	9,712
1998	539	1,456	2,035	3,635	1,061	4,477		1,350 [a]	47	185	9,206
1999	741	2,453	2,651	3,991	496	2,458		689 [a]	165	214	11,367
2000	937	2,903	2,018	3,660	355	2,209		1,805 [a]	62	72	12,174
2001	593	1,380	1,828	2,529	240	1,271		627 [a]	0	129	7,834
2002	507	2,551	1,832	3,663	452	2,765		954 [a]	223	0	8,925
2003	775	2,121	1,751	3,179	314	9,703		2,456 [a]	0	406	8,959
2004	823	2,727	2,474	4,624	268	8,673		4,365 [a]	0	45	10,575
2005	642	1,791	2,202	4,631	149	1,800		1,355 [a]	54	447	10,182
2006	451	1,830	1,606	3,302	62	2,139		1,234 [a]	0	86	7,187
Averages											
1977-2003	951	3,013	1,338	2,772	739	3,222	327	1,022	90	208	13,402
2004-2006	639	2,116	2,094	4,186	160	4,204		2,318	18	193	9,315

Source: Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication).

a Rainbow/steelhead trout caught and released. Retention of this species is prohibited. 1989 catch estimates from unpublished Statewide Harvest Survey data.

Table 16.-Angler participation and harvest and catch of Chinook, coho, pink and sockeye salmon; Dolly Varden; rainbow trout and steelhead trout, Ninilchik River, 1977 - 2006.

	Chinook Salmon[a]		Coho Salmon		Dolly Varden		Rainbow/Steelhead		Pink Salmon	Sockeye Salmon	Angler-days
Year	Harvest	Catch	Harvest	Catch	Harvest	Catch	Harvest	Catch[b]	Harvest	Harvest	of Effort
1977	1,168		122		424		230		0		11,350
1978	1,445		88		1,003		307		46		14,173
1979	1,493		200		2,390		509		0		18,282
1980	723		321		853		381		260		19,706
1981	1,523		432		875		464		0		14,184
1982	1,240		241		514		179		10		11,806
1983	871		210		199		157		42		9,458
1984	648		549		524		137		150	1,405	10,122
1985	983		697		87		501		0	373	10,213
1986	420		336		505		275		13	465	9,250
1987	1,112		924		507		291		108	2,488	13,329
1988	795		709		655		272		36	1,073	12,533
1989	744		379		39			505	216	526	9,997
1990	693	1,598	368	633	116	1,614		177	12	58	8,323
1991	3,123	5,260	789	899	222	887		512	116	203	19,640
1992	5,316	11,425	785	1,433	131	1,573		1,008	37	1,101	27,816
1993	4,235	9,491	845	1,636	29	410		442	0	406	20,466
1994	3,108	5,482	1,089	1,486	65	167		804	17	943	21,827
1995	2,451	4,313	620	971	133	332		178	38	161	16,160
1996	2,401	7,481	1,071	1,332	560	2,297		522	0	284	11,445
1997	3,263	6,879	402	948	141	1,024		380	32	236	11,064
1998	1,453	3,395	836	963	272	1,016		576	13	101	10,994
1999	1,945	4,153	2,980	5,127	114	818		694	107	964	15,344
2000	1,782	4,648	1,724	3,354	228	1,444		760	20	255	12,432
2001	1,399	3,014	708	1,196	228	1,330		283	0	1,181	10,602
2002	830	2,180	1,655	3,238	44	993		468	85	109	9,572
2003	1,452	4,205	2,526	4,596	20	952		984	0	191	9,843
2004	1,240	2,961	3,425	4,440	136	907		400	49	470	10,500
2005	1,342	2,042	1,339	2,663	74	400		934	0	399	9,003
2006	1,329	3,003	2,472	3,069	56	740		563	9	556	9,689
Averages											
1977-2003	1,727	5,252	800	1,987	403	1,061	309	553	50	626	13,701
2004-2006	1,304	2,669	2,412	3,391	89	682		632	19	475	9,731

Source: Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication).

[a] Enhanced return beginning in 1991.

[b] Rainbow/steelhead trout caught and released. Retention of this species is prohibited. 1989 catch estimates from unpublished Statewide Harvest Survey data.

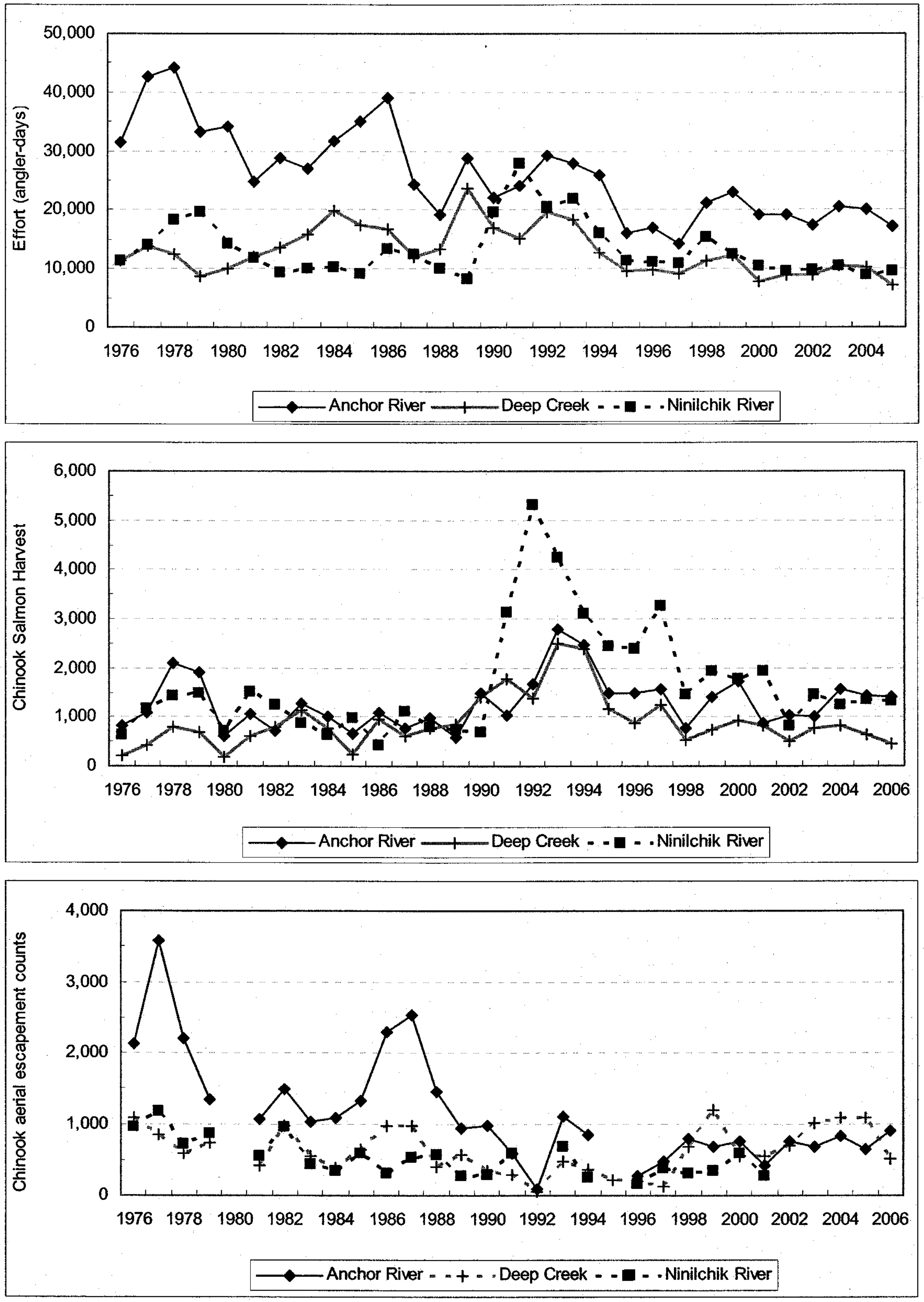

Figure 5.–Sport effort and Chinook salmon harvest (1976-2006) and unexpanded escapement index counts (1976-2007) of Chinook salmon in Anchor River, Deep Creek, and Ninilchik River.

Table 17.-Sport harvest (1976-2006) and unexpanded escapement index counts (1976-2007) of Chinook salmon in Anchor River, Deep Creek, and Ninilchik River (1976-2001).

	Anchor River		Deep Creek		Ninilchik River	
Year	Harvest	Aerial Escapement	Harvest	Aerial Escapement	Harvest	Aerial Escapement
1976	830	2,125	220	1,075	630	956
1977	1,077	3,585	425	848	1,168	1,169
1978	2,109	2,209	804	582	1,445	724
1979	1,913	1,335	703	726	1,493	854
1980 [a]	605		182		723	
1981 [a]	1,069	1,066	604	427	1,523	552
1982	718	1,493	791	977	1,240	947
1983	1,269	1,033	1,154	550	871	445
1984	998	1,087	761	380	648	346
1985	672	1,328	249	644	983	582
1986	1,098	2,287	944	976	420	307
1987	761	2,524	604	968	1,112	523
1988	976	1,458	777	409	795	569
1989	578	940	843	561	744	280
1990	1,479	967	1,411	347	693	288
1991	1,047	589	1,776	294	3,123 [c]	594
1992	1,685	99	1,379	63	5,316 [c]	[b]
1993	2,787	1,110	2,503	486	4,235 [c]	688
1994	2,478	837	2,379	364	3,108 [c]	252
1995	1,475	[b]	1,161	229	2,451 [c]	[b]
1996	1,483	277	886	193	2,401 [c]	158
1997	1,563	477	1,249	136	3,263 [c]	393
1998	783	789	539	676	1,453 [c]	316
1999	1,409	685	741	1,190	1,945 [c]	357
2000	1,730	752	937	556	1,782 [c]	578
2001	889	414	823	551	1,945 [c]	268
2002	1,047	748	507	696	830 [c]	[d]
2003	1,011	680	775	1,008	1,452 [c]	[d]
2004	1,561	834	823	1,075	1,240 [c]	[d]
2005	1,432	651	642	1,076	1,342 [c]	[d]
2006	1,394	899	451	507	1,329 [c]	[d]
2007		678		553		
Averages	1,284	1,132	920	617	1,679	528
SEG				350-800		

Source: Harvest estimates for all three streams in 1976 are from punch card returns (Hammarstrom 1977), all other harvest estimates are from Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication). Escapement estimates are aerial counts.

[a] Escapement counts not conducted or considered minimal due to high turbid water during aerial escapement surveys.

[b] Aerial escapement counts not obtained due to high water.

[c] Enhanced run.

[d] Discontinued. Run strength now indexed by weir count between July 8 and July 24.

Table 18.-Chinook salmon harvest, mortality and escapement counts Ninilchik River weir, 1999-2005.

Year	Component	Weir Count	Weir Proportion	Inriver Harvest	Total Return	Inriver Exploitation	CWT Recovery	Egg Take	Spawning Escapement
1999	Wild	1,644	0.72	973 [a]	2,617	0.37		68	1,576
	Hatchery	641	0.28	972 [a]	1,613	0.60	42	26	573
	Total	2,285 [b]	1.00	1,945	4,230	0.46	42	94	2,149
2000	Wild	1,634	0.66	869	2,503	0.35		81	1,553
	Hatchery	853	0.34	869	1,722	0.5	108	60	685
	Total	2,487	1.00	1,738	4,225	0.41	108	141	2,238
2001	Wild	1,414	0.68	699	2,113	0.33		175	1,239
	Hatchery	673	0.32	699	1,372	0.51	130		543
	Total	2,087	1.00	1,398	3,485	0.40	130	175	1,782
2002	Wild	1,516	0.73			0.78 [c]		176	1,340
	Hatchery	559	0.27			0.22 [c]	109	55	395
	Total	2,075	1.00	830	2,905	0.29	109	231	1,735
2003	Wild	1,258	0.75			0.69 [c]		131	1,127
	Hatchery	425	0.25			0.31 [c]	69	52	336
	Total	1,683	1.00	1,452	3,135	0.46	69	183	1,463
2004	Wild	1,525	0.74					132	1,393
	Hatchery	536	0.26				67	0	469
	Total	2,061	1.00	1,240	3,301	0.38	67	132	1,862
2005	Wild	2,241 [d]	0.83					165	2,076
	Hatchery	462	0.17				53	0	409
	Total	2,703	1.00	1,342	4,045	0.33	53	165	2,485
Averages	Wild	1,605	0.73	847	2,411	0.35 [e]		133	1,472
	Hatchery	593	0.27	847	1,569	0.54 [e]		28	487
	Total	2,197		1,421	3,618	0.39	83	160	1,959

Source: Begich 2006b, Begich 2007b; Balland and Begich *In prep*; Kerkvliet In prep; C. Kerkvliet, Alaska Department of Fish and Game, Division of Sport Fish, Homer, personal communication. Harvest estimates are from Statewide Harvest Survey: Howe et al. 2001d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*

[a] Hatchery harvest estimate average of 50% is based on harvest sampling in 2000 and 2001.

[b] Weir count includes 31 wild Chinook and 38 hatchery Chinook netted downstream of the weir.

[c] Exploitation rate during third regulatory weekend only.

[d] Includes 1 Chinook salmon that died in the live box.

[e] 1999 through 2001 average.

Table 19.-Number of wild and hatchery reared Chinook salmon counted at the Ninilchik River weir during SEG[a] periods from 1994 - 2007.

	Wild Chinook Salmon						Hatchery Chinook Salmon					
	Weir Counts[a]			Escapement Counts[b]			Weir Counts[a]			Escapement Counts[b]		
Year	Total Run	Jul 8-24	Proportion of run	Total Run	Jul 3-31	Proportion of run	Total Run	Jul 8-24	Proportion of run	Total Run	Jul 3-31	Proportion of run
1994		423						40				
1995		503						342				
1996		591						264				
1997		235						358				
1998		422						268				
1999	1,644	799	0.49	1,576	1,283	0.81	641	277	0.43	573	447	0.78
2000	1,634	834	0.51	1,553	1,265	0.81	853	426	0.50	685	618	0.90
2001	1,414	716	0.51	1,239	897	0.72	673	363	0.54	543	471	0.87
2002	1,516	655	0.43	1,340	897	0.67	559	169	0.30	395	238	0.60
2003	1,258	393	0.31	1,127	517	0.46	425	150	0.35	336	204	0.61
2004	1,525	416	0.27	1,393	679	0.49	536	158	0.29	469	342	0.73
2005	2,241	814	0.36	2,076	1,259	0.61	462	129	0.28	409	286	0.70
2006		764			1,013			123		204	191	
2007		532			545			56			61	
Average												
1999 - 2005	1,605	661	0.41		971	0.65	593	239	0.39		372	0.74
		SEG[a] (2001)			SEG[b] (2007)							
		400-850			**550-1,300**							

[a] SEG=Sustainable Escapement Goal established in 2001 based on weir counts of wild Chinook salmon from July 8-July 24, 1994-2000.

[b] SEG=Sustainable Escapement Goal established in 2007 based on weir counts July 3-July 31, 1999-2007.

Table 20.-Estimates of fish passage in the mainstem Anchor River using a combination of DIDSON and floating weir, 2003-2007.

Year	Dates of operation: Sonar	Dates of operation: Weir	Chinook Salmon: Estimate	Chinook Salmon: SE[e]	Coho Salmon	Pink[a] Salmon	Sockeye Salmon	Chum Salmon	Dolly[a] Varden	Steelhead/ rainbow
2003	5/30-7/9		9,238							
2004	5/15-6/9	6/10-9/13	12,016	283	5,728	1,079	45	79	7,846	20
2005	5/13-6/3	6/4-9/9	11,095	229	18,977 [b]	4,916	319	146	5,719	107
2006	5/15-6/13, 8/22-24	6/13-8/18	8,945	289	10,181 [c]	954	38	45	234	4
2007 [d]	5/14-6/7	6/7-9/11	9,634		8,227	3,869	189	148	1,268	313
Average 2004-2007			10,423		10,778	2,705	148	105	3,767	111

[a] Not completely enumerated because weir picket spacing allows passage of Dolly Varden and small pink salmon.
[b] Weir washed out 9/9.
[c] Weir washed out 8/19. DIDSON operated 8/22-8/24, then removed due to high water.
[d] Preliminary.
[e] Standard error for the DIDSON portion of the estimate.

Table 21.-Counts of all species passed upstream at the Anchor River Dolly Varden weir, 1987-1995.

Year	Dates of operation	Dolly Varden	Coho Salmon	Pink Salmon	Chinook Salmon	Sockeye Salmon	Chum Salmon	Steelhead/ rainbow
1987	July 4 - Sept. 10	19,062	2,409	2,084	204	33	19	136
1988	July 3 - Oct. 5	14,935	2,805	777	245	30	24	878
1989	July 6 - Nov. 5	11,384	20,187	4,729	95	212	165	769
1990	July 4 - Aug. 15	10,427	190	355	144	39	17	3
1991	July 4 - Aug. 15	18,002	13	1,757	39	46	9	5
1992	July 4 - Oct. 1	10,051	4,596	992	129	174	39	1,261
1993	July 3 - Aug. 16	8,262	299	1,019	90	71	12	1
1994	July 3 - Aug. 16	17,259	420	723	111	61	2	1
1995	July 4 - Aug. 12	10,994	725	1,094	112	73	4	10

Source: Larson and Balland 1989; Larson et al. 1988; Larson 1990-1995, 1997

Table 22.-Parameter estimates for coho salmon in Deep Creek from coded wire tag and weir projects, 1996-2004.

Tagging Year	Number Smolt Tagged	Recovery Year	Gear Type	Weir Count	Number Examined for CWT	Tagged Proportion	Estimated Smolt Abundance	Inriver harvest	Inriver Return	Exploited Proportion	Marine Survival Fraction
1995	9,671	1996	Gillnet		205	0.278	34,351	2,313			
1996	4,868	1997	Weir	2,017	2,017	0.125	38,683	1,115	3,132	0.36	0.081 [a]
1997	6,948	1998	Weir	1,537	1,537	0.345	20,097	2,035	3,572	0.57	0.178 [a]
1998		1999	Weir	2,267				2,651	4,918	0.54	
1999		2000	Weir	3,425				2,018	5,443	0.37	
2000		2001	Weir	3,747				1,828	5,575	0.33	
2001	2,538	2002	Weir	6,164		0.061	38,473	1,832	7,996	0.23	0.208
2002	7,412	2003	Seine		1,485	0.128	57,672	1,751			
2003	2,667	2004	Seine		1,027	0.059 [b]	44,480 [b]				

Source: Bendock 1996; King and Breakfield 1998, 1999, 2002; Begich 2002, 2006a; Begich and Evans 2005, C. Kerkvliet, Sport Fish Division, Homer, personal communication. Harvest estimates from Howe et al. 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a.

[a] Revised harvest and resulting marine survival estimates differ from unrevised harvest and marine survival estimates published in Breakfield 1999 and 2002.

[b] Preliminary.

Table 23.-Angler participation and harvest of Chinook, coho, and pink salmon; Dolly Varden, rainbow trout and steelhead trout, Stariski Creek, 1977 - 2006.

	Harvest		Coho Salmon		Dolly Varden		Rainbow/ Steelhead		Days
Year	Pink Salmon	Sockeye Salmon	Harvest	Catch	Harvest	Catch	Harvest	Catch	Fished
1977	26		133		461		294		1,442
1978	15		201		1,012		352		3,662
1979			275		2,027		236		1,965
1980			155		327		105		1,499
1981			410		875		118		1,080
1982			119		348		59		1,023
1983			251		283		42		877
1984			0		499		137		519
1985			25				50		1,422
1986			187		183		31		1,162
1987		153	127		199		62		1,612
1988		36	146		182		18		804
1989			396					10 [a]	1,533
1990		29	169	287	167	375		104 [a]	935
1991		13	280	339	65	91		12 [a]	1,143
1992		33	97	138	8	8		70 [a]	523
1993			392	602	67	184		31 [a]	813
1994			446	464	9	36		75 [a]	1,160
1995		105	72	72	55	119		[a]	896
1996			426	482	24	269		47 [a]	694
1997			111	178	64	213		[a]	489
1998			1,168	1,289	25	261		71 [a]	922
1999			153	436		22		305 [a]	327
2000			419	534	24	232		329 [a]	1,217
2001			270	328	11	43		51 [a]	461
2002			367	384		203		203 [a]	640
2003			309	470		161		46 [a]	646
2004			374	915		266		39 [a]	782
2005			379	475		71		106 [a]	875
2006			280	407		39		13 [a]	385
Averages									
1977-2003	21	62	263	429	314	158	125	104	1,091
2004-2006			348	526	18	181		134	749

Source: Statewide Harvest Survey (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication).

[a] Rainbow/steelhead trout caught and released. Retention of this species is prohibited. 1989 catch estimates from unpublished Statewide Harvest Survey data.

Table 24.-Hatchery contribution to the personal use gillnet harvest from the east side of the Homer Spit during open fishing periods in 1999 and 2000.

	1999			2000		
Date	Total Examined	Number Hatchery Origin	Percent Hatchery	Total Examined	Number Hatchery Origin	Percent Hatchery
Period 1	147	102	70	385	318	83
Period 2	43	15	36	290	290	100
Period 3	139	136	98			
Period 4	170	149	87			
Total	499	402	81	675	608	90

Table 25.-Coho salmon harvest, catch and angler effort (angler days) estimates for Silver Salmon Creek and Kamishak River, 1983-2006.

	Silver Salmon Creek				Kamishak River			
Year	Harvest	Catch	Effort	Responses	Harvest	Catch	Effort	Responses
1983	1,872		1,585	23				
1984	661		552	12	112		100	
1985	647		555	8	100		381	
1986	302		292	6				
1987	706		831	19				
1988	709		673	11				
1989	735		1,285	16				
1990	320	1,212	915	12		220	44	1
1991	1,120	1,207	1,112	22				
1992	494	842	597	17	57	202	117	3
1993	1,080	1,280	853	40	76	535	704	10
1994	329	689	270	18	54	134	272	8
1995	1,715	2,831	1,851	34	216	1,040	204	9
1996	2,094	3,440	1,850	34	109	308	85	5
1997	453	1,036	1,179	26	197	1,093	206	8
1998	422	1,104	440	18	201	413	305	4
1999	590	2,157	1,408	22	229	597	183	8
2000	1,013	2,293	904	28	220	1,323	220	10
2001	2,054	3,178	517	15	183	721	185	9
2002	942	2,598	612	22	277	2,258	956	17
2003	2,269	7,377	1,522	25	127	1,488	427	14
2004	1,389	10,902	1,203	27	836	3,564	416	14
2005	1,568	7,053	1,653	24	132	570	357	11
2006	997	5,234	1,680	27	612	2,681	473	10
Averages								
1983-2003	977	2,232	943	20	154	795	293	8
2004-2006	1,318	7,730	1,512	26	527	2,272	415	12

Source: Mills 1984-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, *In prep.*; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication)

Note: No reports were received in years where harvest, catch and effort is blank.

Table 26.-Harvest and catch of Dolly Varden from Lower Kenai Peninsula road side streams, 1977 through 2006.

	Anchor River		Stariski Creek		Deep Creek		Ninilchik River		All	
Year	Harvest	Catch[a]	Harvest	Catch[a]	Harvest	Catch[a]	Harvest	Catch[a]	Harvest	Catch
1977	9,222		461		1,330		424		11,437	
1978	17,357		1,012		3,046		1,003		22,418	
1979	21,364		2,027		2,027		2,390		27,808	
1980	10,948		327		1,028		853		13,156	
1981	15,271		875		1,382		875		18,403	
1982	10,375		348		1,247		514		12,484	
1983	17,277		283		1,112		199		18,871	
1984	5,559		499		973		524		7,555	
1985	7,716				850		87		8,653	
1986	3,914		183		306		505		4,908	
1987	2,735		199		72		507		3,513	
1988	2,746		182		219		655		3,802	
1989	1,476				333		39		1,848	
1990	2,821	11,441	167	375	708	3,862	115	1,614	3,811	17,292
1991	1,409	14,433	65	91	287	2,480	222	887	1,983	17,891
1992	2,532	18,303	8	8	401	2,941	131	1,573	3,072	22,825
1993	1,031	9,719	67	184	145	1,423	29	410	1,272	11,736
1994	1,574	13,305	9	36	377	3,437	65	167	2,025	16,945
1995	1,537	10,957	55	119	301	1,325	133	332	2,026	12,733
1996	963	17,189	24	269	615	4,346	560	2,297	2,162	24,101
1997	1,575	17,467	64	213	276	2,409	140	1,024	2,055	21,113
1998	2,105	16,195	25	261	1,061	4,477	272	1,016	3,463	21,949
1999	1,061	17,076		22	496	2,458	114	818	1,671	20,374
2000	1,903	20,469	24	232	355	2,209	228	1,444	2,510	24,354
2001	1,652	11,980	11	43	240	1,271	228	1,330	2,131	14,624
2002	662	11,419		203	452	2,765	44	993	1,158	15,380
2003	1,124	18,305		161	314	9,703	20	952	1,458	29,121
2004	736	15,052		266	268	8,673	136	907	1,140	24,898
2005	675	6,820		71	149	1,800	74	400	898	9,091
2006	909	13,059		39	62	2,139	56	740	1,027	15,977
Averages										
1977-1989	9,689		581		1,071		660		11,912	
1990-2006	1,428	14,305	47	153	383	3,395	151	994	1,992	18,847

Source: Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, In prep.; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication.

[a] Catch first reported in SWHS during 1990.

Table 27.-Harvest and catch of steelhead trout in Lower Kenai Peninsula roadside streams, 1977 through 2005.

	Anchor River		Stariski Creek		Deep Creek		Ninilchik River		All	
Year	Harvest	Catch[a]	Harvest	Catch[a]	Harvest	Catch[a]	Harvest	Catch[a]	Harvest	Catch
1977	2,099		294		569		230		3,192	
1978	2,305		352		498		307		3,462	
1979	1,782		236		263		509		2,790	
1980	1,186		105		236		381		1,908	
1981	928		118		248		464		1,758	
1982	698		59		239		179		1,175	
1983	1,605		42		315		157		2,119	
1984	985		137		311		137		1,570	
1985	475		50		179		501		1,205	
1986	520		31		688		275		1,514	
1987	643		62		85		291		1,081	
1988	200		18		291		272		781	
1989	0	2,066	0	10	0	409	0	505	0	2,990
1990	0	1,978	0	104	0	1,291	0	177	0	3,550
1991	0	2,349	0	12	0	425	0	512	0	3,298
1992	0	2,720	0	70	0	740	0	1,008	0	4,538
1993	0	4,156	0	31	0	1,448	0	442	0	6,077
1994	0	4,035	0	75	0	1,156	0	804	0	6,070
1995	0	2,232	0		0	520	0	178	0	2,930
1996	0	7,570	0	47	0	1,079	0	522	0	9,218
1997	0	3,103	0		0	384	0	380	0	3,867
1998	0	3,878	0	71	0	1,350	0	576	0	5,875
1999	0	3,920	0	305	0	689	0	694	0	5,608
2000	0	8,693	0	329	0	1,805	0	760	0	11,587
2001	0	3,045	0	51	0	627	0	283	0	4,006
2002	0	3,501	0	203	0	954	0	468	0	5,126
2003	0	3,409	0	46	0	2,456	0	952	0	6,863
2004	0	3,710	0	39	0	4,365	0	400	0	8,514
2005	0	2,524	0	106	0	1,355	0	934	0	4,919
2006	0	4,525	0	13	0	1,234	0	563	0	6,335
Average	1,033	3,699	116	95	327	1,238	309	564	835	5,590

Source: Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, In prep.; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication.

Note: In 1989, these fisheries became catch and release only, so harvest is 0. Average harvest is computed for years 1977-1988.

[a] Catch first estimated by SWHS during 1989. 1989 catch estimates from unpublished Statewide Harvest Survey data.

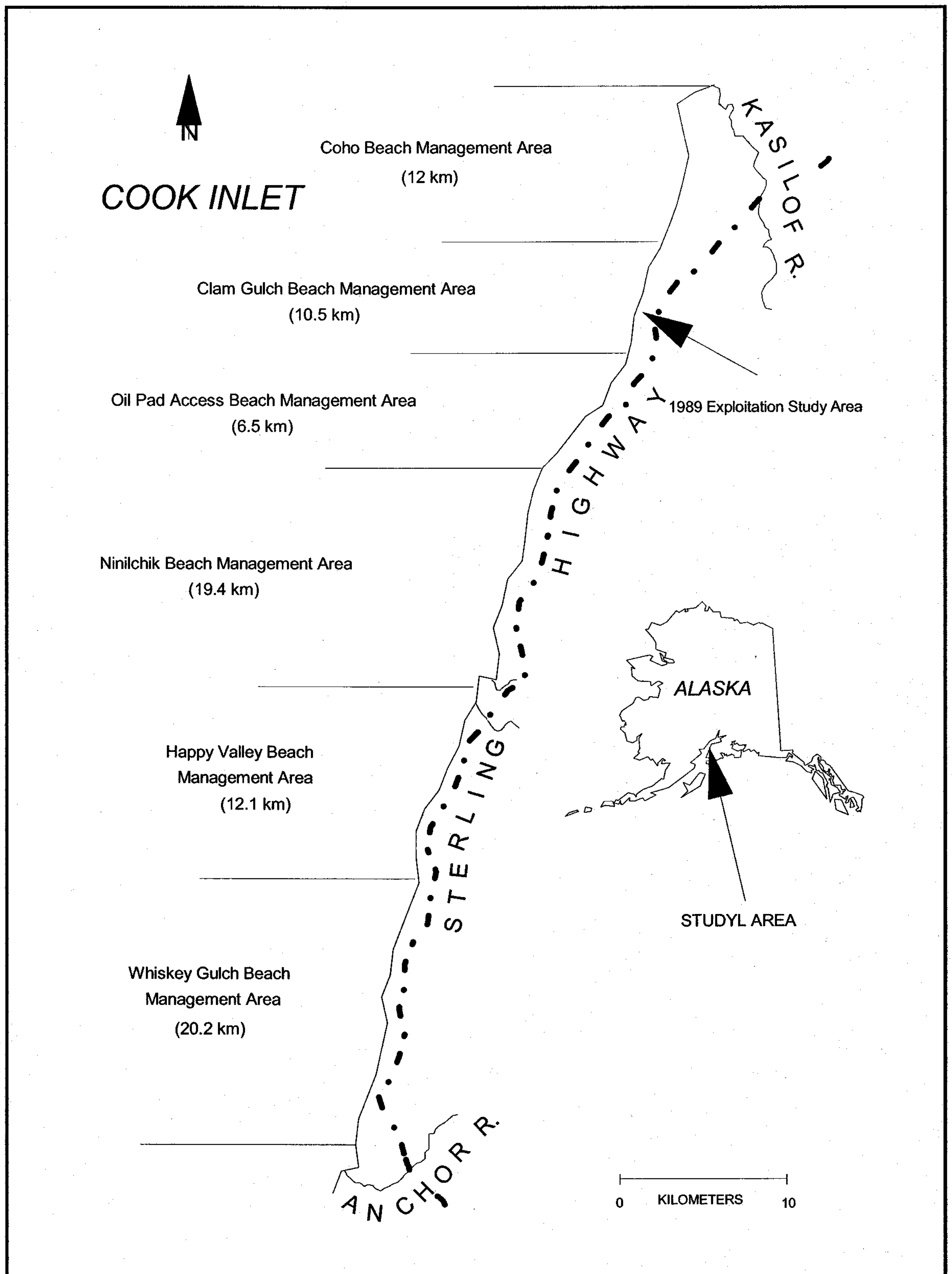

Figure 6.–Eastside Cook Inlet razor clam beaches.

Table 28.-Percentage of harvest by beach area in the Cook Inlet eastside beach razor clam fishery adjusted for relative success rate, 1977-2006.

		Percentage of Harvest					
Year	No. of Surveys	Cohoe	Clam Gulch	Oil Pad	Ninilchik	Happy Valley	Whiskey Gulch
1977	3	2.2	70.6	11.2	11.4	3.1	1.5
1978	9	1.8	74.7	10.4	6.9	4.3	1.9
1979	8	2.5	77.1	7.3	7.5	4.8	0.8
1980	8	2.0	67.5	8.2	11.7	8.3	2.3
1981	9	1.7	60.9	12.8	11.1	10.2	3.4
1982	6	1.2	49.6	10.9	13.7	18.4	6.2
1983	6	1.7	48.5	12.8	15.7	15.0	6.3
1984	6	0.9	45.7	19.5	20.2	10.0	3.7
1985	5	0.9	35.1	17.5	31.1	12.7	2.7
1986	4	1.0	25.3	21.4	35.5	13.3	3.5
1987	3	0.2	21.6	13.1	51.9	9.5	3.7
1988	3	0.8	26.1	4.9	53.3	11.2	3.7
1989	11	0.2	28.8	12.1	50.4	5.7	2.8
1990 [a]	12	0.3	30.5	14.8	46.4	6.0	2.0
1991 [a]	10	0.6	28.0	13.6	50.2	6.2	1.5
1992 [a]	13	0.3	21.6	10.4	61.9	5.0	0.8
1993 [a]	13	0.3	21.0	11.8	61.9	4.3	0.7
1994 [a]	13	0.3	19.8	10.0	65.0	4.0	1.0
1995 [a]	13	0.1	19.9	10.5	65.5	3.2	0.7
1996 [a]	13	0.6	23.3	13.6	57.5	3.9	1.1
1997 [a]	12	0.6	26.5	13.6	56.1	2.2	1.1
1998 [a]	12	1.0	28.3	16.6	50.6	2.4	1.1
1999 [a]	14	1.2	27.1	13.4	53.5	4.0	0.9
2000 [a]	13	2.2	31.1	12.8	47.8	4.9	1.2
2001 [a]	13	1.8	37.1	16.8	39.4	3.6	1.3
2002 [a]	14	2.0	28.0	17.5	47.3	3.4	2.0
2003 [a]	13	1.3	34.2	18.8	39.6	4.3	1.7
2004 [a]	12	1.2	30.5	16.2	44.8	5.1	2.3
2005 [a]	13	0.9	26.4	10.0	53.2	6.3	3.3
2006 [a]	14	0.3	18.1	7.4	62.9	6.7	4.6
Average	10	1.1	36.1	13.0	40.8	6.7	2.3

Source: Athons 1992; Athons and Hasbrouck 1994; Szarzi et al. *In prep.-a*

[a] Harvest percentage weighted by tidal height beginning in 1990.

Table 29.-Estimates of harvest (H), abundance of exploitable individuals (> 80 mm; N), and exploitation rate (Exp) with associated standard errors, of razor clams from Tower to A-frame at Clam Gulch, and from Deep Creek to Lehman's Point.

Beach	Year	Harvest	SE(H)	N_e	SE(N_e)	Exp	SE(Exp)
Clam Gulch	1988 [a]	286,375	14,646	10,340,788	2,148,524	0.028	0.006
	1989 [a]	224,173	11,465	6,768,427	552,057	0.033	0.003
	1999	185,144	10,286	16,048,936	1,292,348	0.012	0.001
Ninilchik	1989 [a]	334,889	18,139	483,289	108,972	0.692	0.160
	1990	321,354	26,342	719,655	199,174	0.447	0.129
	1991	354,583	20,952	2,048,658	360,725	0.173	0.032
	1992	563,709	24,690	2,938,234	781,655	0.192	0.052
	1998	287,423	15,845	887,858	128,443	0.324	0.050
	2001	219,972	12,371	793,900	113,086	0.277	0.042
	2003	210,385	14,293	1,325,497	302,651	0.160	0.038
	2005	220,171	15,042	1,246,125	247,434	0.180	0.037

Source: Athons 1992; Athons and Hasbrouck 1994; Szarzi et al. *In prep.-a*

[a] Harvest estimated as the product of the proportion of total beach harvest that occurred in smaller beach area and the harvest of the entire beach as reported in Table 3 of Athons and Hasbrouck (1994).

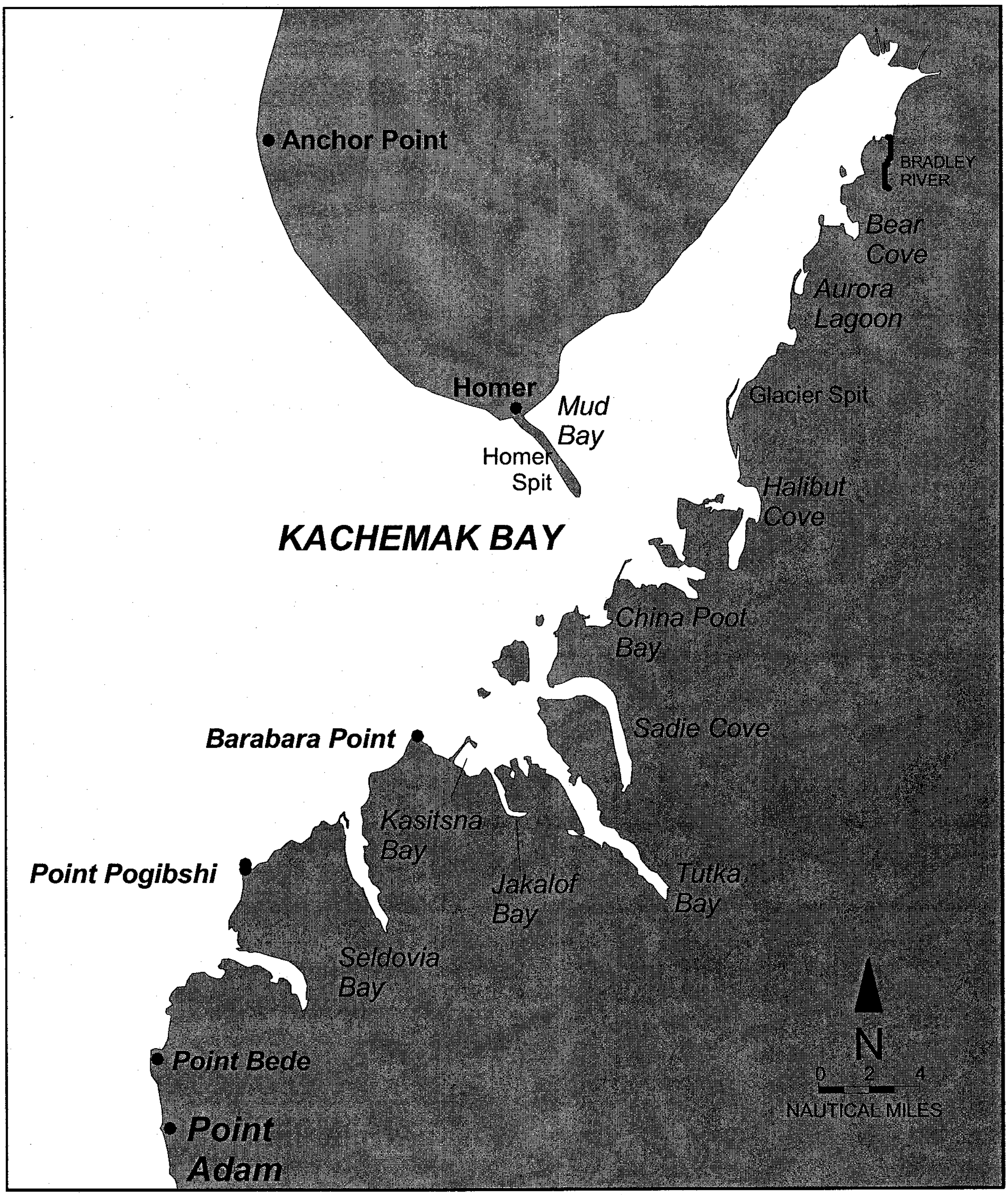

Figure 7.–Kachemak Bay.

Table 30.-Sport and personal use effort directed at crab and sport and personal use harvests of crab in Cook Inlet reported on permits 1996 through 2002 (estimates of harvest not expanded for non-reporting).

	Effort		Harvest	
			Dungeness	Tanner
Location	Trips	Crabber-Days	Numbers	Numbers
1996				
Cook Inlet north of Anchor Point	33		12	300
Cook Inlet remainder	6		0	0
North Gulf Coast	19		15	6
Kachemak Bay east of Homer Spit	2,132		7,337	2,495
Kachemak Bay west of Homer Spit	651		341	9,112
Unknown	55		167	146
Total	2,896		7,872	12,059
1997				
Cook Inlet north of Anchor Point	29	58	146	5
Cook Inlet remainder	30	65	42	791
North Gulf Coast	21	46	6	19
Kachemak Bay east of Homer Spit	1,674	3,057	6,977	2,856
Kachemak Bay west of Homer Spit	560	956	475	7,559
Unknown	34	68	128	146
Total	2,348	4,250	7,774	11,376
1998				
Cook Inlet north of Anchor Point	13	17	40	0
Cook Inlet remainder	10	15	1	46
North Gulf Coast	3	4	0	0
Kachemak Bay east of Homer Spit	232	420	17	2,285
Kachemak Bay west of Homer Spit	850	1,144	58	13,386
Unknown	75	162	0	1,046
Total	1,183	1,762	116	16,763
1999				
Cook Inlet north of Anchor Point	5	5	0	0
Cook Inlet remainder	39	64	77	792
North Gulf Coast	10	10	0	0
Kachemak Bay east of Homer Spit	315	575	303	2,562
Kachemak Bay west of Homer Spit	783	1,066	1,176	13,102
Unknown	50	62	33	589
Total	1,202	1,782	1,589	17,045

-Continued-

Table 30.-Page 2 of 2.

Location	Effort		Dungeness	Tanner
	Trips	Crabber-Days	Numbers	Numbers
2000				
Cook Inlet north of Anchor Point	2	3	0	0
Cook Inlet remainder	12	23	50	204
North Gulf Coast	9	27	0	0
Kachemak Bay east of Homer Spit	258	419	453	2,216
Kachemak Bay west of Homer Spit	1,161	1,603	2,150	16,341
Unknown	76	107	149	911
Total	1,518	2,182	2,802	19,672
2001				
Cook Inlet north of Anchor Point	2	2	0	0
Cook Inlet remainder	6	8	1	76
North Gulf Coast	2	4	0	0
Kachemak Bay east of Homer Spit	205	359	265	932
Kachemak Bay west of Homer Spit	719	1,114	1,180	5,374
Unknown	46	38	3	117
Total	980	1,525	1,449	6,499
2002				
Cook Inlet north of Anchor Point	0	0	0	0
Cook Inlet remainder	2	2	10	10
North Gulf Coast	0	0	0	0
Kachemak Bay east of Homer Spit	94	179	530	214
Kachemak Bay west of Homer Spit	430	756	2,929	924
Unknown	15	10	105	0
Total	541	947	3,574	1,148

Table 31.-Abundance of male Tanner crab in Kachemak Bay estimated from trawl surveys, 1990-2006.

Year	No. of Tows	Pre-4 <70 mm	Pre-3 70-90 mm	Pre-2 91-114 mm		Pre-1 115-139 mm		Recruit 140-165 mm		Post-recruit >165 mm	
				New	Old	New	Old	New	Old	New	Old
1990	19	453,024	682,569	541,891	9,492	403,015	37,055	137,235	163,961	12,081	53,50
1991	20	316,529	295,026	826,589	35,265	790,463	117,838	279,543	187,509	45,587	24,08
1992	18	306,159	134,137	438,453	34,688	683,607	205,970	740,136	138,101	49,547	26,15
1993	19	599,873	89,299	120,343	12,548	215,292	109,962	280,719	185,496	41,158	16,94
1994	20	258,118	169,986	114,102	8,572	95,260	58,967	65,675	94,138	6,726	20,63
1995	20	372,035	356,327	449,225	17,330	386,004	37,399	157,383	62,421	6,049	9,46
1996	19	189,773	42,712	312,708	121,332	368,250	156,423	48,546	45,116	0	
1997	23	148,607	111,729	267,005	6,655	311,678	36,110	143,170	10,525	468	
1998	23	267,276	16,323	11,802	11,915	131,082	37,975	154,674	24,420	5,999	
1999	20	967,083	1,251,769	591,655	81,833	161,674	76,204	66,642	42,056	609	1,89
2000	23	515,098	361,622	282,882	14,222	314,006	10,038	64,935	6,968	0	2,05
2001	22	1,879,906	531,311	243,588	23,149	234,487	96,045	54,960	23,669	0	1,40
2002	21	2,817,821	1,257,893	362,007	24,504	141,853	15,578	67,943	1,429	0	
2003	23	1,267,675	1,065,110	615,012	35,024	241,870	18,789	32,383	9,757	0	
2004	23	358,882	254,780	235,602	28,063	170,888	51,039	23,115	11,283	0	
2005	22	819,361	145,601	80,217	74,931	140,525	132,506	22,233	13,121	0	
2006[a]	23	1,031,750	150,434	161,822	43,459	126,444	45,236	155,044	29,731	0	
Average	21	739,351	406,861	332,641	34,293	289,200	73,125	146,726	61,747	9,896	9,185

Year	Males: Sublegal	Legal	%Legal	Total
1990	2,127,046	366,781	14.7%	2,493,827
1991	2,381,710	536,723	18.4%	2,918,433
1992	1,803,014	953,939	34.6%	2,756,953
1993	1,147,317	524,319	31.4%	1,671,636
1994	705,005	187,172	21.0%	892,177
1995	1,618,320	235,319	12.7%	1,853,639
1996	1,191,198	93,662	7.3%	1,284,860
1997	881,784	154,163	14.9%	1,035,947
1998	476,374	185,093	28.0%	661,467
1999	3,130,217	111,206	3.4%	3,241,423
2000	1,497,867	73,961	4.7%	1,571,828
2001	3,008,486	80,035	2.6%	3,088,522
2002	4,619,656	69,372	1.5%	4,689,028
2003	3,243,480	42,141	1.3%	3,285,620
2004	1,099,254	34,398	3.0%	1,133,652
2005	1,393,140	35,354	2.5%	1,428,494
2006[a]	1,757,648	184,775	9.5%	1,942,423
Average	1,928,715	243,219	13.3%	2,114,702

[a] Preliminary

Table 32.-Dungeness crab catch, in numbers in the Southern District Dungeness pot surveys, 1990-2000.

Year	Dates	Location	Pots Pulled	Females	Sublegal Males	Legal Males	Total Males	Soft-Shell Males (%)
1990	5/15-17	East of Spit	90	53	47	17	64	8 (13)
	6/19-21		90	54	65	23	88	9 (10)
1991	6/04-06	East of Spit	89	6	116	110	226	21 (9)
	7/09-11		90	21	388	263	651	36 (6)
	8/06-08		90	85	625	475	1,100	47 (4)
	9/12-14		90	30	615	492	1,107	5 (<1)
	7/02-06	West of Spit	82	9	6	5	11	2 (18)
	8/14-16		95	9	7	11	18	0 (0)
1992 [a]	5/31-6/04	East of Spit	89	27	276	180	456	2 (1)
	6/30-7/2		89	76	583	578	1,161	31 (3)
	7/27-29		90	65	621	531	1,152	50 (4)
	8/11-13		90	47	849	792	1,641	14 (1)
	8/25-27		88	47	853	737	1,590	24 (2)
	9/10-12		89	47	621	749	1,370	4 (<1)
	10/07-09		90	19	516	349	865	2 (<1)
	7/05-07	West of Spit	96	30	7	14	21	1 (5)
	8/05-07		78	59	49	59	108	0
1993 [a]	5/17-19	East of Spit	90	18	105	120	225	2 (1)
	6/15-17		90	60	226	203	429	5 (1)
	7/20-22		90	95	297	448	745	25 (3)
	8/16-23		90	84	352	555	907	35 (4)
	9/22-24		86	78	148	280	428	5 (1)
	7/13-15	West of Spit	70	11	6	3	9	0
	8/09-11		80	25	9	34	43	0
1994 [a]	5/23-25	East of Spit	90	18	9	7	16	1 (6)
	6/21-23		90	119	28	48	76	0
	7/19-21		90	113	39	93	132	0
	8/22-24		88	37	58	119	177	3 (2)
	7/12-14	West of Spit	70	17	0	3	3	0
	8/16-18		77	13	3	8	11	0

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Table 32.-Page 2 of 2.

Year	Dates	Location	Pots Pulled	Females	Sublegal Males	Legal Males	Total Males	Soft-Shell Males (%)
1995 [a]	5/23-25	East of Spit	90	0	5	3	8	0
	6/27-29		90	14	22	8	30	0
	7/25-27		90	88	20	9	29	0
	8/29-31		90	49	18	13	31	2
	7/18-20	West of Spit	77	31	3	10	13	0
	8/16-18		74	41	8	51	59	0
1996 [a]	6/12-14	East of Spit	89	5	16	6	22	3
	7/13-15		90	20	39	20	59	4
	8/11-13		90	64	55	19	74	0
1997 [a]	6/21-23	East of Spit	90	2	15	8	23	1 (4)
	7/21-23		89	11	19	8	27	1(<1)
	8/20-22		90	21	58	5	63	0
1998 [a]	8/16-18	East of Spit	90	0	11	3	14	0
2000 [a]	8/14-8/16	East of Spit	87	1	8	1	9	1(11)

[a] 33% of escape rings closed 1992-2000.

Table 33.-Estimated recreational halibut harvest (number of fish) by charter and non-charter users in the Central (CCI) and Lower Cook Inlet (LCI) fisheries, 1986-2006[a].

	CCI				LCI			
Year	Charter	Non-charter	Total	%charter	Charter	Non-charter	Total	%charter
1986	1,615	40,457	42,072	4%	21,698	20,245	41,943	52%
1987	2,019	31,020	33,039	6%	22,009	22,371	44,380	50%
1988	3,956	40,365	44,321	9%	47,147	44,541	91,688	51%
1989	4,722	47,017	51,739	9%	44,199	29,693	73,892	60%
1990	7,866	48,531	56,397	14%	58,030	32,350	90,380	64%
1991	12,457	47,966	60,423	21%	58,413	27,992	86,405	68%
1992	24,613	36,057	60,670	41%	49,000	32,430	81,430	60%
1993	30,040	37,786	67,826	44%	57,429	34,628	92,057	62%
1994	40,122	39,653	79,775	50%	52,284	35,976	88,260	59%
1995	44,585	36,737	81,322	55%	56,113	30,719	86,832	65%
1996	41,573	40,234	81,807	51%	67,997	37,971	105,968	64%
1997	43,442	44,828	88,270	49%	67,923	37,723	105,646	64%
1998	43,777	41,376	85,153	51%	60,826	33,383	94,209	65%
1999	38,663	30,601	69,264	56%	53,308	32,931	86,239	62%
2000	48,569	45,422	93,991	52%	65,189	42,547	107,736	61%
2001	53,990	33,628	87,618	62%	65,130	29,734	94,864	69%
2002	44,718	28,680	73,398	61%	60,883	32,742	93,625	65%
2003	45,559	32,149	77,708	59%	63,881	48,505	112,386	57%
2004	50,915	35,192	86,107	59%	76,164	49,431	125,595	61%
2005	54,057	31,491	85,548	63%	81,004	52,143	133,147	61%
2006	55,915	28,704	84,619	66%	79,560	45,263	124,823	64%

[a] Estimates before 1995 do not include the relatively minor West Cook Inlet component.

Table 34.-Management assemblage classification and maximum ages and lengths of rockfishes Sebastes sampled from the Cook Inlet recreational fishery, 1991-2006.

			Cook Inlet Sport Harvest Data[b]			
Assemblage and Common Name	Scientific Name	Maximum Published Age[a]	Max. Age	Number Aged	Max. Length (cm)	Number Measured
Pelagic Shelf						
Black	*S. melanops*	50	46	1,844	65	1,891
Dark	*S. ciliatus*		48	110	54	109
Dusky	*S. variabilis*	67	58	888	57	1039
Yellowtail	*S. flavidus*	64	24	2	52	2
Widow	*S. entomelas*	60	13	2	51	2
Demersal Shelf						
Canary	*S. pinniger*	84	23	28	49	28
China	*S. nebulosus*	78	56	27	40	28
Copper	*S. caurinus*	50	35	5	50	13
Quillback	*S. maliger*	90	71	47	53	49
Tiger	*S. nigrocinctus*	116	68	21	52	29
Yelloweye	*S. ruberrimus*	121	100	1,548	87	1,693
Slope						
Bocaccio	*S. paucispinis*	46	15	1	41	1
Rougheye	*S. aleutianus*	205	30	6	58	6
Shortraker	*S. borealis*	157	24	8	48	7
Silvergray	*S. brevispinis*	81	25	1	56	1

[a] Munk 2001.

[b] Meyer 1992, Meyer 2000, and ADF&G unpublished data for 1996-2006 available in Homer.

Table 35.-Central and Lower Cook Inlet rockfish harvest reported in angler interviews, by target species category, 2004-2006.

Fishery	Target Category	Number of Interviews[a]	Pelagic	Percent	Non-pelagic	Percent
Central Cook Inlet	Bottomfish + salmon	209	0	0%	0	--
	Halibut	1,335	24	100%	0	--
	Salmon	5	0	0%	0	--
	Salmon shark	1	0	0%	0	--
		1,550	24		0	
Lower Cook Inlet	Bottomfish	46	252	34%	31	21%
	Bottomfish + salmon	225	116	16%	13	9%
	Halibut	1,721	318	43%	96	65%
	Lingcod	2	1	0%	8	5%
	Rockfish	3	17	2%	0	0%
	Salmon	112	42	6%	0	0%
		2,109	746		148	

[a] Number of interviews represent vessel-trips.

Table 36.-Estimated recreational rockfish harvest (number of fish) in Cook Inlet, 1977-2006.

Year	Central Cook Inlet	Lower Cook Inlet	Total
1977	206	1,654	1,860
1978	561	3,770	4,332
1979	458	2,531	2,989
1980	16	1,979	1,995
1981	9	3,566	3,575
1982	133	2,339	2,473
1983	301	4,060	4,361
1984	736	2,462	3,198
1985	248	2,475	2,723
1986	949	4,976	5,925
1987	906	2,368	3,274
1988	1,933	7,626	9,559
1989	479	3,592	4,071
1990	361	2,333	2,694
1991	291	2,463	2,754
1992	474	4,063	4,537
1993	799	4,169	4,968
1994	961	4,223	5,184
1995	850	3,549	4,399
1996	1,072	4,157	5,229
1997	561	3,930	4,491
1998	225	3,781	4,006
1999	353	5,764	6,117
2000	291	5,833	6,124
2001	1,224	3,402	4,626
2002	502	5,401	5,903
2003	1,025	6,490	7,515
2004	577	9,179	9,756
2005	840	10,767	11,607
2006	275	9,156	9,431

Table 37.-Estimated recreational rockfish harvest (number of fish) by charter and non-charter users in the Central (CCI) and Lower Cook Inlet (LCI) fisheries, 1986-2006.

	CCI				LCI			
Year	Charter	Non-charter	Total	%charter	Charter	Non-charter	Total	%charter
1986	0	949	949	0%	1,489	3,487	4,976	30%
1987	55	851	906	6%	829	1,539	2,368	35%
1988	509	1,424	1,933	26%	2,000	5,626	7,626	26%
1989	30	449	479	6%	1,330	2,262	3,592	37%
1990	72	289	361	20%	966	1,367	2,333	41%
1991	0	291	291	0%	892	1,571	2,463	36%
1992	285	189	474	60%	1,156	2,907	4,063	28%
1993	304	495	799	38%	2,096	2,073	4,169	50%
1994	648	313	961	67%	2,117	2,106	4,223	50%
1995	430	420	850	51%	1,865	1,684	3,549	53%
1996	577	495	1,072	54%	1,948	2,209	4,157	47%
1997	378	183	561	67%	1,532	2,398	3,930	39%
1998	160	65	225	71%	1,603	2,178	3,781	42%
1999	70	283	353	20%	2,265	3,499	5,764	39%
2000	280	11	291	96%	3,011	2,822	5,833	52%
2001	621	603	1,224	51%	1,721	1,681	3,402	51%
2002	338	164	502	67%	2,454	2,947	5,401	45%
2003	314	711	1,025	31%	3,631	2,859	6,490	56%
2004	268	309	577	46%	4,867	4,312	9,179	53%
2005	540	300	840	64%	4,840	5,927	10,767	45%
2006	175	100	275	64%	5,125	4,031	9,156	56%

Table 38.-Estimated Cook Inlet recreational rockfish harvest in numbers of fish and pounds round weight [a] by assemblage, 1991-2006.

	Pelagic		Demersal		Slope		Harvest	Harvest Biomass
Year	No. Fish	Pounds	No. Fish	Pounds	No. Fish	Pounds	(no. fish)	(lb)
1991	1,106	4,500	1,648	14,200	0	0	2,754	18,700
1992	2,954	9,000	1,556	11,500	26	100	4,537	20,600
1993	2,670	10,600	2,261	21,500	37	100	4,968	32,200
1994	3,087	11,600	2,084	16,400	13	0	5,184	28,000
1995	2,756	11,500	1,615	15,800	28	100	4,399	27,400
1996	3,347	12,300	1,882	23,100	0	0	5,229	35,400
1997	2,045	8,300	2,446	24,500	0	0	4,491	32,800
1998	2,883	12,900	1,002	9,800	121	300	4,006	23,000
1999	4,665	17,000	1,452	14,200	0	0	6,117	31,200
2000	2,952	10,300	3,172	33,400	0	0	6,124	43,700
2001	2,861	10,100	1,765	20,400	0	0	4,626	30,500
2002	4,441	18,400	1,462	15,400	0	0	5,903	33,800
2003	5,410	25,500	2,090	23,800	15	100	7,515	49,400
2004	6,963	31,400	2,793	30,000	0	0	9,756	61,400
2005	8,269	37,500	3,338	34,400	0	0	11,607	71,900
2006	6,283	25,000	2,873	31,000	0	0	9,156	56,000

[a] Preliminary estimate based on assemblage composition of harvest samples from Homer applied to the total Cook Inlet harvest.

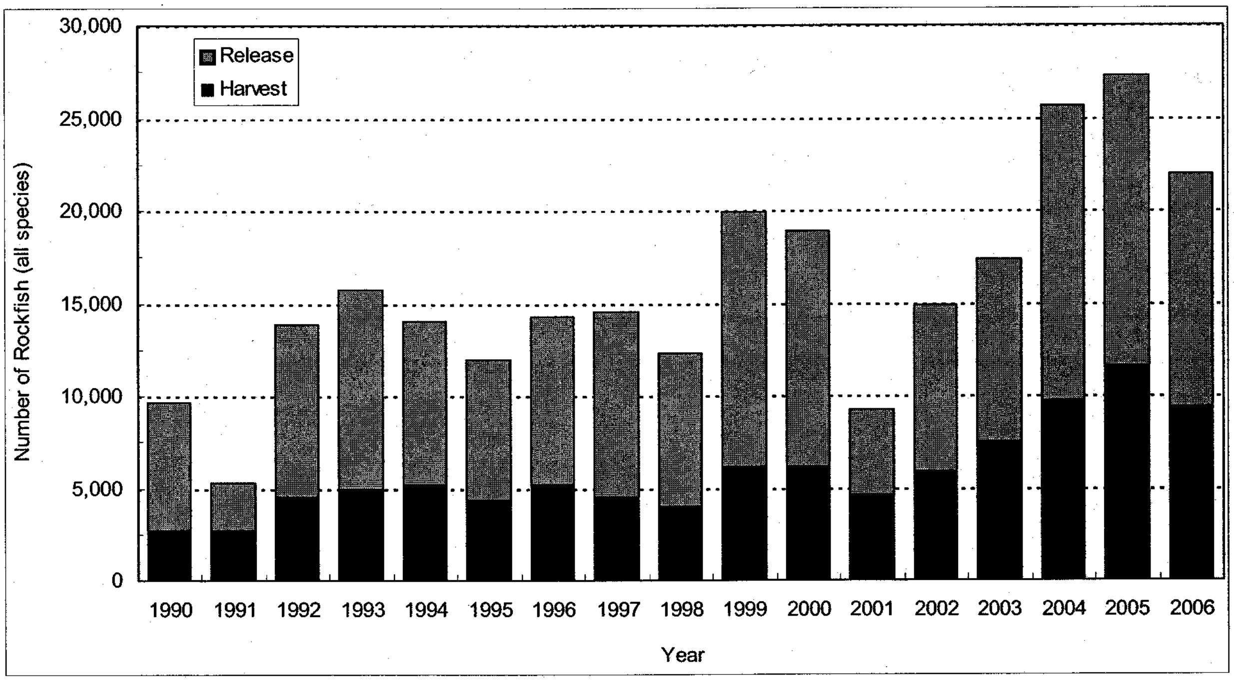


Figure 8.–Estimated numbers of rockfish harvested and released in Cook Inlet, 1990-2006.

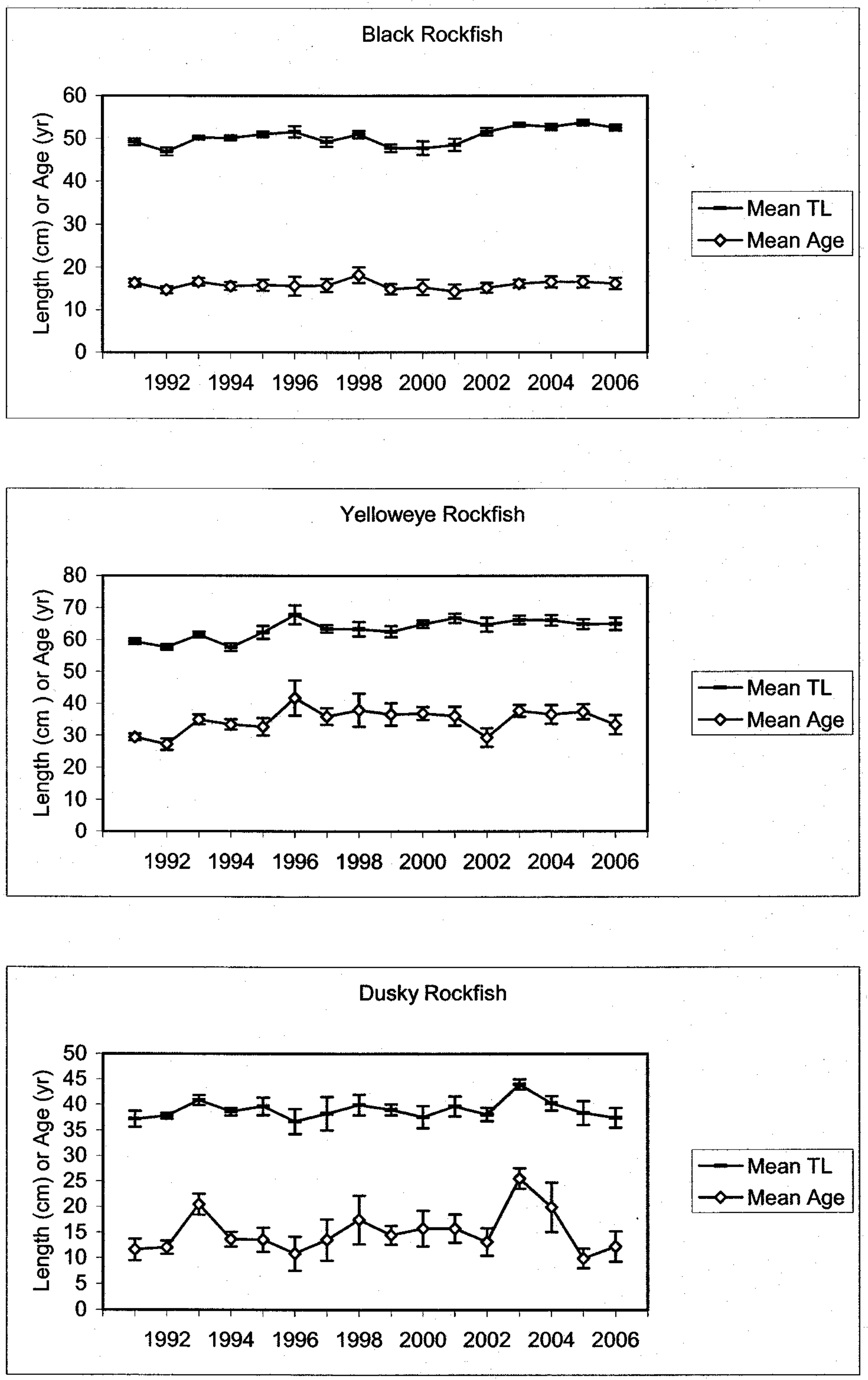
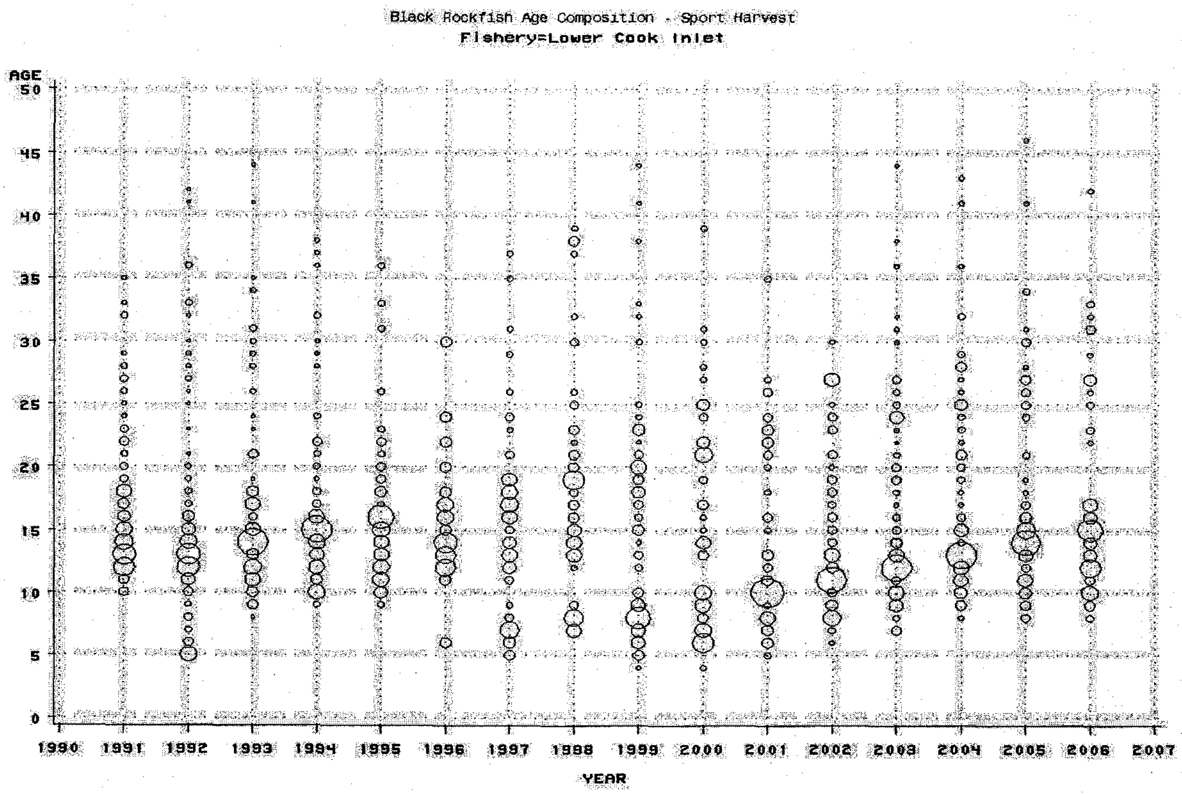


Figure 9.–Trends in mean total length (TL) and age of selected rockfish species in the Lower Cook Inlet sport harvest, 1991-2004. Error bars show 95% confidence intervals.



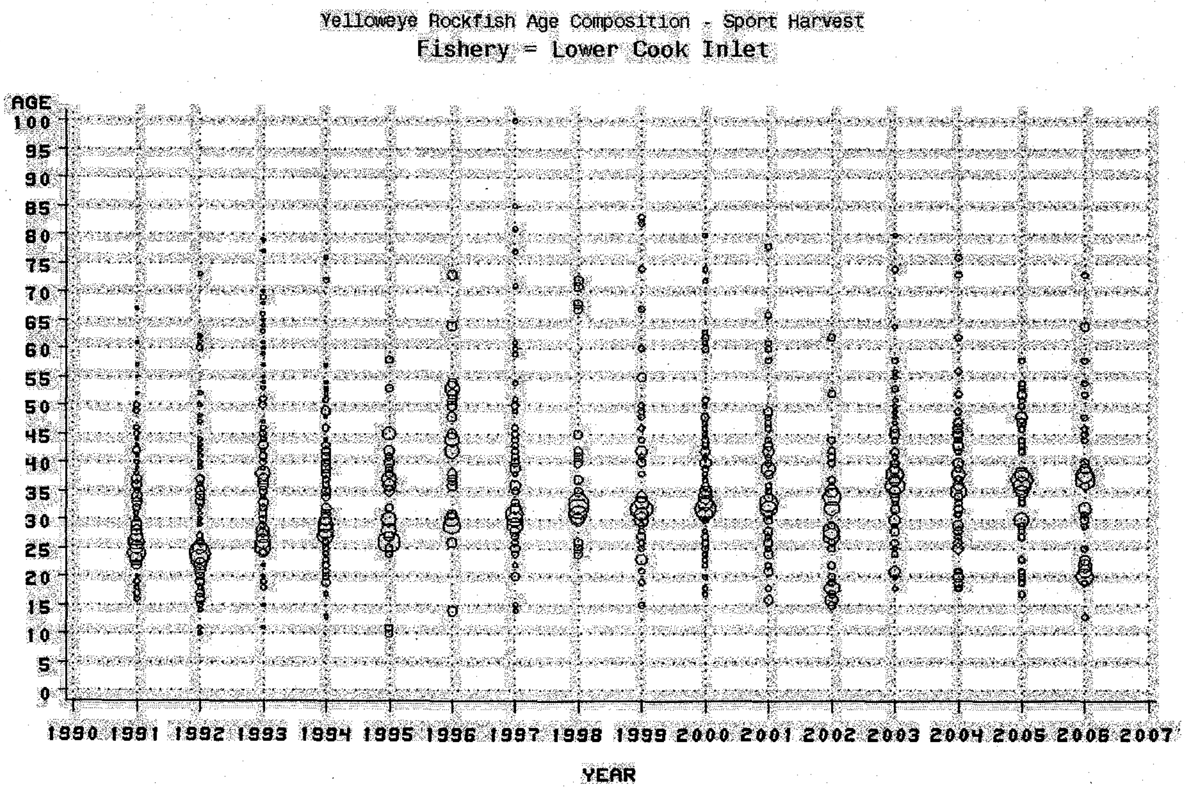


Figure 10.–Age composition of the recreational black and yelloweye rockfish harvest landed at Homer, 1991-2006. Bubble diameter is proportional to the percentage of harvest in each age group.

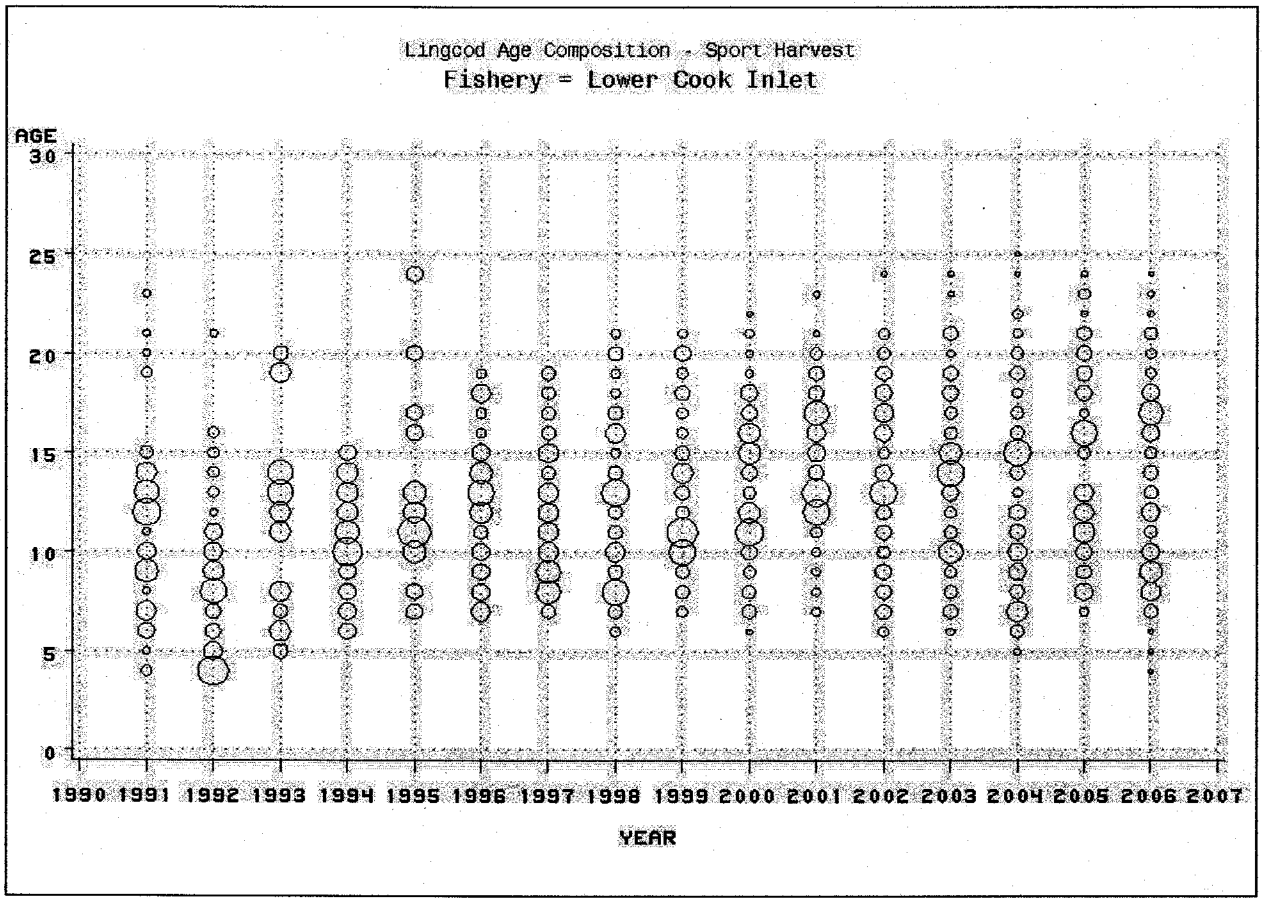


Figure 11.–Age composition of the recreational lingcod harvest landed at Homer, 1991-2004. Bubble diameter is proportional to the percentage of harvest in each age group.

Table 39.-Statewide Harvest Survey estimates of recreational lingcod harvest (number of fish) in Cook Inlet, 1990-2006.

Year	West Cook Inlet	Central Cook Inlet	Lower Cook Inlet	Total
1990	[a]	839	1,805	2,644
1991	35	989	1,751	2,775
1992	0	942	2,257	3,199
1993	45	0	1,636	1,681
1994	56	0	1,184	1,240
1995	28	149	970	1,147
1996	[b]	888	1,317	2,205
1997	[b]	473	1,762	2,235
1998	[b]	461	995	1,456
1999	[b]	219	1,079	1,298
2000	[b]	214	1,600	1,814
2001	[b]	473	1,514	1,987
2002	[b]	236	1,364	1,600
2003	[b]	364	1,755	2,119
2004	[b]	459	2,852	3,311
2005	[b]	283	2,753	3,036
2006	[b]	310	2,997	3,307

Source: Mills 1991-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2004, 2006a-b, 2007, In prep.; G. Jennings, Sport Fish Program Coordinator, RTS, Anchorage; personal communication.

[a] Lingcod information was not requested in the SWHS questionnaire before 1991.

[b] After 1995 the West Cook Inlet estimates were apportioned and merged with the Central and Lower Cook Inlet estimates.

Table 40.-Estimated recreational lingcod harvest (number of fish) by charter and non-charter users in the Central (CCI) and Lower Cook Inlet (LCI) fisheries, 1990-2006[a].

	CCI				LCI			
Year	Charter	Non-charter	Total	%charter	Charter	Non-charter	Total	%charter
1990	71	768	839	8%	1,046	759	1,805	58%
1991	63	926	989	6%	806	945	1,751	46%
1992	327	615	942	35%	802	1,455	2,257	36%
1993	0	0	0	--	993	643	1,636	61%
1994	0	0	0	--	766	418	1,184	65%
1995	140	9	149	94%	703	267	970	72%
1996	392	496	888	44%	855	462	1,317	65%
1997	190	283	473	40%	1,225	537	1,762	70%
1998	336	125	461	73%	617	378	995	62%
1999	112	107	219	51%	616	463	1,079	57%
2000	190	24	214	89%	1,110	490	1,600	69%
2001	345	128	473	73%	1,054	460	1,514	70%
2002	206	30	236	87%	910	454	1,364	67%
2003	242	122	364	66%	1,411	344	1,755	80%
2004	139	320	459	30%	2,027	825	2,852	71%
2005	283	0	283	100%	1,896	857	2,753	69%
2006	301	9	310	97%	2,399	598	2,997	80%

[a] Estimates after 1995 include the West Cook Inlet portion, apportioned between Central and Lower Cook Inlet.

Table 41.-Estimated average weight and harvest in lb round weight in the Cook Inlet recreational lingcod fishery, 1992-2006[a].

Year	Average Weight (lb)[a]	Harvest Biomass (lb)[b]
1992	15.6	49,400
1993	22.9	38,500
1994	27.3	33,900
1995	24.9	28,600
1996	26.9	59,300
1997	26.7	59,600
1998	29.5	43,000
1999	28.7	37,200
2000	29.5	53,600
2001	32.4	64,400
2002	33.3	53,300
2003	31.1	65,900
2004	29.3	97,000
2005	30.9	93,800
2006	31.6	104,500

[a] Based on harvest samples from Homer applied to the total Cook Inlet harvest.

[b] Preliminary estimate to nearest 100 lb.

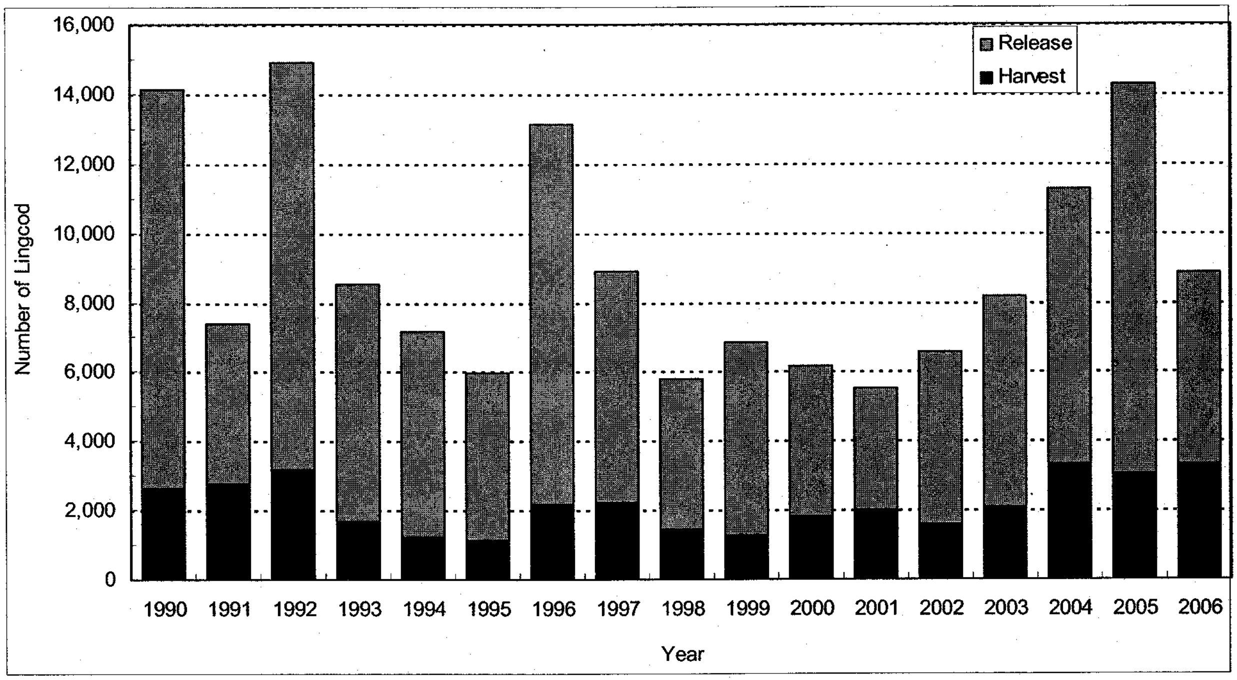


Figure 12.–Estimated numbers of lingcod harvested and released in Cook Inlet, 1990-2003.

Table 42.-Harvest and harvest quotas in the Ninilchik-area educational fisheries, 1993-2007.

Year	Educational fishery participant	Ninilchik Saltwater Fishing Period	Chinook Salmon Quotas Salt-water	Chinook Ninilchik River	Chinook Kasilof River	Chinook Total	Coho Salmon Quotas Salt-water	Coho Ninilchik River	Coho Kasilof River	Coho Total	Total Salmon Quota	Hooligan/ Herring Quota
1993	NTC[a]	May 1- Oct. 31	100	20		100	250	30		250	2000	
1994	NTC	May 1- Oct. 31	100	20		100	250	30		250	2000	
1995	NTC	May 1- Oct. 31	100	20		100	250	30		250	2000	
1996	NTC	May 1- Oct. 31	150	20		150	250	30		250	2000	
1997	NTC	May 1- Oct. 31	150	20		150	250	30		250	2000	
1998	NND[b]	May 1- Oct. 31	75	10		75	125	15		125	1,000	
	NTC	May 1- Oct. 31	75	10		75	125	15		125	1,000	
	Total		150	20		150	250	30		250	2,000	
1999	NND	May 1- Oct. 31	75	10		75	125	15		125	1,000	
	NTC	May 1- Oct. 31	75	10		75	125	15		125	1,000	
	Total		150	20		150	250	30		250	2,000	
2000	NND	May 1- Oct. 31	75	10		75	125	15		125	1,000	
	NTC	May 1- Oct. 31	75	10		75	125	15		125	1,000	
	Total		150	20		150	250	30		250	2,000	
2001	NND	May 1- Oct. 31	100	10		100	125	15		125	1,000	
	NTC	May 1- Oct. 31	100	10		100	125	15		125	1,000	
	Total		200	20		200	250	30		250	2,000	
2002	NND	May 1- Oct. 31	100	10		100	125	15		125	1,000	
	NTC	May 1- Oct. 31	100	10		100	125	15		125	1,000	
	Total		200	20		200	250	30		250	2,000	
2003	NTC	May 1- Oct. 31	100	10		100	100	15		100	850	
	NND	May 1- Oct. 31	100	10		100	100	15		100	850	1,000
	NES[c]	July 1 - Aug. 15	25			25	50			50	250	
	Total		225	20		225	250	30		250	1,950	1,000
2004	NTC	May 1- Oct. 31	100	10		100	100	15		100	850	
	NND	April 1 - Oct. 31	100	10		100	100	15		100	850	1,000
	NES	July 1 - Aug. 15	25			25	50			50	250	
	Total		225	20		225	250	30		250	1,950	1,000
2005	NTC	May 1- Oct. 31	100	10		100	100	15		100	850	
	NND	April 1 - Oct. 31	100	10		100	100	15		100	850	1,000
	NES	July 1 - Aug. 15	25			25	50			50	250	
	Total		225	20		225	250	30		250	1,950	1,000
2006	NTC	May 1- Oct. 31	100	10		100	100	15		100	850	
	NND	April 1 - Oct. 31	100	10		100	100	15		100	850	NO LIMIT[d]
	NES	July 1 - Aug. 15	25			25	50			50	250	
	Total		225	20		225	250	30		250	1,950	
2007[e]	NTC	May 1- Sept. 15[e]	300	10	50	300	300	15	200	500	2,800	
	NND	April 1 - Oct. 31	200	10		200	200	15		200	2,800	NO LIMIT[d]
	NES	July 1 - Aug. 15	25			25	50			50	250	
	Total		525	20	50	525	550	30	200	750	5,850	

[a] Ninilchik Traditional Council.

[b] Ninilchik Native Descendents.

[c] Ninilchik Emergency Services.

[d] Unlimited hooligan harvest permitted. Herring harvest not permitted because opportunity is available via personal use regulations.

[e] Fishing will end before September 15 if 12 steelhead have been harvested on or after September 4.

Table 43.-Harvest in the Ninilchik-area educational fisheries, 1993-2007.

			Ninilchik Area Harvest				
Year	Educational fishery participant	Ninilchik Saltwater Fishing Period	Chinook Salmon Harvest	Sockeye Salmon Harvest	Coho Salmon Harvest	Pink Salmon Harvest	Total Harvest
1993	NTC[a]	May 1- Oct. 31					215
1994	NTC	May 1- Oct. 31	7	162	119	16	304
1995	NTC	May 1- Oct. 31	77	229	85	23	414
1996	NTC	May 1- Oct. 31	101	910	56	8	1,075
1997	NTC	May 1- Oct. 31	94	474	99	55	722
1998	NND[b]	May 1- Oct. 31	52	139	110	20	317
	NTC	May 1- Oct. 31	67	506	95	57	721
	Total		119	645	205	77	1,038
1999	NND	May 1- Oct. 31	56	302	76	18	452
	NTC	May 1- Oct. 31	117	434	84	5	640
	Total		173	736	160	23	1,092
2000	NND	May 1- Oct. 31	51	199	96	15	361
	NTC	May 1- Oct. 31	50	439	59	57	605
	Total		101	638	155	72	966
2001	NND	May 1- Oct. 31	73	310	123	0	506
	NTC	May 1- Oct. 31	75	760	125	42	1002
	Total		148	1070	248	42	1508
2002	NND	May 1- Oct. 31	65	339	106	52	562
	NTC	May 1- Oct. 31	44	138	95	31	308
	Total		109	477	201	83	870
2003	NTC	May 1- Oct. 31	86	426	100	15	627
	NND	May 1- Oct. 31	65	98	80	12	255
	NES[c]	July 1 - Aug. 15	0	4	0	0	4
	Total		151	528	180	27	886
2004	NTC	May 1- Oct. 31	73	395	83	0	551
	NND	April 1 - Oct. 31	78	199	79	14	370
	NES	July 1 - Aug. 15	1	77	0	9	87
	Total		152	671	162	23	1,008
2005	NTC	May 1- Oct. 31	70	264	83	0	417
	NND	April 1 - Oct. 31	88	84	78	15	265
	NES	July 1 - Aug. 15	0	5	0	0	5
	Total		158	353	161	15	687
2006	NTC	May 1- Oct. 31	75	550	100	0	671
	NND	April 1 - Oct. 31	64	55	99	10	171
	NES	July 1 - Aug. 15			Did not fish		
	Total		139	605	199	10	842
2007[d]	NTC	May 1- Sept. 15	300	1,363	483	2	2,148
	NND	April 1 - Oct. 31	65	210	102	12	389
	NES	July 1 - Aug. 15			Did not fish		
	Total		365	1,573	585	14	2,537

[a] Ninilchik Traditional Council.
[b] Ninilchik Native Descendents.
[c] Ninilchik Emergency Services.
[d] Preliminary.

APPENDIX A. EMERGENCY ORDERS

Appendix A1.-Emergency orders issued for LCIMA waters during 1996-2007.

Emergency Orders issued in 1996:

1. E.O. No. 2-SHR-1-08-96 closed the recreational shrimp fishery in Kachemak Bay east of a line from Anchor Point to Point Pogibshi. Effective April 15 through December 31, 1996.
2. E.O. No. 2-KS-1-20-96 extended the Chinook salmon fishery on the Ninilchik River on a continual basis between Saturday, June 15 through Monday, June 24. Effective June 15, 12:01 a.m. through Monday June 24, 1996.
3. E.O. No. 2-SS-1-41-96 opened the Homer spit lagoon to snagging for Chinook salmon and coho salmon. Effective September 8 through December 31, 1996.

Emergency Orders issued in 1997:

1. E.O. No. 2-SHR-7-01-97 closed sport fishing for shrimp in all of Kachemak Bay east of a line from Anchor Point to Point Pogibshi. Effective January 1 through December 31, 1997.
2. E.O. No. 2-PU-H-02-96 closed the personal use fishery for shrimp in waters of Kachemak Bay east of a line from Anchor Point to Point Pogibshi. Effective January 1 through December 31, 1997.
3. E.O. No. 2-KS-7-21-97 opened snagging at the Homer Lagoon. Effective 12:00 p.m. July 2 through July 7, 1997.
4. E.O. No. 2-PS-7-32-97 increased the bag limit for pink salmon to 12 per day in the marine waters of Tutka Bay. Effective August 9 through September 21, 1997.
5. E.O. No. 2-SS-7-35-97 closed the Fox Creek Personal Use dip net fishery.
6. E.O. No. 2-SS-7-36-97 increased the daily bag and possession limit for salmon other than Chinook salmon, including silver salmon 16 inches or more in length from one to three in Ninilchik River, Deep Creek, Stariski Creek and the Anchor River. Effective August 29 through October 15, 1997.
7. E.O. No. 2-SS-7-41-97 opened the Homer Lagoon to snagging. Effective August 7 through December 31, 1997.

Emergency Orders issued in 1998:

1. E.O. No. 2-DC-7-05-98 closed the Dungeness crab sport fishery in Lower Cook Inlet east of a line extending from Anchor Point to Point Bede. Effective May 29 until further notice.
2. E.O. No. 2-DC-7-06-98 closed the personal use fishery for Dungeness crab in Lower Cook Inlet east from a line extending from Anchor Point to Point Bede. Effective May 29 until further notice.

3. E.O. No. 2-KS-7-13-98 opened the Homer Spit and enhancement lagoon to snagging. Effective July 1 through July 7, 1998.
4. E.O. No. 2-RS-7-24-98 closed the Ninilchik Traditional Council Educational Fishery. Effective July 28 through August 10, 1998.
5. E.O. No. 2-RS-1-27-98 rescinded E.O. No. 2-RS-7-24-98 and restored the Ninilchik Traditional Council Educational fishery to the regular fishing times. Effective August 3 through October 1, 1998.
6. E.O. No. 2-PU-7-29-98 closed the personal use dip net fishery in Fox Creek. Effective August 22 through December 31, 1998.
7. E.O. No. 2-SS-7-32-98 opened snagging on the Homer Spit. Effective 12:00 p.m. September 18 through December 31, 1998.

Emergency Orders issued in 1999:

1. E.O. No. 2-KS-7-08-99 opened the Homer Spit fishing lagoon to snagging. Effective 12:00 p.m. June 30 through July 4, 1999.
2. E.O. No. 2-RS-7-19-99 opened China Poot Creek to sockeye dipnetting. Effective 12:00 p.m. August 11 through 12:00 p.m. August 20, 1999.
3. E.O. No. 2-SS-7-24-99 opened Homer Spit and enhancement lagoon to snagging. Effective 12:00 p.m. September 24 through December 31, 1999.

Emergency Orders issued in 2000:

1. E.O. No. 2-KS-7-08-00 opened snagging on the Homer Spit and enhancement lagoon. Effective June 24 through July 2, 2000.
2. E.O. No. 2-SS-7-22-00 opened the Homer Spit and lagoon to snagging. Effective 12:00 p.m. September 22 through December 31, 2000.

Emergency Orders issued in 2001:

1. E.O. No. 2-RS-7-02-01 closed all waters of the English Bay River drainage and Port Graham Subdistrict to sockeye salmon sport fishing from June 1, 2001 12:01 a.m. until August 31.
2. E.O. No. 2-KS-7-05-01 opened Deep Creek downstream of the regulatory marker for an additional 3-day weekend, June 16, 2001, 12:01 a.m. to June 18, 2001, 11:59 p.m.
3. E.O. No. 2-KS-7-05-02 opened the Ninilchik River downstream of the regulatory marker for an additional 3-day weekend, June 16, 2001, 12:01 a.m. to June 18, 2001, 11:59 p.m.
4. E.O. No. 2-KS-7-10-01 opened the Homer Spit Enhancement Lagoon area to snagging from noon, Friday, June 29, 2001, until 11:59 p.m., Sunday, July 8, 2001.

5. E.O. No. 2-KS-7-11-01 prohibited the use of weighted hooks or weights following hooks in the Homer Spit Enhancement Lagoon area from Monday, July 9, 2001 until superceded by E.O.
6. E.O. No. 2-TC-7-19-01 reduced the personal use daily bag and possession limit from 20 male crab to five and the pot limit from five to one per person and two per boat.
7. E.O. No. 2-TC-7-18-01 reduced the sport fishery daily bag and possession limit from 20 male crab to five and the pot limit from five to one per person and two per boat.
8. E.O. No. 2-SS-7-22-01 opened the Homer Spit Enhancement Lagoon area to snagging from noon, Sunday September 16, 2001 through 11:59 p.m., Monday, December 31, 2001.

Emergency Orders issued in 2002:

1. E.O. No. 2-KS-7-08-02 opened the Ninilchik River from its mouth to the downstream edge of the Sterling Highway Bridge, from Saturday, June 15, 12:01 a.m. to Monday, June 17, 11:59 p.m., 2002, to sport fishing for hatchery king salmon only. The daily bag and possession limit was one fish 20 inches or greater in length or 10 fish under 20 inches. Only unbaited artificial lures were permitted.
2. E.O. No. 2-KS-7-16-02 opened the Homer Spit Enhancement Lagoon area to snagging for king salmon from noon, Friday, June 28, 2002 until 11:59 p.m., Sunday, July 7, 2002.
3. E.O. No. 2-TC-7-19-02 reduced sport Tanner crab bag and possession limits from 20 per person to 5 per person, effective July 19, 2002. The number of pots used to harvest Tanner crab were reduced to are two per person and a maximum of two per vessel.
4. E.O. No. 2-TC-7-20-02 reduced personal Tanner crab bag and possession limits from 20 per person to 5 per person effective July 19, 2002. The number of pots used to harvest Tanner crab were reduced to are two per person and a maximum of two per vessel.
5. E.O. No. 2-SS-7-16-02 opened the Homer Spit Enhancement Lagoon area to snagging for silver salmon from noon, Friday, September 13, 2002 through 11:59 p.m. Tuesday, December 31, 2002.

Emergency Orders issued in 2003:

1. E.O. No. 2-KS-7-03-03 opened the Ninilchik River from its mouth to the downstream edge of the Sterling Highway Bridge, from Saturday, June 14, 12:01 a.m., 2003 to Monday, June 30, 11:59 p.m., 2003, to sport fishing for hatchery king salmon only. The daily bag and possession limit was one fish 20 inches or greater in length and 10 fish under 20 inches. Use of only one single hook was allowed.
2. E.O. 2-KS-7-09-03 opened the Homer Spit Enhancement Lagoon area to snagging from noon, Wednesday, June 25, 2003 until 11:59 p.m., Sunday, July 6, 2003.
3. E.O. No. 2-SS-7-24-03 opened the Homer Spit Enhancement Lagoon area to noon, Wednesday, September 17, 2003 until 11:59 p.m., Wednesday, December 31, 2003.

Emergency Orders issued in 2004:

1. E.O. No. 2-KS-7-03-04 opened the Ninilchik River from its mouth upstream to the regulatory marker located approximately two miles upstream, to fishing for hatchery king salmon 7 days per week. Bait was allowed. Only one, single hook may could be used. A person could not possess a king salmon that had been filleted, headed, mutilated or otherwise disfigured in a manner that prevented identification of hatchery or wild origin until permanently transported away from the fishing site if the fish was taken from the riverbank. "Fishing site" meant the riverbank where the fish was hooked and removed from the water. The emergency order was effective 12:01 a.m., Saturday, May 29, 2004 until 11:59 p.m. December 31, 2004.
2. E.O. No. 2-KS-7-07-04 opened the Anchor River to fishing on 12:00 a.m., Saturday, June 26, 2004, through 11:59 p.m. June 28, 2004 from its mouth upstream approximately two miles to the Department marker located approximately 600 feet downstream of the confluence of the North and South forks of the Anchor River.
3. E.O. No. 2-KS-7-12-04 opened the Homer Spit to snagging king salmon, 12:01 p.m., Thursday, July 1, 2004 through 11:59 p.m., Monday July 5, 2004.
4. E.O. No. 2-KS-7-15-04 rescinded Emergency Order 2-KS-7-03-04 which opened the Ninilchik River to fishing for hatchery king salmon 7 days per week.
5. E.O. No. 2-SS-7-24-04 opened the Homer Spit to snagging silver salmon noon, Friday, September 10 through 11:59 p.m., Friday, December 31, 2004

Emergency Orders issued in 2005:

1. E.O. No. 2-RS-7-4-05 closed the waters of the English Bay drainage and Pt. Graham Subdistrict to sport fishing for sockeye salmon from 11:59 p.m., Wednesday, June 1 until further notice.
2. E.O. No. 2-KS-7-11-05 opened the Homer Spit to snagging king salmon, noon, Wednesday, June 29 through 11:59 p.m., Monday, July 4.
3. E.O. No. 2-RS-7-19-05 rescinds E.O. No. 2-RS-7-4-05, effective Saturday, July 2 at 12:01 a.m.
4. E.O. No. 2-SS-7-29-05 opened the Homer Spit to snagging silver salmon noon, Wednesday, September 14 through 11:59 p.m., Saturday, December 31, 2005.

Emergency Orders issued in 2006:

1. E.O. No. 2-KS-7-12-06 opened the Ninilchik River from the mouth to the regulatory markers approximately 2 miles upstream to harvest of hatchery king salmon Wednesday, June 4 12:01 a.m. until Friday, July 14, 11:59 p.m.. Bait is allowed but only one single hook may be used.
2. E.O. No. 2-RS-7-9-06 closed the waters of the English Bay drainage and Pt. Graham Subdistrict to sport fishing for sockeye salmon from 11:59 p.m., Wednesday, May 31 through Monday, July 31, 11:59 p.m..
3. E.O. No. 2-KS-7-22-06 opened the Homer Spit to snagging king salmon, 12:01 p.m., Thursday, July 6 through 11:59 p.m., Sunday July 9.
4. E.O. No. 2-RS-7-23-06 rescinds E.O. No. 2-RS-7-9-06, effective Thursday, July 6 at 12:01 a.m.

Emergency Orders issued in 2007:

1. E.O. No. 2-KS-7-06-07 opened the Ninilchik River from the mouth to the regulatory markers approximately 2 miles upstream to harvest of hatchery king salmon. Effective 12:01 a.m, Saturday, May 26 through Sunday, July 15, 12:59 p.m.. Bait is allowed but only one single hook may be used.
2. E.O. No. 2-RS-7-11-07 closed the waters of the English Bay drainage and Pt. Graham Subdistrict to sport fishing for sockeye salmon from 12:01 a.m., Thursday, May 31, 2007 through 11:59 p.m., Tuesday, July 31, 2007.
3. E.O. No. 2-KS-7-23-07 opened the Homer Spit to snagging from 12:00 noon, Thursday, July 5, 2007, through 11:59 p.m. Sunday, July 8.
4. E.O No. .2-RS-7-18-07 rescinds English Bay/Pt. Graham closure effective 6:00 a.m., Tuesday June 26, 2007

Appendix A2.-Snag opening dates at the Homer Spit Fishing Lagoon.

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
early Chinook	6/24	6/24	6/24	6/24	6/24	6/24	6/28	no snag	Wed 7/02-7/07	Wed 7/01-7/05	Fri 6/30-7/4	Sat 6/24-7/2	Fri 6/29-7/8	Fri 6/28-7/7	Wed 6/25-7/6	Thu 7/1-7/5	Wed 6/29-7/1	Thu. 7/6-7/9	Thu.7 /5-7/9
late Chinook	NA	NA	NA	NA	NA	no snag	no snag	no snag	no snag	no snag	no snag	no snag	no snag	no snag	NA	NA	NA	NA	NA
Coho	9/02 Sat	9/17 Mon	9/18 Wed	9/18 Fri	9/22 Wed	9/14 Wed	9/14 Thu	9/08 Sun	9/20 Sat	9/18 Fri	9/24 Fri	9/22 Fri	9/16 Sun	9/13 Fri	9/17 Wed	9/10 Fri	Wed 9/14	NA	NA
Pink	7/01	no snag	no snag	7/28	8/04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Fishery Manuscript No. 07-05

Stock Status and Recommended Escapement Goal for Anchor River Chinook Salmon

by

Nicole J. Szarzi,

Steve J. Fleischman,

Robert A. Clark,

and

Carol M. Kerkvliet

October 2007

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: Fishery Manuscripts, 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 Department of Fish and Game	ADF&G
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)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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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STOCK STATUS AND RECOMMENDED ESCAPEMENT GOAL FOR ANCHOR RIVER CHINOOK SALMON

by
Nicole J. Szarzi
Division of Sport Fish, Homer, Alaska

Steve J. Fleischman and
Robert A. Clark
Division of Sport Fish, Anchorage Alaska
and
Carol M. Kerkvliet
Division of Sport Fish, Homer, Alaska

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

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Nicole J. Szarzi [a] *and Carol M. Kerkvliet*
Alaska Department of Fish and Game, Division of Sport Fish
3298 Douglas Place, Homer Alaska 99603-8027
and
Steve J. Fleischman and Robert A. Clark
Alaska Department of Fish and Game, Division of Sport Fish,
333 Raspberry Road, Anchorage Alaska 99518-1565

[a] *Author to whom all correspondence should be addressed: nicky.szarzi@alaska.gov*

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ABSTRACT

The Policy for Management of Sustainable Salmon Fisheries (5 AAC 39.222) and the Policy for Statewide Salmon Escapement Goals (5 AAC 39.223) direct the Alaska Department of Fish and Game to develop, periodically review and update salmon escapement goals to maintain escapements at a level that sustains yield into the future. The Anchor River sustainable escapement goal (SEG) for Chinook salmon, based on single aerial counts conducted annually, was rescinded in 2004 because a new sonar and weir project begun in 2003 found that many more Chinook salmon *Oncorhynchus tsawytscha* escaped into the Anchor than were indicated by aerial counts. The department recommends an SEG threshold of 5,000 adult Chinook salmon in the Anchor River based on a full probability spawner recruit model using all available data including 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. Implementation of the stock assessment project should continue to improve estimation of population statistics and management of this stock.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, Anchor River, spawning abundance, escapement goal, stock-recruit analysis, Ricker Spawner-Recruit model, sustained yield, Bayesian statistics, Markov Chain Monte Carlo, WinBUGS

INTRODUCTION

The Anchor River, located on the southwestern portion of the Kenai Peninsula (Figure 1), supports a popular Chinook salmon fishery in the lower 2 river-miles. Chinook salmon escapement was indexed in the past to monitor stock sustainability. Full enumeration of recent escapements has allowed the development of an escapement goal threshold for the Anchor River. This report recounts the management history and historical database for Anchor River Chinook salmon, and details the statistical methods employed to develop and evaluate the recommended threshold.

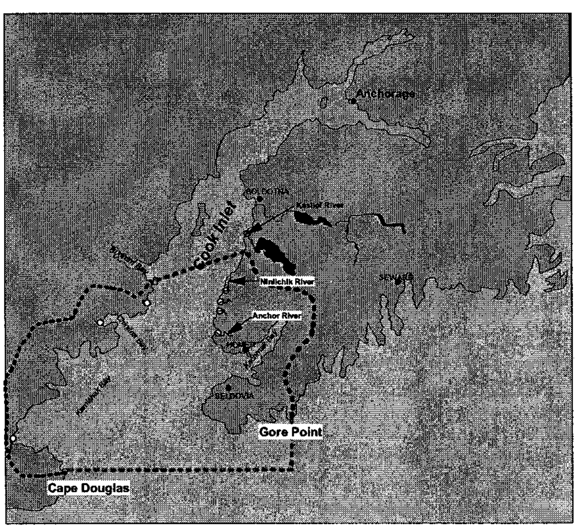

Figure 1.–The location of the Anchor River within the Lower Cook Inlet Management Area.

MANAGEMENT HISTORY

Chinook salmon escapements have been monitored in the Anchor River since 1962 with a combination of aerial and foot surveys conducted once per year. Aerial counts were expanded if foot survey counts in an index area within the aerial survey area were higher. Beginning in 1976, helicopters rather than fixed wing aircraft were used.

Escapement goals, first adopted in 1993, were the average of the expanded aerial surveys (Fried 1994). Beginning in 1996, only aerial counts were conducted to index escapement because ground counts were redundant (Szarzi and Begich 2004a). In 1998, escapement goals were changed to the 40^{th} and 80^{th} percentiles of aerial counts from 1976 to 1997 (Szarzi and Begich 2004a). After passage of the Sustainable Fisheries and Escapement Goal policies by the Board of Fisheries (BOF) in 2001, the criteria for setting escapement goals in streams such as the Anchor River, where total returns cannot be enumerated, were standardized and based upon different percentiles depending upon the contrast or range of escapement counts (Bue and Hasbrouck *Unpublished*). In 2001, Anchor River escapement goals were evaluated using these criteria.

No change was needed to the Anchor River goal in 2001 but restriction of the Anchor River fishery was indicated by the general decline in escapement index counts, with six of 12 escapement indices measured since 1989 (1989-2001) below the SEG range of 750 to 1,500 fish and by escapements in 4 of the last 6 consecutive years (1996-2001) below the SEG range (Table 1). During the BOF meeting in November 2001, in response to the guidelines established in the Sustainable Salmon Fisheries Policy, the BOF designated Anchor River Chinook salmon as a stock of "management concern" defined in the policy as "a concern arising from a chronic inability, despite use of specific management measures, to maintain escapements for a salmon stock within the bounds of the SEG, BEG, OEG, or other specified management objectives for the fishery" (5 AAC 39.222 (f) (21)). The regulatory fishery openings were reduced from five to four 3-day weekends.

The department re-evaluated the Anchor River escapement goal in 2004 incorporating the additional data collected since the last review in 2001 (Otis and Hasbrouck 2004). Staff recommended rescinding the Anchor River goal because a sonar and weir project begun in 2003 found that many more Chinook salmon returned to the river than was evident from aerial surveys.

At their meeting in 2004, the BOF approved the department's recommendation to rescind the stock of management concern designation and remove the Sustainable Escapement Goal (SEG) for Anchor River Chinook salmon because of the higher than expected escapements and low exploitation rates. The Department clarified to the Board that there were insufficient data for an escapement goal at that time, but pledged to initiate the development of a biological escapement goal (BEG) for the Anchor River using return data from the sonar and weir project and present a preliminary goal in 2007.

HISTORICAL HARVEST AND ESCAPEMENT DATA

The Anchor River supports the largest freshwater sport harvest of wild Chinook salmon within the Lower Cook Inlet Management Area (LCIMA). The annual freshwater harvest has been estimated since 1977 with a mail survey administered to the households of a random sample of Alaska sport fishing license holders (Table 2). The estimated harvest has ranged from 605 (in 1980) to 2,787 (in 1993) but is relatively stable (no trend) over the range of the data; the average annual harvest from 2001 to 2006 of 1,222 is close to the historic annual average from 1977 to 2000 of 1,323 (Mills 1979-1980, 1981a-b, 1982-1994; Howe et al. 1995, 1996, 2001 a-d; Walker et al. 2003; Jennings et al. 2007, In prep.; Jennings et al. 2004; 2006 a-b; Jennings[1]).

Chinook salmon bound for the Anchor River are harvested in the Cook Inlet marine sport fishery. The number harvested is unknown, but the exploitation rate of Anchor River Chinook salmon in the marine recreational fishery should be similar to that of Deep Creek and Ninilchik River Chinook salmon, which was estimated to be approximately 4% in the late 1990s (Begich and Evans *In prep.*, King and Breakfield 1999 and Szarzi and Begich 2004b).

Anchor River Chinook salmon are also harvested in fresh water, in a sport fishery that has been consistently and heavily restricted. Only the lower 2 river-miles of the drainage have been open and only on weekends and the following Mondays in late May and June. From 1977 to 1988 Chinook salmon fishing was open for four 3-day weekends (Table 2). To increase fishing opportunity a fifth weekend opening was added in 1989. The fishery has been open for five 3-day weekends each year since, except 2002 and 2003, when it was restricted to four 3-day weekends because aerial survey counts were below the lower bounds of the SEG range. A fifth 3-day weekend was added after the last weekend opening by Emergency Order in 2004, based upon sonar and weir counts. The fifth 3-day weekend opening was restored by regulation in 2005, when the Board approved a proposal to liberalize the sport fishery for Chinook salmon by adding a 3-day weekend fishery opening before Memorial Day weekend.

Aerial surveys may not precisely represent the yearly trends in Chinook salmon escapement to the Anchor River, however, in general[2], they have been conducted in a consistent manner throughout the history of the survey and the average counts

---

[1] Preliminary data from Area P0_Detail_Harvest_06.xls, 2006 Statewide Harvest Survey, Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services, Gretchen Jennings, Program Coordinator, ADF&G, Anchorage: personal communication.

[2] One potential exception is that the drop in survey counts from 1988 and before to 1989 and after may be due to the change in observers between the 1988 and 1989 seasons.

Table 1.–Anchor River Chinook salmon aerial index counts (South Fork only) and DIDSON/weir estimates 1976-2007.

Year	Aerial survey count	Sonar/weir (number)	SE
1976	2,125		
1977	3,585		
1978	2,209		
1979	1,335		
1980	No survey		
1981	1,066		
1982	1,493		
1983	1,033		
1984	1,087		
1985	1,328		
1986	2,287		
1987	2,524		
1988	1,458		
1989	940		
1990	967		
1991	589		
1992	99		
1993	1,110		
1994	837		
1995	No survey		
1996	277		
1997	477		
1998	789		
1999	685		
2000	752		
2001	414		
2002	748		
2003	680	13,280[a]	196
2004	834	12,016	283
2005	651	11,156	299
2006	899	8,945	289
2007	678	9,622	238

[a]2003 sonar count expanded temporally; actual count 9,238.

Table 2.–Anchor River Chinook salmon inriver sport harvest, standard error and fishery openings 1977-2006, plus estimates of inriver sport fishery exploitation rates 2002-2006.

	Harvest					Estimated	Inriver	Exploitation
Year	(number)	(SE)	Fishing days per week	Weeks	Total fishing days	Escapement[a]	Return	Rate
1977	1,077		2	4	8			
1978	2,109		3	4	12			
1979	1,913		3	4	12			
1980	605		3	4	12			
1981	1,069		3	4	12			
1982	718		3	4	12			
1983	1,269		3	4	12			
1984	998		3	4	12			
1985	672		3	4	12			
1986	1,098		3	4	12			
1987	761	163	3	4	12			
1988	976	217	3	4	12			
1989	578	115	3	5	15			
1990	1,479	201	3	5	15			
1991	1,047	142	3	5	15			
1992	1,685	245	3	5	15			
1993	2,787	339	3	5	15			
1994	2,478	351	3	5	15			
1995	1,475	190	3	5	15			
1996	1,483	201	3	5	15			
1997	1,563	186	3	5	15			
1998	783	119	3	5	15			
1999	1,409	192	3	5	15			
2000	1,730	193	3	5	15			
2001	889	162	3	5	15			
2002	1,047	192	3	4	12			
2003	1,011	157	3	4	12	13,280	14,291	0.071
2004[b]	1,561	198	3	5	15	12,016	13,577	0.115
2005	1,432	233	3	5	15	11,156	12,588	0.114
2006	1,394	197	3	5	15	8,945	10,294	0.131
2007	na	na	3	5	15			

[a] Data from Table 1, above.

[b] In 2004 opened a 5th weekend by EO.

should reflect large scale changes in escapement. Helicopter surveys of Chinook salmon escapement have been conducted on the same reach of the South Fork of the Anchor River since their inception in 1976. Three observers conducted the bulk of the surveys: one from 1976 to approximately 1989, a second from 1989 until 1995 and a third from 1997 through 2005. Counts have been made by tandem observers since 1996 to compare consistency between surveyors. The average aerial survey count for each decade declined from 2,314 in the latter 1970's to 1,468 in the 1980's and 648 in the 1990's. In the 21st century, the aerial counts average 707 (Table 1).

Dual Frequency Identification Sonar (DIDSON) and a floating weir have been used in combination to enumerate Chinook salmon escapement above the sport fishery in the Anchor River since 2003 (Kerkvliet et al. *In prep*, Kerkvliet and Burwen *In prep*). Only the sonar was operated in 2003, and it was installed on May 30, after the beginning of the Chinook salmon migration. Since 2003, the sonar has been in place at the start of migration on approximately May 15 and operated until spring high water conditions receded to a level where installation of a floating weir was possible.

Species of similar size cannot be differentiated with DIDSON so netting was conducted upstream in the North and South forks to apportion sonar counts and collect sex, length and age composition information. Netting has been prevented by high water until approximately June 1 each year since 2003.

Escapement counts ranged from 8,945 (SE 289) in 2006 to 12,016 (SE 283) in 2004 (Table 1). If the 2003 sonar count is expanded to include the period when counts were missed between approximately May 15 and May 29, using the average proportion of the run that escaped up the river in 2004 and 2005 (two years with similar water temperature and flow rate patterns) the estimated escapement in 2003 would have been 13,280 (SE 196; Table 1).

Sonar estimates of Chinook salmon escapement are biased very slightly low. To calculate net upstream passage, all downstream-traveling fish are subtracted from gross upstream passage. These downstream fish include a few outmigrating steelhead, which cannot be distinguished from Chinook salmon by the sonar. The number of fish subtracted from the count that are truly outmigrating steelhead is thought to be negligible based on the low numbers of netted steelhead, the low steelhead population size relative to the more abundant Chinook salmon, lack of discontinuity in the Chinook salmon counts at the time of transition from sonar to weir and the high correlation of downstream counts with upstream counts.

A weir was operated in the North Fork of the Anchor River in 2004. An estimated 16% (1,919/12,016) of the Chinook salmon counted in the mainstem in 2004 used the North Fork for spawning and 84% used the South Fork (Kerkvliet et al. *In prep*).

Exploitation rates of Anchor River Chinook salmon in recreational fisheries (~4% in the marine fishery, 7-13% inriver; Table 2) are low. Historic exploitation rates are probably also low, based on the stability of aerial survey counts and harvest estimates throughout the history of data collection.

Age composition of the Chinook salmon escapement was estimated from fish netted in the North and South forks during sonar operation in combination with fish subsampled at the weir after its installation. Age composition differed statistically between the North and South forks in 2003 and 2004, but the difference was not biologically meaningful (Kerkvliet et al. *In prep*). Age composition from the two forks was pooled in 2005 and 2006 because few fish were observed in 2005 in the North Fork (Kerkvliet et al. *In prep*). Overall, age 1.3 was the dominant age class each year from 2003-2006. Age 1.4 were the second most dominant in the escapement in 2004 and 2006 and age 1.2 the second most dominant in 2003 and 2005 (Table 3).

In summary, the Anchor River Chinook dataset consists of a long historical record of imprecise escapement index counts with no age data, followed by four to five years of accurate escapement and age composition estimates. Throughout the historical record, the inriver recreational harvest was estimated consistently and precisely, and the marine recreational harvest was not measured but small.

Table 3.–Estimated ocean age composition of Chinook salmon sampled from the Anchor River escapement, 2003-2006.

		Ocean Age			
		1	2	3	4
2003	Percent	5	23	58	14
	SE Percent	1.1	2.1	2.5	1.8
2004	Percent	8.8	20.7	48.6	21.9
	SE Percent	1.9	2.6	3.2	2.6
2005	Percent	5	23.9	52.2	18.9
	SE Percent	1.2	2.1	2.5	2
2006	Percent	6.4	16.5	52.1	25
	SE Percent	2.1	2.7	3.8	3.5

METHODS

Two separate statistical methods were used to analyze the Anchor River Chinook data. The first is termed a "full probability model" for this report, because it leverages the entire historical database, explicitly incorporating and considering the effects of measurement error and missing age data. Markov Chain Monte Carlo (MCMC) methods were employed to fit this model. This methodology reduces bias caused by the measurement error, and provides a more realistic assessment of uncertainty than is possible with other statistical methods. The second method, labeled a "theoretical model" for this report, analyzes only the most recent, high-quality data, making reasonable assumptions about productivity in order to make inference about carrying capacity and optimal escapement levels.

FULL PROBABILITY MODEL

Anchor River Chinook spawner-recruit data were analyzed in the context of the following statistical model. For a similar analysis see Ericksen and Fleischman 2006.

A Ricker spawner-recruit function (Ricker 1975) was chosen to model the relationship between escapement and recruitment. Under the Ricker model, the total recruitment R from brood year y is:

$$R_y = S_y \, \alpha \, e^{-\beta S_y} e^{\varepsilon_y} \qquad (1)$$

where S is the number of spawners, α and β are parameters, and the $\{\varepsilon_y\}$ are normally distributed process errors with variance σ^2_{SR}. Parameter α is the number of recruits per spawner in the absence of density dependence and is a measure of the productivity of a stock. Parameter β is a measure of density dependence; the inverse of β is the number of spawners that produces the theoretical maximum return (S_{MAX}).

Equilibrium spawning abundance, in which the expected return $R = S$, is

$$S_{EQ} = \frac{\ln(\alpha')}{\beta} \qquad (2)$$

where $\ln(\alpha)$ is corrected for asymmetric lognormal process error as follows:

$$\ln(\alpha') = \ln(\alpha) + \frac{\sigma^2_{SR}}{2} \qquad (3)$$

Number of spawners leading to maximum sustained yield S_{MSY} is approximately (Hilborn 1985)

$$S_{MSY} \approx S_{EQ}\left(0.5 - 0.07\ln(\alpha')\right). \qquad (4)$$

The Ricker relationship can be linearized by dividing both sides of equation 1 by S and taking the natural logarithm, yielding:

$$\ln\frac{R}{S} = \ln(\alpha) - \beta S + \varepsilon \qquad (5)$$

This streamlines parameter estimation, because the relationship can now be viewed as a simple linear regression (SLR) of $\ln(R/S)$ on S, in which the intercept is an estimate of $\ln(\alpha)$, the negative slope an estimate of β, and the mean squared error an estimate of the process error variance σ^2_{SR}.

The SLR approach requires reasonably precise estimates of S and R for a minimum of 8-10 complete brood years. Accurate estimates of S are especially important because moderate to high measurement error in S can cause standard estimates of S_{MSY} to be biased. Zero pairs of precise S and R estimates exist for the Anchor River, because the weir, sonar, and age sampling projects have been operating for less than one full life cycle. S and R pairs from 1977 to 2000 can be reconstructed from expanded aerial surveys and freshwater harvest estimates, with imputed age composition estimates. However such estimates are likely affected by substantial measurement error.

Ricker parameters can be estimated using imprecise estimates of S and R, however it is critical to assess how much uncertainty and bias is introduced into the parameter estimates as a result of the imprecision. This is difficult to accomplish with classical statistical methods. Therefore we employed Markov Chain Monte Carlo (MCMC) methods, which are especially well-suited for modeling complex population and sampling processes, including measurement error. We implemented the MCMC algorithms in WinBUGS, which is a Bayesian software program. Bayesian statistical methods employ probability as a language to quantify uncertainty about model parameters. Knowledge existing about the parameters outside the framework of the experimental design is the "prior" probability distribution. The output of the Bayesian analysis is called the "posterior" probability distribution, which is a synthesis of the prior information and the information in the data.

The Bayesian MCMC analysis considers all the data simultaneously in the context of the following "full-probability" statistical model. Returns of Chinook salmon originating from spawning escapement in brood years y = 1971 - 2004 are modeled as a Ricker stock-recruit function with autoregressive lognormal errors

$$\ln(R_y) = \ln(S_y) + \ln(\alpha) - \beta S_y + \phi \nu_{y-1} + \varepsilon_y \qquad (6)$$

where α and β are Ricker parameters, ϕ is the autoregressive coefficient, $\{\nu_y\}$ are the model residuals

$$\nu_y = \ln(R_y) - \ln(S_y) - \ln(\alpha) + \beta S_y, \qquad (7)$$

and the $\{\varepsilon_y\}$ are independently and normally distributed process errors with variance σ^2_{SR}.

Age proportion vectors $\underline{\boldsymbol{p}}_y = (p_{y3}, p_{y4}, p_{y5}, p_{y6})$ from brood year y returning at age a are drawn from a common Dirichlet distribution (multivariate analogue of the beta). The Dirichlet is re-parameterized such that the usual parameters:

$$D_a = \pi_a D \qquad (8)$$

are written in terms of location (overall age proportions π_a) and inverse scale (D, which governs the inverse dispersion of the $\underline{\boldsymbol{p}}_y$ age proportion vectors among brood years).

The abundance N of age-a Chinook salmon in calendar year t (t = 1977-2007) is the product of the age proportion scalar p and the total return R from brood year $y = t\text{-}a$:

$$N_{ta} = R_{t-a}\, p_{t-a,a} \qquad (9)$$

Total abundance during year t is the sum of abundance at age across ages:

$$N_{t.} = \sum_a N_{ta}\,. \qquad (10)$$

Inriver return is total abundance minus marine harvest,

$$IR_t = N_{t.} - H_{Mt} \qquad (11)$$

where H_{Mt} is marine recreational harvest in Cook Inlet, with exploitation rates $\{\mu_{Mt}\}$.[3]

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[3] Marine harvests of Anchor River chinook salmon are unobserved, however both Ninilchik and Deep Creek Chinook had approximately 4% exploitation rates in the marine fishery in the late 1990s. Thus we modeled the harvest rate as beta(40,960) ≥1996 and beta(50,950) ≤1995, when fishery regulations were less restrictive and harvests averaged approximately 20% higher

$$H_{Mt} = \mu_{Mt} N_{t.} \quad (12)$$

Spawning abundance during year *t* is:

$$S_t = IR_t - H_{Ft} \quad (13)$$

where H_{Ft} is the freshwater sport harvest, which in turn is the product of the annual exploitation rate μ_{tFt} and inriver return IR_t:

$$H_{Ft} = \mu_{Ft} IR_t . \quad (14)$$

Freshwater exploitation rate is an exponential function of annual freshwater fishing mortality F

$$\mu_{Ft} = 1 - \exp(-F_t) , \quad (15)$$

which in turn is the product of an annual catchability coefficient q_t and annual fishing effort (days the fishery was open) E_t:

$$F_t = q_t E_t . \quad (16)$$

Annual catchability coefficients $\{q_t\}$ (fraction of the population harvested by a single unit of effort) are drawn from a common beta distribution with parameters:

$$B_1 = Q\sigma_Q^{-2} . \quad (17)$$

and $B_2 = 1 - B_1$, where the location parameter Q is the mean catchability coefficient and the scale parameter σ_Q governs the dispersion of the annual catchability coefficients $\{q_t\}$.

Spawning abundance yielding peak return S_{MAX} is calculated as the inverse of the Ricker β parameter. Equilibrium spawning abundance S_{EQ} and spawning abundance leading to maximum sustained yield S_{MSY} are obtained using equations 2-4, except that ln(α) is corrected for AR1 serial correlation as well as lognormal process error:

$$\ln(\alpha') = \ln(\alpha) + \frac{\sigma_{SR}^2}{2(1-\phi^2)} . \quad (18)$$

Expected sustained yield at a specified escapement S is calculated by subtracting spawning escapement from the expected return, again incorporating corrections for lognormal process error and AR1 serial correlation:

$$SY = E[R] - S = Se^{\ln(\alpha') - \beta S} - S . \quad (19)$$

Probability that a given level of escapement would produce yields exceeding 90% of MSY was obtained by calculating expected sustained yield SY (Equation 19) at multiple incremental values of S (0 to 10,000) for each Monte Carlo sample, then comparing SY with 90% of the value of MSY for that sample. The proportion of samples in which SY exceeded 0.9 MSY is the desired probability.

Observed data include estimates of spawning abundance, aerial survey counts, estimates of harvest, and scale age counts. Likelihood functions for the data follow.

Estimated spawning abundance is modeled as:

$$\hat{S}_t = S_t e^{\varepsilon_{WSt}} \quad (20)$$

where the $\{\varepsilon_{WSt}\}$ are normal $(0, \sigma^2_{WSt})$ with individual variances $\{\sigma^2_{WSt}\}$ assumed known from weir / sonar coefficients of variation.

Aerial survey counts (1977-2007, except 1980 and 1995) are modeled as linearly related to true spawning abundance[4]

$$c_t = \lambda_i S_t e^{\varepsilon_{ASt}} \quad (21)$$

where λ is the fraction of spawning salmon observed in the aerial surveys during period i = 1 (1977-1988) or i = 2 (1989-2007)[5], the $\{\varepsilon_{ASt}\}$ are normal $(0, \sigma^2_{AS})$, and the common error variance σ^2_{AS} is informed by the relationship between $\hat{S}$ and *c* for years 2003-2006.

Estimated harvest (1977–2006) is modeled as

$$\hat{H}_t = H_t e^{\varepsilon_{Ht}} \quad (22)$$

where ε_{Ht} are normal $(0, \sigma^2_{Ht})$ with individual variances σ^2_{Ht} assumed known from SWHS coefficients of variation.

[4] We cannot test the assumption of linearity at present because we lack contrast in recent escapements. An alternative model choice would be an allometric relationship between aerial counts and escapement, which would allow for the possibility that aerial survey detection could saturate, i.e., the fraction detected would decline as abundance increased. However, given the low density of Chinook salmon on the Anchor River spawning grounds, we consider saturation very unlikely.

[5] There was a change in observers between 1988 and 1989 that caused an apparent drop in the proportion of Chinook salmon detected.

Numbers of fish sampled for scales (n) that were classified as age-a in calendar year t (x_{ta}) are multinomially (r_{ta},n) distributed, with proportion parameters as follows:

$$r_{ta} = \frac{N_{ta}}{N_{t\cdot}} \tag{23}$$

Bayesian analyses require that prior probability distributions be specified for all unknowns in the model. Non-informative priors (chosen to have a minimal effect on the posterior) were used throughout. Initial returns R_{1971}-R_{1976} (those with no linked spawner abundance) were modeled as drawn from a common lognormal distribution with median μ_{LOGR} and variance σ^2_{LOGR}. Normal priors with mean zero, very large variances, and constrained to be positive, were used for ln(α) and β (Millar 2002), as well as for μ_{LOGR}. The initial model residual v_0 was given a normal prior with mean zero and variance $\sigma^2_{SR}/(1-\phi^2)$. Diffuse conjugate inverse gamma priors were used for σ^2_{SR}, σ^2_{AS}, and σ^2_{LOGR}.

A uniform prior was used for σ_Q. An informative lognormal(4,6) prior was used for the Dirichlet inverse scale parameter D, based on a meta-analysis of 7 other Pacific salmon stocks.

Markov-chain Monte Carlo samples were drawn from the joint posterior probability distribution of all unknowns in the model. For each of two Markov chains initialized, a 5,000-sample burn-in period was discarded, thinning by a factor of 10 was initiated, and 7,500 additional updates were generated. The resulting total of 15,000 samples were used to estimate the marginal posterior means, standard deviations, and percentiles. The diagnostic tools of WinBUGS (Gilks et al. 1994) assessed mixing and convergence, and no major problems were encountered. Interval estimates were obtained from the percentiles of the posterior distribution.

THEORETICAL MODEL

Theoretical spawner-recruit (S-R) relationships were investigated for Chinook salmon in the Anchor River, in a manner similar to the methods used by Clark 2005 and Clark et al. 2006 for coho salmon. The results from this analysis provide no assessment of uncertainty, but point estimates were generated for comparison with those from the full-probability model.

Long term yields and escapement in the Anchor River are likely at equilibrium because historic harvests are relatively stable and full enumeration of the spawning escapement since 2003 has revealed that the exploitation rate of Anchor River Chinook salmon stocks is low. Average escapements estimated with DIDSON/weir were assumed to represent average historical escapements and average harvests during years when escapement was fully enumerated to represent historic exploitation. The S-R relationship for Anchor River Chinook salmon was assumed to follow the form of Ricker (Ricker 1975). A range of productivity parameters for Chinook salmon stocks were used to estimate preliminary escapement goal ranges that may result in maximized yields.

Escapement counts ($\bar{s}$) were averaged (I = 2003-2006):

$$\bar{s} = \frac{1}{n}\sum_{i}^{n} s_i \tag{24}$$

Harvest estimates (h), including marine harvests replaced escapement counts (s) in equation (24) to estimate average harvest ($\bar{h}$).

Assuming that harvest and escapements are in equilibrium, average maximum exploitation rate ($\bar{u}$) was estimated as:

$$\bar{u} = \frac{\bar{h}}{(\bar{s} + \bar{h})} \tag{25}$$

Exploitation rate at maximum sustained yield (MSY) depends solely on the Ricker productivity parameter α. The range of the productivity chosen (2.72 to 4.85) brackets a conservative estimate of the productivity of Chinook salmon stocks where 4.85 is the average productivity parameter for stream-type Chinook salmon from Parken et al. 2004. Assuming α was known and the observed average exploitation rate from 2003-2006 and average escapement counted with DIDSON and weir from 2003-2006 represent equilibrium, estimates of escapement that will produce MSY can be calculated from Hilborn and Walters 1992) and Ricker 1975):

$$S_{MSY} = \bar{s}\frac{0.5\ln(\alpha) - 0.07\ln(\alpha)^2}{\ln(\alpha(1-\bar{u}))} \quad (26)$$

To compare estimates of S_{MSY} and S-R relationships derived from the two different assumed α's, the β parameters were estimated for each S-R by first estimating the exploitation rate at MSY by solving:

$$\ln(\alpha) = \mu_{MSY} - \ln(1-\mu_{MSY}) \quad (27)$$

for u_{MSY} (from Ricker 1975). The β parameter was then calculated from (Ricker 1975):

$$\beta = \frac{\mu_{MSY}}{s_{MSY}} \quad (28)$$

From these S-R relationships the range around S_{MSY} that produces 90% or more of MSY was also calculated.

RESULTS

FULL PROBABILITY MODEL

The posterior distribution from an age-structured fisheries model is multivariate with many dozens of free parameters. Additionally, any quantity that can be calculated from model parameters can also be monitored by WinBUGS and its posterior density estimated. A summary of posterior percentiles from key model quantities is in Table 4.

Information from both the aerial surveys and the harvests contribute to our knowledge of individual annual escapements, as synthesized and summarized by the posterior percentiles for S (Figure 2). As expected, uncertainty in S differs dramatically before and after the weir/sonar projects were initiated in 2003.

The estimates of R show a similar pattern, except that precision changes more gradually with time because each brood year crosses four calendar years (Figure 2). Brood years at the beginning and end of the time series show additional uncertainty due to incomplete data from missing ages. The uncertainty in *R* is primarily due to measurement error in S, because escapement has comprised a large fraction of the total return. Harvest estimate sampling error, and lack of scale sampling data before 2003 also contribute to uncertainty in R.

When the 80% intervals of R vs S are plotted against each other (Figure 3), most individual {R,S} pairs are only marginally distinguishable from each other. Due to the low contrast and moderate to high measurement error, information about {R,S} is mostly limited to knowledge of their central location, rather than the individual annual values. Yet, because of the large number of years of data, our information about the central location of the cluster of points is strong. It is located near the replacement line, meaning harvest rate is very low and the stock is oscillating near carrying capacity.

A sampling of Ricker relationships that could have resulted in the observed data (Figure 4) shows that most of the possible curves pass through the replacement line within a fairly narrow window, i.e., S_{EQ} is well-defined. This is borne out in a narrow 80% interval estimate for S_{EQ} (11,080 to 14,550; Table 4) On the other hand the corresponding intervals are much wider for ln(α) (0.78–1.93) and β (6.0–16.7 x 10^{-5}). S_{MSY} is fairly well estimated (80% interval 4,155–6,248; Table 4). S_{MSY} is equally likely to be above or below 5,006.

The width of the 80% interval divided by the posterior median of S_{MSY} is an index of the relative uncertainty (RU) of our knowledge about S_{MSY}. For Anchor Chinook this ratio was RU_{80} = 0.42, which is near the lower end of the range of values from other salmon stocks analyzed in a similar manner (Table 5).

The probability that a given spawning escapement will result in *SY* exceeding 90% of maximum sustained yield is plotted in Figure 5. The probability of achieving sustained yields in excess of 90% of MSY is at least 60% between spawning abundances of 3,400 and 6,800 fish (Figure 5). That probability reaches a maximum of 97% near S_{MSY} = 5,000.

Table 4.–Posterior percentiles from a Bayesian Ricker spawner-recruit analysis of Anchor River Chinook salmon, 1977–2004 brood years. Parameters are defined in text of Methods section.

Parameter	$p_{2.5}$	p_{10}	p_{50}	p_{90}	p_{95}
$\ln(\alpha)$	0.48	0.78	1.35	1.93	2.25
α	1.62	2.19	3.85	6.90	9.47
$\beta \times 10^5$	3.31	5.95	11.04	16.71	19.77
σ_{SR}	0.08	0.10	0.17	0.29	0.38
ϕ	-0.72	-0.44	0.23	0.76	0.92
S_{MAX}	5,058	5,985	9,061	16,800	30,260
S_{EQ}	10,280	11,080	12,480	14,550	17,170
S_{MSY}[c]	3,765	4,155	5,006	6,248	7,592
MSY	2195	3449	6499	11,400	15,390
π_1	0.046	0.0655	0.076	0.100	0.114
π_2	0.173	0.192	0.227	0.263	0.283
π_3	0.436	0.461	0.504	0.546	0.570
π_4	0.142	0.159	0.191	0.226	0.247
D	40	50	82	126	159
λ_1	0.101	0.116	0.148	0.190	0.219
λ_2	0.044	0.049	0.058	0.069	0.076
$1/\lambda_1$	4.57	5.27	6.78	8.65	9.93
$1/\lambda_2$	13.11	14.47	17.25	20.59	22.80
σ_{AS}	0.38	0.42	0.51	0.62	0.69
$Q_H \times 10^3$	6.9	7.4	8.3	9.4	10.2
σ_H	0.014	0.019	0.026	0.035	0.041

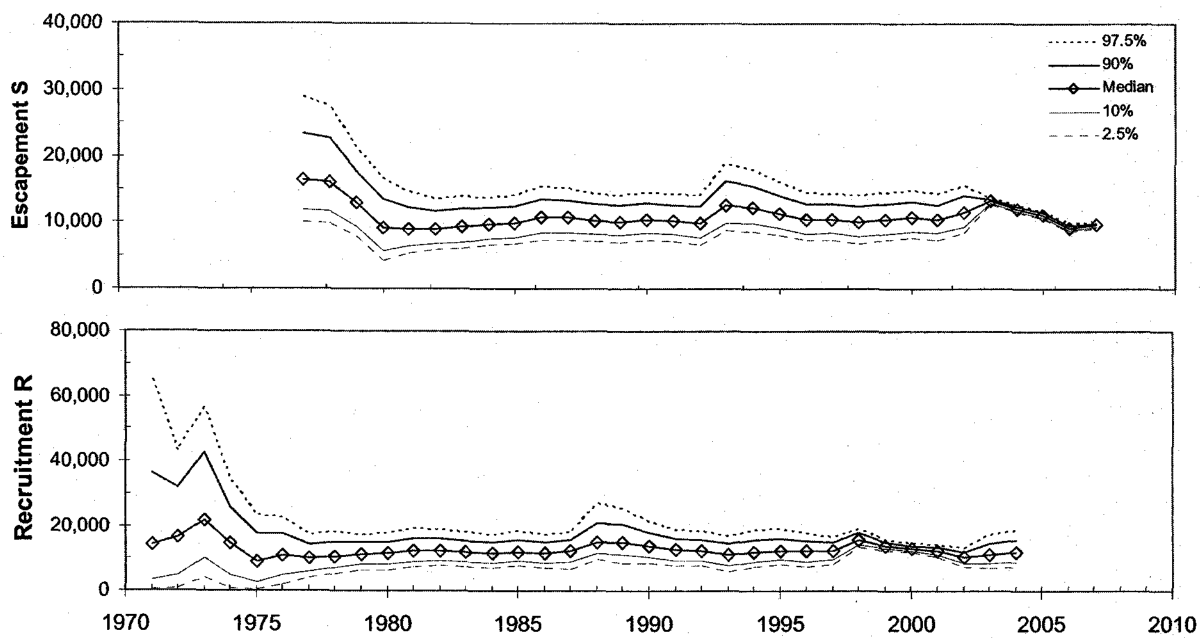

Figure 2.–Posterior percentiles of estimated escapement and recruitment, Anchor River Chinook salmon.

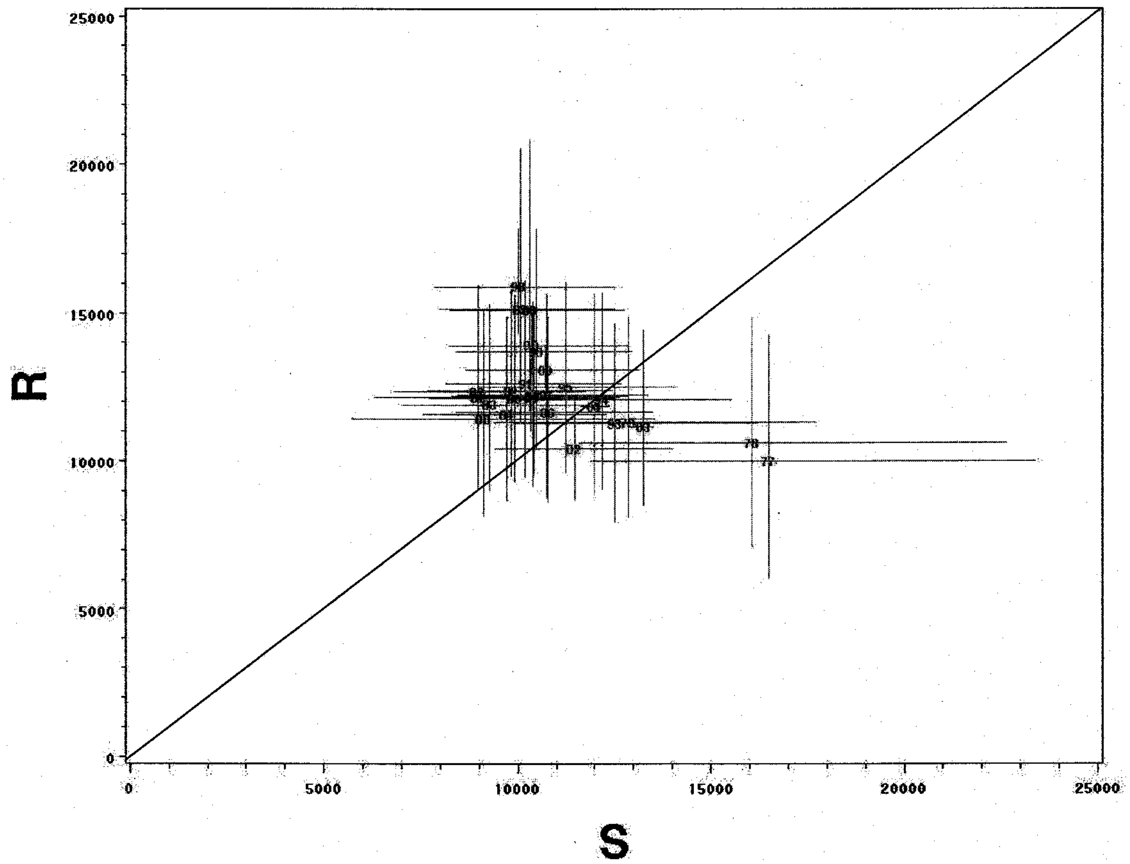

Figure 3.– Scatter plot of point/interval estimates of recruitment versus escapement, Anchor River Chinook salmon, brood years 1977-2003. Posterior medians are plotted as two-digit year labels, 10th and 90th posterior percentiles are bracketed by error bars.

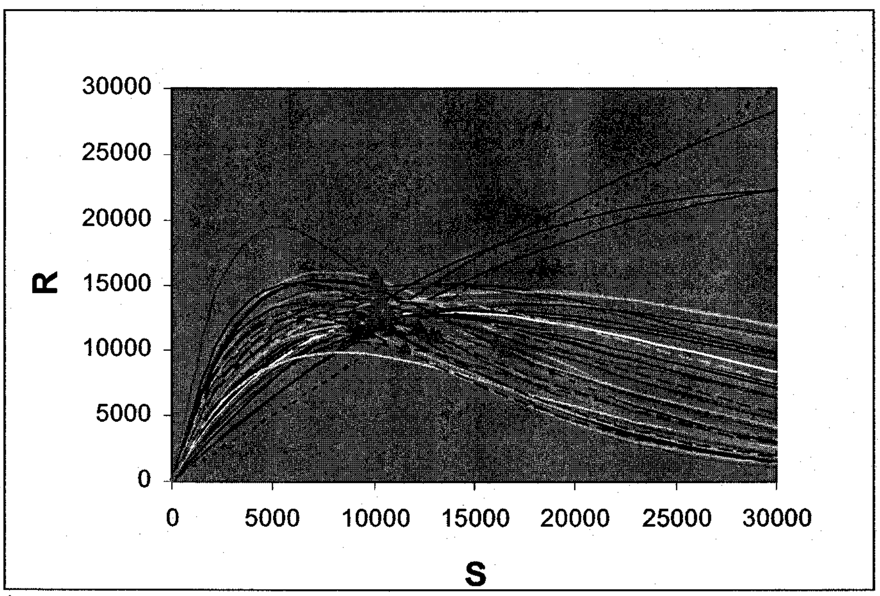

Figure 4.–Ricker curves represented by ~40 paired values of ln(α) and β sampled from the posterior probability distribution of stock-recruitment statistics, Anchor River Chinook salmon. Symbols are posterior medians of R and S. Curves can be interpreted as a sampling of Ricker relationships that could have resulted in the observed data.

Table 5.–Relative uncertainty (RU_{80}) of Ricker spawner-recruit parameter estimates for Pacific salmon populations analyzed with Bayesian age-structured spawner recruit methods. RU_{80} is defined as the width of 80% credibility intervals (90th posterior percentile – 10th posterior percentile) divided by the posterior median.

					RU_{80}				
Species	River	Years[a]	*S* contrast[b]	*S* uncertainty	$\hat{\phi}$	$\hat{\sigma}_{SR}$	$\ln(\alpha)$	β	S_{MSY}
Coho	Chilkat	7/9	5.5	high	0.69	0.31	0.67	0.60	0.51
Chinook	Anchor[c]	5/31	2.5	high	0.23	0.17	0.85	0.98	0.42
Chinook	Karluk[d]	12/29	3.2	low	0.16	0.49	1.46	1.63	1.39
Chinook	Ayakulik[d]	12/28	22.2	low	-0.17	0.51	1.44	0.59	0.38
Chinook	Kenai, early run[d]	17	2.5	mod	0.35	0.26	0.67	0.86	0.55
Chinook	Kenai, late run[d]	17	2.6	mod	0.58	0.25	0.87	1.52	1.70
Chinook	Deshka[d]	10/31	10.1	low	0.67	0.44	0.77	0.69	0.57
Sockeye	Buskin[d]	8	1.7	low	0.43	0.57	1.21	1.63	2.11

[a] Years of complete data/any data.
[b] *S* contrast = max(*S*) / min(*S*).
[c] this stock.
[d] Ericksen and Fleischman 2006.

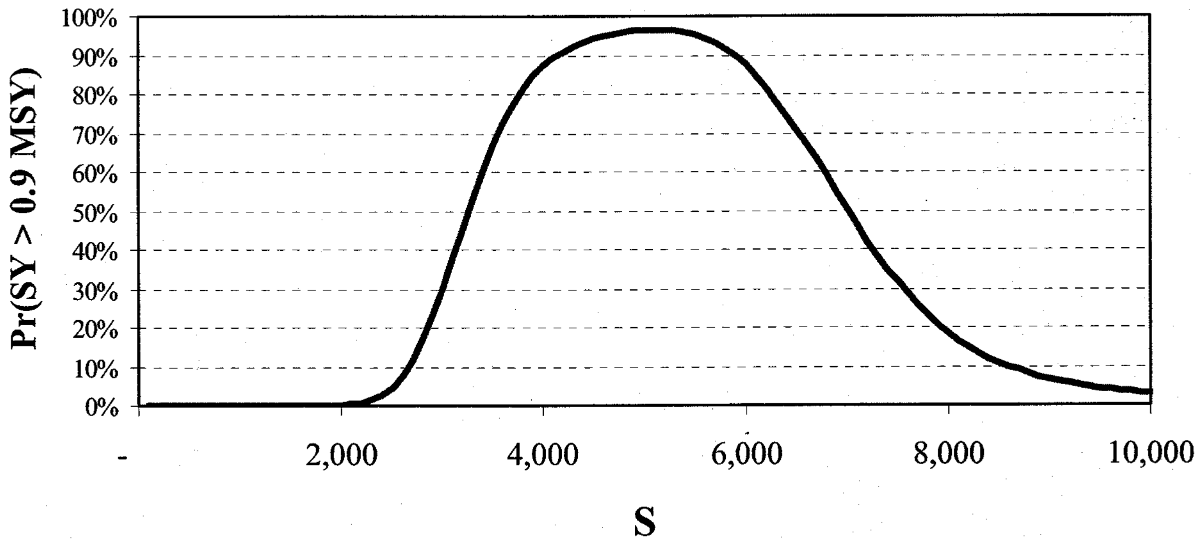

Figure 5.–Probability that a specified spawning abundance will result in sustained yield exceeding 90% of maximum sustained yield, Anchor River Chinook salmon.

THEORETICAL MODEL

The average of annual escapements counted by DIDSON and weir between 2003 and 2006 was 11,349 and average return for the same years was (average return=average escapement + average harvest; 13,228=11,349 + 1,879) (Table 1). Assuming Ricker α for Chinook salmon ranged from 2.72 to 4.85 (ln(α) ranged from 1.0 to 1.58) and that the average escapement and average harvest represented an equilibrium exploitation rate of 0.14, two theoretical S-R relationships that have the same equilibrium values were calculated (Figure 6). In addition, from the two theoretical S-R relationships, escapements that would produce MSY and a range of escapements that would produce 90% or more of MSY were also calculated. When ln(α) = 1.0, S_{MSY} = 5,801 and the range of escapements that would produce 90% or more of MSY was 3,812-7,966. For ln(α) = 1.58, S_{MSY} = 4,914 and the range of escapements that would produce 90% or more of MSY was 3,162-6,923. S_{EQ} was 13,402 for ln(α) = 1.0 and 12,568 for ln(α) = 1.58.

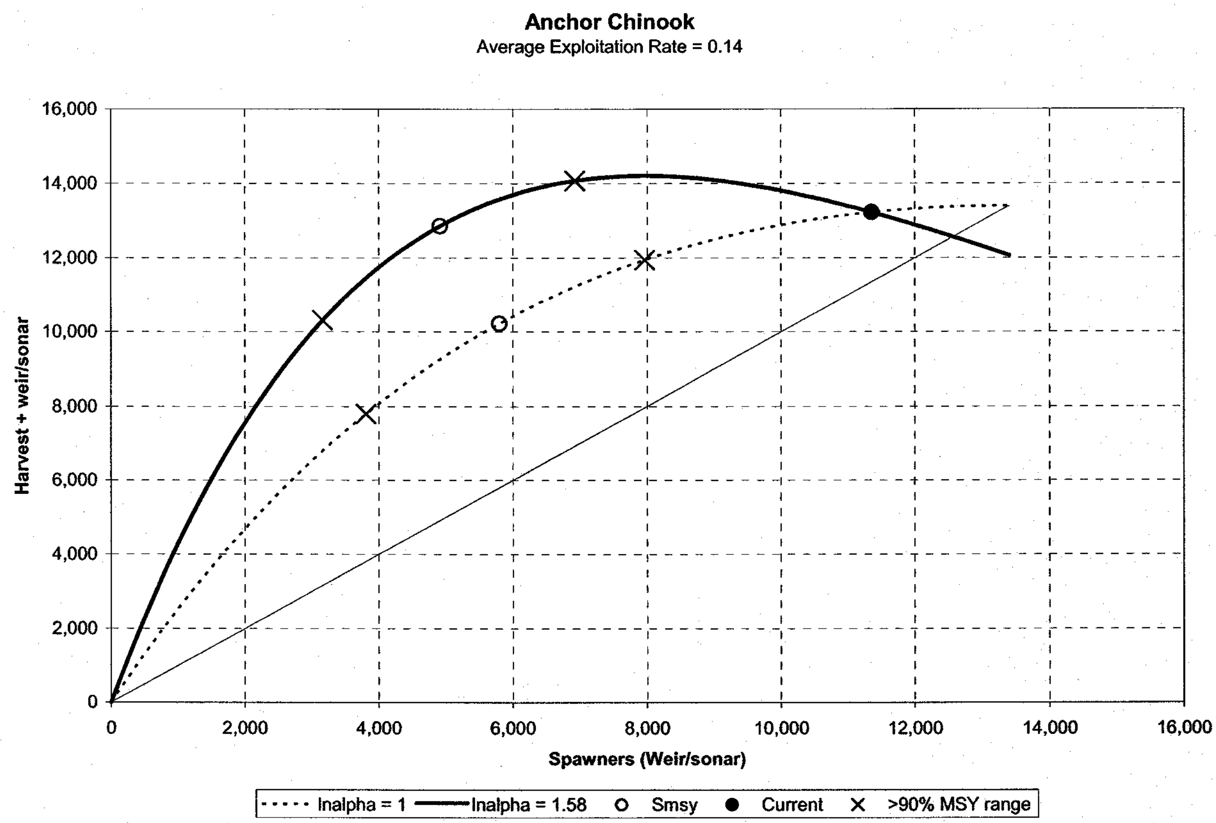

Figure 6.–Theoretical Ricker stock-recruitment relationships for Chinook salmon in the Anchor River.

Note: Relationship based on average escapement from sonar/weir of 11,349 and average freshwater and marine harvest of 1,879 (2003-2006; •). The dotted line represents the Ricker curve with an α-parameter of 2.72; the heavy solid line represents the Ricker curve with an α-parameter of 4.85 and the straight solid line, the replacement line. S_{msy} (o) and escapements that produce 90% of MSY (x) are also shown.

DISCUSSION

The results from the full probability model, based on 31 years of data, and the theoretical model, based on 5 years of full, high-quality data and some reasonable assumptions about productivity, were in close agreement. The posterior median of S_{MSY} from the full probability model (5,006) was similar to estimates from the theoretical model of 5,801 (ln (α) = 1.0) and 4,914 (ln (α) = 1.58). From the full probability model, there is a 60–97% probability that escapements between 3,400 and 6,800 will produce sustained yields exceeding 90% of MSY. This was also consistent with the results of the theoretical model.

Clearly, by comparing these numbers with recent high-quality estimates of escapement, the stock is able to support higher exploitation rates. We recommend a sustainable escapement goal (SEG) threshold of 5,000 fish based on the point estimate (posterior median) of S_{MSY} from the full probability model (5,006). Cautious incremental increase of the harvest through liberalization of sport fishing regulations is justified, and this escapement goal will allow that. Continued collection and analysis of stock assessment data is strongly recommended.

From a statistical and theoretical perspective, we have enough information about S_{MSY} to specify a biological escapement goal (BEG). Of the stocks listed in Table 5, the Anchor River Chinook stock has the second lowest amount of uncertainty about S_{MSY}, and all except Buskin sockeye currently have BEGs.

On the other hand, our certainty about the (low) exploitation level of this stock is very recent, being based almost entirely on only five weir/sonar estimates of escapement. As recently as 2002, the stock was thought to be at risk of over-exploitation. Both of the statistical methodologies employed assume to some degree that the most recent five years are representative of previous years. We believe that this is a reasonable assumption, yet it cannot be proven. Moreover, we cannot directly evaluate the performance of our estimate of S_{MSY} because we have no actual production data from escapements at or near our estimate of S_{MSY}. Therefore we recommend that changes to the fishery be implemented gradually, allowing time for their impact to be evaluated and for more production data to be collected, especially at escapements closer to the recommended SEG threshold than previously observed.

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Customary and Traditional Use Worksheet
Proposal 392 (formerly ACR 12)
Marine Invertebrates, Cook Inlet Area outside the Nonsubsistence Area

Prepared by

Alaska Department of Fish and Game, Division of Subsistence

Alaska Board of Fisheries

November 13-15, 2007

Homer, Alaska

November 2007

Alaska Department of Fish and Game **Division of Subsistence**

Alaska Department of Fish and Game, Division of Subsistence,
Anchorage, Alaska

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BACKGROUND

Proposal 392 (formerly Agenda Change Request 12) requests that the Alaska Board of Fisheries reexamine customary and traditional use findings for shellfish in those portions of the Cook Inlet Management Area outside the Anchorage-Matsu-Kenai Nonsubsistence Area (Figure 1) and adopt regulations providing a reasonable opportunity to harvest shellfish stocks that support subsistence uses. The Board follows "Joint Boards of Fisheries and Game Subsistence Procedures" (5 AAC 99.010) ("the eight criteria") to identify fish stocks that are customarily and traditionally taken or used by Alaska residents for subsistence uses.

In 1982, the Board of Fisheries adopted regulations allowing the subsistence harvesting of clams in the Port Graham Subdistrict. At the same time, the Board repealed all other subsistence shellfish regulations pertaining to the Lower Cook Inlet Area. Written findings explaining this decision were not made. This worksheet is based on an original prepared in November 1992, with additions in January 1993, as part of the Board's consistency review following passage of revisions to the state subsistence statute in 1992. The worksheet has been updated with more recent harvest and use data.

There are three communities on the lower Kenai Peninsula outside the Anchorage-Matsu-Kenai Nonsubsistence Area (Figure 1), Nanwalek (formerly English Bay), Port Graham, and Seldovia. Nanwalek had an estimated population of 228 people in 2006; in 2000, 93% of the population was Alaska Native. Port Graham had an estimated population of 136 people in 2006; in 2000, 88% of the population was Alaska Native. The estimated population of Seldovia was 379 people; in 2000, 23% of the population was Alaska Native (U. S. Bureau of the Census 1981; Alaska Department of Labor and Workforce Development 2007).

THE EIGHT CRITERIA

Criterion 1. A long-term consistent pattern of noncommercial taking, use, and reliance on the fish stock or game population that has been established over a reasonable period of time of not less than one generation, excluding interruption by circumstances beyond the user's control, such as unavailability of the fish or game caused by migratory patterns.

Evidence of human utilization of marine invertebrates throughout the Cook Inlet area exists in both the archaeological and oral history records as summarized in Stanek et al. 1982. For example, there are numerous shell middens along the shores of Kachemak Bay and the west side of Cook Inlet which contain the remains of numerous shellfish, including butter clams, razor clams, cockles, and snails. Stanek (1985:70) noted:

> Historically, Kachemak Bay groups harvested shellfish in the spring. This may be related to the lack of other resources during that season, the exhaustion of stored resources like salmon, and harsh weather conditions which prevented hunters and fishers from venturing far from their homes.

Since the early 1980s, periodic household surveys conducted by the Division of Subsistence, ADF&G, have documented shellfish harvests in the Cook Inlet communities Port Graham, Nanwalek, and Seldovia. Table 1 lists the marine invertebrates known to be used by residents of these communities from the 1980s to the present. Uses of species not listed in this table may occur. Table 2 presents household survey data for all species of marine invertebrates combined for all study years for each community. In all years, a large majority of households in the communities used marine invertebrates for food.[1] As illustrated in Figure 2, most households in the three communities participate in marine invertebrate harvests. For all marine invertebrates combined, harvest levels have ranged between 9 pounds per person (usable weight) in Port Graham during 1989 (the year of the *Exxon Valdez* oil spill) and 34 pounds per capita in Seldovia during 1991/92 (Table 2, Figure 3). These resources are a major source of food for these communities, providing about 5-10 percent or more of the annual subsistence harvest in Seldovia, Port Graham, and Nanwalek (Fall 1992:47-56).

Tables 3 through 20 provide harvest and use information for those marine invertebrates harvested in the largest amounts or used by the largest number of households, based on household surveys.

Elders from Port Graham and Nanwalek reported that crabs are part of a large group of bottom-dwelling animals called *uyangtaaq* (Stanek 1985:157-158). These resources are usually found in shallow waters of bays and intertidal areas. Crab harvests have been documented for lower Cook Inlet communities (Tables 2, 10-13). When interviewed in the 1980s, Port Graham and Nanwalek residents reported that crab numbers, particularly Dungeness, in the area had declined greatly since the time commercial fishing for crab began in the 1960s. Stanek (1985:7) reported the following:

> Several informants [in Nanwalek and Port Graham] recalled spearing crab in their childhood and recounted spearfishing for Dungeness and king crab in the 1950s in Port Graham Bay. Spears made of sapling spruce about 10 to 12 feet long were armed with points. During historic times, points were made of soft metal available from traders, canneries, and sawmills. In the 1960s, commercial crabbers moved into the Port Graham area depleting the crab population. Subsequently, harvesting crab in shallow waters with spears became unproductive. At about the same time, people acquired pots and began crabbing in deeper water.

By the 1980s, population declines led to closures of all Cook Inlet commercial crab fisheries. Crab were harvested at relatively low levels for home use in the early 1980s, but an even more severe decline in harvest has since taken place. Subsistence fishing for crab has not been authorized since 1982. Personal use and sport fishing for king crab has been closed since 1985, Dungeness crab since 1998, Tanner crab since 2003, and shrimp since 1997.

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[1] The *Exxon Valdez* Oil Spill of March 1989 severely disrupted subsistence harvests of many resources, and especially shellfish, in Nanwalek, Port Graham, and Seldovia (and other communities). Levels of harvests and uses of these resources in 1989 and several years afterward are not typical of pre-spill levels of harvest and use.

Criterion 2. A pattern of taking or use recurring in specific seasons of each year.

The harvest of shellfish in Nanwalek, Port Graham, and Seldovia is characterized by annual and monthly cycles (Reed 1985:161-162; Stanek 1985:159-162). In lower Cook Inlet, harvesters take advantage of the monthly spring tides to access intertidal habitats of mussels, littleneck clams, limpets, chitons, and snails. Each spring, several series of extreme low tides in April, May, June, and July expose the best sand and mud habitats of butter clams, cockles, razor clams, and octopus.

In the past, crab were usually taken whenever they were present in accessible areas. With the use of pots, harvest capability probably increased. Like some other shellfish, extreme low tides make crab more accessible for hand picking or other means of harvest. Seldovia residents typically fish for crab between May and August.

Criterion 3. A pattern of taking or use consisting of methods and means of harvest that are characterized by efficiency and economy of effort and cost.

In almost all cases, the patterns of accessing and gathering shellfish are typified by methods readily available and within the economic means of local community residents. Access to shellfish harvest areas is typically by foot and small skiffs. A road connects Seldovia with harvest areas at Kasitsna and Jacolof bays. In the harvest of shellfish resources, the primary method of removal is by hand with the use of small handheld tools such as knives, sticks, hooks, and shovels. Quantities of resources are collected in buckets, pots, plastics bags, gunny sacks, or tubs (Reed 1985:159-162; Stanek 1985:159; Fall et el. 1982:129-138).

Stanek (1985:159) described shellfish harvest methods in Nanwalek and Port Graham in the 1980s as follows:

> Harvest strategies similar to traditional practices were followed for snails, chiton, crab, mussels, and octopus during the study period. Intertidal areas were searched at low tides and a variety of species collected by hand or with the aid of sticks, knives, or shovels. Occasionally pots were set for crab and shrimp. Usually harvesting was done daily in local intertidal areas. Individual daily household harvests were relatively small. An example of one day's harvest might include a half-gallon of snails, 2 to 3 dungeness crab, 10 to 20 chitons, and an octopus.
>
> Clams and cockles were sometimes collected in the same manner as chitons and snails, but normally were sought on special clamming trips made during minus tidal periods. Clams were collected in five-gallon buckets, brought back to the villages, and part of the harvest distributed to those households unable to make the trip. Sea cucumbers were sometimes taken incidentally when they were found.

In lower Cook Inlet communities, up to the 1950s, crab were harvested with spears and by hand in shallow water (Stanek 1985:70, 158). A sketch of a traditional spear, called a *panaq*, appears in Stanek 1985:63. In deeper water, crab may have been taken incidentally on hooks set for bottomfish (see sketch in Stanek 1985:68). In more recent times several pots were placed in favorite harvest locations. (See also discussion in Criterion 1.) The pots were attended by their owners, or permission was given to others to remove crab from the pots. Quantities of crab were often distributed around the community to whoever wanted some. Occasionally, commercial fishermen removed crab from their catches for their personal use and to distribute to others in the communities (Stanek field notes).

Criterion 4. The area in which the noncommercial, long-term, and consistent pattern of taking, use, and reliance upon the fish stock or game population has been established.

Maps which appear in division technical papers (Stanek 1985) depict the harvest areas of Nanwalek and Port Graham into the mid-1980s (Figure 4). Most harvest areas were within easy access of the users' homes. More distant areas were accessed by small skiffs or larger boats owned by the users. In lower Cook Inlet, Port Graham and Nanwalek residents frequently traveled to Kasitsna Bay for clams and cockles. They occasionally traveled to areas which were previously occupied by current residents of Nanwalek or Port Graham or their families. These areas included Koyuktolik Bay, Port Chatham, Chugach Bay, Windy Bay, Rocky Bay, and Port Dick. Seldovia residents used Kasitsna Bay and other local beaches for marine invertebrate harvests.

Port Graham and Nanwalek residents' crab harvests, for the most part, took place within the areas described for the taking of other shellfish (see Figure 4 and Stanek 1985). Occasionally, as with other shellfish, other areas were used, including Tutka Bay, Sadie Cove, Port Chatham, Chugach, Rocky Bay, Windy Bay, and Port Dick. Harvest areas for Seldovia have not been recorded on maps by the Division of Subsistence. Seldovia residents commonly used Seldovia Bay as their source of Dungeness crab.

Criterion 5. The means of handling, preparing, preserving, and storing fish or game which has been traditionally used by past generations, but not excluding recent technological advances where appropriate.

Historically, various marine invertebrate resources were harvested and stored for later use in seal oil (Stanek et al. 1982:6). Currently, the majority of the shellfish harvest is consumed within a relatively short period after harvest. Resources that can be gathered in large quantities at one time, such as clams and chitons, may be canned or frozen for later use. They may then be prepared into chowders, sauces, deep fried, or mixed with rice and made into various other dishes (Stanek 1985:162).

Most commonly, crab are boiled in water for eating, but on occasion they may be roasted on open fires. Most crab are eaten shortly after harvest, unless very large numbers are taken, in which case they may be frozen.

Criterion 6. A pattern of taking or use which includes the handing down of knowledge of fishing or hunting skills, values, and lore from generation to generation.

Descriptions of the social importance and organization of shellfish harvest and use in Port Graham and Nanwalek has been described in Stanek (1985:162) and Stanek et al. (1982:7-8). Shellfish harvesting is a highly social activity in these communities and involves individuals of both sexes and all age groups. Owing to the sedentary and accessible nature of many of these resources, most people are able to access harvest areas and gather the resources. This creates a social context in which young people are taught harvest methods, as well as ideas, philosophies, and traditions about utilizing wild resources.

Crab harvesting, as with other shellfish species, provides the opportunity for experienced harvesters to teach children and young adults the skills of obtaining food from the ocean. They also learn to provide for themselves and share with others.

Stanek (1985:162) noted:

> The harvest of intertidal species was important not only for the food produced but also as a social activity, especially for older people unable to participate in more strenuous and dangerous harvest activities. It was an opportunity to be outdoors, and it also allowed older people to teach their children and grandchildren how to use local resources. Field observations in both communities [Nanwalek and Port Graham] found chiton and clams occurring as food items in over half the households following suitable low tides. The harvest of these resources was often discussed by residents in social settings and was of particular interest to the older people. Most intertidal resources were highly valued food products in both communities. Searching for chiton with the aide of a lantern during nighttime low tidal periods in late fall and winter was a common practice among experienced people. Summer months found many residents searching areas abundant with chiton and other intertidal species during the long daylight periods.

Criterion 7. A pattern of taking, use, and reliance where the harvest effort or products of that harvest are distributed or shared, including customary trade, barter, and gift-giving.

Marine invertebrates are widely shared within and between Cook Inlet communities. Household survey data from Nanwalek, Port Graham, and Seldovia communities indicated high levels of sharing with over 80% of households receiving some shellfish resources in some years (Tables 2 through 22).

Crab were typically harvested by a few individuals in the communities and then widely shared. Table 10 illustrates the extensive sharing in Nanwalek in 1987: while no surveyed household harvested crab, 52% used crab that they received from successful harvesters (likely either a Nanwalek household that was not interviewed or a household from neighboring Port Graham). Similar patterns occurred in Port Graham in 1987: 9% of households harvested crab, but 57% received crab and 63% used crab (Table 10). In Seldovia for the early 1980s (Reed (1985:160-161), 3 crab species were used by 91% of the households, but harvested by 20%. A similar pattern was found in the early 1990s, when Division of Subsistence researchers interviewed commercial crabbers who removed quantities of crab from their harvests and distributed them throughout Seldovia (Table 10) (Fall and Utermohle 1995).

Criterion 8. A pattern that includes taking, use, and reliance for subsistence purposes upon a wide variety of the fish and game resources and that provides substantial economic, cultural, social, and nutritional elements of the subsistence way of life.

Overall subsistence harvests in Nanwalek, Port Graham, and Seldovia are relatively high, ranging from about 200 to 400 pounds per person per year in the late 1980s, 1990s, and early 2000s (Table 23). Marine invertebrates are one of several groups of resources taken by communities in the Cook Inlet area. In Nanwalek, an average of 25 different resources were used in 2003, while in Port Graham an average of 18 different resources were recorded (Fall 2006:18). These are some of the highest levels recorded in the state (Fall 1992:51-62). Seldovia households surveyed in 1984 used 32 different species or groups of resources (Reed 1985:153). The average household in Seldovia used 13 kinds of wild foods in 1993-94 (Fall and Utermohle 1995:VII-41).

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TABLES AND FIGURES

Table 1. Marine invertebrates known to be used by residents of Nanwalek, Port Graham, or Seldovia

	Common English Name	Scientific name	Alutiiq name
Chiton		Polyplacophora	
	Chitons, black ("bidarkies")	*Katharina tunicata*	urriitarpak
	Chitons, red ("gumboot")	*Cryptochiton stelleri*	urriitaq
Clams		Bivalvia	salaq
	Clams, butter	*Saxidomus giganteus*	salaq
	Clams, littleneck	*Protothaca staminea*	salaq
	Clams, razor	*Siliqua patula*	cingtaataq
	Horse clams	*Tresus capax*	salaq
Cockles		*Clinocardim nuttallii*	taugtaaq
Crab		Decapoda/Brachyura	yual'ayak
	Crab, Dungeness	*Cancer magister*	canipgaq
	Crab, king	*Paralithodes camtschaticus*	yual'ayakcak
	Crab, Tanner	*Chionoecetes bairdi*	pupsuleryu'alq
Limpets		Acmaeidae	melungqucak
Mussels		*Mytilus edulis/trossulus*	amyak
Octopus		*Octopus vulgaris*	amikuq
Sea cucumber		Holothuroidea	kingugpak
Sea urchin		Echinoidea	uutuk
Shrimp		Decapoda	taugtaaq
	Shrimp, pink	*Pandalus borealis*	
	Shrimp, humpy	*Pandalus goniurus*	
	Shrimp, sidestripe	*Pandalopsis dispar*	
	Shrimp, pot	*Pandalopsis platyceros*	
Snail		Megogastropa/Neogastropoda	ipuk
	Snail, moon	*Polinices lewisii*	
	Snail, turban	*Tegula funebralis*	
Whelk	Whelk, dog	*Thais lamellosus*	ipuk, kauk
Scallops	Scallops, weathervane	*Patinopecten caurinus*	salaq

Source: Stanek 1985; Preikshot and Leer, n.d.

Table 2. Harvest and uses of marine invertebrates in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving				
Nanwalek	1987	97.0	90.9	90.9	81.8	75.8	2,811	70.3	18.6	14
Nanwalek	1989	90.9	87.9	87.9	66.7	75.8	2,507	61.2	16.0	15
Nanwalek	1990	97.1	91.4	91.4	80.0	68.6	3,074	75.0	16.7	14
Nanwalek	1991	100.0	89.7	89.7	79.3	69.0	3,929	95.8	24.4	37
Nanwalek	1992	100.0	90.6	90.6	87.5	87.5	4,232	103.2	24.8	17
Nanwalek	1993	100.0	97.0	97.0	90.9	90.9	3,296	89.1	23.3	17
Nanwalek	1997	82.8	79.3	79.3	55.2	72.4	1,512	39.8	9.0	23
Nanwalek	2003	100.0	100.0	100.0	95.5	90.9	3,579	70.2	15.4	68
Port Graham	1987	98.1	87.0	87.0	79.6	42.6	3,010	47.8	16.7	13
Port Graham	1989	70.8	66.7	64.6	45.8	47.9	1,385	22.7	8.6	16
Port Graham	1990	97.8	87.0	87.0	82.6	65.2	2,380	43.3	14.5	11
Port Graham	1991	95.9	79.6	79.6	89.8	69.4	3,475	59.9	21.6	16
Port Graham	1992	100.0	89.6	89.6	95.8	79.2	3,986	68.7	23.9	13
Port Graham	1993	100.0	82.4	80.4	92.2	72.5	2,786	45.7	16.0	17
Port Graham	1997	86.4	75.0	75.0	61.4	56.8	1,994	31.7	12.8	22
Port Graham	2003	89.4	74.5	74.5	78.7	72.3	1,875	28.8	12.0	21
Seldovia	1991	86.4	68.2	68.2	74.2	43.9	10,371	89.4	30.4	35
Seldovia	1992	89.2	73.8	73.8	70.8	50.8	6,673	48.7	17.8	33
Seldovia	1993	90.8	78.5	78.5	70.8	63.1	14,627	95.6	34.0	33

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 3. Harvests and Uses of Chitons, Nanwalek, Port Graham, and Seldovia

		Percentage of Households									
Community	study year	using	trying	harvesting	receiving	giving	Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (+/-%)
Nanwalek	1987	93.9	87.9	87.9	57.6	63.6	353	1,411	35.3	9.3	15
Nanwalek	1989	90.9	87.9	87.9	39.4	63.6	246	984	24.0	6.3	17
Nanwalek	1990	97.1	88.6	88.6	37.1	60.0	306	1,224	29.9	6.7	16
Nanwalek	1991	96.6	86.2	86.2	44.8	55.2	455	1,791	43.7	11.1	36
Nanwalek	1992	96.9	84.4	84.4	43.8	65.6	478	1,893	46.2	11.1	26
Nanwalek	1993	97.0	87.9	87.9	48.5	69.7	261	1,037	28.0	7.3	16
Nanwalek	1997	75.9	58.6	58.6	48.3	58.6	221	874	23.0	5.2	27
Nanwalek	2003	100.0	100.0	100.0	68.2	90.9	373	1,414	27.7	6.1	28
Port Graham	1987	96.3	83.3	83.3	46.3	27.8	230	919	14.6	5.1	12
Port Graham	1989	60.4	58.3	58.3	22.9	39.6	145	580	9.5	3.6	21
Port Graham	1990	97.8	80.4	80.4	60.9	52.2	251	1,002	18.2	6.1	13
Port Graham	1991	91.8	75.5	73.5	65.3	49.0	263	1,020	17.6	6.3	16
Port Graham	1992	95.8	83.3	83.3	72.9	62.5	342	1,363	23.5	8.2	15
Port Graham	1993	96.1	68.6	68.6	72.5	60.8	250	1,000	16.4	5.7	14
Port Graham	1997	84.1	68.2	68.2	52.3	50.0	312	1,240	19.7	8.0	24
Port Graham	2003	78.7	63.8	63.8	51.1	51.1	203	805	12.4	5.0	23
Seldovia	1991	18.2	13.6	13.6	9.1	4.5	180	720	6.2	2.1	80
Seldovia	1992	16.9	15.4	15.4	4.6	9.2	46	183	1.3	0.5	69
Seldovia	1993	26.2	24.6	24.6	9.2	15.4	185	741	4.8	1.7	55

Source: Alaska Department of Fish and Game 2007; Fall 2006

Table 4. Harvest and uses of clams in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1987	66.7	45.5	45.5	54.5	42.4	207	753	18.8	5.0	29
Nanwalek	1989	66.7	51.5	51.5	51.5	48.5	303	1129	27.5	7.2	21
Nanwalek	1990	97.1	62.9	62.9	77.1	51.4	338	1189	29.0	6.5	19
Nanwalek	1991	79.3	48.3	48.3	65.5	48.3	331	1404	34.2	8.7	41
Nanwalek	1992	90.6	75.0	75.0	68.8	71.9	441	1696	41.4	10.0	26
Nanwalek	1993	90.9	54.5	54.5	81.8	57.6	500	1681	45.4	11.9	22
Nanwalek	1997	34.5	17.2	17.2	20.7	20.7	45	177	4.7	1.1	51
Nanwalek	2003	81.8	50.0	50.0	77.3	50.0	420	1259	24.7	5.4	84
Port Graham	1987	72.2	40.7	40.7	46.3	24.1	289	1012	16.1	5.6	28
Port Graham	1989	35.4	31.3	27.1	27.1	22.9	111	423	6.9	2.6	33
Port Graham	1990	89.1	52.2	52.2	73.9	34.8	222	797	14.5	4.9	19
Port Graham	1991	85.7	42.9	42.9	75.5	44.9	418	1483	25.6	9.2	24
Port Graham	1992	95.8	50.0	50.0	87.5	54.2	484	1755	30.3	10.5	19
Port Graham	1993	96.1	45.1	41.2	88.2	51.0	329	1180	19.3	6.8	27
Port Graham	1997	25.0	9.1	9.1	20.5	13.6	28	118	1.9	0.8	65
Port Graham	2003	61.7	23.4	21.3	51.1	19.1	95	286	4.4	1.8	43
Seldovia	1991	75.8	60.6	60.6	43.9	31.8	978	5157	44.5	15.1	29
Seldovia	1992	80.0	70.8	70.8	44.6	36.9	737	4662	34.0	12.4	28
Seldovia	1993	83.1	76.9	76.9	43.1	49.2	1565	11049	72.2	25.7	34

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 5. Harvest and uses of butter clams in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1987	63.6	39.4	39.4	54.5	39.4	172	516	15.6	4.1	35
Nanwalek	1989	63.6	48.5	48.5	39.4	45.5	257	771	23.4	6.1	23
Nanwalek	1990	80.0	45.7	45.7	62.9	40.0	208	625	17.9	4.0	23
Nanwalek	1991	62.1	34.5	34.5	55.2	37.9	249	747	25.8	6.6	46
Nanwalek	1992	84.4	59.4	59.4	65.6	65.6	363	1089	34.0	8.2	31
Nanwalek	1993	84.8	48.5	48.5	75.8	54.5	457	1371	41.5	10.9	24
Nanwalek	1997	10.3	10.3	10.3	3.4	10.3	35	105	3.6	0.8	64
Nanwalek	2003	72.7	40.9	40.9	59.1	40.9	325	974	19.1	4.2	108
Port Graham	1987	68.5	37.0	37.0	42.6	18.5	240	720	13.3	4.7	33
Port Graham	1989	33.3	27.1	22.9	27.1	18.8	90	270	5.6	2.1	39
Port Graham	1990	76.1	41.3	41.3	63.0	32.6	202	605	13.1	4.4	20
Port Graham	1991	83.7	40.8	40.8	69.4	44.9	266	797	16.3	5.9	25
Port Graham	1992	89.6	43.8	43.8	81.3	50.0	401	1204	25.1	8.7	20
Port Graham	1993	84.3	39.2	37.3	78.4	41.2	254	762	14.9	5.2	32
Port Graham	1997	6.8	6.8	6.8	2.3	4.5	18	53	1.2	0.5	82
Port Graham	2003	59.6	23.4	21.3	46.8	19.1	87	261	4.0	1.7	47
Seldovia	1991	63.6	51.5	51.5	27.3	28.8	544	1632	24.7	8.4	31
Seldovia	1992	70.8	64.6	64.6	35.4	32.3	481	1443	22.2	8.1	32
Seldovia	1993	78.5	72.3	72.3	30.8	47.7	1105	3314	51.0	18.1	37

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 6. Harvest and uses of horse clams in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1991	3.4	0.0	0.0	3.4	0.0	0	0	0.0	0.0	
Nanwalek	1992	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	1993	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	1997	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	2003	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1991	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1992	4.2	4.2	4.2	0.0	4.2	1	4	0.1	0.1	50
Port Graham	1993	3.9	3.9	2.0	2.0	0.0	1	2	0.0	0.0	81
Port Graham	1997	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	2003	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Seldovia	1992	3.1	1.5	1.5	1.5	0.0	<1	0	0.0	0.0	145
Seldovia	1993	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 7. Harvest and uses of Pacific littleneck clams in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1987	36.4	24.2	24.2	27.3	15.2	34	102	3.1	0.8	48
Nanwalek	1989	6.1	6.1	6.1	6.1	6.1	5	15	0.5	0.1	66
Nanwalek	1990	62.9	48.6	48.6	34.3	25.7	67	201	5.8	1.3	24
Nanwalek	1991	41.4	31.0	31.0	24.1	31.0	68	204	7.0	1.8	43
Nanwalek	1992	28.1	28.1	28.1	18.8	21.9	52	157	4.9	1.2	38
Nanwalek	1993	9.1	3.0	3.0	6.1	3.0	10	30	0.9	0.2	63
Nanwalek	1997	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0
Nanwalek	2003	40.9	22.7	18.2	22.7	9.1	30	90	1.8	0.4	117
Port Graham	1987	20.4	13.0	13.0	13.0	5.6	26	78	1.4	0.5	36
Port Graham	1989	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1990	26.1	15.2	15.2	17.4	4.3	20	60	1.3	0.4	35
Port Graham	1991	44.9	24.5	24.5	28.6	16.3	131	392	8.0	2.9	45
Port Graham	1992	43.8	22.9	22.9	33.3	18.8	71	214	4.5	1.6	26
Port Graham	1993	33.3	17.6	17.6	21.6	19.6	58	175	3.4	1.2	34
Port Graham	1997	11.4	0.0	0.0	11.4	6.8	0	0	0.0	0.0	0
Port Graham	2003	12.8	4.3	4.3	8.5	2.1	8	25	0.4	0.2	88
Seldovia	1991	63.6	51.5	50.0	25.8	24.2	339	1017	15.4	5.2	40
Seldovia	1992	36.9	30.8	30.8	15.4	10.8	162	487	7.5	2.7	39
Seldovia	1993	66.2	61.5	61.5	24.6	30.8	412	1235	19.0	6.8	39

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 8. Harvest and uses of razor clams in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1987	6.1	3.0	3.0	3.0	0.0	1	3	0.1	0.0	100
Nanwalek	1989	21.2	12.1	12.1	12.1	9.1	41	123	3.7	1.0	49
Nanwalek	1990	20.0	11.4	11.4	14.3	8.6	63	189	5.4	1.2	59
Nanwalek	1991	34.5	10.3	10.3	24.1	10.3	14	42	1.4	0.4	60
Nanwalek	1992	21.9	15.6	15.6	9.4	15.6	26	78	2.4	0.6	45
Nanwalek	1993	21.2	18.2	18.2	12.1	15.2	33	98	3.0	0.8	32
Nanwalek	1997	27.6	6.9	6.9	20.7	10.3	10	30	1.0	0.2	69
Nanwalek	2003	45.5	13.6	13.6	40.9	13.6	65	195	3.8	0.8	110
Port Graham	1987	9.3	5.6	5.6	5.6	5.6	23	69	1.3	0.5	44
Port Graham	1989	12.5	12.5	10.4	10.4	8.3	21	63	1.3	0.5	40
Port Graham	1990	17.4	2.2	2.2	17.4	0.0	1	2	0.0	0.0	100
Port Graham	1991	32.7	8.2	8.2	28.6	8.2	21	63	1.3	0.5	43
Port Graham	1992	29.2	4.2	4.2	27.1	6.3	10	30	0.6	0.2	58
Port Graham	1993	25.5	5.9	5.9	23.5	13.7	15	45	0.9	0.3	44
Port Graham	1997	11.4	2.3	2.3	9.1	2.3	10	30	0.7	0.3	111
Port Graham	2003	10.6	0.0	0.0	10.6	0.0	0	0	0.0	0	
Seldovia	1991	25.8	7.6	7.6	19.7	6.1	95	285	4.3	1.5	79
Seldovia	1992	24.6	15.4	15.4	13.8	3.1	91	272	4.2	1.5	52
Seldovia	1993	18.5	10.8	9.2	15.4	4.6	49	146	2.2	0.8	66

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 9. Harvest and uses of cockles in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1987	30.3	15.2	15.2	21.2	12.1	22	66	2.0	0.5	40
Nanwalek	1989	12.1	12.1	12.1	3.0	3.0	27	81	2.5	0.7	64
Nanwalek	1990	40.0	25.7	25.7	20.0	11.4	52	157	4.5	1.0	34
Nanwalek	1991	27.6	17.2	17.2	13.8	10.3	37	110	3.8	1.0	71
Nanwalek	1992	18.8	15.6	15.6	12.5	12.5	21	63	2.0	0.5	48
Nanwalek	1993	12.1	9.1	9.1	9.1	6.1	8	24	0.7	0.2	44
Nanwalek	1997	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	2003	4.5	0.0	0.0	4.5	0.0	0	0	0.0	0.0	
Port Graham	1987	29.6	20.4	18.5	14.8	7.4	72	216	4.0	0.5	25
Port Graham	1989	10.4	10.4	10.4	6.3	4.2	19	57	1.2	1.3	41
Port Graham	1990	39.1	23.9	21.7	23.9	6.5	61	184	4.0	0.8	41
Port Graham	1991	34.7	18.4	18.4	22.4	14.3	38	113	2.3	0.7	28
Port Graham	1992	43.8	22.9	20.8	29.2	14.6	33	98	2.0	0.2	28
Port Graham	1993	7.8	3.9	3.9	3.9	3.9	10	30	0.6	0.0	58
Port Graham	1997	6.8	4.5	4.5	2.3	0.0	2	5	0.1	0.0	82
Port Graham	2003	6.4	4.3	4.3	2.1	4.3	6	12	0.3	0.1	82
Seldovia	1991	12.1	10.6	10.6	3.0	1.5	43	128	1.9	0.7	76
Seldovia	1992	10.8	7.7	7.7	3.1	3.1	4	13	0.2	0.1	77
Seldovia	1993	9.2	9.2	9.2	0.0	4.6	26	78	1.2	0.4	114

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 10. Harvest and uses of crab in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total number crab	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1987	51.5	0.0	0.0	51.5	3.0	0	0	0.0	0.0	
Nanwalek	1989	6.1	3.0	3.0	3.0	3.0	20	14	0.4	0.1	87
Nanwalek	1990	14.3	2.9	2.9	14.3	0.0	5	4	0.1	0.0	66
Nanwalek	1991	6.9	0.0	0.0	6.9	0.0	0	0	0.0	0.0	
Nanwalek	1992	31.3	3.1	3.1	31.3	6.3	25	18	0.5	0.1	90
Nanwalek	1993	18.2	6.1	6.1	18.2	6.1	22	15	0.5	0.1	43
Nanwalek	1997	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0
Nanwalek	2003	22.7	13.6	13.6	9.1	13.6	21	8	0.3	0.1	67
Port Graham	1987	63.0	11.1	9.3	57.4	9.3	81	87	1.6	0.6	45
Port Graham	1989	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1990	2.2	0.0	0.0	2.2	0.0	0	0	0.0	0.0	
Port Graham	1991	28.6	16.3	16.3	16.3	14.3	102	74	1.5	0.6	33
Port Graham	1992	18.8	2.1	2.1	16.7	6.3	12	8	0.2	0.1	80
Port Graham	1993	21.6	2.0	2.0	21.6	9.8	4	3	0.1	0.0	80
Port Graham	1997	13.6	4.5	2.3	13.6	0.0	4	3	0.1	0.0	111
Port Graham	2003	17.0	0.0	0.0	17.0	0.0	0	0	0.0	0.0	
Seldovia	1991	66.7	19.7	18.2	54.5	21.2	910	1453	22.0	7.5	63
Seldovia	1992	69.2	12.3	12.3	61.5	20.0	318	508	7.8	2.9	66
Seldovia	1993	61.5	16.9	15.4	53.8	27.7	508	772	11.9	4.2	68

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 11. Harvest and uses of Dungeness crab in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households used	Percentage of Households trying	Percentage of Households harvesting	Percentage of Households receving	Percentage of Households giving	Total crab	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
Nanwalek	1987	51.5	0.0	0.0	51.5	3.0	0	0	0.0	0.0	
Nanwalek	1989	6.1	3.0	3.0	3.0	0.0	20	14	0.4	0.0	87
Nanwalek	1990	11.4	2.9	2.9	11.4	0.0	5	4	0.1	0.0	66
Nanwalek	1991	6.9	0.0	0.0	6.9	0.0	0	0	0.0	0.0	
Nanwalek	1992	25.0	3.1	3.1	25.0	6.3	25	18	0.5	0.0	90
Nanwalek	1993	18.2	6.1	6.1	18.2	6.1	22	15	0.5	0.0	43
Nanwalek	1997	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	2003	18.2	13.6	13.6	4.5	13.6	19	13	0.3	0.1	82
Port Graham	1987	50.0	7.4	5.6	46.3	7.4	47	33	0.6	0.0	63
Port Graham	1989	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1990	2.2	0.0	0.0	2.2	0.0	0	0	0.0	0.0	
Port Graham	1991	20.4	16.3	16.3	4.1	14.3	99	69	1.4	0.0	35
Port Graham	1992	16.7	2.1	2.1	14.6	6.3	12	8	0.2	0.0	80
Port Graham	1993	9.8	2.0	2.0	9.8	5.9	4	3	0.1	0.0	80
Port Graham	1997	9.1	4.5	2.3	9.1	0.0	4	3	0.1	0.0	111
Port Graham	2003	12.8	0.0	0.0	12.8	0.0	0	0	0.0	0.0	
Seldovia	1991	21.2	4.5	4.5	19.7	4.5	23	16	0.2	0.0	87
Seldovia	1992	12.3	0.0	0.0	12.3	0.0	0	0	0.0	0.0	
Seldovia	1993	21.5	6.2	4.6	20.0	1.5	56	39	0.6	0.0	132

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 12. Harvest and uses of king crab in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households used	trying	harvesting	receving	giving	Total Number Crab	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
Nanwalek	1987	3.0	0.0	0.0	3.0	0.0	0	0	0.0	0.0	
Nanwalek	1989	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	1990	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	1991	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	1992	9.4	0.0	0.0	9.4	3.1	0	0	0.0	0.0	
Nanwalek	1993	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	1997	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	2003	13.6	4.5	4.5	9.1	4.5	1	2	0.1	0.0	153
Port Graham	1987	5.6	0.0	0.0	5.6	0.0	0	0	0.0	0.0	
Port Graham	1989	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1990	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1991	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1992	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1993	5.9	0.0	0.0	5.9	2.0	0	0	0.0	0.0	
Port Graham	1997	6.8	0.0	0.0	6.8	0.0	0	0	0.0	0.0	
Port Graham	2003	4.3	0.0	0.0	4.3	2.1	0	0	0.0	0.0	
Seldovia	1991	13.6	4.5	3.0	12.1	6.1	25	58	0.9	0.3	122
Seldovia	1992	4.6	0.0	0.0	4.6	1.5	0	0	0.0	0.0	
Seldovia	1993	12.3	3.1	3.1	10.8	4.6	13	30	0.5	0.2	106

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 13. Harvest and uses of Tanner crab in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households: used	trying	harvesting	receving	giving	Total number crab	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
Nanwalek	1987	12.1	0	0	12.1	0	0	0	0.0	0.0	
Nanwalek	1989	3.0	0	0	3.0	3.0	0	0	0.0	0.0	
Nanwalek	1990	5.7	0	0	5.7	0	0	0	0.0	0.0	
Nanwalek	1991	0	0	0	0	0	0	0	0.0	0.0	
Nanwalek	1992	18.8	0	0	18.8	3.1	0	0	0.0	0.0	
Nanwalek	1993	0	0	0	0	0	0	0	0.0	0.0	
Nanwalek	1997	0	0	0	0	0	0	0	0.0	0.0	
Nanwalek	2003	0	0	0	0	0	0	0	0.0	0.0	
Port Graham	1987	35.2	3.7	3.7	33.3	7.4	34	54	1.0	0.4	64
Port Graham	1989	0	0	0	0	0	0	0	0.0	0.0	
Port Graham	1990	0	0	0	0	0	0	0	0.0	0.0	
Port Graham	1991	14.3	2.0	2.0	12.2	2.0	3	5	0.1	0.0	75
Port Graham	1992	8.3	0	0	8.3	2.1	0	0	0.0	0.0	
Port Graham	1993	15.7	0	0	15.7	5.9	0	0	0.0	0.0	
Port Graham	1997	4.5	0	0	4.5	0	0	0	0.0	0.0	
Port Graham	2003	8.5	0	0	8.5	4.3	0	0	0.0	0.0	
Seldovia	1991	62.1	16.7	15.2	51.5	18.2	862	1380	20.9	7.1	62
Seldovia	1992	61.5	12.3	12.3	53.8	20.0	318	508	7.8	2.9	66
Seldovia	1993	52.3	15.4	15.4	43.1	26.2	439	702	10.8	3.8	73

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 14. Harvest and uses of limpets in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1989	6.1	6.1	6.1	3.0	6.1	2	3	0.1	0.0	50
Nanwalek	1990	8.6	8.6	8.6	0.0	0.0	2	2	0.1	0.0	50
Nanwalek	1991	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	1992	9.4	6.3	6.3	3.1	0.0	1	2	0.0	0.0	100
Nanwalek	1993	12.1	12.1	12.1	0.0	3.0	2	3	0.1	0.0	50
Nanwalek	1997	10.3	10.3	10.3	0.0	3.4	3	5	0.2	0.0	72
Nanwalek	2003	27.3	27.3	27.3	4.5	9.1	10	15	0.3	0.1	60
Port Graham	1989	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1990	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1991	4.1	4.1	4.1	0.0	2.0	1	2	0.0	0.0	100
Port Graham	1992	6.3	6.3	6.3	2.1	2.1	14	20	0.4	0.1	75
Port Graham	1993	2.0	2.0	2.0	0.0	2.0	5	8	0.1	0.1	83
Port Graham	1997	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0
Port Graham	2003	6.4	4.3	4.3	2.1	2.1	3	4	0.1	0.0	72
Seldovia	1991	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Seldovia	1992	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Seldovia	1993	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 15. Harvest and uses of mussels in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1987	51.5	48.5	48.5	21.2	24.2	114	171	5.2	1.4	31
Nanwalek	1989	24.2	21.2	21.2	12.1	12.1	12	18	0.5	0.1	39
Nanwalek	1990	40.0	31.4	31.4	11.4	5.7	33	50	1.4	0.3	35
Nanwalek	1991	27.6	27.6	27.6	3.4	10.3	41	61	2.1	0.5	48
Nanwalek	1992	25.0	25.0	25.0	9.4	15.6	26	39	1.2	0.3	42
Nanwalek	1993	30.3	27.3	27.3	3.0	12.1	22	33	1.0	0.3	24
Nanwalek	1997	37.9	34.5	34.5	6.9	13.8	26	39	1.3	0.3	43
Nanwalek	2003	40.9	36.4	36.4	9.1	4.5	72	108	2.1	0.5	54
Port Graham	1987	24.1	22.2	22.2	7.4	5.6	27	41	0.8	0.3	31
Port Graham	1989	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1990	10.9	10.9	10.9	0.0	4.3	9	13	0.3	0.1	39
Port Graham	1991	26.5	18.4	18.4	8.2	12.2	44	65	1.3	0.5	37
Port Graham	1992	16.7	14.6	14.6	4.2	8.3	11	17	0.4	0.1	35
Port Graham	1993	13.7	11.8	11.8	3.9	5.9	8	12	0.2	0.1	33
Port Graham	1997	4.5	2.3	2.3	4.5	4.5	2	3	0.1	0.0	111
Port Graham	2003	23.4	23.4	23.4	2.1	10.6	39	58	0.9	0.4	42
Seldovia	1991	22.7	21.2	21.2	10.6	7.6	75	112	1.7	0.6	46
Seldovia	1992	20.0	12.3	12.3	10.8	4.6	25	38	0.6	0.2	67
Seldovia	1993	18.5	16.9	16.9	3.1	6.2	45	68	1.0	0.4	58

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 16. Harvest and uses of octopus in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total octopus	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1987	48.5	36.4	33.3	27.3	21.2	48	192	5.8	1.5	27
Nanwalek	1989	48.5	39.4	36.4	15.2	18.2	38	152	4.6	1.2	25
Nanwalek	1990	57.1	48.6	37.1	25.7	20.0	74	294	8.4	1.9	25
Nanwalek	1991	58.6	20.7	20.7	41.4	13.8	75	300	10.3	2.6	50
Nanwalek	1992	78.1	40.6	40.6	53.1	31.3	75	300	9.4	2.3	30
Nanwalek	1993	69.7	45.5	45.5	39.4	48.5	97	388	11.8	3.1	18
Nanwalek	1997	75.9	62.1	58.6	44.8	51.7	64	256	8.8	2.0	28
Nanwalek	2003	90.9	63.6	63.6	68.2	63.6	148	593	11.6	2.6	38
Port Graham	1987	81.5	59.3	55.6	42.6	16.7	133	532	9.9	3.4	14
Port Graham	1989	41.7	31.3	31.3	22.9	16.7	56	224	4.7	1.8	22
Port Graham	1990	60.9	41.3	37.0	37.0	26.1	63	252	5.5	1.8	28
Port Graham	1991	75.5	51.0	49.0	46.9	34.7	117	468	9.6	3.4	20
Port Graham	1992	79.2	54.2	50.0	50.0	43.8	125	500	10.4	3.6	16
Port Graham	1993	72.5	47.1	41.2	54.9	41.2	101	402	7.9	2.8	20
Port Graham	1997	68.2	43.2	38.6	47.7	38.6	102	408	9.3	3.7	30
Port Graham	2003	74.5	40.4	38.3	55.3	34.0	129	514	7.9	3.3	37
Seldovia	1991	15.2	9.1	9.1	7.6	3.0	215	860	13.0	4.4	119
Seldovia	1992	13.8	9.2	9.2	9.2	6.2	44	175	2.7	1.0	88
Seldovia	1993	29.2	16.9	13.8	20.0	9.2	55	218	3.4	1.2	103

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 17. Harvest and uses of scallops in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households: used	trying	harvesting	receving	giving	Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
Nanwalek	1990	2.9	0.0	0.0	2.9	0.0	0.0	0	0.0	0.0	
Nanwalek	1991	3.4	0.0	0.0	3.4	0.0	0.0	0	0.0	0.0	
Nanwalek	1992	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	
Nanwalek	1993	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	
Nanwalek	1997	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	
Nanwalek	2003	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	
Port Graham	1991	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	
Port Graham	1992	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	
Port Graham	1993	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	
Port Graham	1997	2.3	0.0	0.0	2.3	0.0	0.0	0	0.0	0.0	
Port Graham	2003	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	
Seldovia	1991	1.5	0.0	0.0	1.5	0.0	0.0	0	0.0	0.0	
Seldovia	1992	1.5	1.5	1.5	0.0	0.0	<1.0	<1.0	<1.0	<1.0	150
Seldovia	1993	3.1	0.0	0.0	3.1	0.0	0.0	0	0.0	0.0	

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 18. Harvest and uses of sea cucumber in Nanwalek, Port Graham, and Seldovia

Community[a]	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1990	0	0	0	0	0	0.0	0.0	0	0	
Nanwalek	1997	3.4	3.4	3.4	0	3.4	0.3	0.7	<0.1	<0.1	100
Nanwalek	2003	0	0	0	0	0	0.0	0.0	0	0	
Port Graham	1990	0	0	0	0	0	0.0	0.0	0	0	
Port Graham	1997	0	0	0	0	0	0.0	0.0	0	0	
Port Graham	2003	0	0	0	0	0	0.0	0.0	0	0	

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

[a] The survey instrument administered for 1987, 1989, 1991, 1992, and 1993 did not systematically collect data for sea cucumbers.

Table 19. Harvest and uses of sea urchin in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1989	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	1990	8.6	8.6	8.6	2.9	2.9	3	1	0.0	0.0	33
Nanwalek	1991	10.3	6.9	6.9	3.4	0.0	1	1	0.0	0.0	100
Nanwalek	1992	3.1	3.1	3.1	3.1	3.1	1	0	0.0	0.0	100
Nanwalek	1993	9.1	9.1	9.1	0.0	3.0	3	2	0.0	0.0	33
Nanwalek	1997	10.3	6.9	6.9	6.9	3.4	4	2	0.1	<0.1	86
Nanwalek	2003	13.6	13.6	13.6	4.5	9.1	12	6	0.1	<0.1	96
Port Graham	1989	4.2	2.1	2.1	4.2	2.1	<1.0	<1.0	<0.1	<0.1	NA
Port Graham	1990	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1991	4.1	10.2	4.1	0.0	0.0	1	1	0.0	0.0	100
Port Graham	1992	8.3	8.3	8.3	2.1	0.0	4	2	0.0	0.0	60
Port Graham	1993	2.0	0.0	0.0	2.0	2.0	0	0	0.0	0.0	
Port Graham	1997	4.5	2.3	2.3	2.3	2.3	1	0	0.0	0.0	111
Port Graham	2003	2.1	2.1	2.1	0.0	0.0	4	2	0.0	0.0	105
Seldovia	1991	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Seldovia	1992	1.5	1.5	1.5	0.0	0.0	1	1	0.0	0.0	150
Seldovia	1993	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 20. Harvest and uses of shrimp in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total number	units	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving						
Nanwalek	1989	3.0	3.0	3.0	0.0	3.0	10	pounds	10	0.3	0.0	91
Nanwalek	1990	8.6	0.0	0.0	8.6	0.0	0		0	0.0	0.0	
Nanwalek	1991	0.0	0.0	0.0	0.0	0.0	0		0	0.0	0.0	
Nanwalek	1992	3.1	0.0	0.0	3.1	0.0	0		0	0.0	0.0	
Nanwalek	1993	3.0	0.0	0.0	3.0	0.0	0		0	0.0	0.0	
Nanwalek	1997	0.0	0.0	0.0	0.0	0.0	0		0	0.0	0.0	
Nanwalek	2003	4.5	4.5	4.5	0.0	0.0	35	pounds	35	0.7	0.2	153
Port Graham	1989	0.0	0.0	0.0	0.0	0.0	0		0	0.0	0.0	
Port Graham	1990	0.0	0.0	0.0	0.0	0.0	0		0	0.0	0.0	
Port Graham	1991	0.0	0.0	0.0	0.0	0.0	0		0	0.0	0.0	
Port Graham	1992	0.0	0.0	0.0	0.0	0.0	0		0	0.0	0.0	
Port Graham	1993	0.0	0.0	0.0	0.0	0.0	0		0	0.0	0.0	
Port Graham	1997	0.0	0.0	0.0	0.0	0.0	0		0	0.0	0.0	
Port Graham	2003	8.5	6.4	6.4	4.3	4.3	8	pounds	8	0.1	0.0	73
Seldovia	1991	4.5	0.0	0.0	4.5	0.0	0		0	0.0	0.0	
Seldovia	1992	6.2	4.6	4.6	3.1	1.5	58	gallons	116	1.8	0.7	122
Seldovia	1993	9.2	6.2	6.2	6.2	1.5	14	gallons	28	0.4	0.2	78

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 21. Harvest and uses of snails in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1987	66.7	60.6	60.6	33.3	27.3	70	105	3.2	0.8	24
Nanwalek	1989	42.4	42.4	42.4	6.1	15.2	26	39	1.2	0.3	25
Nanwalek	1990	60.0	51.4	51.4	11.4	11.4	34	51	1.5	0.3	19
Nanwalek	1991	34.5	34.5	34.5	10.3	13.8	33	49	1.7	0.4	39
Nanwalek	1992	68.8	62.5	62.5	28.1	31.3	53	80	2.5	0.6	30
Nanwalek	1993	57.6	48.5	48.5	15.2	33.3	33	49	1.5	0.4	19
Nanwalek	1997	58.6	48.3	48.3	31.0	34.5	33	50	1.7	0.4	24
Nanwalek	2003	68.2	68.2	63.6	27.3	36.4	83	125	2.5	0.5	62
Port Graham	1987	51.9	48.1	48.1	13.0	13.0	33	50	0.9	0.3	12
Port Graham	1989	20.8	20.8	20.8	8.3	10.4	13	20	0.4	0.2	29
Port Graham	1990	37.0	34.8	34.8	4.3	15.2	22	32	0.7	0.2	23
Port Graham	1991	61.2	51.0	51.0	24.5	30.6	44	65	1.3	0.5	15
Port Graham	1992	64.6	54.2	54.2	31.3	39.6	47	70	1.5	0.5	17
Port Graham	1993	47.1	35.3	33.3	25.5	19.6	36	53	1.0	0.4	21
Port Graham	1997	29.5	22.7	22.7	9.1	15.9	16	24	0.5	0.2	42
Port Graham	2003	57.4	48.9	46.8	19.1	31.9	73	109	1.7	0.7	19
Seldovia	1991	6.1	4.5	4.5	1.5	0.0	3	4	0.1	0.0	75
Seldovia	1992	6.2	6.2	6.2	1.5	4.6	10	15	0.2	0.1	85
Seldovia	1993	4.6	3.1	3.1	1.5	1.5	2	3	0.0	0.0	100

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 22. Harvest and uses of whelk in Nanwalek, Port Graham, and Seldovia

Community	Study year	Percentage of Households					Total gallons	Total pounds	Average pounds per HH	Per capita pounds	95% CI (± %)
		used	trying	harvesting	receving	giving					
Nanwalek	1990	8.6	8.6	8.6	0.0	2.9	3	5	0.1	0.0	50
Nanwalek	1991	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Nanwalek	1992	3.1	3.1	3.1	0.0	0.0	1	1	0.0	0.0	100
Nanwalek	1993	6.1	6.1	6.1	0.0	3.0	1	2	0.0	0.0	0
Nanwalek	1997	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	0
Nanwalek	2003	9.1	9.1	9.1	0.0	0.0	5	7	0.1	0.0	103
Port Graham	1990	6.5	6.5	6.5	0.0	0.0	2	3	0.1	0.0	50
Port Graham	1991	4.1	4.1	4.1	0.0	0.0	12	2	0.0	0.0	64
Port Graham	1992	4.2	4.2	4.2	2.1	4.2	2	2	0.0	0.0	50
Port Graham	1993	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Port Graham	1997	4.5	2.3	2.3	2.3	2.3	1	2	0.0	0.0	111
Port Graham	2003	4.3	4.3	4.3	0.0	4.3	3	4	0.1	0.0	72
Seldovia	1991	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	
Seldovia	1992	1.5	1.5	1.5	0.0	0.0	1	1	0.0	0.0	100
Seldovia	1993	0.0	0.0	0.0	0.0	0.0	0	0	0.0	0.0	

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

Table 23. Uses and Harvests of Wild Resources, Nanwalek, Port Graham, and Seldovia

		Percentage of Households					Usable Lbs Harvested	
Community	Year	using	trying	harvesting	receiving	giving	Per Household	Per Capita
Nanwalek	1987	97	94	94	94	94	1,078	285
Nanwalek	1989	100	100	100	100	94	538	141
Nanwalek	1990	100	100	100	100	97	813	181
Nanwalek	1991	100	100	100	100	100	1,017	259
Nanwalek	1992	100	100	100	100	94	1,160	279
Nanwalek	1993	100	100	100	100	97	1,164	305
Nanwalek	1997	100	100	100	100	90	1,121	254
Nanwalek	2003	100	100	100	100	100	1,787	393
Port Graham	1987	100	100	100	98	82	657	229
Port Graham	1989	96	94	94	92	65	323	122
Port Graham	1990	100	100	100	98	89	637	214
Port Graham	1991	100	96	96	98	88	780	281
Port Graham	1992	100	100	100	100	98	784	273
Port Graham	1993	100	98	98	100	90	608	212
Port Graham	1997	100	98	98	96	86	628	253
Port Graham	2003	98	96	96	98	94	1,121	466
Seldovia	1991	99	92	92	96	85	604	205
Seldovia	1992	99	94	94	95	85	397	145
Seldovia	1993	95	95	95	86	79	517	184

Source: Alaska Department of Fish and Game 2007; Fall et al. 2006

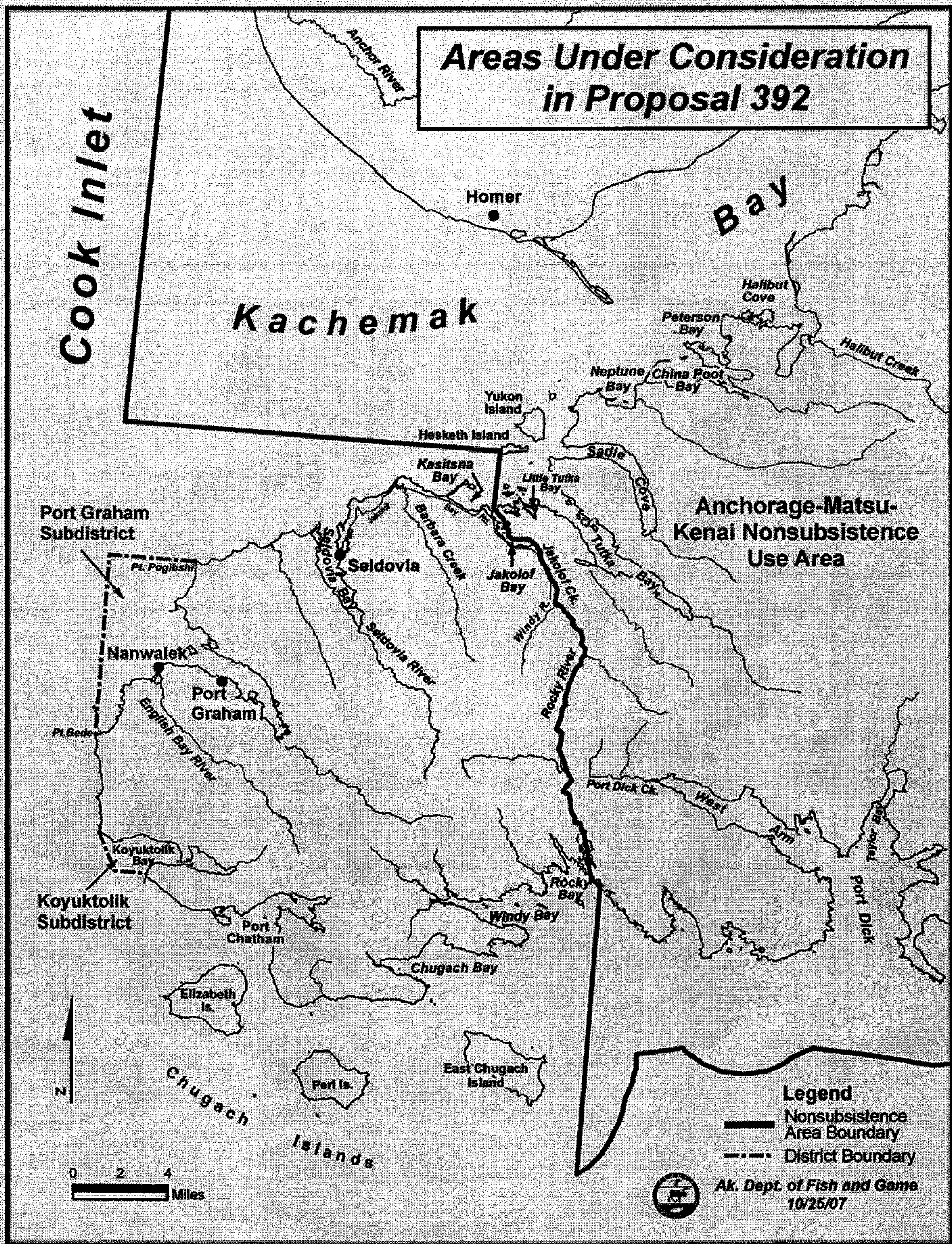


Figure 1. Areas under consideration in proposal 392

Figure 2. Percentage of Households Participating in Shellfish Harvesting, Nanwalek, Port Graham, and Seldovia

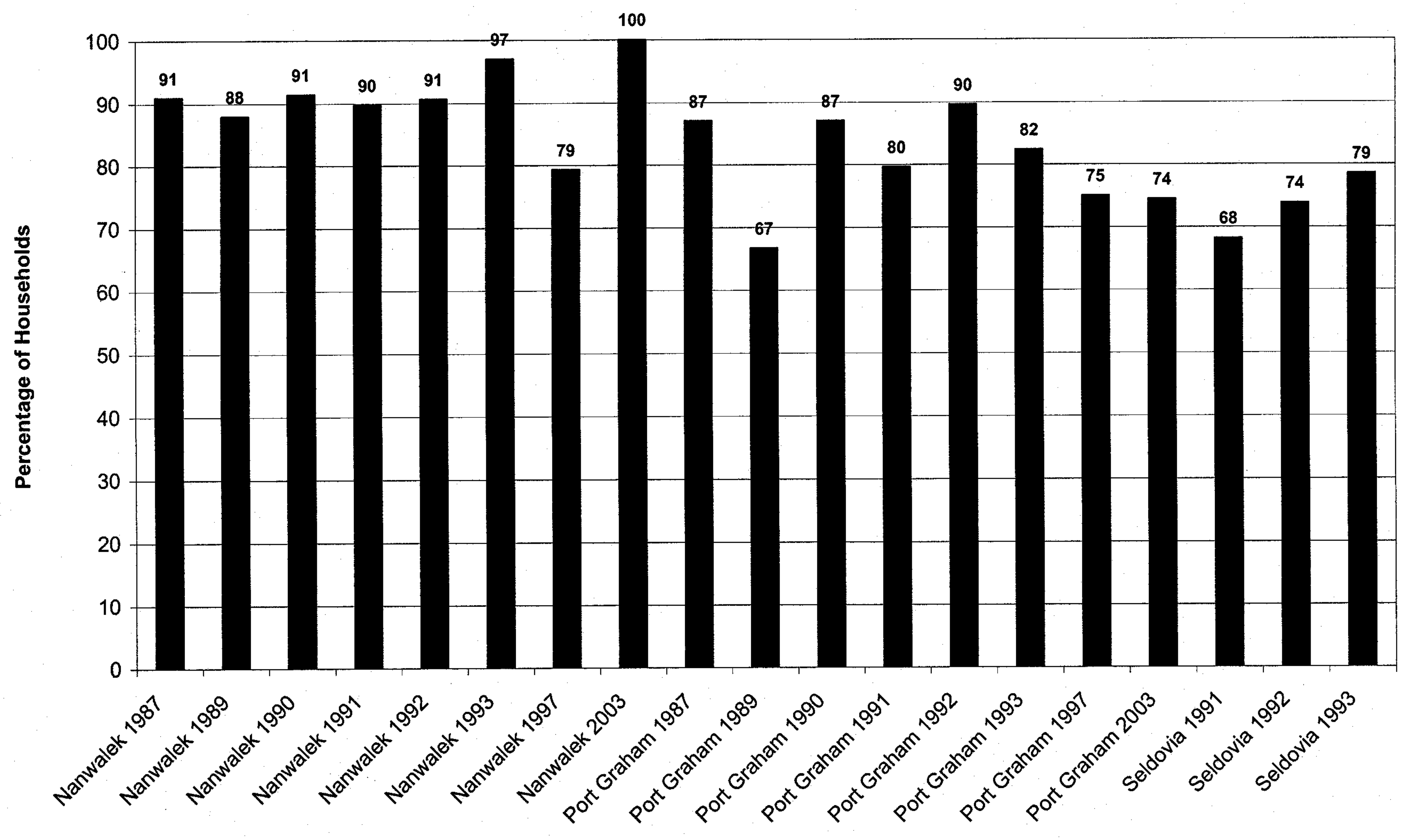
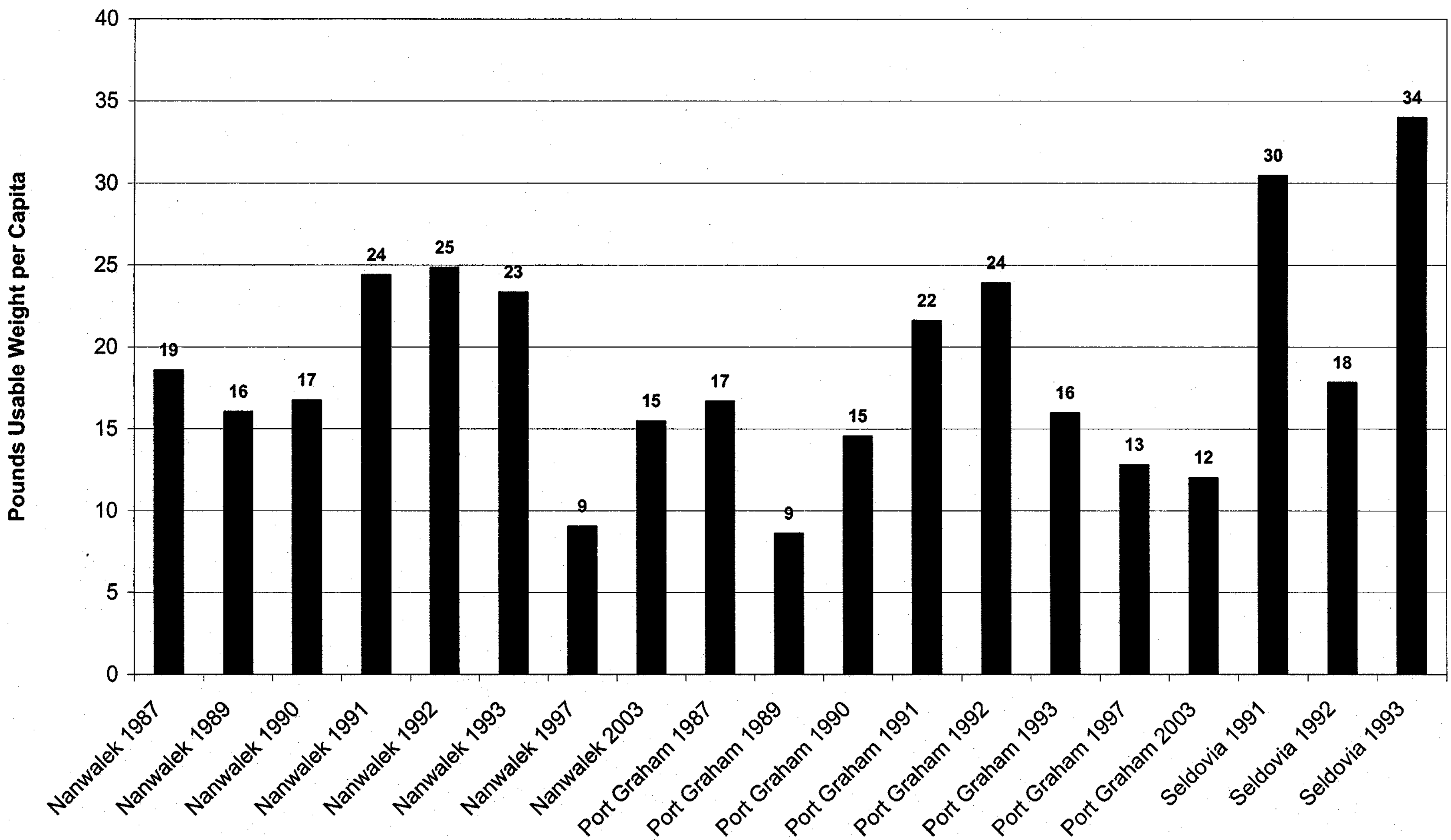


Figure 3. Estimated Harvests of Shellfish in Pounds Usable Weight per Capita, Nanwalek, Port Graham, and Seldovia



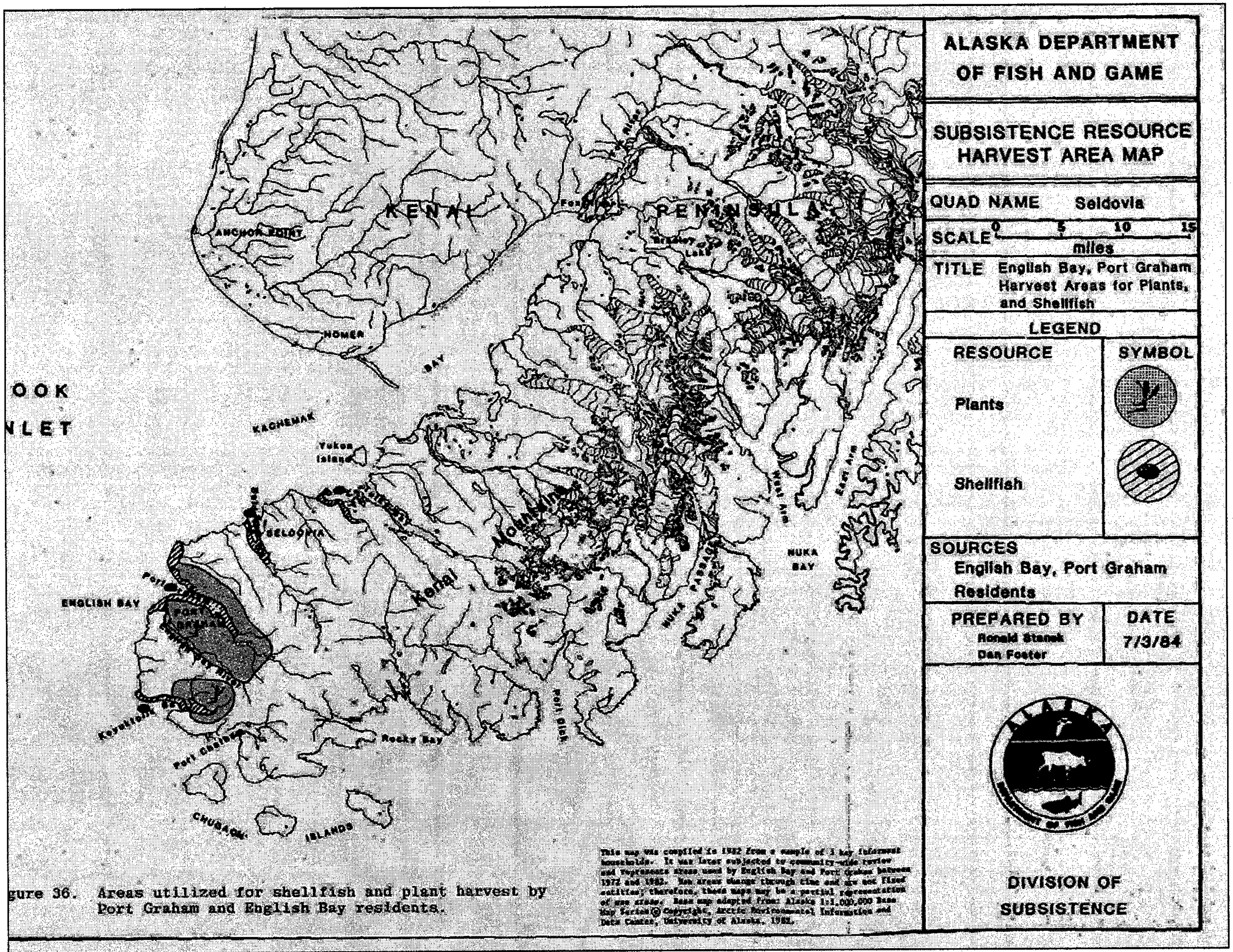


Figure 4. Areas utilized for shellfish harvesting, Port Graham and Nanwalek, 1972 – 1982.