Special Publication No. 08-19

Chum Salmon Stock Status and Escapement Goals in Southeast Alaska

There have been corrections made to Appendices A4 and A5 of this report. Therefore, all copies of Special Publication No. 08-19 obtained prior to May 05, 2010 have been superseded by this version of the report.

by

Douglas M. Eggers

and

Steven C. Heinl

December 2008

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

SPECIAL PUBLICATION NO. 08-19

CHUM SALMON STOCK STATUS AND ESCAPEMENT GOALS IN SOUTHEAST ALASKA

By
Douglas M. Eggers
Alaska Department of Fish and Game, Division of Commercial Fisheries, Douglas
and
Steven C. Heinl
Alaska Department of Fish and Game, Division of Commercial Fisheries, Ketchikan

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

December 2008

The Special Publication series was established by the Division of Sport Fish 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 became a joint divisional series in 2004 with the Division of Commercial Fisheries. Special Publications are intended for fishery and other technical professionals. Special Publications are available through the Alaska State Library, Alaska Resources Library and Information Services (ARLIS) and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm. This publication has undergone editorial and peer review.

Douglas M. Eggers,,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
802 Third Street, Douglas, Alaska 99824, USA

Steven C. Heinl,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
2030 Sea Level Drive #205, Ketchikan, AK 99901, USA

This document should be cited as:
Eggers, D. M., and S. C. Heinl. 2008. Chum salmon stock status and escapement goals in Southeast Alaska. Alaska Department of Fish and Game, Special Publication No. 08-19, Anchorage.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

Figure **Page**

LIST OF FIGURES (Continued)

LIST OF APPENDICES

ABSTRACT

The annual harvest of chum salmon in Southeast Alaska averaged 11.5 million fish per year since 1998; hatchery-produced fish accounted for least 75% of the commercial harvest. We developed a series of chum salmon stock designations based on regional aggregates of streams by area, summer- or fall-run timing. We recommend Sustainable Escapement Goals (SEG) thresholds for 3 aggregates of summer-run chum salmon harvested primarily in mixed-stock fisheries in the following subregions: Southern Southeast (68,000 index spawners); Northern Southeast Inside (149,000 index spawners); and Northern Southeast Outside (19,000 index spawners). We recommend SEG ranges for 4 fall-run chum salmon aggregates supporting directed purse seine fisheries as follows: Cholmondeley Sound (30,000–48,000 index spawners), Port Camden (2,000–7,000 index spawners), Security Bay (5,000–15,000 index spawners), and Excursion Inlet, (4,000–18,000 index spawners). Finally, one range for a total escapement estimate (75,000–170,000 fish) is recommended for Chilkat River fall-run chum salmon (harvested in the Lynn Canal gillnet fishery), based on estimated escapement and fish wheel index counts. The abundance of summer-run chum salmon has increased since the early 1970s and escapement indices have been stable or increasing since 1980. The abundance of fall-run chum salmon has decreased from the high levels observed from the 1960s to the early 1970s; however, fall-run chum salmon escapement indices have been relatively stable for two decades and have increased since the mid 1990s for Chilkat River. Escapement indices for chum salmon for the recent 10-year period have been generally within or above the proposed escapement goals. The 2008 summer chum salmon runs were weak, with observed escapements below the recommended goals for the northern inside and southern aggregates. There are no stocks of concern identified for Southeast Alaska chum salmon stocks.

Key words: chum salmon, *Oncorhynchus keta*, escapement goals, escapement index, stock status, Chilkat River, Cholmondeley Sound, Excursion Inlet, Lynn Canal, Port Camden, Security Bay, Taku River, Tenakee Inlet.

INTRODUCTION

Chum salmon (*Oncorhynchus keta*) are known to spawn in more than 1,200 streams in Southeast Alaska. Chum salmon are harvested primarily in commercial net fisheries, and to a lesser extent by commercial troll fisheries, as well as sport, personal use, and subsistence fisheries. Annual commercial harvests of chum salmon in Southeast Alaska were historically at high levels in the early to mid-1900s and then gradually declined to their lowest levels in the 1960s and 1970s (Figure 1). Chum salmon harvests increased dramatically in the 1990s, including a peak harvest of 16.0 million fish in 1996, and the harvest has averaged 11.5 million fish over the past 10 years. Much of this increase, however, was due to the production of hatchery fish, primarily by Southern Southeast Regional Aquaculture Association, Northern Southeast Regional Aquaculture Association, Douglas Island Pink and Chum, Inc., and Kake Nonprofit Fisheries Corporation. Hatchery fish accounted for at least an average of 75% of the commercial harvest of chum salmon over the 10 year period of 1998–2007. Over that same 10-year period, the total ex-vessel value of the commercial chum salmon harvest averaged \$26.7 million a year—well ahead of the next most valuable species, pink salmon (*O. gorbuscha*), at \$20.4 million a year.

The Sustainable Salmon Fisheries Policy (5 AAC 39.222) requires the Alaska Department of Fish and Game (ADF&G) to conduct an assessment of the status of salmon stocks in Southeast Alaska and Yakutat. The Policy for Statewide Escapement Goals (5 AAC 39.223) directs ADF&G to document existing salmon escapement goals, to establish goals when the department can reliably estimate escapement levels, and to perform an analysis when these goals are created or modified. The first assessment of Southeast Alaska and Yakutat chum salmon was conducted by Heinl et al. (2004). They did not identify any chum salmon stocks in Southeast Alaska and Yakutat for which existing information was sufficient to establish escapement goals. Much of the available information about the region’s chum salmon escapements comes from aerial surveys, often obtained in conjunction with aerial surveys directed primarily at estimating numbers of spawning pink salmon. Stock-specific harvest information is not available for the vast majority of wild chum salmon stocks in Southeast Alaska, which are predominantly harvested in mixed-stock fisheries far from their spawning grounds.

ADF&G has standardized survey programs to estimate an annual index of spawning chum salmon abundance. The trends in these indices provide a meaningful indicator of trends in the relative abundance of spawning chum salmon, and are the basis of the following evaluation of chum salmon stock status and the establishment of escapement goals. We develop a series of chum salmon stock designations patterned after methods used for pink salmon (c.f. Zadina et al. 2004), that are broad regional aggregates of streams by area and run timing (summer-run and fall-run). These stock definitions reflect, to some extent, the stock composition of catches by respective area and time. For each stock we tabulate available indicators of abundance trends (escapement, escapement indices, and catch), evaluate stock status, and establish appropriate sustainable escapement goals.

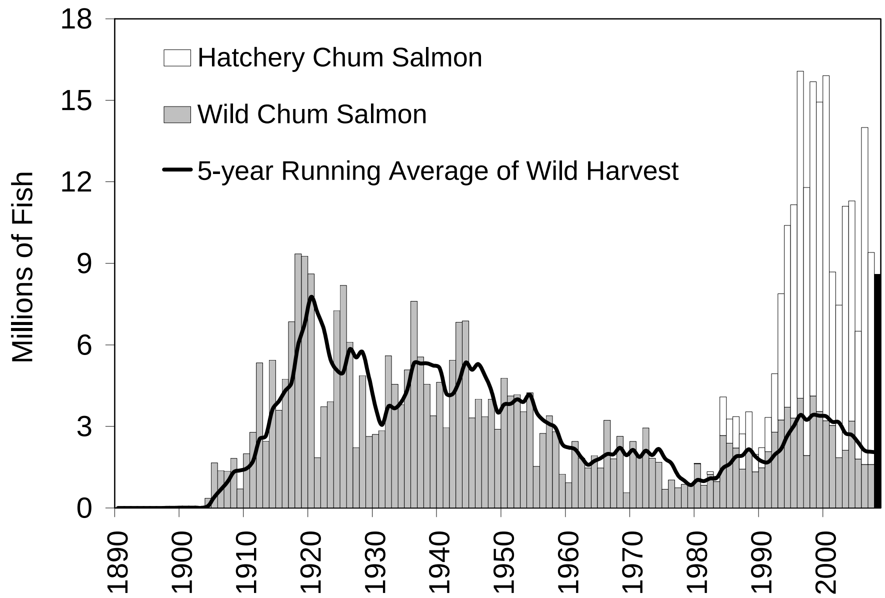

Figure 1.–Annual harvest of chum salmon in Southeast Alaska from 1890 to 2008 showing the harvest of both hatchery-produced and wild chum salmon. (Data prior to 1960 are from Byerly et al. 1999; 2008 hatchery contribution not available.)

STOCK STATUS

ESCAPEMENT MONITORING

There are some 1,230 streams and rivers in Southeast Alaska for which ADF&G has a record of at least one annual adult chum salmon spawning count since 1960 (ADF&G Integrated Fisheries Database). The vast majority of those 1,230 streams do not have a long time-series of survey information because most are not significant producers of chum salmon. Of the chum salmon populations that have been monitored, most have been monitored through aerial surveys, although several have been monitored annually by foot surveys, and in-river fish wheel counts have been used to monitor salmon escapements to the Taku and Chilkat rivers, two large glacial, mainland river systems.

The increase in the pink salmon population has masked the abundance of chum salmon and greatly limited ADF&G's ability to estimate numbers of chum salmon in many or most streams in Southeast Alaska (Van Alen 2000). The high abundance of pink salmon in mainland areas of District 1 has sometimes made it nearly impossible to estimate numbers of chum salmon in some of the index streams. Pink salmon runs in the Sitka area have exhibited substantial increases over the past 15 years (Zadina et al. 2004), also making it difficult to separate chum salmon from pink salmon.

In their review of available ADF&G chum salmon escapement survey data, 1960–2002, Heinl et al. (2004) identified 82 chum salmon streams, 76 summer-run and six fall-run, that had sufficient survey information to be useful for assessing trends in spawning populations. Another three stocks were also examined, but treated separately (Fish Creek–Hyder, Taku River, and Chilkat-Klehini River). Efforts have been made to continue to monitor this set of streams on an annual basis and Heinl (2005) updated that information through 2004. In this report we added the following streams to the index: P Beauclerc S Arm E (ADF&G stream number 105-20-012), Calder Creek (ADF&G stream number 105-42-005), Petrof Bay W Head (ADF&G stream number 109-62-024), Rodman Creek (ADF&G stream number 113-54-007), and Ushk Bay W End (ADF&G stream number 113-56-003). We removed Peterson Creek (ADF&G stream number 111-50-010) from the index, as it is located at a major hatchery release site for summer-run chum salmon at Amalga Harbor.

Heinl et al. (2004) pointed out the many limitations of these survey counts. Chum salmon are most easily observed early in the season when there are few pink salmon in the streams. However, it is often not possible to estimate numbers of chum salmon in streams that have substantial populations of pink salmon and high pink salmon escapements may have masked high chum salmon escapements in many areas (Van Alen 2000), particularly since the mid-1980s. Perhaps the primary limitation is that these subjective survey estimates can only be used as is, and it is not possible to adjust them to account for counting bias among observers. The maximum escapement estimates used here also underestimate the true escapement and can only be considered a relative indicator of escapement level.

WILD CHUM SALMON STOCKS

Chum salmon populations in Southeast Alaska are generally divided into two runs based on migration timing: summer-run fish generally peak during the period mid-July to mid-August and fall-run fish peak in September or later (Figure 2). Allozyme studies by Kondzela et al. (1994), Phelps et al. (1994), and Wilmot et al. (1994) suggested that run-timing is an isolating mechanism for chum salmon populations: "reproductive isolation between summer-run and fall-run chum salmon is an important component of the genetic diversity of this species" (Phelps et al. 1994).

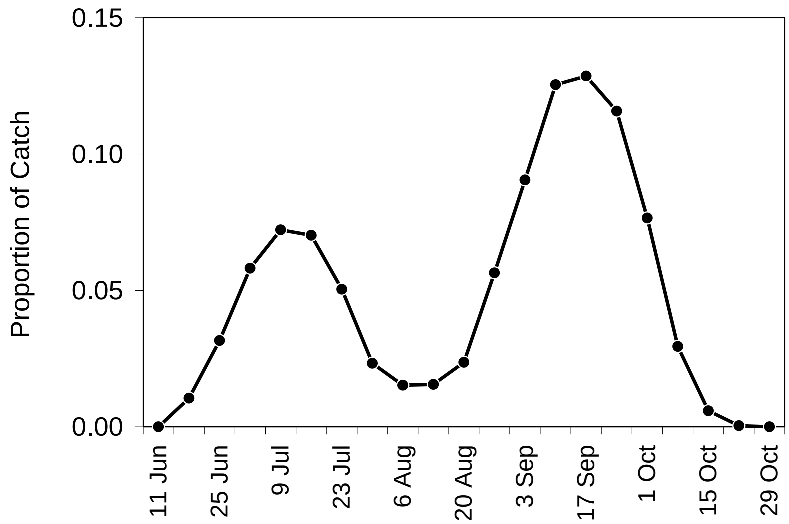

Figure 2.–Mean run-timing of chum salmon in the Lynn Canal (District 15) commercial drift gillnet fishery, illustrated by plotting the mean weekly proportion of the total annual harvest of chum salmon in the fishery, from 1960 to 2007. All chum salmon harvested in this fishery from statistical week 34 (average mid-week date 20 August) and later are considered fall-run fish.

Marine tagging experiments conducted in the 1900s (e.g., Rich 1926, Rich and Suomela 1927, and Rich and Morton 1930) demonstrated that Southeast Alaska chum salmon populations are mostly segregated into northern and southern components: northern fish migrated to inside waters via the entrances to Icy and Chatham straits, while southern fish migrated to spawning areas through the entrance to Sumner Strait and Dixon Entrance. Genetic studies of Southeast Alaska and northern British Columbia chum salmon by Kondzela et al. (1994) supported this separation of northern and southern components. The 37 Alaska populations included in their study formed three regional groups: southern Southeast Alaska (and northern British Columbia), which included populations of summer-run fish on the inner islands and mainland of Southeast Alaska from Sumner Strait south; central Southeast Alaska, which included populations on inside waters of Southeast Alaska north of Sumner Strait; and Prince of Wales Island, which was composed of fall-run fish that were distinct from summer-runs on the adjacent inner islands and mainland. This study did not include fall-run chum salmon populations from the central or northern areas of Southeast Alaska and did not include samples from Chichagof Island or northern Admiralty Island where there are many summer-run chum salmon populations.

We have attempted, based on the marine-tagging and genetic studies, to group Southeast Alaska chum salmon index streams into appropriate stock groups by area and run-timing. In some cases these stocks are aggregates of many index streams; in other cases the stock may be only one stream or a smaller group of streams that support a directed fishery. We have compiled annual peak aerial and foot survey data for all of the index streams. If a particular index stream was missing escapement counts for any given year, an iterative EM algorithm (McLachlan and Krishnan 1997) was used to impute a missing value. Values were imputed based on the assumption that the expected count for a given year was equal to the sum of all counts for a given stream, times the sum of all the counts in a given year for all the streams in the unit of interest, divided by the sum of all counts over all years for all the streams in the unit of interest.

Data were arranged in a matrix and the imputed value was calculated as the row total times column total divided by grand total—in this case, the unit of interest is the stock group, and interpolations for missing values were made at the stock group level. This method is based on an assumed multiplicative relation between yearly count and unit count, with no interaction.

Southern Southeast Summer-Run Chum Salmon

This stock group includes summer-run chum salmon on the inner islands and mainland of southern Southeast Alaska, from Sumner Strait south to Dixon entrance. Peak escapement survey data were available since 1980 for 13 index streams (Figure 3; Appendix A1). The exploitation rate on summer chum salmon in the traditional mixed-stock commercial net fisheries throughout Districts 1–8 is assumed to be at least moderate based on the harvest rates achieved on hatchery stocks in southern southeast common property fisheries (Appendix B). Catches of wild chum salmon in southern Southeast Alaska areas increased in the 1980s and have been relatively stable since (see Harvest below). Escapement indices also have been relatively stable during this period indicating that wild salmon abundance since 1980 has been high relative to earlier periods.

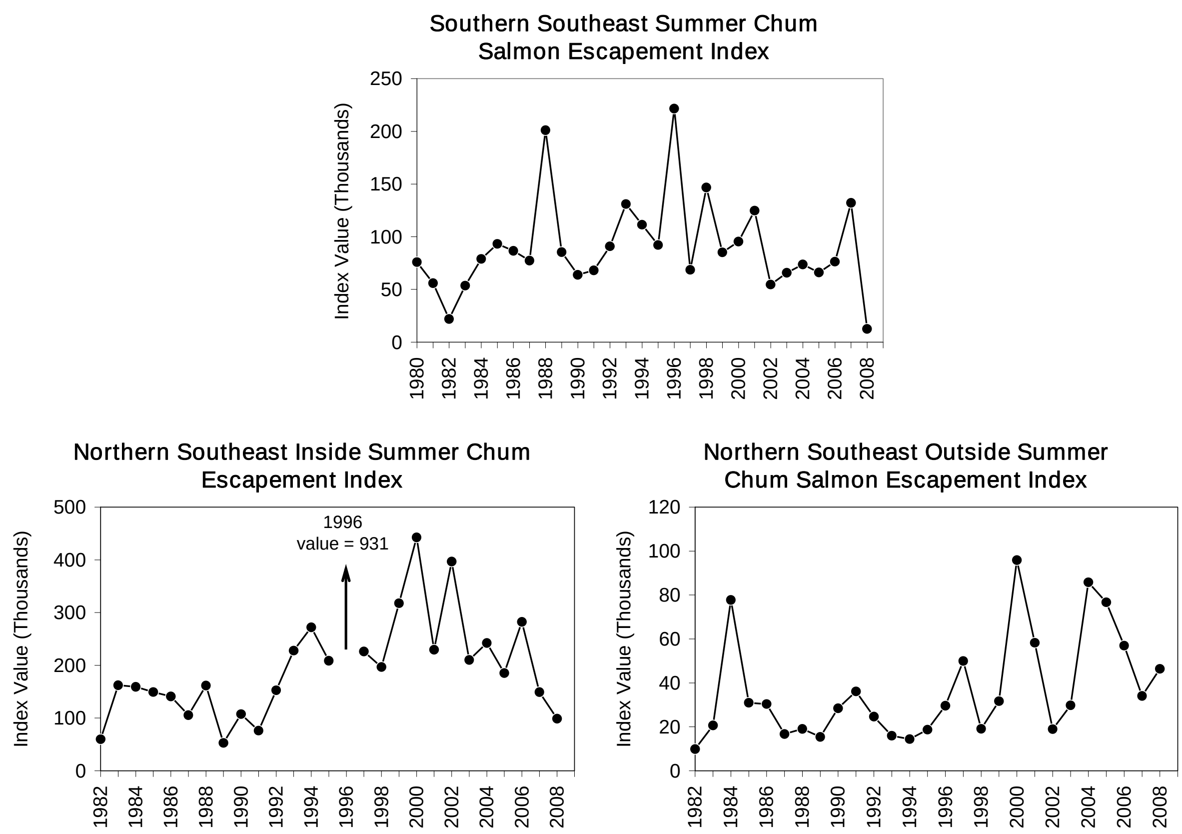

Figure 3.–Wild summer-run chum salmon escapement index for the Southern Southeast stock group (1980–2008), Northern Southeast Inside stock group (1982–2008), and Northern Southeast Outside stock group (1982–2008).

Northern Southeast Inside Summer-Run Chum Salmon

This stock group includes summer-run chum salmon on the inside waters of northern Southeast Alaska north of Sumner Strait (Districts 9–12, 14, and District 13 subdistricts 51 to 59). Peak escapement survey data were available since 1982 for 63 index streams (Figure 3; Appendix A2). The exploitation rate on summer-run chum salmon in the traditional, mixed-stock commercial net fisheries is assumed to be at least moderate; however, little stock specific harvest data were available and the large annual contribution of hatchery fish to the common property fisheries in this sub-region makes it nearly impossible to accurately estimate the harvest at this time.

Tenakee Inlet chum salmon are included within the Northern Southeast Inside stock group. Located along the Chatham Strait shoreline of eastern Chichagof Island (District 12), Tenakee Inlet is among the largest producers of wild summer chum salmon in the Alexander Archipelago. Early season management of the purse seine fishery at Tenakee Inlet is directed on chum salmon returns from late June through early July; thereafter, management emphasis switches to pink salmon. Chum salmon harvests averaged 59,000 chum salmon in the 1980s, but increased to an average of 152,000 in the 1990s, including two years when catches exceeded 300,000 (Figure 4). Catches declined to an average of 77,000 since 2001. Increased chum salmon production at the Hidden Falls Hatchery may have contributed to the increase in commercial harvest of chum salmon at Tenakee Inlet. Stock composition estimates of chum salmon catches at Tenakee Inlet are not available, but it is possible that catches in the outer portions of the Inlet have included Hidden Falls Hatchery chum salmon that sagged into the Inlet on their return migration to the hatchery.

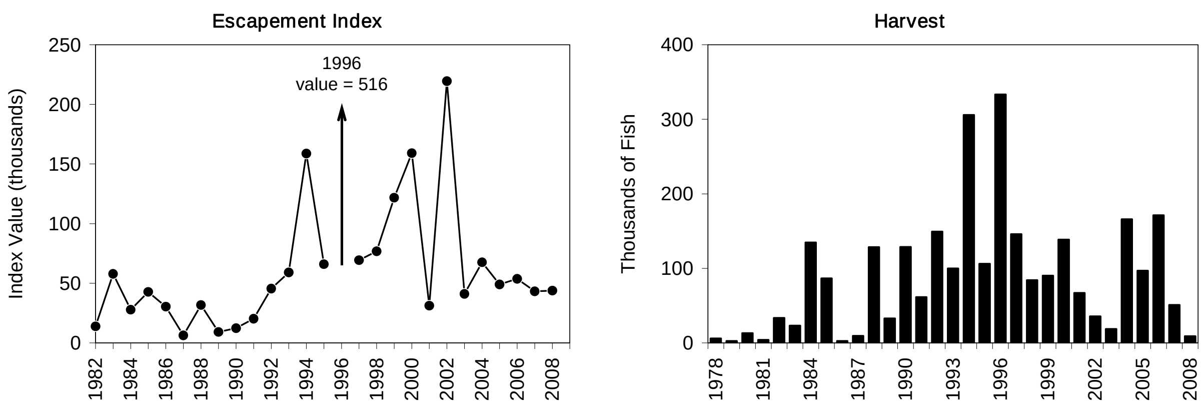

Figure 4.–Annual escapement index of wild summer-run chum salmon in Tenakee Inlet (1982–2008) and purse seine harvest of summer chum salmon in subdistricts 112-41, 42, and 45 (1978–2008).

Northern Southeast Outside Summer-Run Chum Salmon

This stock group includes primarily summer-run chum salmon on the outside waters of Chichagof and Baranof islands in Northern Southeast Alaska (District 13, excluding Peril Straits and Hoonah Sound subdistricts 51 to 59). Peak escapement survey data were available since 1982 for five index streams (Figure 3; Appendix A3). No stock specific harvest data were available; however, the exploitation rate on summer chum salmon in the traditional mixed-stock commercial purse seine fisheries is assumed to be at least moderate.

Cholmondeley Sound Fall-Run Chum Salmon

Cholmondeley Sound (Prince of Wales Island) supports an annual commercial purse seine fishery on fall chum salmon. The chum salmon harvest inside Cholmondeley Sound (District 102-40) increased from an average of 42,000 fish in the 1970s and 1980s to an average of 122,000 fish a year from 1991 to 2004, including a peak catch of 359,000 in 1998 (Figure 5). These fish are also harvested in other mixed-stock fisheries prior to reaching the terminal area, so a complete accounting of the total harvest was not possible.

Management of the commercial purse seine fishery in Cholmondeley Sound, for the past 30 years, was based on an informal escapement target of 30,000 chum salmon at Disappearance Creek (ADF&G stream number 102-40-043) and since about 1985, peak aerial escapement survey counts of 10,000 to 15,000 fish in Lagoon Creek (ADF&G stream number 102-40-060; Heinl et al. 2004). Those targets are not escapement goals as defined in the Escapement Goal Policy (5 AAC 39.223) since they were not established from critical examination of biological data. Rather, the escapement targets were established by area management staff using their professional judgment in the early days of state management. From 1961 to 1984, the informal escapement target for Disappearance Creek was met by counting 30,000 fish through a weir on the stream. Because of budget restrictions, the weir was removed annually once the escapement target had been met and was not always operated continually when it was in place.

Peak escapement survey data were available since 1980 for Disappearance Creek and Lagoon Creek, the two primary fall-run chum salmon streams in Cholmondeley Sound (Figure 5; Appendix A4). Although stable over the past two decades, abundance of chum salmon in Cholmondeley Sound was very low in 2005 and 2007, and the fall purse seine fishery was curtailed in both years.

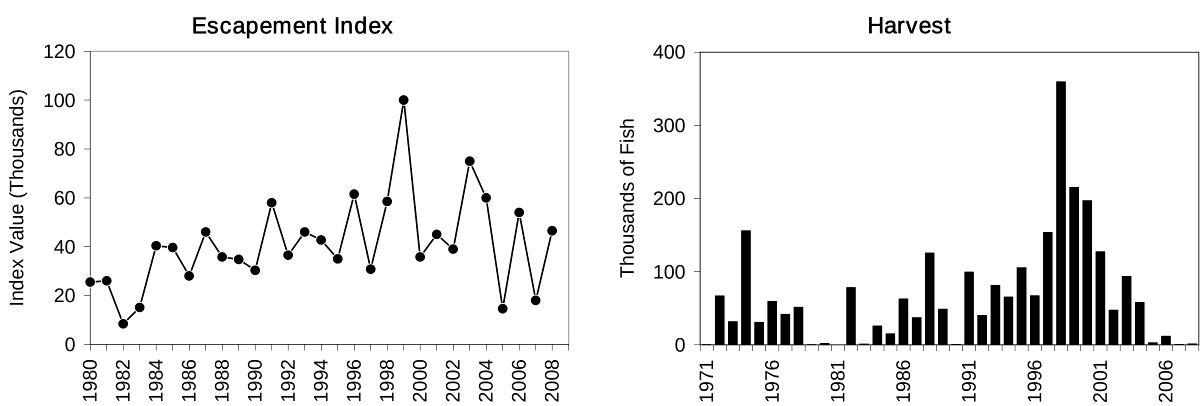

Figure 5.–Annual escapement index of wild fall-run chum salmon in Cholmondeley Sound (1980–2008) and purse seine harvest of fall chum salmon in subdistrict 102-40 (1971–2008). All chum salmon harvested in statistical week 34 (average mid-week date 20 August) and later were considered fall-run fish.

Port Camden Fall-Run Chum Salmon

Port Camden (Kuiu Island) fall-run chum salmon have been harvested in a terminal fishery in District 109-43 in years when the run-strength appeared to be adequate (Figure 6). The chum salmon harvest at Port Camden averaged 12,000 fish in years when the terminal fishery was conducted, with a maximum harvest of 51,000 fish in 1992. Port Camden fall chum salmon are likely also harvested in other mixed-stock fisheries prior to reaching the terminal area so a complete accounting of the total harvest was not possible. With the exception of 2001, peak escapement survey data were available since 1964 for the two primary fall-run chum salmon streams in Port Camden: Port Camden South Head Creek (ADF&G stream number 109-43-006) and Port Camden West Head Creek (ADF&G stream number 109-43-008; Figure 6; Appendix A5). Both are relatively short streams in terms of spawning habitat; runs average slightly smaller in the west head creek and run timing is about 10–14 days later than the south head creek (William R. Bergmann, Petersburg Area Management Biologist, ADF&G, pers. comm.). Management of the fishery at Port Camden has been based on an informal escapement target of peak aerial survey counts of 4,000 chum salmon to each stream (W. R. Bergmann, pers. comm.). Those targets are not escapement goals as defined in the Escapement Goal Policy (5 AAC 39.223), but were based on the best professional judgment of area management staff.

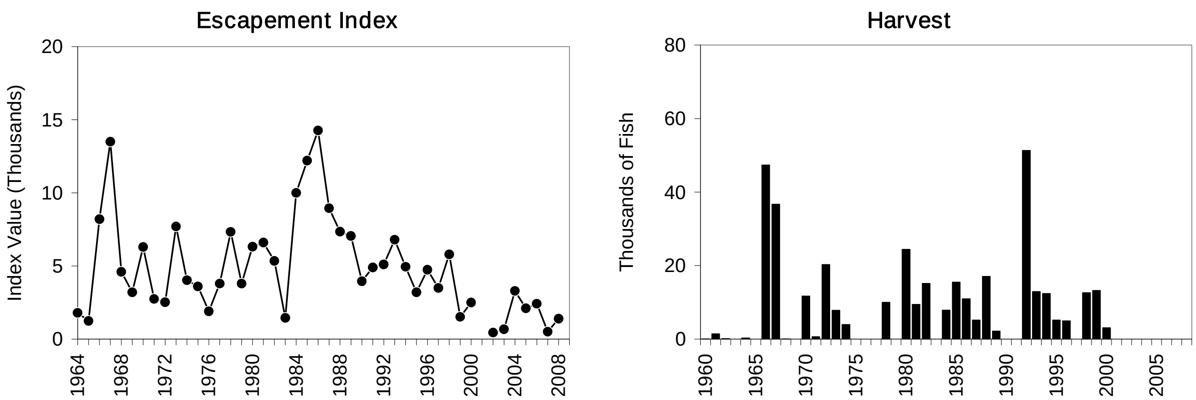

Figure 6.–Annual escapement index of wild fall-run chum salmon in Port Camden (1964–2008) and purse seine harvest of fall chum salmon in subdistrict 109-43 (1960–2008). All chum salmon harvested in statistical week 34 (average mid-week date 20 August) and later were considered fall-run fish.

Enhancement projects were conducted at the two Port Camden streams beginning in the mid-1980s by NSRAA, U. S. Forest Service (USFS), and ADF&G (ADF&G 2004). The goals of the enhancement projects were to rehabilitate the naturally spawning fall chum salmon stocks in Port Camden and to provide additional fall chum salmon to the common property fishery. NSRAA constructed and operated instream incubation boxes on the two Port Camden streams, and were permitted to take up to 10 million chum salmon eggs annually. Fry were released from the incubation boxes from 1986 to 1998, with an average release of more than 4 million fry from 1991 to 1998 (Table 1). In addition, the USFS constructed an intertidal spawning channel in the west head creek in 1989. The channel was designed to allow for easier passage of fish from the intertidal area into the stream (W. R. Bergmann, pers. comm.) and to take advantage of available groundwater in an area not previously used by spawning chum salmon, although little actual spawning occurred in the constructed channel (ADF&G 2004).

The enhancement work did not result in increased production of fall chum salmon at Port Camden and the enhancement project was cancelled in 2000. Runs of chum salmon to Port

Camden have been poor since the late 1990s and there has not been a fall fishery since 2000. The peak survey counts to both index streams combined averaged 6,000 fish per year from 1964 to 1998, but only 2,000 fish per year since 1999.

Table 1.–Annual release of fall chum salmon fry from incubation boxes at two Port Camden streams, 1986–1998.

	Thousands of Fry Released	
Year	Port Camden South Head Creek	Port Camden West Head Creek
1986	34	
1987	99	99
1988	594	5
1989	726	583
1990	733	
1991	1,837	562
1992	2,458	1,754
1993	2,301	2,139
1994	2,875	2,105
1995	2,832	2,317
1996	2,910	1,917
1997	1,626	2,766
1998	1,864	505

Security Bay Fall-Run Chum Salmon

Security Bay (Kuiu Island) fall-run chum salmon have been harvested in a terminal fishery in District 109-45 during years when the run-strength appeared to be adequate (Figure 7). The chum salmon harvest at Security Bay averaged 11,500 fish in years when the terminal fishery was conducted, with a maximum harvest of 71,000 fish in 1984. These fish are likely also harvested in other mixed-stock fisheries prior to reaching the terminal area, so a complete accounting of the total harvest was not possible. With the exception of 1963, peak escapement survey data were available since 1960 for Salt Chuck Creek (ADF&G stream number 109-45-013), the primary chum salmon stream in Security Bay (Figure 7; Appendix A5). Management of the fishery at Security Bay has been based on an informal escapement target of peak aerial survey counts of 10,000 to 20,000 fish to Salt Chuck Creek (W. R. Bergmann, ADF&G, pers. comm.). Those targets are not escapement goals as defined in the Escapement Goal Policy (5 AAC 39.223), but were based on the best professional judgment of area management staff.

Salt Chuck Creek supported a small subsistence fishery on chum salmon for many years. The annual reported harvest from 1985 to 2000 averaged 350 chum salmon from an average of 12 subsistence fishing permits. The maximum reported harvest was 958 chum salmon in 1985 (from 26 permits). Since 2001, fewer subsistence permits have been fished (only three per year on average), and subsequently, the reported harvest has only averaged 90 fish per year. This decrease in subsistence fishing effort probably reflects a change in subsistence fishing patterns or use rather than a change in chum salmon abundance, because the chum salmon escapement appears to have been stable since 1985 (Figure 7).

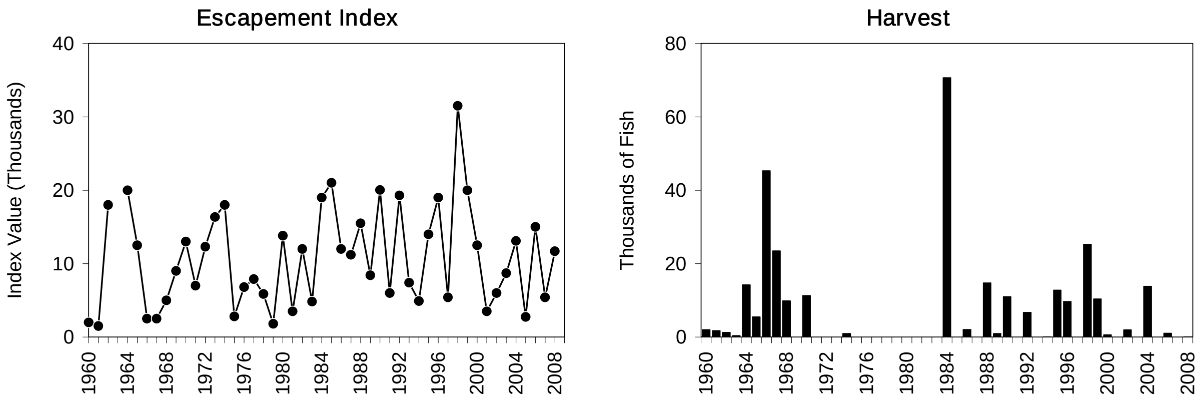

Figure 7.–Annual escapement index of wild fall-run chum salmon in Salt Chuck Creek and purse seine harvest of fall chum salmon in Security Bay subdistrict 109-45 (1960–2008). All chum salmon harvested in statistical week 34 (average mid-week date 20 August) and later were considered fall-run fish.

Excursion River Fall-Run Chum Salmon

Excursion Inlet fall-run chum salmon have been harvested in a terminal fishery in District 114-80 during years when the run-strength appeared to be adequate (Figure 8). These fish are likely also harvested in other mixed-stock fisheries prior to reaching the terminal area, so a complete accounting of the total harvest was not possible. The area that is open to seining is limited to section 14-C by the northern southeast seine salmon fishery management plan (5 AAC 33.366(b)) to minimize the impact openings might have on other migrating stocks (for example, Chilkat River fall chum salmon). With the exception of 1963, peak escapement survey data were available since 1960 for Excursion River (ADF&G stream number 114-80-020), the primary chum salmon producing stream in Excursion Inlet (Figure 8; Appendix A5). Survey and catch data suggest runs were much larger in the 1960s and 1970s than in more recent times. The harvest averaged 95,000 fish from 1960 to 1981 in years when the terminal fishery was conducted, but has only averaged 30,000 since that time; similarly, peak aerial survey estimates at the Excursion River averaged 20,000 fish from 1960 to 1981, but only 7,000 since 1981.

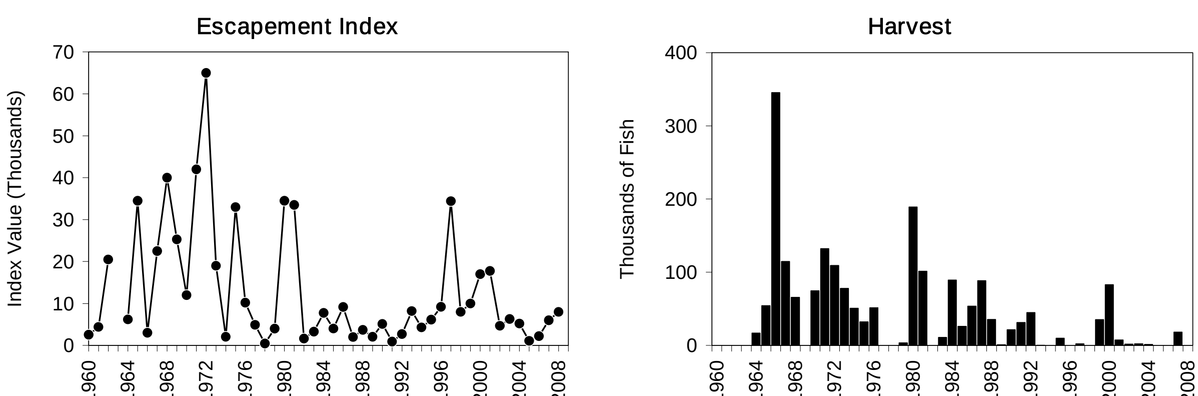

Figure 8.–Annual escapement index of wild fall-run chum salmon in the Excursion River and purse seine harvest of fall chum salmon in Excursion Inlet, subdistrict 114-80 (1960–2008). All chum salmon harvested in statistical week 34 (average mid-week date 20 August) and later were considered fall-run fish.

Lynn Canal Fall-Run Chum Salmon

The Chilkat River drainage near Haines supports one of the largest fall chum salmon runs in the region. Most of the spawning takes place in the mainstem and side channels of the Chilkat River (ADF&G Stream Number 115-32-025) and its major tributary, the Klehini River (ADF&G Stream Number 115-32-046). Chilkat River fall-run chum salmon are primarily harvested in the Lynn Canal (District 15) commercial drift gillnet fishery, although they are likely also harvested to some degree in other mixed-stock fisheries prior to reaching Lynn Canal.

Harvest and survey data suggest runs were much larger in the 1960s to early 1970s (Figures 9 and 10). The chum salmon escapement to the Chilkat River drainage was historically monitored via aerial surveys; however, the department considers historic aerial surveys of the drainage to be unreliable primarily due to the highly glacial nature of the system. Peak escapement survey data were available since 1969 for both the Chilkat River and the Klehini River, with the exception of 1974, 1977, 1978, 1986, and 1995 (Appendix A6). Harvests and fisheries performance measures for the Chilkat River fall chum stock declined during the 1990s. Catches have been lower in many recent years, due in part to fishery restrictions specifically implemented to protect this stock by reducing effort in the fishery (Bachman 2005).

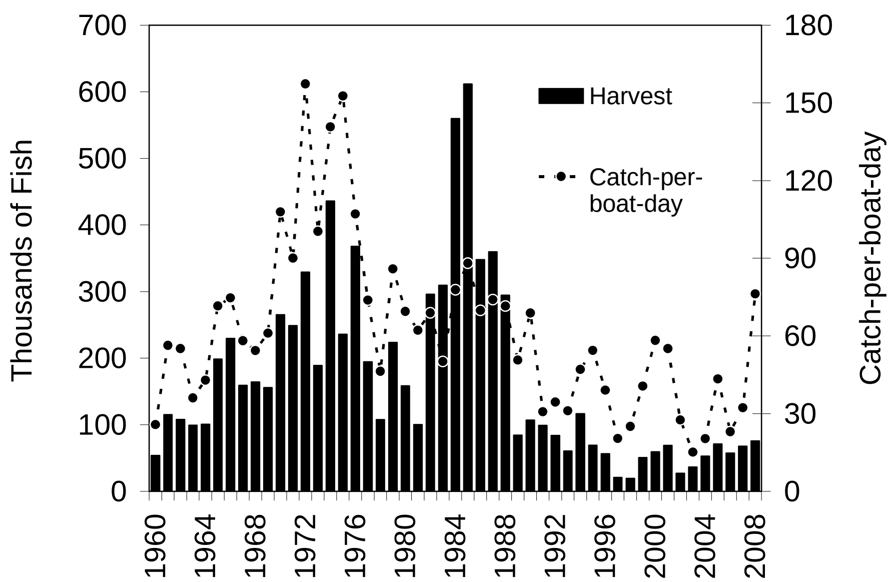

Figure 9.–Annual drift gillnet harvest and catch-per-boat-day of fall chum salmon in Lynn Canal (District 15), 1960–2008. All chum salmon harvested in statistical week 34 (average mid-week date 20 August) and later were considered fall-run fish.

Fish wheels operated by ADF&G on the river since 1994 have provided some evidence that escapements have likely improved since the mid-1990s (Table 2). The department conducted in-river mark-recapture studies in 1990 and from 2002 to 2005, designed to estimate the spawning population of chum salmon and relate those estimates to the fish wheel catches and aerial surveys of the primary spawning areas. During those five years, the total spawning population estimates ranged from about 166,000 to 310,000 (Bachman 2005, and unpublished data), and there was a good relationship between the average total escapement and cumulative fish wheel catch (through mid-October) of chum salmon. The cumulative fish wheel catch, which averaged 1.5% of total escapement, was used to estimate the total chum salmon escapement for years when the fish wheels were operated and a mark recapture estimate was not available (Table 2). The harvest rate on Chilkat River fall chum salmon in Lynn Canal ranged from 8% to 79% and averaged 25% (Table 2). Although Chilkat River fall chum salmon are likely harvested incidentally in other mixed-stock fisheries, these estimates suggest that exploitation has been relatively low in recent years. The assessments of Chilkat River chum salmon total escapement since the early 1990s clearly show that runs have been increasing in response to reduced fishing on this stock (Figure 10).

Table 2.–Total escapement of Chilkat River fall chum salmon, based on mark-recapture experiments (1990, 2002–2005) and expanded fishwheel catches (1994–2001 and 2005–2008), and estimated annual commercial catches, total returns, and harvest rates.

	Fish Wheel Operation		Peak Aerial			Estimated	Estimated
			Survey	Estimated	Commercial	Total	Harvest
Year	Dates	Catch	Count[a]	Escapement[b]	Catch[c]	Return	Rate[d]
1990	14 Aug to 25 Oct	**3,025**	29,350	**275,000**	107,014	**382,014**	28%
1994	18 Jun to 11 Sept	*454*[e]	24,000	*30,296*	116,599	146,895	79%
1995	18 Jun to 11 Sept	*1,107*[e]		*61,123*	69,201	130,324	53%
1996	18 Jun to 11 Sept	*1,010*[e]	16,000	*58,523*	56,437	114,960	49%
1997	11 Jun to 9 Oct	**1,315**	9,000	*87,667*	20,850	108,517	19%
1998	8 Jun to 13 Oct	**1,947**	28,000	*129,800*	19,239	149,039	13%
1999	7 Jun to 8 Oct	**4,250**	46,000	*283,333*	50,576	333,909	15%
2000	9 Jun to 7 Oct	**4,045**	78,000	*269,667*	60,201	329,868	18%
2001	6 Jun to 7 Oct	**4,680**	9,000	*312,000*	68,898	380,898	18%
2002	7 Jun to 19 Oct	**2,895**	63,300	**206,000**	39,942	**245,942**	16%
2003	6 Jun to 21 Oct	**3,402**	46,600	**166,000**	36,565	**202,565**	18%
2004	7 Jun to 19 Oct	**4,266**	58,700	**310,000**	52,394	**362,394**	14%
2005	6 Jun to 11 Oct	**3,126**	51,300	**202,000**	71,020	**273,020**	26%
2006	9 Jun to 14 Oct	**10,563**	83,000	*704,000*	58,256	762,256	8%
2007	7 Jun to 9 Oct	**4,967**	50,250	*331,000*	65,629	396,629	17%
2008	6 Jun to 10 Oct	**6,770**	28,150	*451,000*	75,822	526,822	14%
Average		4,250	41,377	242,338	60,540	302,878	25%

[a] Drainage-wide aerial counts include the Klehini and Chilkat rivers combined.
[b] Escapements for years in bold text based on mark-recapture; in other years, escapement estimated by expanding fish wheel catch by 1÷0.015.
[c] Commercial catch of fall chum salmon includes all Lynn Canal (District 15) chum salmon harvested from statistical week 34 through the end of the season.
[d] Harvest rate considered minimum; stock likely also harvested in mixed-stock fisheries prior to entering Lynn Canal.
[e] Fish wheel catch was expanded for early closure based on run timing in 1997–2007.

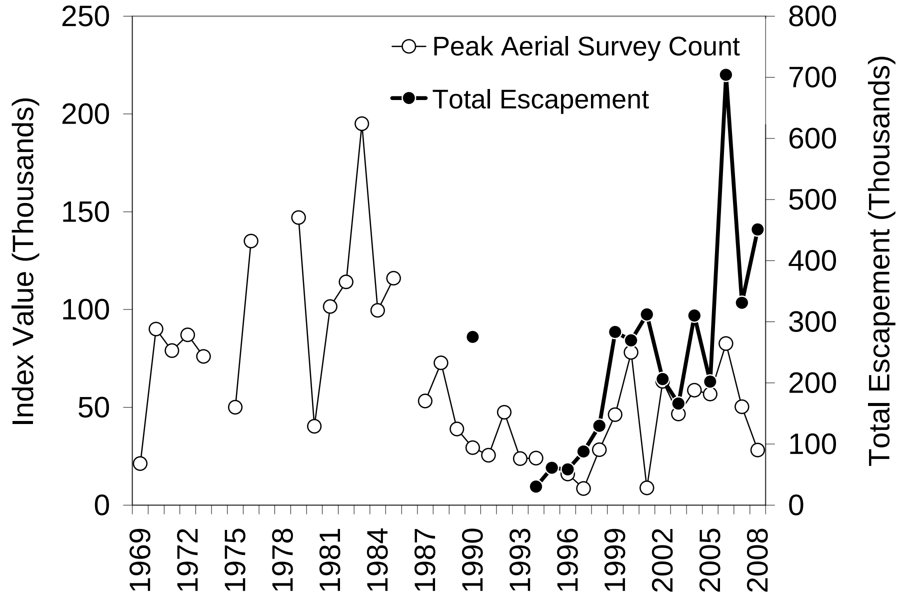

Figure 10.–Annual peak aerial survey index of spawning chum salmon in the Chilkat and Klehini rivers, 1969–2008; and total escapement of chum salmon in the Chilkat River in 1990 and 1994–2008.

Taku River Fall-Run Chum Salmon

The transboundary Taku River (ADF&G Stream Number 111-32-032) supports a fall run of chum salmon that spawns in Canada. Taku River fall chum salmon stocks are primarily harvested in the commercial drift gillnet fishery in Taku Inlet (subdistrict 111-32), but were also harvested incidentally in the Canadian in-river coho salmon drift gillnet fishery. The Transboundary Technical Committee established an interim escapement goal of 50,000 to 80,000 chum salmon for the Taku River in the 1980s (PSC 1993). There was no scientific basis for the goal which was established by professional judgment based on perceived run sizes at the time. The goal has not been formally adopted by ADF&G (Heinl et al. 2004). Fish wheels, operated jointly by ADF&G and Canadian Department of Fisheries and Oceans (CDFO), provide the only index of abundance available for Taku River fall chum salmon. Attempts by ADF&G and CDFO to estimate escapement through mark-recapture methods have been unsuccessful due to low rates of tagging. Aerial survey counts have also proven to be an unreliable measure of abundance due to the highly glacial nature of the Taku River system (Andel *in prep*.).

The harvest of fall chum salmon in Taku Inlet increased in the 1970s and averaged 45,000 fish a year from 1970 to 1985. The harvest then declined in the late 1980s to very low levels in the late 1990s and has averaged only 2,600 fish a year over the past decade (Figure 11). In addition, the number of boats fishing during the fall season in Taku Inlet has declined over the past 10 years (Figure 12). Fish wheel counts also declined sharply in the early 1990s. Abundance appears to have remained fairly stable since the early 1990s and has rebounded to a slight degree (in both the catch and at the fish wheels) since 2003 (Figure 13).

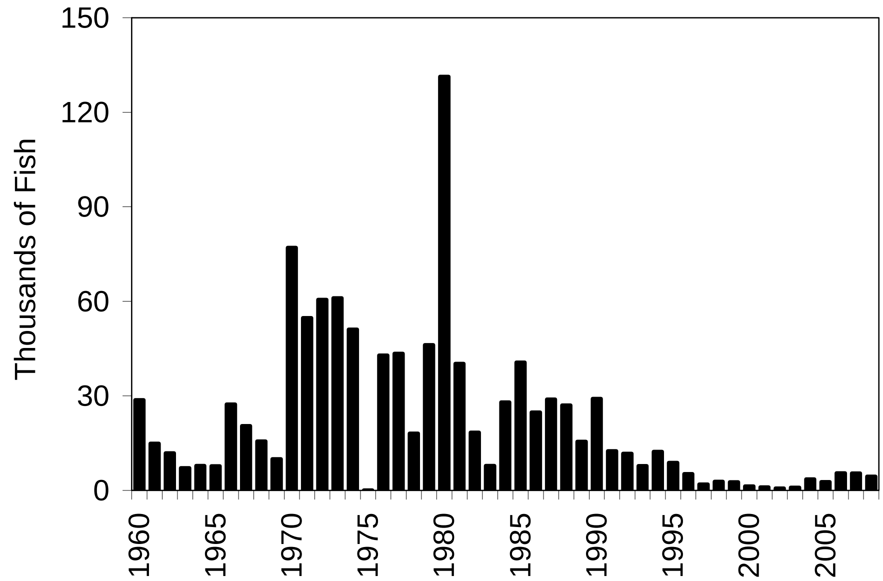

Figure 11.–Annual drift gillnet harvest of wild fall-run chum salmon in Taku Inlet (subdistrict 111-32; 1960–2008). All chum salmon harvested in statistical week 34 (average mid-week date 20 August) and later are considered fall-run fish.

The department intends to closely monitor this stock and implement conservative fishery management when needed. Catches have been lower in recent years, due in part to fishery restrictions specifically implemented to protect this stock by reducing effort in the fishery, particularly later in the season (statistical weeks 35–36; August 20–September 9; PSC 2007). In addition, the retention of fall chum in Canadian in-river fisheries has not been permitted for many years (e.g., see PSC 2007). Given the current lack of reliable escapement information, the lack of a meaningful escapement goal, and the apparent stability of escapement based on the Taku River fish wheel catches since the early 1990s, the department did not recommended Taku River chum salmon as a candidate stock of concern (Heinl et al. 2004).

HATCHERY CHUM SALMON STOCKS

Although salmon hatcheries have contributed to the commercial harvest in Southeast Alaska since well before the 1980s, the hatchery production of chum salmon in Southeast Alaska increased dramatically in the last two and a half decades. In 1980, hatchery operators in Southeast Alaska released 8.7 million chum salmon fry at eight locations; by 2007, this number had risen to 454 million fry released at 22 locations (Figure 14). In Southeast Alaska, hatchery-produced chum salmon accounted for an average of at least 75% of the commercial harvest of this species—94 million fish—over the 10 years from 1995 to 2004 (Heinl 2005; Figure 1). The proportion of hatchery-produced chum salmon reported in the Southeast commercial fisheries in 2006 was nearly 84% (White 2007).

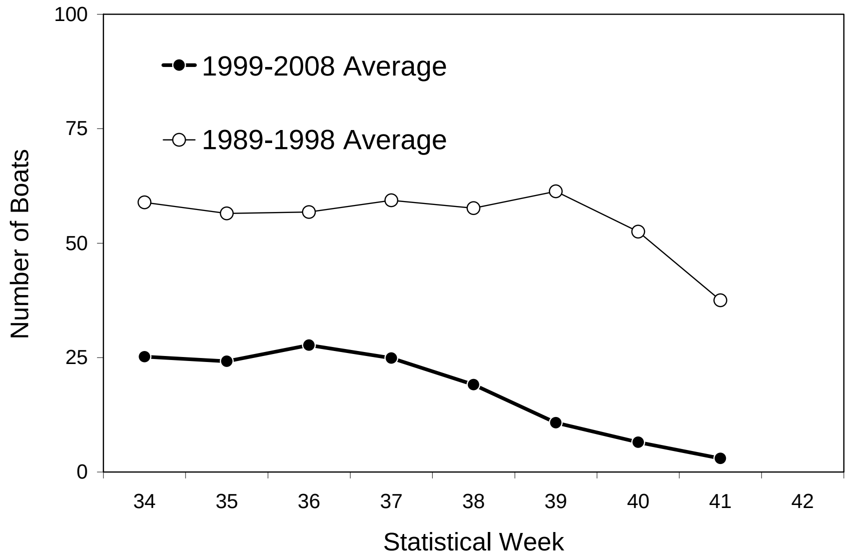

Figure 12.–Average number of boats fishing by statistical week in the Taku Inlet (subdistrict 111-32) drift gillnet fishery, 1960–2008. All chum salmon harvested in statistical week 34 (average mid-week date 20 August) and later are considered fall-run fish.

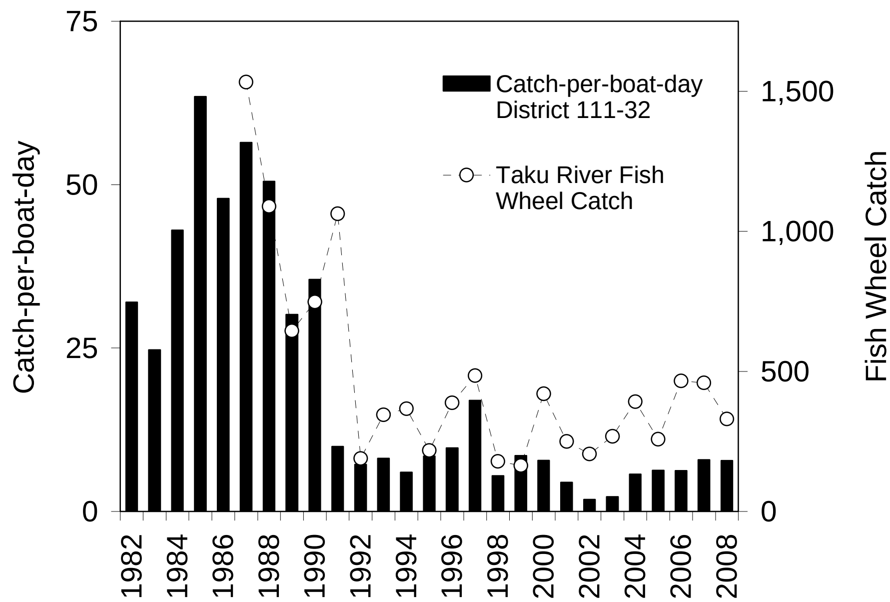

Figure 13.–Annual drift gillnet catch-per-boat-day of fall-run chum salmon in Taku Inlet (subdistrict 111-32; 1982–2008) plotted with the Taku River fish wheel catch of all chum salmon (1982–2008). All chum salmon harvested in statistical week 34 (average mid-week date 20 August) and later are considered fall-run fish.

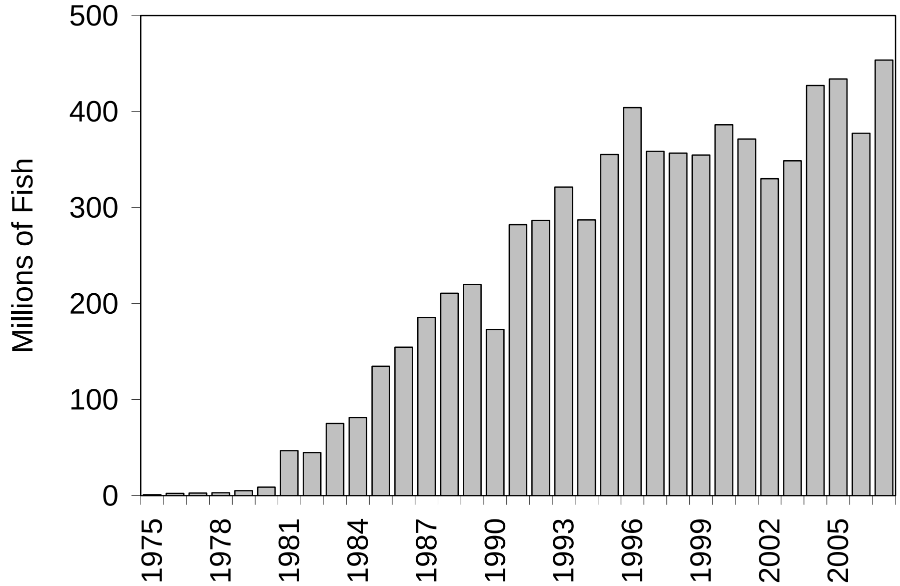

Figure 14.–Number of hatchery-produced chum salmon fry released annually in Southeast Alaska, 1975–2008.

Significant hatchery runs of chum salmon have been developed by Southern Southeast Regional Aquaculture Association (SSRAA), with initial releases occurring in 1980 (Figure 15). SSRAA releases increased through the 1980s to an average of 94 million fish per year in the 1990s (range: 76 to 100 million fry). Production recently increased to an average of 119 million fish per year over the brood years 2003–2007. SSRAA has released chum salmon at Nakat Inlet, Earl West Cove, Neets Bay, Anita Bay, and Kendrick Bay. Over the years, SSRAA has marked nearly 100% of all of its releases in order to track returns: broods 1979 through 2002 were marked with coded-wire tags, and broods 2002 and later were thermally marked. The 2002 brood was double-marked with both coded-wire tags and thermal marks in order to compare estimates of the harvest based on analyses using each mark type.

Significant hatchery runs of chum salmon have been developed by Northern Southeast Regional Aquaculture Association (NSRAA), with initial releases occurring in 1981 (Figure 15). NSRAA's largest chum salmon releases have been at Hidden Falls and Deep Inlet, and also at Boat Harbor, where releases are from combined NSRAA and Douglas Island Pink and Chum, Inc. production. NSRAA releases increased steadily over time and averaged 140 million fry a year over the past five years, making it the largest producer of chum salmon in the state. NSRAA has not consistently marked its releases (Figure 15); however, thermal marking was initiated with the 1991 brood and the proportion of NSRAA releases that were thermally marked increased to more than 80% of the brood year releases since 2003.

Significant hatchery runs of chum salmon have been developed by Douglas Island Pink and Chum, Inc. (DIPAC), with initial releases occurring in 1977. DIPAC releases increased through the 1980s, but have been fairly stable since the 1990 brood with average releases of 98 million fry annually (range: 68 to 115 million fry; Figure 15). DIPAC releases chum salmon at Amalga Harbor and Gastineau Channel, and at Limestone Inlet and Boat Harbor where releases are from combined

DIPAC and NSRAA production. DIPAC has consistently marked its releases, initially with coded-wire tags (through the 1992 brood) and later with thermal marks (since the 1991 brood). DIPAC has marked 100% of its releases with thermal marks since the 1997 brood (Figure 15).

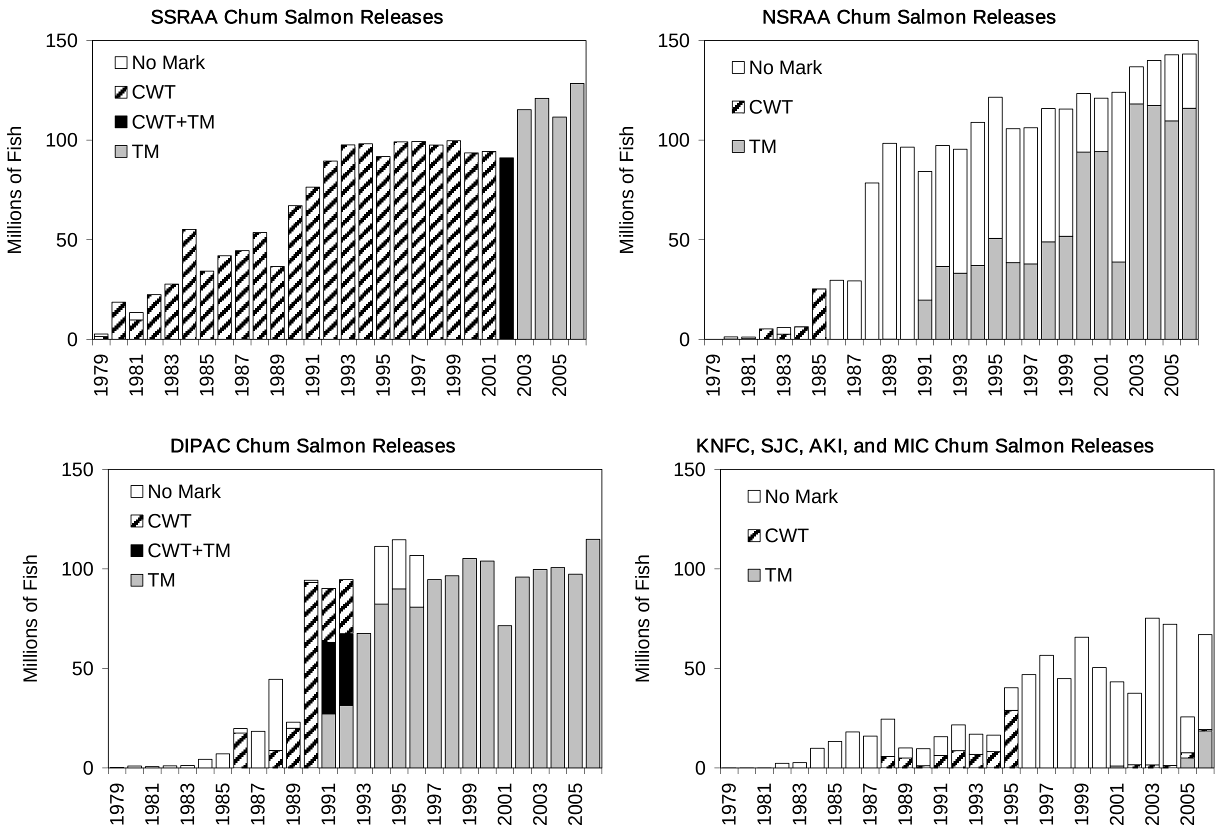

Figure 15.–Releases of chum salmon from the major private nonprofit hatcheries in Southeast Alaska (NSRAA; DIPAC; SSRAA; and KNFC, SJC, AKI, and MIC pooled), by brood year, 1979–2006. Releases are presented by type of mark: no mark, coded-wire tag (CWT), thermal mark (TM), and coded-wire tag and thermal mark (TM) combined (CWT+TM). (Does not include ADF&G hatchery releases from 1976 to 1991.)

Smaller hatchery runs of chum salmon were also developed by Kake Non-Profit Fisheries Corporation (KNFC; at Gunnuck Creek and Southeast Cove), Sheldon Jackson College (SJC; at Crescent Bay and Deep Inlet), Armstrong-Keta, Inc. (AKI; at Port Armstrong) and Metlakatla Indian Community (MIC; at Tamgas Creek). The releases for KNFC, SJC, AKI, and MIC, in aggregate, have ranged from 35 to 75 million fish (Figure 15).

Brood stocks used to develop the above hatchery runs were taken from wild stocks generally near the release areas (c.f. ADF&G 2004). The hatchery runs at DIPAC, NSRAA, MIC, SJC, and KNFC are entirely summer-run. SSRAA releases fall-run stocks at Nakat Inlet and Neets Bay. SSRAA releases are predominantly summer-run; however, fall runs averaged roughly 20% of production over the last 10 years.

HARVEST

Wild chum salmon are harvested primarily in mixed-stock or passing-stock fisheries, typically some distance from spawning areas, and it is usually not possible to account for stock-specific harvests. Chum salmon are mostly harvested incidentally to other species in common property fisheries which are managed based on abundance of the target species; for example, summer-run chum salmon stocks in Southeast Alaska are harvested incidentally in directed pink salmon purse seine fisheries. Some chum salmon runs are harvested directly in terminal or near-terminal fisheries, which allows for some accounting of harvest; however, in nearly all such cases, these fish also migrate through other common-property fisheries prior to reaching the terminal areas.

Hatchery runs are intensively harvested in terminal areas defined in regulation: either terminal harvest areas or special harvest areas. Both are considered terminal areas and catch in these areas are considered specific to the respective hatchery stocks released at that site. Substantial harvest of chum salmon hatchery stocks also occurs in common property fisheries targeting other species. Salmon catches are reported by common property statistical areas, which are defined as districts and sub-districts. In addition, catches in terminal areas are accounted for, and include both cost recovery and catch by various gear groups fishing in the terminal areas.

A large proportion of the chum salmon catch in common property fisheries since the early 1990s has been composed of hatchery stocks, particularly during the summer-run period. The chum salmon releases from SSRAA facilities have been coded-wire tagged or thermal marked from the outset of production (Figure 15). In addition, almost all of the common property chum salmon harvested in southern Southeast Alaska (i.e., Districts 1–8) fisheries have been sampled for coded-wire tags or thermal marks since 1983, which allowed us to estimate the catch of hatchery chum salmon in southern Southeast Alaska. (See details of the methods used in Appendix B.) Prior to the onset of hatchery runs in the early 1980s, wild chum salmon harvests were relatively stable, averaged 650 thousand, and ranged from 70 thousand to 1.25 million. Hatchery runs increased steadily from the early 1980s through the mid 1990s. Since the mid 1990s, the hatchery runs have declined slightly from the peak runs of the mid 1990s. For the last decade hatchery runs have been relatively stable at high levels and have consistently averaged 70% of the total harvests of chum salmon in southern Southeast Alaska (Figure 16). The harvest of wild stocks increased in concordance with hatchery runs—they tend to fluctuate with the hatchery runs and have been relatively high since the early 1990s (Figure 16).

Stock identification was not possible for the common property fisheries in Northern Southeast Inside areas because the hatchery stocks were not completely marked until recently; however, the catches of chum salmon in Lynn Canal (District 15) and the Taku-Snettisham area (District 11) during the summer-run period are composed almost entirely of hatchery stocks. Hatchery runs of chum salmon in Northern Southeast (closely tracked by the District 15 and 11 summer-run harvests and hatchery terminal harvests) increased rapidly in the early 1990s and have remained high since the mid-1990s (Figure 17). Hatchery runs have averaged almost 82% of the total Northern Southeast Inside chum salmon harvest since 1995. Wild chum salmon harvests in Northern Southeast Inside areas declined from the late 1970s, and were at relatively low levels until the mid 1980s. Harvest increased in the common property fisheries outside of hatchery terminal areas coincident with, and partially due to, the onset of hatchery runs in Northern Southeast Inside areas (Figure 17). The wild chum salmon harvests in the fall-run period declined in the early 1990s, and have been relatively low since. Annual fall-run harvests in Northern Southeast areas averaged 420 thousand from 1960 to 1990, but only 150 thousand since 1995.

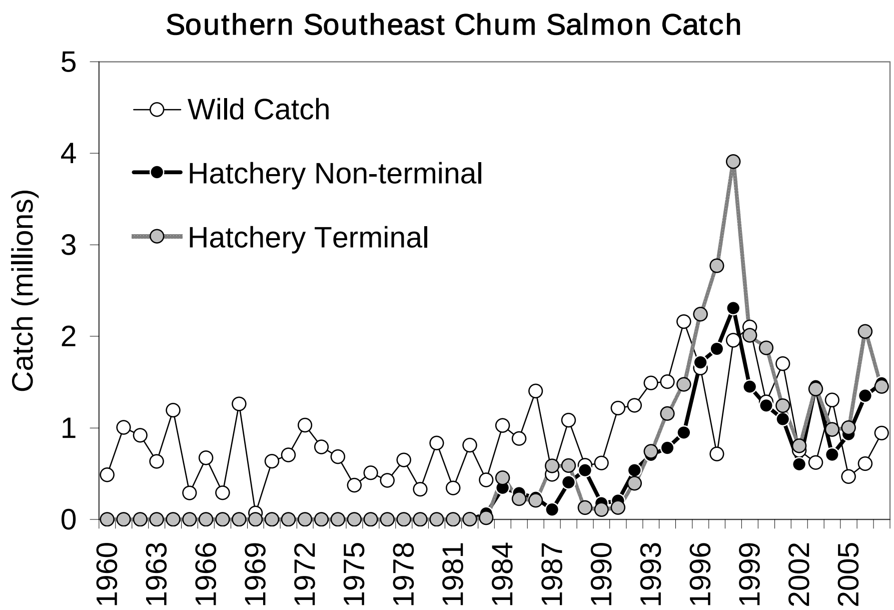

Figure 16.–Chum salmon catch in Southern Southeast Alaska, including estimated catches of wild chum salmon, and hatchery chum salmon in non-terminal and hatchery terminal areas, 1960–2007.

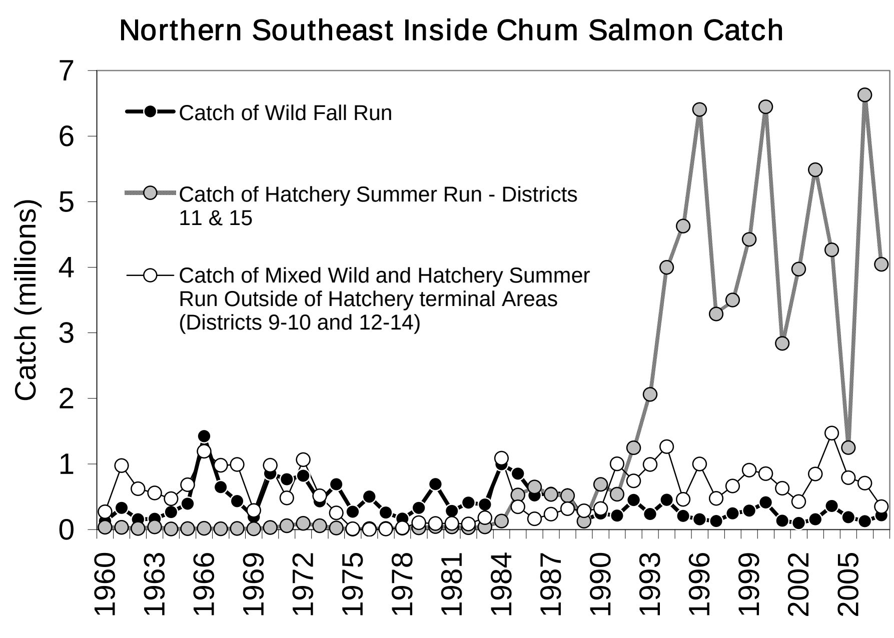

Figure 17.–Chum salmon catch in Northern Southeast Alaska Inside areas, including catch in wild fall-run fisheries, catch of summer-run hatchery chum salmon in areas of known hatchery origin (Districts 11 and 15), and catch of mixed wild-hatchery summer-run chum salmon stocks in areas outside of hatchery terminal areas, 1960–2007.

In Northern Southeast Outside areas chum salmon harvests were relatively low until the onset of hatchery runs in the early 1980s. Chum salmon harvests have greatly increased since the 1990s and increases were made entirely of hatchery runs (Figure 18).

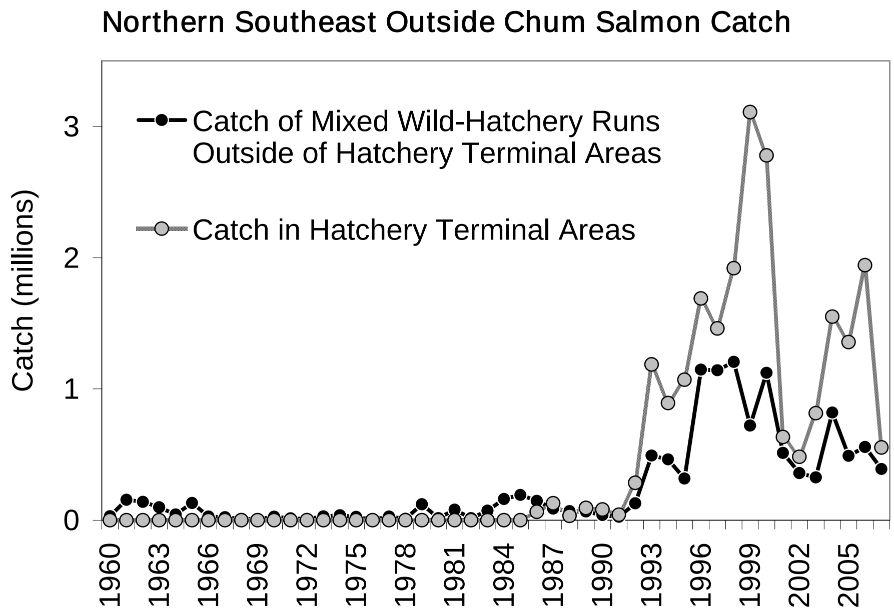

Figure 18.–Chum salmon catch in Northern Southeast Alaska Outside area, including catch of mixed wild-hatchery summer-run chum salmon stocks in areas outside of hatchery terminal areas and catch of hatchery fish inside hatchery terminal areas, 1960–2007.

ESCAPEMENT GOALS

Generally, two types of escapement goals have been established for Alaska fisheries based on the State of Alaska Policy for the Management of Sustainable Salmon Fisheries (5 AAC 39.222):

> *biological escapement goal* (BEG): the escapement that provides the greatest potential for maximum sustained yield; and
>
> *sustainable escapement goal* (SEG): a level of escapement, indicated by an index or an escapement estimate, that is known to provide for sustained yield over a 5 to 10 year period, used in situations where a BEG cannot be estimated due to the absence of a stock specific catch estimate.

The state's Policy for Statewide Salmon Escapement Goals (5 AAC 39.223) further requires that *biological escapement goals* be established for "salmon stocks for which the department can reliably enumerate escapement levels, as well as total annual returns." Biological escapement goals, therefore, require accurate knowledge of catch and escapement by age class.

At this time, we have identified only one chum salmon stock in Southeast Alaska with sufficient information to establish a *biological escapement goal* under the Sustainable Salmon Fisheries Policy (Lynn Canal fall chum salmon). Available information for most chum salmon stocks in Southeast Alaska fits into the "fair" or "poor" categories as defined by Bue and Hasbrouck

(*Unpublished*)[1], primarily due to lack of stock-specific harvest information, estimates of total escapement, or estimates of return by age:

> Fair: Escapement estimated or indexed and harvest estimated with reasonably good accuracy but precision lacking for one if not both; no age data; data insufficient to estimate total return and construct brood tables.
>
> Poor: Escapement indexed (e.g., single foot/aerial survey) such that the index provides a fairly reliable measure of escapement; no harvest and age data.

METHODS FOR SETTING ESCAPEMENT GOALS

Two methods were used to evaluate potential *sustainable escapement goals* (SEG) for most of the chum salmon stocks in Southeast Alaska. The first was the simple percentile approach recommended by Bue and Hasbrouck (*Unpublished*) for setting an SEG based on percentiles of historic escapement data. The second method was the risk analysis method by Bernard et al. (*Unpublished*)[2]. Both methods have been used extensively throughout Alaska to set SEGs for chum salmon in situations where stock assessment data were insufficient to establish a *biological escapement goal* through a more technical approach; e.g., see escapement goals for chum salmon in Prince William Sound (Bue et al. 2002), Lower Cook Inlet (Otis and Hasbrouck 2004, Otis and Szarzi 2007), Upper Cook Inlet (Hasbrouck and Edmundsen 2007), Kodiak (Honnold et al. 2007a), Chignik (Witteveen et al. 2007), Alaska Peninsula/Aleutian Islands (Honnold et al. 2007b), Bristol Bay (Baker et al. 2006), and Kuskokwim areas (Molyneaux and Brannian 2006). In addition, we used standard stock-recruit analysis to evaluate potential escapement goals for Lynn Canal fall chum salmon.

Threshold SEG goals were established for some stocks of chum salmon, rather than a range, because they are harvested incidentally in mixed-stock commercial fisheries and their escapements cannot be effectively managed to fall within a range. This is particularly true for the summer-run chum salmon stocks in Southeast Alaska that are harvested incidentally in directed pink salmon fisheries. We also note that our escapement goal analyses were conducted prior to the 2008 season; therefore, we used data available through the 2007 field season, but we updated catch and escapement information in this report through 2008.

Percentile Method

Bue and Hasbrouck (*Unpublished*) suggested a simple, algorithm-based method to estimate SEGs for salmon stocks that used percentiles of observed escapements (total estimates or indices of abundance) that incorporated contrast in the escapement data and information about the relative exploitation of the stock (Table 3). Percentile ranking is the percent of all escapement values that fall below a particular value. To calculate percentiles, escapement data were ranked

---

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

[2] Bernard, D. R., J. J. Hasbrouck, Alaska Department of Fish and Game, Division of Sport Fish, and B. G. Bue Alaska Department of Fish and Game, Division of Commercial Fisheries. *Unpublished study*. Estimating risk of management error from precautionary reference points (PRPs) for non-target salmon stocks. Supsequently referred to as Bernard et al (*Unpublished*).

from the smallest to the largest value, with the smallest value equal to the 0th percentile (i.e., none of the escapement values are less than the smallest). The percentile of all remaining escapement values is a cumulative, or summation, of 1/(*n*-1), where *n* is the number of escapement values. Contrast in the escapement data is simply the maximum value divided by the minimum value. As contrast increased, Bue and Hasbrouck recommended that percentiles used to estimate the SEG be narrowed, primarily from the upper range, to allow the SEG to include a range of escapements. For exploited stocks with high contrast, the lower end of the SEG range was increased to the 25th percentile as a precautionary measure for stock protection.

Table 3.–Criteria used to estimate sustainable escapement goals (SEG).

Escapement Contrast[a] and Exploitation	SEG Range
Low contrast (<4)	15th percentile to maximum observation
Medium contrast (4–8)	15th to 85th percentile
High contrast (>8); low exploitation	15th to 75th percentile
High contrast (>8); exploited population	25th to 75th percentile

[a] Relative range of the entire time series of escapement data calculated by dividing the maximum observed escapement by the minimum observed escapement.

Risk Analysis Method

Bernard et al. (*Unpublished*) described a method of estimating the competing risk of management error associated with setting a sustainable escapement goal based on the historical observations of spawning escapement. The competing management error risks include the risk of unneeded action (i.e., the risk of taking management action when no action is warranted) and risk of mistaken inaction (i.e., the risk of not taking management action when it is warranted). The determination of these risks depends on a stochastic model of escapement, the level of escapement goal, and, in the case of risk of mistaken inaction, a level of population decline where management action is needed. The underlying model of escapement variation is the log normal probability distribution estimated from observed historical escapements. If the historical escapements are serially correlated, then the escapements were modeled by an autoregressive process and lognormal process errors (c.f. Bernard et al. *Unpublished*). For each of the Southeast Alaska chum salmon stocks, we present the competing risks (unneeded action and mistaken inaction for 50%, 75% and 85% declines) for a range of escapement goals that encompass the proposed SEG based on the percentile method.

Stock Recruit Analysis Method

Where assessment of total return by age is available, biological escapement goals can be established based on stock-recruit analysis. The stock recruit model used are Ricker-type (Ricker 1975) and hierarchal terms including escapement density, and a first-order autoregressive term. Three models were constructed: 1) linear, no density dependence escapement; 2) straight Ricker, escapement density dependence; and 3) autoregressive Ricker, density dependence with first order autoregressive term. The significance of the relative fit of the alternative models was evaluated using a likelihood-ratio test (Hilborn and Mangel 1997).

Model 1; Linear:

$$R_i = S_i \exp(\alpha)\exp(\varepsilon_i)\text{, and} \tag{1}$$

Model 2; Straight Ricker:

$$R_i = S_i \exp\left(\alpha\left(1 - S_i/\beta\right)\right)\exp(\varepsilon_i)\text{, and} \tag{2}$$

Model 3; Autoregressive Ricker:

$$R_i = S_i \exp\left(\alpha\left(1 - S_i/\beta\right)\right)\exp(\phi\varepsilon_{i-1})\text{,} \tag{3}$$

where α, β, ϕ are model parameters, and the data are total recruits from brood year *i* escapement (R_i), escapement in brood year *i* (S_i), and ε_i is the process error, $\ln(\varepsilon_i) \sim \text{normal}(0,\sigma)$. Parameters were selected to maximize likelihood (L). The log normal error structure was used to derive the likelihood function (L).

The parameters (α, β, ϕ, and σ) of the respective models were estimated using EXCEL. The models were fit to the data using the solver routine to search over the parameter space to maximize L. The α and β parameters of the stock-recruit models were bias-corrected using procedures in Hilborn and Walters (1992). Appropriate reference points were calculated using the bias corrected parameters (α' and β'):

$$\alpha' = \alpha + \sigma^2/2\text{,}$$

$$\beta' = \frac{\alpha'}{\alpha}\beta\text{, and} \tag{4}$$

$$\sigma^2 = \frac{\sum \ln\left(\frac{\hat{R}_i}{S_i}\right)^2}{n - p}\text{.} \tag{5}$$

For the autoregressive model the bias correction is:

$$\alpha' = \alpha + \sigma^2/2(1-\phi^2)\text{.} \tag{6}$$

For each model applied to stock-recruit data, we calculated the maximum sustained yield (MSY) escapement goal, the range of escapement that produces 90% of MSY, and MSY harvest rate. In addition, the likelihood profile for the MSY escapement goal and the MSY harvest rate were calculated. The likelihood profiles were estimated using a numerical method described in Hilborn and Mangel (1997) and used to evaluate the uncertainty in these reference points.

ESCAPEMENT GOAL ANALYSIS

Southern Southeast Summer-Run Chum Salmon

Peak escapement survey data were available for analysis over a 28-year period (1980–2007) for 13 summer-run chum salmon index streams in the Southern Southeast sub-region (Appendix

A1). There was high contrast (>8) in the aggregate escapement index series for all 13 streams combined. The exploitation rate on summer chum salmon in the traditional mixed-stock commercial net fisheries is assumed to be at least moderate, based on the harvest rates on hatchery stocks in Southern Southeast common property fisheries (Appendix B).

Percentile Approach

We used the 25th percentile of the aggregate escapement series, based on high contrast in the escapement index and at least moderate exploitation, to calculate a peak-survey SEG threshold of 68,000 index spawners. The escapement index fell below this SEG value for three consecutive years only one time since 1980 (1981–1983; Figure 19).

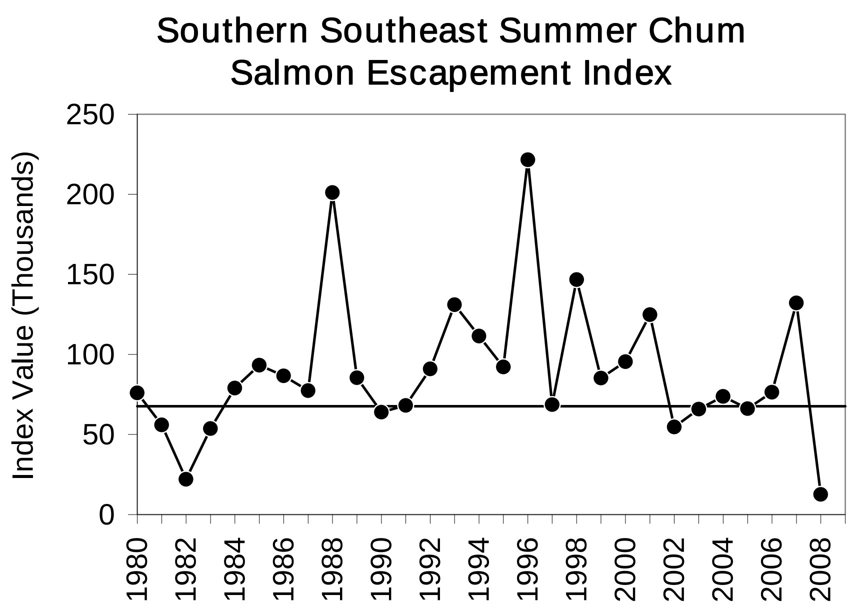

Figure 19.–Observed escapement index value, 1980–2008, (solid circles) and recommended SEG threshold of 68,000 index spawners (horizontal line) for Southern Southeast sub-region summer-run chum salmon.

Risk Analysis Approach

Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in abundance, were calculated for Southern Southeast sub-region summer-run chum salmon (Figure 20). These were based on the log-normal probability distribution fit to historical escapements. The proposed SEG of 68,000 index spawners has very low (<2%) risk of unneeded action and low (<3%) risk of management inaction given steep declines in abundance, and moderate risk of management inaction given moderate declines in abundance.

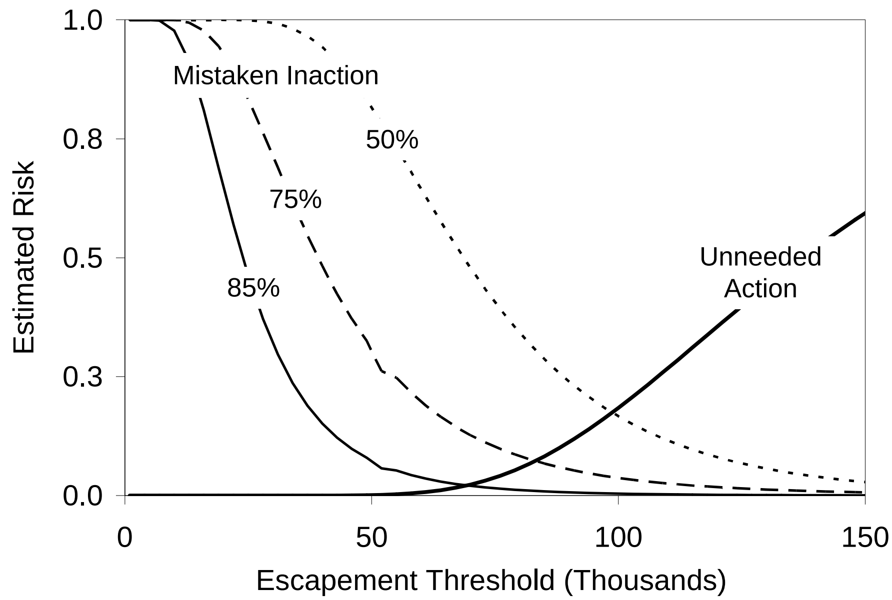

Figure 20.–Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in population for Southern Southeast sub-region summer-run chum salmon.

Northern Southeast Inside Summer-Run Chum Salmon

Peak escapement survey data were available for analysis over a 26-year period (1982–2007) for 63 summer-run chum salmon streams in the Northern Southeast Inside sub-region (Appendix A2). There was high contrast (>8) in the aggregate escapement index series for all 63 streams combined. Little stock specific harvest data were available for the stock group as a whole; however, the exploitation rate on summer chum salmon in the traditional mixed-stock commercial net fisheries is assumed to be at least moderate.

Percentile Approach

We used the 25th percentile of the aggregate escapement series, based on high contrast in the escapement index and at least moderate exploitation, to calculate a peak-survey SEG threshold of 149,000 index spawners. The escapement index fell below this SEG value during a period of five of six consecutive years in 1986–1991 (Figure 21).

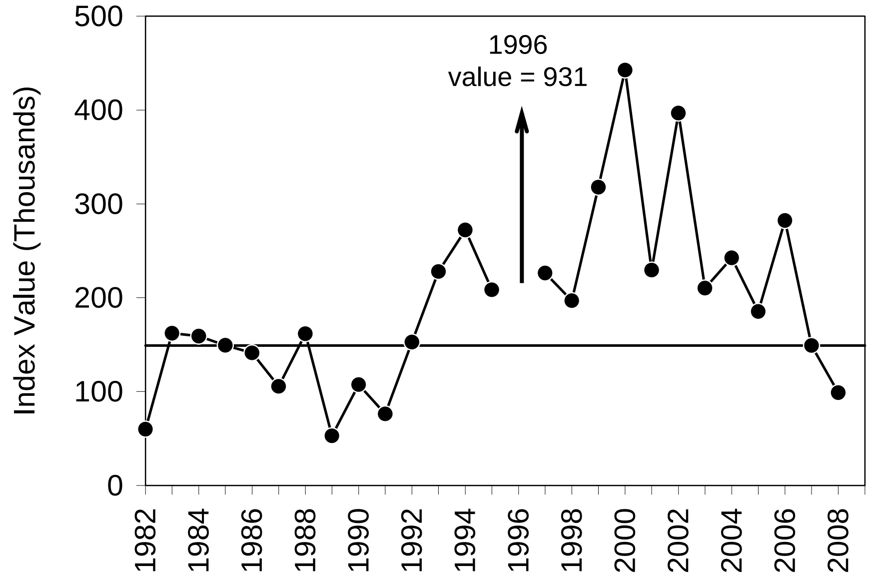

Figure 21.–Observed escapement index value, 1982–2008, (solid circles) and recommended SEG threshold of 149,000 index spawners (horizontal line) for Northern Southeast Inside sub-region summer-run chum salmon.

Risk Analysis Approach

Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in abundance, were calculated for Northern Southeast Inside sub-region summer-run chum salmon (Figure 22). These were based on the log-normal probability distribution fit to historical escapements. The proposed SEG of 149,000 index spawners has very low (< 1%) risk of unneeded action and very low (<2%) risk of management inaction for given steep declines in abundance, and moderate risk of management inaction for moderate declines in abundance.

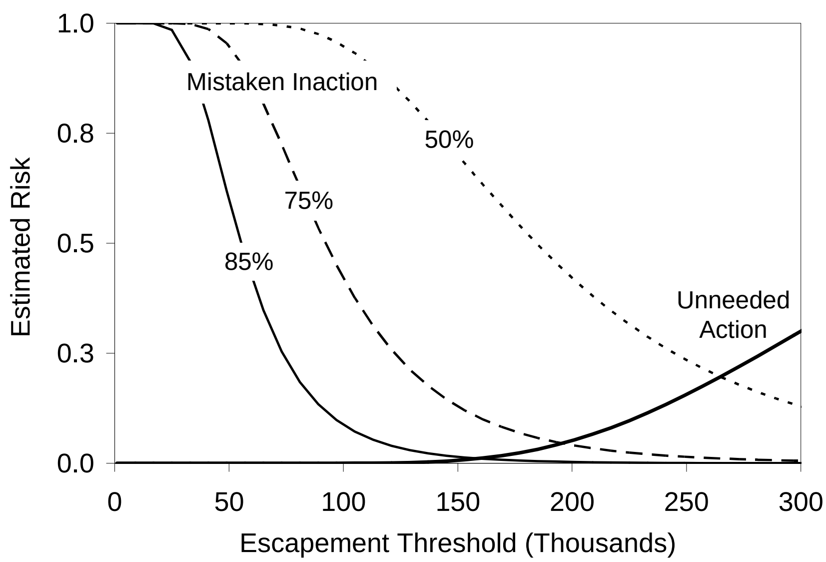

Figure 22.–Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in population for Northern Southeast Inside sub-region summer-run chum salmon.

Northern Southeast Outside Summer-Run Chum Salmon

Peak escapement survey data were available for analysis over a 26-year period (1982–2007) for five summer-run chum salmon streams in the Northern Southeast Outside sub-region (Appendix A3). There was high contrast (>8) in the aggregate escapement index series for all five streams combined. No stock specific harvest data were available; however, the exploitation rate on summer chum salmon in the traditional mixed-stock commercial net fisheries is assumed to be at least moderate.

Percentile Approach

We used the 25th percentile of the aggregate escapement series, based on high contrast in the escapement index and at least moderate exploitation, to calculate a peak-survey SEG threshold of 19,000 index spawners. The escapement index fell below this SEG value for three consecutive years only one time since 1982 (1993–1995; Figure 23).

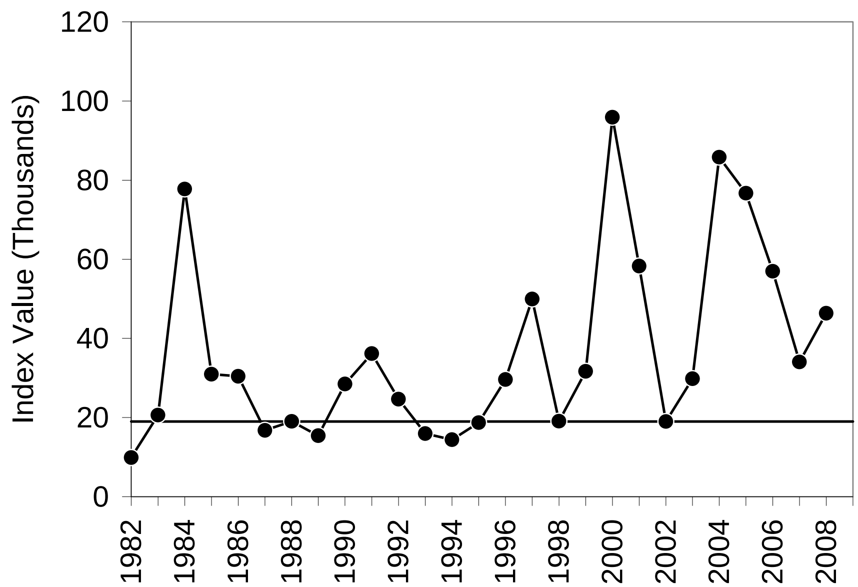

Figure 23.–Observed escapement index value, 1982–2008, (solid circles) and recommended SEG threshold of 19,000 index spawners (shaded area) for Northern Southeast Outside sub-region summer-run chum salmon.

Risk Analysis Approach

Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in abundance, were calculated for Northern Southeast Outside sub-region summer-run chum salmon (Figure 24). These were based on the log-normal probability distribution fit to historical escapements. The proposed SEG of 19,000 index spawners has very low risk (< 1%) of unneeded action and low (< 5%) risk of management inaction given steep declines in abundance and moderate risk of management inaction given moderate declines in abundance.

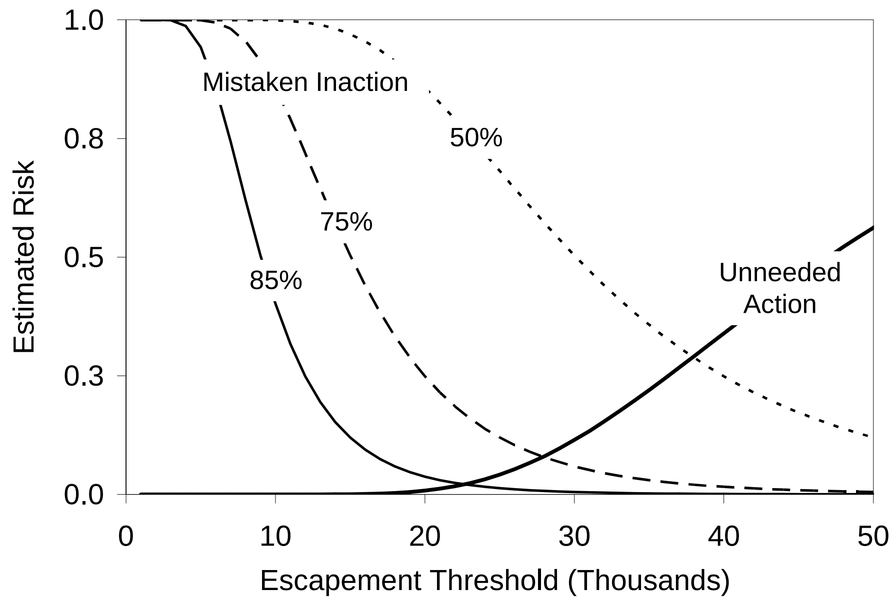

Figure 24.–Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in population for Northern Southeast Outside sub-region summer-run chum salmon.

Cholmondeley Sound Fall-Run Chum Salmon

Peak escapement survey data were available for analysis over a 28-year period (1980–2007) for the two primary fall-run chum salmon streams in Cholmondeley Sound on the east coast of Prince of Wales Island: Disappearance Creek and Lagoon Creek (Appendix A4). Based on the historical median escapement index to each stream, Lagoon Creek accounted for 41% of the escapement index and Disappearance Creek accounted for 59% of the escapement index. There was high contrast (>8) in the aggregate escapement index series for both streams combined. Cholmondeley Sound fall chum salmon have been harvested annually in a terminal fishery and the exploitation rate is assumed to be at least moderate. These fish are likely also harvested in other mixed-stock fisheries prior to reaching the terminal area.

Percentile Approach

We used the 25th and 75th percentiles of the aggregate escapement series, based on high contrast in the escapement index and at least moderate exploitation, to calculate a peak-survey SEG range of 30,000 to 48,000 index spawners. The escapement index fell below this SEG value for the first four consecutive years (1980–1983) and in two of the most recent four years (2005–2008; Figure 25).

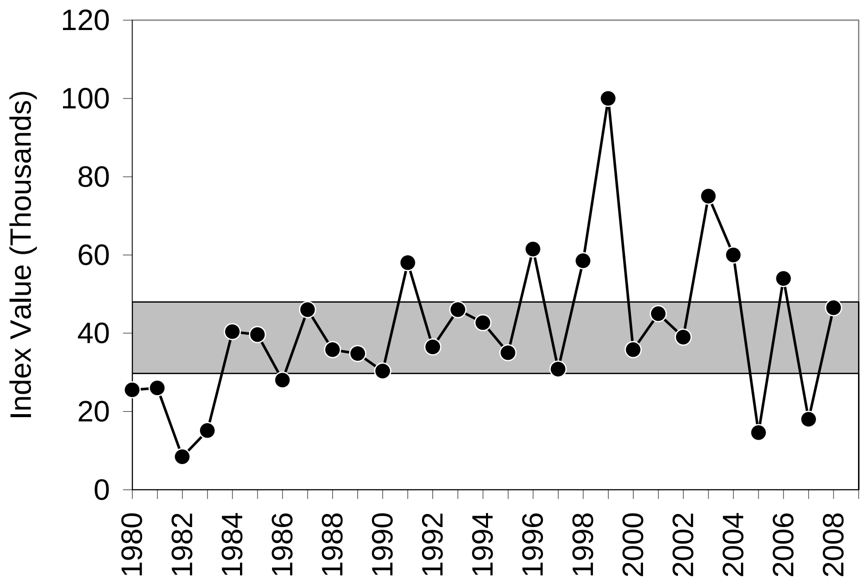

Figure 25.–Observed escapement index value, 1980–2008, (solid circles) and recommended SEG range of 30,000 to 48,000 index spawners (shaded area) for Cholmondeley Sound fall-run chum salmon.

Risk Analysis Approach

Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in abundance, were calculated for Cholmondeley Sound fall-run chum salmon (Figure 26). These were based on the log-normal probability distribution fit to historical escapements. The proposed lower bound SEG of 30,000 index spawners has very low (< 1%) risk of unneeded action and very low (< 1%) risk of management inaction given steep declines in abundance, and moderate risk of management inaction given moderate declines in abundance.

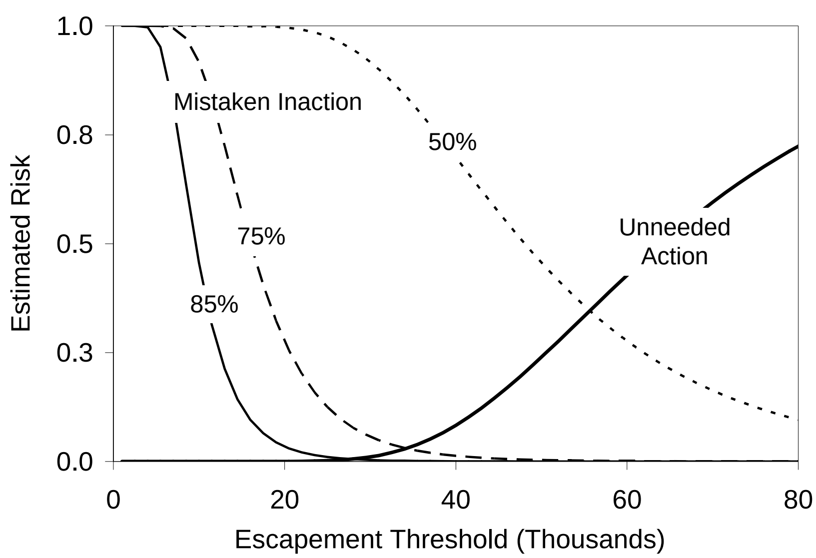

Figure 26.–Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in population for Cholmondeley Sound fall-run chum salmon.

Port Camden Fall-Run Chum Salmon

With the exception of 2001, peak escapement survey data were available for analysis over a 44-year period (1964–2007) for the two primary fall-run chum salmon streams in Port Camden: Port Camden S Head Creek and Port Camden W Head Creek (Appendix A5). Based on the historical median escapement index to each stream, Port Camden S Head Creek accounted for 73% of the escapement index and Port Camden W Head Creek accounted for 27% of the escapement index. There was high contrast (>8) in the aggregate escapement index series for both streams combined. Port Camden fall chum salmon have been harvested intermittently in a terminal fishery and the exploitation rate is assumed to be at least moderate. These fish are likely also harvested in other mixed-stock fisheries prior to reaching the terminal area. There was a decline in survey data since the late 1990s, from an average peak survey index of 6,000 from 1964 to 1998, to an average peak survey index of 2,000 since 1999.

Percentile Approach

We used the 25th and 75th percentiles of the 1964–1998 escapement series, based on high contrast in the escapement index and at least moderate exploitation, to calculate a peak-survey SEG range of 4,000 to 7,000 index spawners.

Risk Analysis Approach

Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in abundance, were calculated for Port Camden (District 109-43) fall-run chum salmon (Figure 27). These were based on the log-normal probability distribution fit to historical escapements. The proposed lower bound SEG of 4,000 index spawners, based on the percentile approach, has relatively high risk of unneeded action (Figure 27). In view of this risk, we recommend a lower SEG range of 2,000 to 7,000 index spawners. This lower bound SEG has a low (4%) risk of unneeded action and low (<4%) risk of management inaction given a steep decline in abundance, and moderate risk of management inaction given a moderate decline in abundance. The escapement index fell below this proposed lower bound SEG value (2,000 index spawners) in five of the most recent nine years (1999–2008, not including 2001; Figure 28).

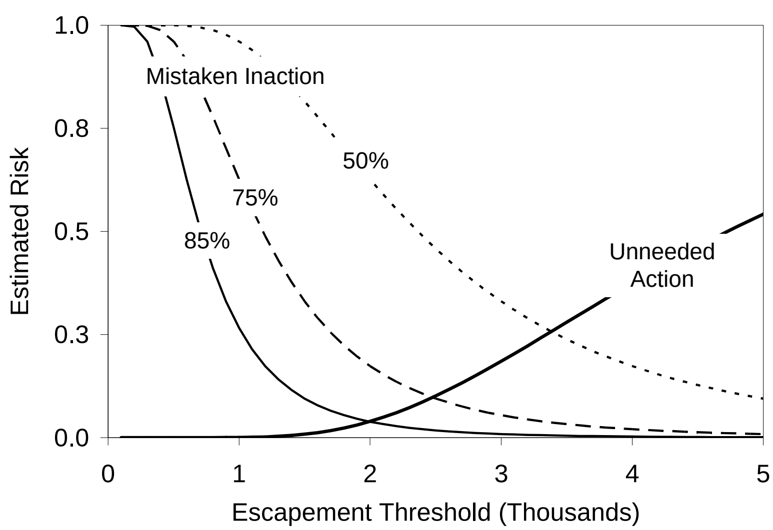

Figure 27.–Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in population for Port Camden (District 109-43) fall-run chum salmon.

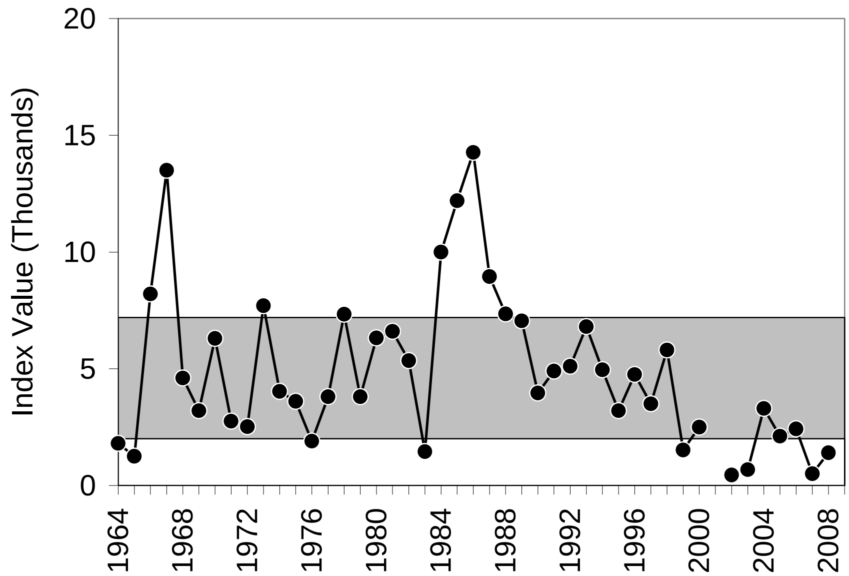

Figure 28.–Observed escapement index value, 1964–2008, (solid circles) and recommended SEG range of 2,000 to 7,000 index spawners (shaded area) for Port Camden (District 109-43) fall-run chum salmon.

Security Bay Fall-Run Chum Salmon

Peak escapement survey data were available for analysis over a 44-year period (1964–2007) for Salt Chuck Creek in Security Bay, Kuiu Island (Appendix A5). There was high contrast (>8) in the escapement index series. Security Bay fall chum salmon have been harvested intermittently in a terminal fishery and the exploitation rate is assumed to be at least moderate. These fish are likely also harvested in other mixed-stock fisheries prior to reaching the terminal area.

Percentile Approach

We used the 25th and 75th percentiles of the escapement series, based on high contrast in the escapement index and at least moderate exploitation, to calculate a peak-survey SEG range of 5,000 to 15,000 index spawners. The escapement index fell below this SEG value for three consecutive years only one time since 1964 (1966–1968; Figure 29).

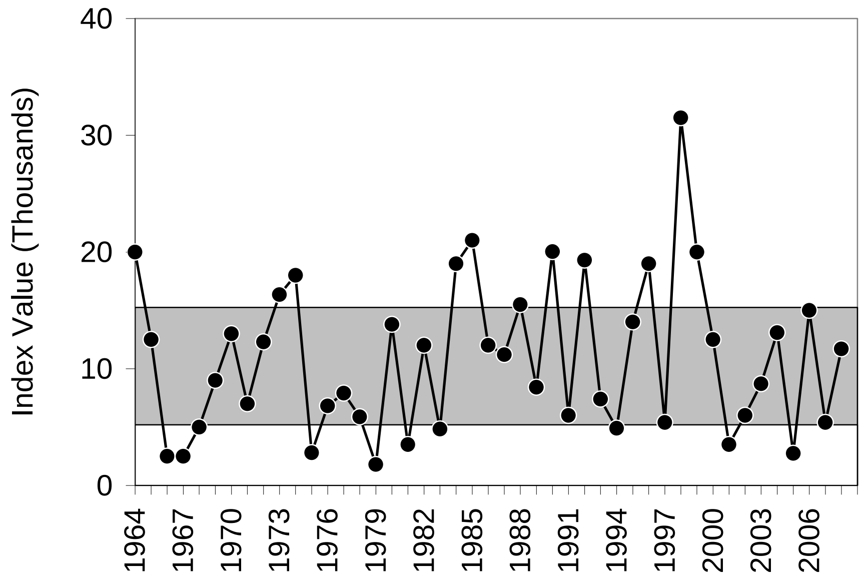

Figure 29.–Observed escapement index value, 1964–2008, (solid circles) and recommended SEG range of 5,000 to 15,000 index spawners (shaded area) for Security Bay (District 109-45) fall-run chum salmon.

Risk Analysis Approach

Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in abundance, were calculated for Security Bay (District 109-45) fall-run chum salmon (Figure 30). These were based on the log-normal probability distribution fit to historical escapements. The proposed lower bound SEG of 5,000 index spawners has very low (<1%) risk of unneeded action and low (13.7%) risk of management inaction given steep declines in abundance, and moderate risk of management inaction given moderate declines in abundance.

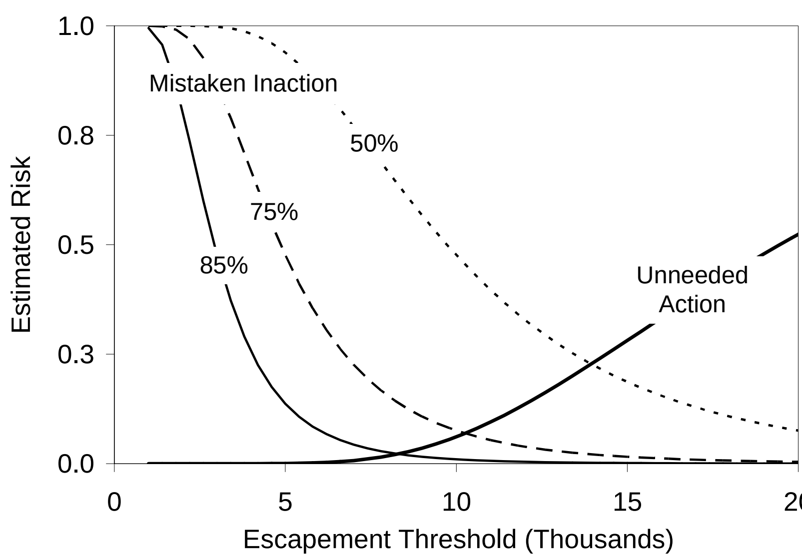

Figure 30.–Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in population for Security Bay (District 109-45) fall-run chum salmon.

Excursion River Fall-Run Chum Salmon

Peak escapement survey data were available for analysis over a 44-year period (1964–2007) for Excursion River fall-run chum salmon (Appendix A5). There was high contrast (>8) in the escapement index series. Excursion River fall chum salmon have been harvested nearly annually in a terminal fishery and the exploitation rate is assumed to be at least moderate. These fish are likely also harvested in other mixed-stock fisheries prior to reaching the terminal area. Survey and catch data suggest runs were much larger in the 1960s to early 1970s.

Percentile Approach

We used the 25th and 75th percentiles of the escapement series, based on high contrast in the escapement index and at least moderate exploitation, to calculate a peak-survey SEG range of 4,000 to 18,000 index spawners. The escapement index never fell below the lower range of the SEG for three consecutive years (1964–2007; Figure 31).

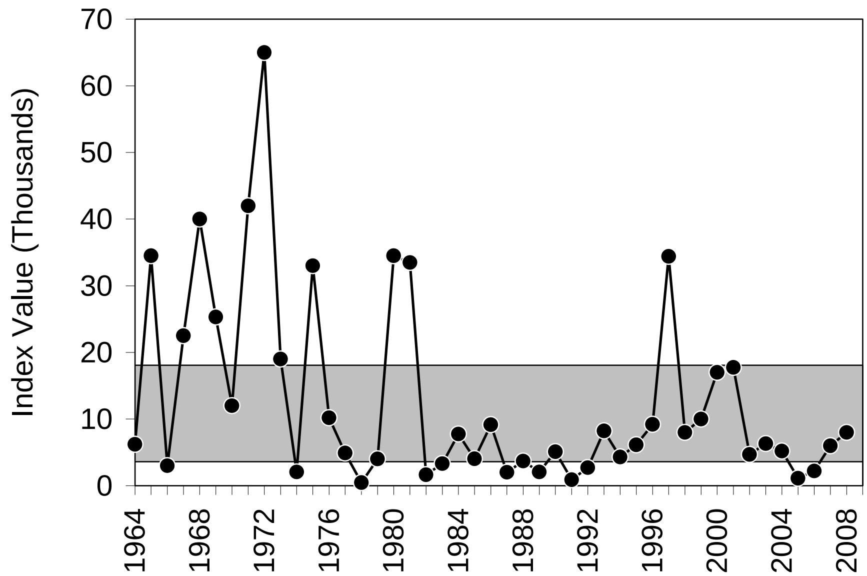

Figure 31.–Observed escapement index value, 1964–2008, (solid circles) and recommended SEG range of 4,000 to 18,000 thousand index spawners (shaded area) for Excursion River (114-80-020) fall-run chum salmon.

Risk Analysis Approach

Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in abundance, were calculated for Excursion River (District 114-80) fall-run chum salmon (Figure 32). These were based a first-order autoregressive time series model with log-normal process error to historical escapement time series. The proposed lower bound SEG of 4,000 index spawners has very low (<2%) risk of unneeded action and low risk of management inaction given steepest declines in abundance, and moderate risk (37%) of management inaction given steep to moderate declines in abundance.

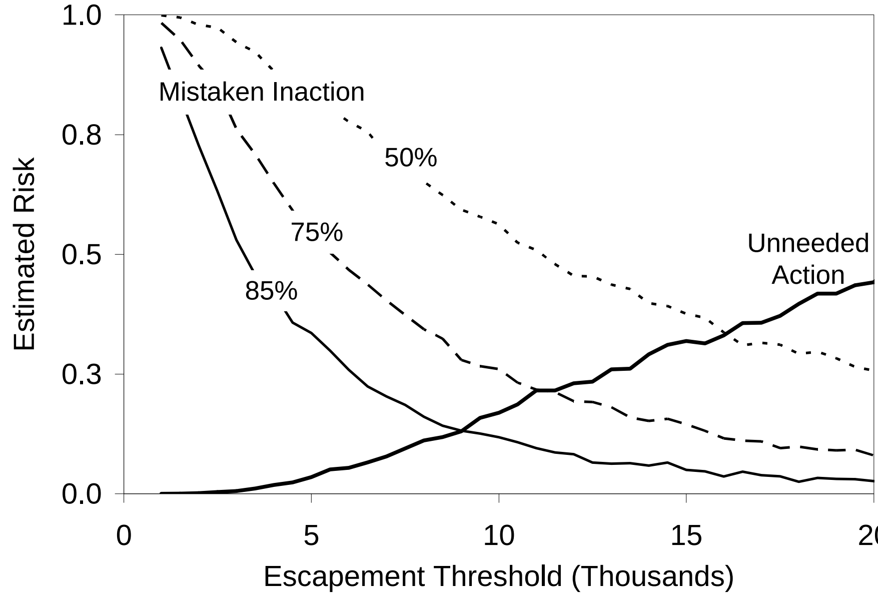

Figure 32.–Risk of unneeded action and mistaken inaction, given an 85%, 75%, and 50% drop in population for Excursion River (114-80-020) fall-run chum salmon.

Lynn Canal Fall-Run Chum Salmon

Peak escapement survey data were available over a 39-year period (1969–2007) for the Chilkat River and one of its tributaries, the Klehini River (Appendix A6); however, no peak survey data were available for five of those years (1974, 1977, 1978, 1986, and 1995). Survey and catch data suggest runs were much larger in the 1970s to the late 1980s. A complete assessment of Chilkat River total run (catch + escapement) by age was available for 1991, and 1994–2007. For those years, there was a relatively poor relationship between the peak survey counts and total escapement. Because of this, and the availability of total returns from parent escapement for 1994–2002 brood years, a stock recruit analysis was used to determine escapement goals for Chilkat River fall chum salmon.

Stock-Recruit Analysis Approach

The hierarchal set of stock-recruit models was fit to the Chilkat River fall-run chum salmon recruits (Table 4) from parent escapement for the 1994–2002 brood years (Table 5). There was reasonable contrast (9.4) in the limited stock-recruit data. There also was significant density dependence in the stock-recruit data; the model with the escapement term (Model 2) exhibited a significant fit improvement (likelihood ratio test p = 0.00) over the linear model (Model 1; Figure 33), and exhibited good definition of MSY escapement level and 90% MSY escapement range (Figure 34). There was no significant autocorrelation in the Model 2 residuals (Figure 35) and the Model 3 (i.e., with the autoregressive term, ϕ = 0.26, which corrects for time-series bias) provided no significant improvement in fit (likelihood ratio test, p = .67). Model 2 was selected as the best model: the recommended escapement goal is a total estimated escapement of 75,000 to 170,000 chum salmon, based on the 90% MSY escapement range. Note that simulated yields based on the bootstrapped stock recruit models and a given escapement levels suggest that expected yield is high for the recommended escapement goal (Figure 34).

Table 4.–Total recruits of Chilkat River fall chum salmon by age class for brood years 1994 to 2003. Quantities in bold italics are age classes from incomplete broods and are estimated from returns of older or younger age classes for that respective brood year.

Brood Year	Recruits by Age				Escapement	Total Recruits
	3	4	5	6		
1994	5,247	94,399	42,316	1,079	30,296	143,040
1995	7,457	267,745	64,517	2,869	61,123	342,588
1996	23,131	263,403	194,943	466	58,523	481,942
1997	1,139	178,045	61,972	1,084	87,667	242,239
1998	5,353	155,565	29,975	158	129,800	191,051
1999	15,132	156,769	74,252	1,398	283,333	247,551
2000	14,812	280,522	89,709	0	269,667	385,043
2001	8,132	167,424	157,093	3,893	312,000	336,541
2002	14,489	572,386	105,384	***3,426***	206,000	695,686
2003	32,777	255,111	***117,052***	***2,004***	166,000	406,944

Table 5–Results of model fits to the escapement recruit data, 1994–2003 brood years. Estimated parameters, reference points (MSY escapements, 90% MSY escapement goal ranges, MSY harvest rates), measures of fit (-log L, AIC), and p-values for likelihood ratio tests for significance of straight Ricker relative to linear and autoregressive Ricker relative to straight Ricker.

Model	Parameters			MSY Escape-ment	90% MSY Escapement Goal Range		MSY Harvest Rate	Fit Criteria		Number of Parameters	*p*-value
	α	β	ϕ		Lower	Upper		-log l	AIC		
1. Linear	0.9							16.52	18.52	1	
2. Straight Ricker	1.8	31		118	75	169	0.719	4.57	8.57	2	<0.00
3. Autoregressive Ricker	1.99	308	0.262	114	65	146	0.735	4.15	10.15	3	0.657

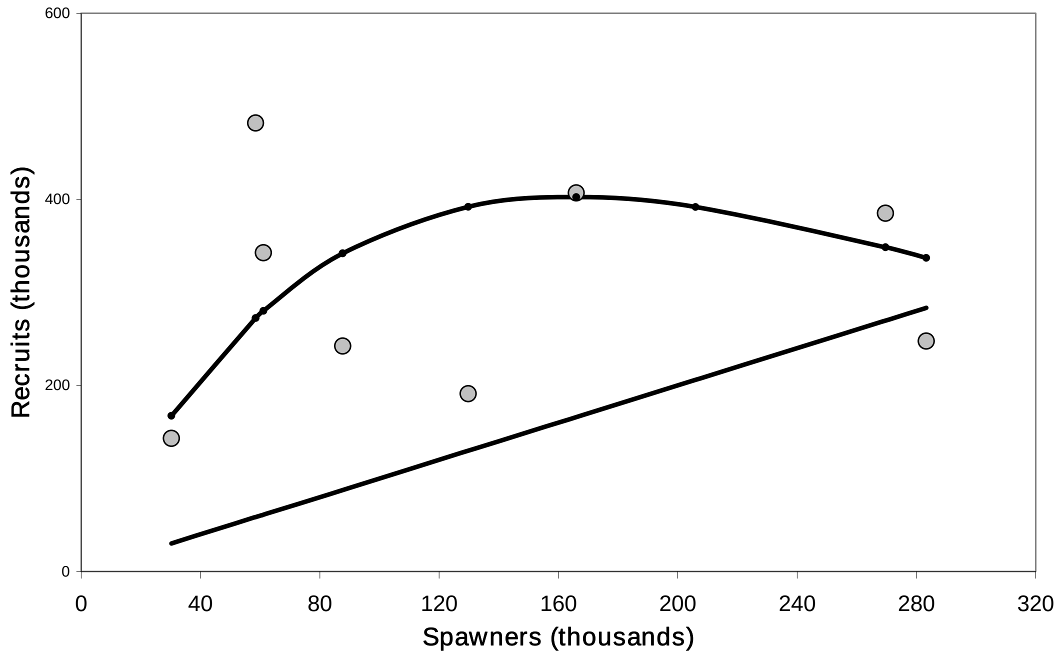

Figure 33.–Stock recruit relationship for Chilkat River chum salmon, 1994 to 2003 brood years. (Solid circles are observed recruits from parent escapement, solid line with gray points is Model 2 predicted recruits, and black line is the replacement line.)

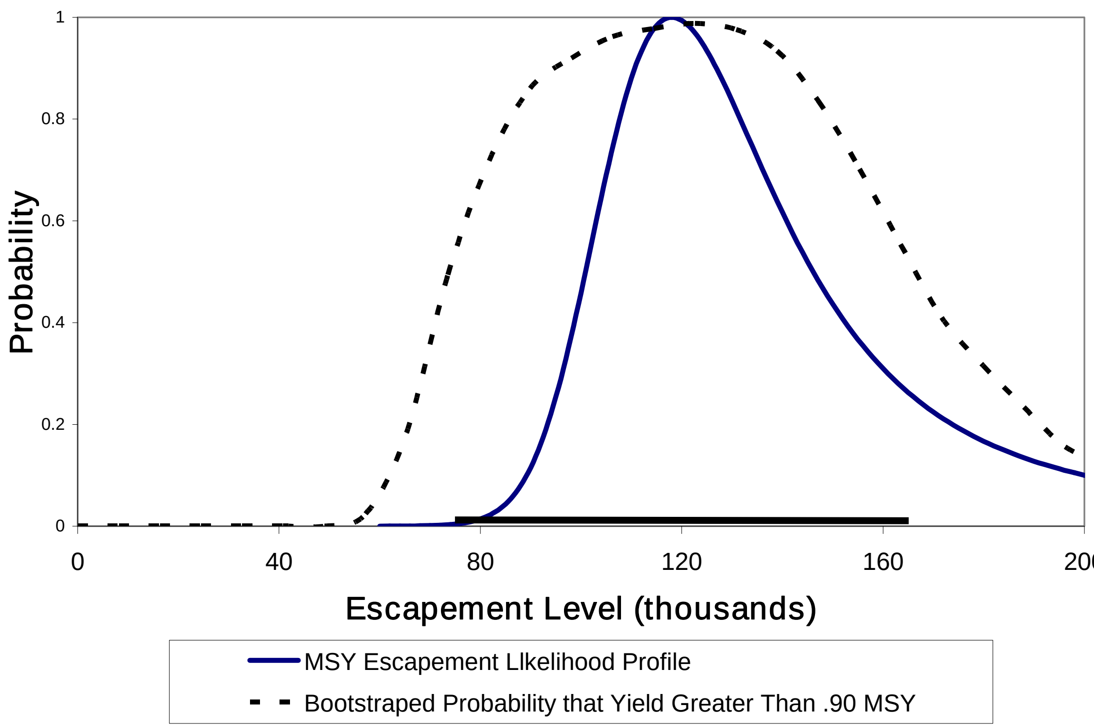

Figure 34**.–**Likelihood profile for MSY escapement level, Model 2 fit to stock-recruit data for fall-run Chilkat River chum salmon, 1994–2003 brood years. Bootstrapped probability that yield greater or equal to .90 MSY, for a given escapement level. Range of escapements indicated by bold line on X axis is recommended escapement goal.

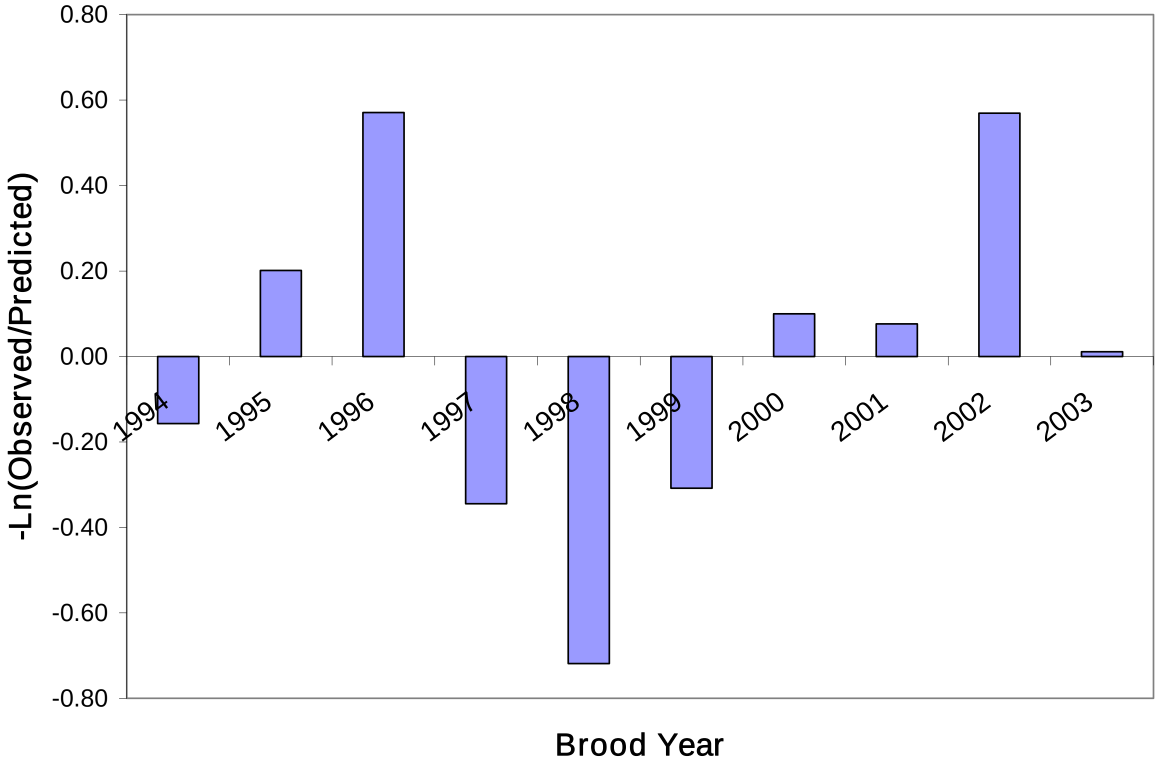

Figure 35.–Residual plots for the Model 2 stock-recruit relationship fit to the 1994 to 2003 brood years for Chilkat River fall-run chum salmon.

The escapement was below or near the lower range of the escapement goal range for a period of three years 1994–1996 (Figure 36) and within the escapement goal range in 1997 and 1998. The estimated escapement has been well above the recommended escapement goal range for Chilkat River fall-run chum salmon since 1999. There will be a significant increase in the escapement contrast in the future stock-recruit data when returns from recent large escapements are manifested. The recommended goal should be considered an SEG rather than a *biological escapement goal* because the data series has few years and the goal should be revaluated in the future as more stock-recruit data become available.

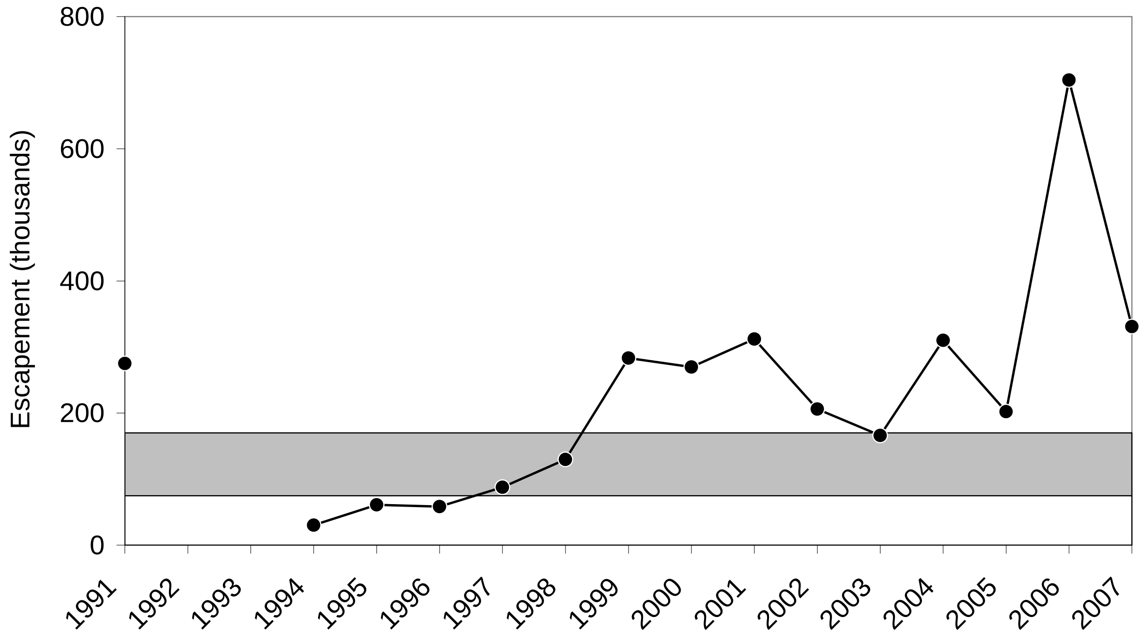

Figure 36.–Observed escapement by year (solid circles) and recommended SEG range of 75,000 to 170,000 total spawners (shaded area) for Lynn Canal fall-run chum salmon.

ESCAPEMENT GOAL RECOMMENDATIONS

We summarize the escapement goal recommendations as follows:

1. Southern Southeast summer-run chum salmon: establish an SEG threshold of 68,000 index spawners. Index counts are the aggregate peak aerial and foot survey counts for the 13 indicator streams for this stock.
2. Northern Southeast Inside summer-run chum salmon: establish an SEG threshold of 149,000 index spawners. Index counts are the aggregate peak aerial and foot survey counts for the 63 indicator streams for this stock.
3. Northern Southeast Outside summer-run chum salmon: establish an SEG threshold of 19,000 index spawners. Index counts are the aggregate peak aerial and foot survey counts for the five indicator streams for this stock.
4. Cholmondeley Sound fall-run chum salmon: establish an SEG range of 30,000–48,000 index spawners. Index counts are the aggregate peak aerial survey counts for the two indicator streams for this stock.
5. Port Camden fall-run chum salmon: establish an SEG range of 2,000–7,000 index spawners. Index counts are the aggregate peak aerial survey counts for the two indicator streams for this stock.

6. Security Bay fall-run chum salmon: establish an SEG range of 5,000–15,000 index spawners. Index counts are the peak aerial survey counts for the one indicator stream for this stock.
7. Excursion River fall-run chum salmon: establish an SEG range of 4,000–18,000 index spawners. Index counts are the peak aerial survey counts for the one indicator stream for this stock.
8. Chilkat River fall-run chum salmon: establish an SEG range of 75,000–170,000 estimated total escapement, or, equivalently, a fish wheel index catch of 1,125–2,550 chum salmon. The estimated escapement is the total escapement estimated from mark-recapture assessments and the fish wheel index catch is the cumulative annual catch of fall chum salmon.

DISCUSSION

Recent stock status reports on Southeast Alaska chum salmon (Heinl et al. 2004, Heinl 2005) provided broad, regionwide overviews of the abundance of wild chum salmon, primarily through analyses of trends in escapement survey measures and harvests. ADF&G has continued to monitor chum salmon abundance through the set of index streams that were identified by Heinl et al. (2004), and we used these data to establish escapement indicator stocks and reasonable sustainable escapement goals for wild chum salmon in Southeast Alaska. These goals are intended to provide meaningful conservation benchmarks for management of fisheries that target and incidentally harvest wild chum salmon.

Our knowledge of the harvest of wild chum salmon, particularly summer-run fish, is still imprecise. Hatchery operators are required to provide ADF&G with estimates of the total number of chum salmon harvested each year (see White 2007 and previous reports in that series). Most hatchery fish are harvested in terminal fisheries that are segregated from wild stocks; however, hatchery fish are also harvested in mixed-stock fisheries during their migration to terminal areas. Although harvests are presented as if they are known, there is certainly error in the estimates that are reported, and methods used to estimate harvests in mixed-stock fisheries vary from comprehensive thermal mark sampling to best estimates based on consultation of ADF&G management biologists and hatchery operators (Heinl 2005). In areas where stock identification of catch is not available (e.g., much of Northern Southeast Alaska), the occurrence of hatchery fish in mixed-stock fisheries masks our ability to monitor trends in the harvest of wild chum salmon. The department obtained funding in 2008 to begin sampling mixed-stock fisheries in the northern portion of the region.

In the past, harvest estimates of wild chum salmon have been based on estimates of the harvest of hatchery fish; i.e., simply subtracting the estimated contribution of hatchery fish to the common property fisheries from the total commercial harvest of chum salmon (Heinl et al. 2004, McGee 2004, Heinl 2005). Annual harvests of wild summer-run chum salmon, based on this information, appear to have increased since the late 1970s throughout Southeast Alaska (Figure 1). Even so, chum salmon harvest levels and total population levels have not rebounded to nearly the same degree as pink salmon (Zadina et al. 2004) and wild coho salmon (*O. kisutch*; Shaul et al. 2004), and are still well below harvest levels of the early 20th century (Van Alen 2000). In Southern Southeast Alaska, where stock identification of common property harvests are available, the harvest of wild chum salmon increased during the 1990s to the highest level since Statehood, then declined over the past decade to levels comparable to those of the 1960s (Figure 16).

Recent stock status assessments of Southeast Alaska chum salmon have noted that most stocks for which we have sufficient information appeared to be stable or exhibited increasing trends in escapement (Baker et al. 1996; Van Alen 2000, Heinl et al. 2004, Heinl 2005; this report). A concern is that the increasing trend in some chum salmon escapement indices in Southeast Alaska may simply be due to straying of hatchery fish into wild chum salmon streams. ADF&G initiated a study in 2008 to detect large-scale hatchery straying into wild chum salmon index streams. This is an important consideration given the fact that our best measure of wild chum salmon abundance in Southeast Alaska is from the set of chum salmon index streams. If large-scale straying is detected, then official wild-stock escapement measures will need to be either adjusted or qualified in the future. Adequate samples of post-spawning chum salmon were obtained from eight index streams in 2008 and one in 2007; a poor chum run in 2008 resulted in many fewer streams being sampled than was originally planned. Preliminary analysis showed that samples from four of the nine chum salmon index stream had no hatchery fish, while samples from the remaining five streams had an average of 1.5% hatchery fish (range: 1% to 3%; ADF&G unpublished data). Full results of this study will be published at a future date.

We did identify some fall-run chum salmon populations that have exhibited declines in escapement indices from the high levels observed in the 1960s and early 1970s. These include the Port Camden fall-run, Excursion Inlet fall-run, Lynn Canal fall-run, and Taku River fall-run chum salmon populations. Survey indices of escapement for these stocks have been stable over the last decade, albeit at lower levels. The Chilkat and Taku rivers were historically two of the largest fall chum salmon producers in the region (Heinl et al. 2004; Bachman 2005), and reasons for the decline are almost certainly complex and remain unknown. Possible contributing factors include natural hydrological changes in spawning areas (in both the Chilkat River and the Taku River), overharvest, interspecific competition, or reduced survival due to interactions with hatchery releases of chum salmon that occurred during the same period (Jensen 1999, Tobler 2002). Improved assessment of Chilkat River fall chum salmon since 1990 indicate that escapements have increased substantially since the lowest observed levels of the early 1990s. Further, these studies have demonstrated low harvest rates on the stock in the face of the fishery restrictions (Table 2). No detailed studies of Taku River fall-run chum salmon were conducted during the historical periods of high abundance; however, ADF&G conducted a radio-telemetry study in 2004 to identify the primary chum salmon spawning areas within the Taku River drainage. In contrast to historical aerial surveys, when most spawners were observed in the King Salmon flats area, radio-tagged fish were found spawning in mainstem areas between the Tulsequah and Inklin confluences (Andel *in prep*.), suggesting a shift or change in available spawning habitat.

Studies conducted in the neritic environment of Icy Strait suggest that chum salmon consume only a small portion of the available food resource and other species of planktivorous fish may have a greater impact on food sources available to wild chum salmon than hatchery-produced stocks of chum salmon (Orsi et al. 2004). The department has worked cooperatively with the University of Alaska and the National Marine Fisheries Service-Auke Bay Lab to implement studies funded through the Southeast Sustainable Salmon Fund to assess interaction of Taku River fall chum salmon fry and DIPAC-released summer-run chum salmon in the Taku Inlet-Stephens Passage area. These studies examined predator-prey relationships, and early marine interactions of wild and hatchery chum salmon. The results of these studies have not yet been published.

ACKNOWLEDGEMENTS

We would like to thank William Bergmann, Dave Harris, and Kevin Monagle for providing information and comments, particularly on fall chum salmon. We also wish to thank Gary Freitag and Sue Doherty with Southern Southeast Regional Aquaculture Association for sharing CWT and thermal mark information that allowed us to provide an assessment of the harvest of wild chum salmon in Southern Southeast Alaska.

REFERENCES CITED

Alaska Department of Fish and Game. 2004. Comprehensive salmon enhancement plan for Southeast Alaska: Phase III. Joint Northern/Southern Southeast Regional Planning Team. Alaska Department of Fish and Game, Juneau.

Andel, J.E. *In prep*. Distribution of chum salmon in the Taku River drainage, 2004. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Bachman, R. L. 2005. Stock assessment studies of Chilkat River adult sockeye and chum salmon stocks in 2002. Alaska Department of Fish and Game, Fishery Data Series No. 05-36, Anchorage.

Baker, T. T., A. C. Wertheimer, R. D. Burkett, R. Dunlap, D. M. Eggers, E. I. Fritts, A. J. Gharrett, R. A. Holmes, and R. L. Wilmot. 1996. Status of Pacific salmon and steelhead escapements in southern Alaska. Fisheries 21(10) 6–18.

Baker, T. T., L. F. Fair, R. A. Clark, and J. J. Hasbrouck. 2006. Review of salmon escapement goals in Bristol Bay, Alaska, 2006. Alaska Department of Fish and Game, Fishery Manuscript No. 06-05, Anchorage.

Bue, B. G., J. J. Hasbrouck, and M. J. Evenson. 2002. Escapement goal review of Copper and Bering Rivers, and Prince William Sound Pacific salmon stocks: report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A02-35.

Byerly, M., B. Brooks, B. Simonson, H. Savikko, and H. J. Geiger. 1999. Alaska commercial salmon catches, 1878–1999. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J99-05, Juneau.

Clark, J. E. and D. R. Bernard. 1987. A compound multivariate binomial-hypergeometric distribution describing coded microwire tag recovery from commercial salmon catches in Southeastern Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report No. 202, Juneau.

Hasbrouck, J. J., and J. A. Edmundson. 2007. Escapement goals for salmon stocks in Upper Cook Inlet, Alaska: report to the Alaska Board of Fisheries, January 2005. Alaska Department of Fish and Game, Special Publication No. 07-10, Anchorage.

Heinl, S. C. 2005. Chum salmon stock status and escapement goals in Southeast Alaska 2005 [*in*] J. A. Der Hovanisian and H. J. Geiger, editors. Stock status and escapement goals for salmon stocks in Southeast Alaska 2005. Alaska Department of Fish and Game, Special Publication No. 05-22, Anchorage.

Heinl, S. C., T. P. Zadina, A. J. McGregor, and H. J. Geiger. 2004. Chum salmon stock status and escapement goals in Southeast Alaska [*in*] Der Hovanisian, J. A. and H. J. Geiger, editors. Stock status and escapement goals for salmon stocks in Southeast Alaska 2005. Alaska Department of Fish and Game, Special Publication No. 04-02, Anchorage.

Hilborn, R. and C. J. Walters. 1992. Quantitative Fisheries Stock Assessment Choice, Dynamics, and Uncertainty. Chapman and Hall, New York.

Hilborn, R. and M. Mangel. 1997. The Ecological Detective Confronting Models with Data. Princeton University Press, Princeton, New Jersey.

Honnold, S. G., M. J. Witteveen, M. B. Foster, I. Vining., and J. J. Hasbrouck. 2007a. Review of escapement goals for salmon stocks in the Kodiak Management Area, Alaska. Alaska Department of Fish and Game, Fishery Manuscript No. 07-10, Anchorage.

REFERENCES CITED (Continued)

Honnold, S. G., M. J. Witteveen, I. Vining, H. Finkle, M. B. Foster, and J. J. Hasbrouck. 2007. Review of salmon escapement goals in the Alaska Peninsula Aleutian Islands Management Areas, 2006. Alaska Department of Fish and Game, Fishery Manuscript No. 07-10, Anchorage.

Jensen, K. 1999. Research programs and stock status for salmon in three transboundary rivers: The Stikine, Taku and Alsek. [In] pp. 273–294. E. E. Knudsen, C. R. Steward, D. D. MacDonald, J. E. Williams, and D. W. Reiser [eds.] Sustainable Fisheries Management: Pacific Salmon. Lewis Publishers, Boca Raton, Florida.

Kondzela, C. M., C. M. Guthrie, S. L. Hawkins, C. D. Russell, and J. H. Helle. 1994. Genetic relationships among chum salmon populations in southeast Alaska and northern British Columbia. Can. J. Fish. Aquat. Sci. 51(Suppl. 1):50–64.

McGee, S. G. 2004. Salmon hatcheries in Alaska—plans, permits, and policies designed to provide protection for wild stocks. American Fisheries Society Symposium 44:317–331.

McLachlan, G. J., and T. Krishnan. 1997. The EM Algorithm and Extensions. John Wiley and Sons. New York.

Molyneaux, D. M., and L. K. Brannian. 2006. Review of escapement and abundance information for Kuskokwim area salmon stocks. Alaska Department of Fish and Game, Fishery Manuscript No.06-08, Anchorage.

Orsi, J. A., A. C. Wertheimer, M. V. Sturdevant, E. A. Fergusson, D. G. Mortenson, and B. L. Wing. 2004. Juvenile chum salmon consumption of zooplankton in marine waters of southeastern Alaska: a bioenergetics approach to implications of hatchery stock interactions. Reviews in Fish Biology and Fisheries 14:335–359.

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

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

PSC (Pacific Salmon Commission). 1993. Salmon management and enhancement plans for the Stikine, Taku, and Alsek rivers, 1993. Pacific Salmon Commission Transboundary Technical Committee Report TCTR (93)-2.

PSC (Pacific Salmon Commission). 2007. Salmon management and enhancement plans for the Stikine, Taku, and Alsek rivers, 2007. Pacific Salmon Commission Transboundary Technical Committee Report TCTR (07)-03.

Phelps, S. R., L. L. LeClair, S. Young, and H. L. Blankenship. 1994. Genetic diversity patterns of chum salmon in the Pacific Northwest. Can. J. Fish. Aquat. Sci. 51(Suppl. 1):65–83.

Rich, W. H. 1926. Salmon-tagging experiments in Alaska, 1924 and 1925. U.S. Bur. Fish., Bull. 42:109–146.

Rich, W. H., and A. J. Suomela. 1929. Salmon-tagging experiments in Alaska, 1926. U.S. Bur. Fish., Bull. 43 (Part 2):71–104.

Rich, W. H., and F. G. Morton. 1930. Salmon-tagging experiments in Alaska, 1927 and 1928. U. S. Bur. Fish., Bull. 45:1–23.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin 191 of the Fisheries Research Board of Canada.

Shaul, L., S. McPherson, E. Jones, and K. Crabtree. 2004. Coho salmon stock status and escapement goals in Southeast Alaska [*in*] Stock Status and Escapement Goals for Salmon Stocks in Southeast Alaska. H. J. Geiger and S. McPherson [*eds*]. Alaska Department of Fish and Game, Divisions of Sport and Commercial Fisheries, Special Publication No. 04-02, Anchorage.

Tobler, P. 2002. Investigating the decline of the Taku River chum salmon: an evaluation of current knowledge. Report prepared for the Taku and Atlin Area Community Fisheries Working Group. EDI Environmental Dynamics Inc., Suite 206-4133 4th Avenue, Whitehorse, YT Y1A 1H8.

Van Alen, B. W. 2000. Status and stewardship of salmon stocks in Southeast Alaska. Pages 161–194 in E. E Knudsen, C.R. Steward, D. D. McDonald, J. E. Williams, D. W. Reiser, editors. Sustainable Fisheries Management: Pacific salmon. CRC Press. Boca Raton.

REFERENCES CITED (Continued)

White, B. 2007. Alaska salmon enhancement program 2006 annual report. Alaska Department of Fish and Game, Fishery Management Report No. 07-04, Anchorage.

Wilmot, R. L., R. J. Everett, W. J. Spearman, R. Baccus, N. V. Varnavskaya, and S. V. Putivkin. 1994. Genetic stock structure of western Alaska chum salmon and a comparison with Russian far east stocks. Can. J. Fish. Aquat. Sci. 51(Suppl. 1):84–94.

Witteveen, M. J., J. J. Hasbrouck, and I. Vining. 2007. Review of salmon escapement goals in the Chignik Management Area, 2007. Alaska Department of Fish and Game, Fishery Manuscript No. 07-09, Anchorage.

Zadina, T. P., S. C. Heinl, A. J. McGregor, and H. J. Geiger. 2004. Pink salmon stock status and escapement goals in Southeast Alaska and Yakutat [*in*] Stock Status and Escapement Goals for Salmon Stocks in Southeast Alaska. H.J. Geiger and S. McPherson [*eds*]. Alaska Department of Fish and Game, Divisions of Sport and Commercial Fisheries, Special Publication No. 04-02, Anchorage.

APPENDIX A

Appendix A1.–Peak escapement index series for 13 Southern Southeast summer-run chum salmon index streams, by survey type.

Area / District	Ketchikan 101								
Stream Name	Hidden Inlet	Tombstone River	Fish Creek	Keta River	Marten River	Carroll Creek	Wilson River	Blossom River	King Creek
Stream No.	101-11-101	101-15-019	101-15-085	101-30-030	101-30-060	101-45-078	101-55-020	101-55-040	101-71-04K
Year / Survey Type	Aerial	Aerial	Foot	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial
1980	2,900	4,580	4,951	10,000	9,200	8,200	**8,752** [a]	4,000	7,000
1981	350	1,000	1,797	3,500	400	800	4,000	8,000	600
1982	550	550	2,452	3,000	300	8,000	500	200	500
1983	3,600	18,500	2,455	800	500	3,500	300	**3,316**	**3,940**
1984	800	9,250	2,237	16,500	300	11,000	**9,093**	4,100	6,000
1985	1,400	5,000	4,556	30,000	1,200	5,850	10,700	8,000	5,000
1986	430	10,000	5,604	46,000	1,000	600	10,000	**5,359**	3,300
1987	1,500	12,800	16,080	10,100	1,000	5,000	**8,912**	**4,783**	**5,684**
1988	1,400	20,000	11,591	47,000	17,500	44,000	28,000	5,000	10,000
1989	500	12,100	7,433	11,000	**4,335**	**8,943**	10,800	800	300
1990	650	4,400	2,403	30,000	**3,243**	**6,690**	10,000	1,100	800
1991	150	5,500	1,187	11,000	**3,459**	5,000	5,000	5,000	300
1992	500	2,600	8,731	20,000	6,000	13,000	10,000	4,000	9,200
1993	**2,278**	22,800	14,620	28,000	3,500	5,500	5,000	3,500	7,000
1994	1,500	7,500	4,500	40,100	2,500	3,200	23,000	8,000	15,000
1995	5,000	5,000	3,150	20,000	950	25,000	800	12,000	8,000
1996	2,700	5,200	2,564	90,000	4,000	30,000	**25,529**	12,000	12,000
1997	160	5,500	483	15,000	1,500	3,500	18,000	1,500	10,000
1998	4,300	8,000	4,707	43,000	10,100	10,000	10,000	10,000	35,000
1999	800	3,000	1,296	20,000	1,000	10,000	5,000	5,000	8,000
2000	600	4,000	5,395	22,000	1,000	14,000	16,000	2,000	11,000
2001	3,800	4,000	3,540	45,000	200	20,000	15,000	12,000	4,000
2002	700	3,000	4,250	20,000	**2,775**	2,000	9,000	5,000	1,500
2003	1,200	5,400	8,640	16,000	**3,338**	**6,886**	**7,578**	**4,067**	**4,833**
2004	550	14,000	15,790	8,000	**3,741**	2,500	**8,493**	5,000	**5,416**
2005	550	3,000	3,910	5,000	**3,356**	**6,923**	10,000	8,000	8,000
2006	**1,327**	4,000	9,100	20,000	5,500	2,000	10,000	7,000	**5,609**
2007	5,000	20,000	4,140	10,000	40,000	10,000	20,000	12,000	3,000
2008	1,500	200	418	500	1,000	**1,319**	1,000	3,000	1,000

[a] Bold values were interpolated.

–continued–

Appendix A1.–Page 2 of 2.

Area	Petersburg				
District	105		107		
Stream Name	P Beauclerc S Arm E	Calder Creek	Oerns Creek	Harding River	
Stream No.	105-20-012	105-42-005	107-40-025	107-40-049	
Year / Survey Type	Aerial	Aerial	Aerial	Aerial	Sum of Surveys (x 1,000)
1980	**910** [a]	**1,178**	1,200	13,100	76
1981	200	**869**	**498**	34,000	56
1982	200	200	280	5,300	22
1983	**643**	1,500	**477**	14,100	54
1984	**946**	**1,224**	1,080	16,400	79
1985	700	290	590	20,000	93
1986	400	2,000	**770**	1,200	87
1987	200	700	1,300	9,300	77
1988	2,600	1,000	490	12,520	201
1989	**1,024**	200	4,000	24,000	85
1990	300	**991**	530	2,800	64
1991	**817**	**1,057**	700	29,000	68
1992	600	700	150	15,500	91
1993	4,000	2,000	800	32,000	131
1994	300	1,300	50	4,500	112
1995	1,200	150	900	10,000	92
1996	3,500	3,500	1,600	29,000	222
1997	1,500	700	**610**	**10,169** [a]	69
1998	1,000	3,500	1,100	6,000	147
1999	500	2,700	2,900	25,000	85
2000	2,200	3,000	500	13,800	95
2001	800	500	1,000	15,000	125
2002	1,020	400	50	5,000	55
2003	**788**	850	200	6,000	66
2004	1,000	3,000	30	6,200	74
2005	2,400	3,000	1,000	11,000	66
2006	800	2,900	100	8,000	76
2007	600	900	200	6,300	132
2008	250	1,000	**112**	1,300	13
Minimum=					22 [b]
Maximum=					222
Contrast=					10.1

[a] Bold values were interpolated.
[b] includes only 1980–2007 data.

Appendix A2.–Peak escapement index series for 63 Northern Southeast Inside summer-run chum salmon index streams, 1982–2008.

Area	Petersburg											
District	108	109							110			
Stream Name	North Arm Creek	Tyee Head East	Saginaw Bay S Head	Saginaw Creek	Lookout Point Cr Sec B	Rowan Creek	Sample Creek	Petrof Bay W Head	Dry Bay Creek	Amber Creek N Arm Pybus	Donkey Creek	Cannery Cove Pybus Bay
Stream No.	108-41-	109-30-	109-44-	109-44-	109-45-017	109-52-	109-62-	109-62-	110-13-	110-22-	110-22-	110-22-
Year/ Survey Type	Foot	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Foot	Aerial	Aerial	Aerial
1982	840	700	350	650	30	50	200	150	568	40	1,600	220
1983	812	**4,700** [a]	**885**	150	**492**	**1,161**	150	**495**	177	50	1,300	150
1984	3,470	**4,611**	2,590	400	500	500	1,600	**485**	**928**	300	2,600	1,000
1985	1,826	400	2,600	**455**	350	500	700	2,000	**870**	160	1,455	150
1986	1,068	7,000	1,300	350	1,150	1,300	4,500	300	**823**	500	450	350
1987	1,040	6,100	1,600	600	600	150	500	100	1,675	250	3,300	1,515
1988	1,280	13,500	500	500	350	700	1,200	700	329	300	6,300	3,350
1989	404	4,000	300	50	1,000	1,300	800	45	290	**124**	600	**465**
1990	4,095	10,000	**587**	50	800	100	**483**	**328**	1,582	850	2,800	700
1991	265	600	**416**	**232**	200	**546**	**343**	400	56	200	1,200	100
1992	708	8,500	600	1,000	**463**	**1,094**	600	1,700	1,360	**359**	1,500	1,500
1993	926	7,500	1,100	300	800	900	500	**695**	3,218	500	6,000	2,700
1994	740	4,500	600	300	400	300	300	400	1,055	**640**	3,900	2,400
1995	570	23,300	1,540	50	950	1,200	1,100	**636**	1,550	600	7,900	1,600
1996	2,530	18,000	3,200	3,300	2,000	650	2,000	2,000	3,771	1,200	13,000	4,800
1997	1,420	1,950	300	**690**	300	2,000	**1,017**	600	4,200	50	11,000	1,800
1998	**1,115**	1,050	1,100	1,000	900	2,000	300	300	1,344	500	12,000	2,900
1999	**1,801**	6,300	3,000	**969**	**964**	1,400	400	500	336	800	10,500	3,400
2000	2,280	34,000	3,000	800	**1,342**	3,200	300	500	**2,579**	2,100	15,000	6,200
2001	820	400	400	1,000	**696**	2,100	**1,032**	500	540	450	4,500	2,800
2002	881	100	**2,164**	**1,209**	400	**2,840**	**1,783**	**1,210**	**2,312**	**933**	2,100	1,525
2003	606	2,500	**1,147**	**641**	300	**1,505**	**945**	**641**	355	**494**	2,500	1,300
2004	800	4,100	500	1,400	**735**	4,700	2,200	1,400	1,790	600	8,100	5,200
2005	850	300	**1,011**	**565**	700	600	**833**	350	741	200	4,000	1,800
2006	1,100	4,000	300	**860**	**856**	10,000	1,500	1,100	1,060	1,150	10,000	3,100
2007	883	1,300	**813**	300	**452**	**1,067**	1,000	300	570	400	2,500	450
2008	**560**	500	**540**	200	**300**	**708**	1,000	200	139	500	800	600

[a] Bold values were interpolated.

–continued–

Appendix A2.–Page 2 of 6.

Area	Petersburg								Juneau			
District	110								111			
Stream Name	Johnston Creek	Bowman Creek	Snug Cove Gambier Bay	East of Snug Cove	Chuck River Windham Bay	Lauras Creek	Glen Creek	Sanborn Creek	Mole River	Windfall Harbor W Side	Pack Creek	Swan Cove Creek
Stream No.	110-23-008	110-23-010	110-23-019	110-23-040	110-32-009	110-33-013	110-34-006	110-34-008	111-13-010	111-15-024	111-15-030	111-16-040
Year/ Survey Type	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial
1982	10	20	150	30	**316** [a]	2,000	50	1,200	400	300	950	350
1983	600	80	**539**	**841**	25	200	**766**	350	150	**713**	100	**479**
1984	2,500	400	750	1,200	700	3,500	1,200	1,900	400	1,500	1,000	2,100
1985	400	**474**	**496**	600	**788**	900	700	400	500	**656**	2,400	300
1986	600	500	700	1,500	300	1,500	500	900	300	300	700	1,000
1987	800	400	300	**547**	**557**	700	405	2,000	**934**	200	1,000	200
1988	8,000	3,460	2,300	4,300	2,600	3,520	900	3,400	700	350	300	600
1989	400	100	**175**	150	**279**	500	600	500	**468**	**232**	**771**	**156**
1990	2,000	400	950	1,650	600	1,500	**507**	2,400	500	200	600	550
1991	700	**242**	450	1,150	30	1,050	900	1,000	200	100	200	100
1992	500	**485**	700	150	1,000	1,800	800	900	300	700	600	**452**
1993	1,200	500	800	800	1,000	1,400	1,600	2,900	200	250	800	**674**
1994	**1,929**	250	**904**	**1,411**	500	1,500	850	950	4,000	200	3,500	1,200
1995	550	300	180	320	400	800	500	1,600	340	20	800	**617**
1996	7,200	2,000	800	1,200	7,100	2,320	500	14,300	**8,247**	3,000	8,000	900
1997	500	300	600	**1,173**	2,000	180	3,000	1,000	**2,004**	**995**	6,500	200
1998	600	**625**	**653**	400	**1,039**	500	725	1,000	**1,742**	3,000	8,000	2,000
1999	600	400	450	800	300	900	100	700	6,000	1,100	4,000	500
2000	2,700	1,100	900	1,100	3,050	4,800	4,000	8,200	2,010	600	2,600	625
2001	1,050	500	1,000	400	1,100	1,300	500	2,500	875	2,500	1,500	100
2002	**2,811**	**1,259**	400	900	200	**2,670**	1,800	1,200	3,100	1,950	5,000	1,000
2003	**1,490**	**667**	**698**	**1,090**	**1,110**	350	700	1,095	500	4,000	17,000	500
2004	2,100	900	1,300	400	3,000	2,800	3,000	7,300	8,000	**1,066**	12,500	1,000
2005	900	500	420	2,300	**979**	650	700	6,300	6,000	**815**	1,000	**548**
2006	1,000	2,300	1,600	4,000	1,400	600	1,000	7,300	3,000	300	4,500	**834**
2007	300	400	1,200	1,900	500	1,420	1,300	1,700	900	**655**	1,000	300
2008	200	400	100	100	400	900	400	1,500	**876**	300	950	1,000

[a] Bold values were interpolated.

–continued–

Appendix A2.–Page 3 of 6.

Area	Juneau						Sitka		Juneau			
District	111				112		112		112			
Stream Name	King Salmon River	Prospect Creek Speel	Admiralty Creek	Fish Creek Douglas Is.	Robinson Creek	Wilson River	Clear River Kelp Bay	Ralphs Creek	Kadashan Creek	Saltery Bay Head	Seal Bay Head	Long Bay Head
Stream No.	111-17-010	111-33-010	111-41-005	111-50-069	112-15-062	112-19-010	112-21-005	112-21-006	112-42-025	112-44-010	112-46-009	112-47-010
Year/ Survey Type	Aerial	Aerial	Aerial	Foot	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial
1982	500	300	450	1,219	500	200	5,000	3,000	**1,567** [a]	**1,119**	2,800	5,000
1983	300	75	520	1,466	3,200	**2,083**	8,000	6,000	**4,249**	12,300	7,700	12,000
1984	4,150	800	5,100	3,380	550	3,800	4,000	1,000	**4,168**	250	6,200	8,430
1985	3,200	**692**	1,500	6,683	500	160	2,000	5,000	3,000	400	5,000	7,000
1986	4,750	500	1,000	2,047	1,200	500	12,000	4,200	1,800	1,000	4,500	10,000
1987	2,000	200	500	281	500	400	23,000	1,000	**2,764**	300	1,000	1,000
1988	1,300	1,750	250	609	350	350	25,000	100	7,600	200	6,200	6,000
1989	300	50	200	1,187	400	500	**1,608**	3,000	1,000	500	1,000	1,200
1990	1,050	300	800	1,486	1,200	500	8,000	2,000	2,100	200	2,700	2,200
1991	1,300	200	200	2,194	1,000	**979**	2,000	**1,822**	1,000	1,000	5,500	3,200
1992	1,300	400	200	1,839	1,000	1,900	4,000	1,100	2,000	1,100	9,300	10,100
1993	1,000	400	500	639	1,800	6,000	3,500	4,000	3,500	1,050	7,000	7,100
1994	5,800	500	500	3,943	1,500	2,000	5,000	2,000	6,200	2,800	19,000	42,500
1995	2,200	600	200	2,941	400	2,200	8,000	10,800	3,600	2,000	7,000	10,000
1996	9,000	**4,320**	900	6,595	2,750	5,600	5,000	8,395	43,000	32,700	89,000	105,000
1997	3,400	321	50	1,890	4,000	500	12,000	7,000	3,500	3,500	5,700	19,900
1998	7,100	5,000	700	849	1,000	3,100	3,000	4,000	3,000	400	11,000	15,000
1999	3,500	500	**1,874**	1,570	2,000	4,000	15,000	5,000	2,500	1,100	20,000	28,000
2000	4,110	2,250	300	7,915	1,350	5,700	4,800	11,300	10,800	10,500	22,500	28,500
2001	1,150	1,000	5,500	815	**1,621**	2,000	5,500	14,400	700	4,150	5,000	2,275
2002	2,800	3,000	3,500	146	4,750	3,100	3,000	9,000	19,000	21,000	55,000	42,000
2003	4,000	400	600	1,150	3,200	10,000	**6,401**	8,430	5,700	700	7,600	4,000
2004	5,000	1,100	**1,429**	**2,408**	1,000	3,000	3,000	5,600	10,000	4,100	12,000	10,700
2005	6,000	**860**	500	**1,841**	2,500	5,500	**5,644**	5,300	3,000	2,000	13,000	9,000
2006	3,500	800	2,500	2,710	**1,995**	10,000	1,100	12,300	3,500	2,500	8,000	12,200
2007	1,150	800	4,700	270	**1,054**	1,000	2,500	4,000	**3,905**	500	3,600	12,000
2008	800	1,100	**583**	888	800	2,900	400	4,000	2,500	1,100	6,050	19,000

[a] Bold values were interpolated.

–continued–

Appendix A2.–Page 4 of 6.

Area	Juneau										
District	112										
Stream Name	Big Goose Creek	Little Goose Creek	West Bay Head Creek	Tenakee Inlet Head	Kennel Creek	Freshwater Creek	Greens Creek	Weir Creek N Arm Hood Bay	Weir Creek S Arm Hood Bay	Chaik Bay Creek	Whitewater Creek
Stream No.	112-48-015	112-48-019	112-48-023	112-48-035	112-50-020	112-50-030	112-65-024	112-72-011	112-73-024	112-80-028	112-90-014
Year/ Survey Type	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial
1982	3,000	10	1,000	300	140	250	**553** [a]	450	500	1,600	300
1983	14,100	**1,606**	2,000	4,000	500	600	500	700	500	2,000	2,550
1984	7,600	**1,576**	1,600	1,000	1,400	600	1,800	1,800	1,600	6,900	3,000
1985	10,050	100	15,300	1,900	2,000	2,000	4,000	5,000	5,800	2,500	2,000
1986	10,000	50	2,000	1,050	2,200	750	6,500	1,300	3,000	8,300	2,000
1987	1,300	**1,045**	1,000	1,100	450	**696**	1,750	630	1,800	2,000	700
1988	5,400	130	4,300	1,925	1,100	300	800	1,600	620	6,500	1,800
1989	2,100	**523**	1,800	1,300	500	300	500	700	400	2,000	2,000
1990	3,050	100	500	1,500	4,050	300	4,150	1,000	500	1,500	1,700
1991	5,000	**755**	2,000	2,000	2,050	100	200	1,000	200	500	**1,070**
1992	8,300	200	8,400	6,100	3,150	1,000	600	8,300	4,300	11,200	5,000
1993	19,700	1,000	10,500	9,200	8,900	1,650	1,000	7,700	2,200	23,600	9,900
1994	39,200	1,500	29,510	18,000	1,300	1,300	1,100	2,300	500	6,500	2,500
1995	22,000	500	7,900	13,000	4,200	6,000	900	650	1,500	6,300	4,100
1996	84,000	2,000	57,000	103,000	39,300	2,600	11,500	22,000	13,000	21,000	4,500
1997	9,400	1,400	15,000	11,000	7,000	500	2,000	**4,003**	4,900	8,100	3,000
1998	10,000	7,700	23,000	6,700	2,700	**1,297**	500	500	550	5,000	2,000
1999	21,000	2,150	32,000	15,000	3,300	**2,095**	1,200	13,000	6,000	10,000	8,950
2000	25,000	4,800	42,000	15,000	3,000	**2,918**	2,300	3,000	16,500	21,700	5,300
2001	2,935	1,000	5,200	10,000	5,000	1,000	1,500	3,900	3,600	12,000	1,700
2002	23,000	7,500	23,500	28,500	2,950	4,750	1,450	8,000	4,050	10,750	1,500
2003	1,100	5,000	5,000	12,000	1,000	500	3,000	500	500	3,800	3,700
2004	4,500	800	20,000	5,500	2,000	2,400	2,150	2,300	2,500	13,000	4,200
2005	1,500	8,000	8,000	4,500	1,400	1,800	500	4,000	2,500	4,000	2,500
2006	2,900	6,500	12,800	5,300	3,700	**1,861**	**2,610**	7,100	3,500	8,700	4,000
2007	3,500	1,950	12,500	4,000	1,500	**983**	1,000	2,000	**2,120**	2,500	**2,092**
2008	900	5,700	5,800	2,800	400	1,000	550	**1,749**	500	4,100	1,500

[a] Bold values were interpolated.

–continued–

Area	Sitka			Juneau							
District	113			114							
Stream Name	Saook Bay West Head	Rodman Creek	Ushk Bay W End	Mud Bay River	Homeshore Creek	Spasski Creek	Game Creek	Seagull Creek	Neka River	Humpback Creek	Trail River
Stream No.	113-53-003	113-54-007	113-56-003	114-23-070	114-25-010	114-27-030	114-31-013	114-32-004	114-33-023	114-34-010	114-40-035
Year/ Survey Type	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial
1982	**1,124**	300	**1,172** [a]	500	**339**	800	2,500	220	2,500	2,300	370
1983	**3,046**	**2,903**	**3,176**	400	550	500	8,000	1,550	24,500	2,250	3,000
1984	1,500	**2,849**	2,025	220	7,000	3,250	12,200	2,400	10,550	4,000	1,650
1985	5,000	500	500	**1,129**	**846**	3,500	4,300	5,300	7,000	3,700	500
1986	1,000	1,000	2,000	**1,068**	515	2,300	3,900	500	12,500	4,500	400
1987	**1,982**	3,000	3,000	150	**598**	500	8,000	2,300	8,000	2,500	500
1988	3,500	500	3,500	100	150	950	5,600	600	4,000	550	2,500
1989	**992**	**945**	**1,034**	**399**	100	910	1,500	200	2,800	800	500
1990	3,500	3,000	300	**813**	300	2,500	2,000	110	11,000	1,500	200
1991	2,000	**1,365**	3,000	200	600	1,500	2,300	1,200	4,400	2,800	7,400
1992	2,000	**2,734**	**2,992**	50	700	3,000	3,000	1,200	9,700	4,400	400
1993	**4,280**	**4,080**	**4,464**	2,000	1,100	3,700	11,900	4,100	12,500	5,500	800
1994	500	**4,872**	500	300	2,200	4,600	3,400	1,700	9,300	6,300	300
1995	100	**3,733**	**4,084**	300	4,000	3,200	4,800	1,700	9,700	4,600	**1,843**
1996	6,600	8,000	1,600	1,100	1,050	9,700	35,100	7,000	24,800	27,000	500
1997	1,700	3,500	**4,431**	1,000	200	4,500	9,000	7,800	9,500	5,600	1,400
1998	4,000	2,500	**3,854**	200	400	4,200	4,000	300	8,600	4,000	500
1999	**5,968**	3,800	**6,224**	3,500	500	2,000	7,000	3,000	20,000	6,500	8,000
2000	10,630	6,800	19,000	350	500	900	4,100	1,250	29,000	7,400	4,000
2001	9,500	8,100	12,100	4,500	1,300	9,500	12,100	3,000	23,000	6,050	200
2002	5,500	5,500	9,000	2,250	1,100	9,400	2,000	4,500	11,500	4,350	6,500
2003	**3,947**	9,000	1,500	**1,590**	800	3,500	15,000	600	16,000	2,500	1,000
2004	3,500	7,500	3,000	3,100	2,200	4,000	5,000	800	7,400	2,500	1,300
2005	**3,481**	1,410	**3,630**	5,000	1,500	3,000	2,000	**1,820**	4,800	3,500	3,500
2006	17,500	8,710	15,500	7,500	**1,600**	2,500	7,500	**2,772**	20,000	3,200	1,900
2007	6,950	8,060	**2,920**	6 –	3,000	3,550	5,300	1,500	8,000	2,000	2,500
2008	1,800	1,800	1,070	600	**561**	1,500	3,760	75	1,050	500	560

[a] Bold values were interpolated.

–continued–

Area	Juneau					
District	115					
Stream Name	St James Bay NW Side	St. James River	Endicott River	Berners River	Sawmill Creek Berners River	
Stream No.	115-10-042	115-10-046	115-10-080	115-20-010	115-20-052	
Year/ Survey Type	Aerial	Aerial	Aerial	Aerial	Aerial	Sum of Surveys (x 1,000)
1982	400	**342**	**937**	**515** [a]	4,580	60
1983	825	5,000	**2,539**	**1,397**	250	162
1984	800	60	500	800	2,500	159
1985	2,910	100	**2,337**	5,400	400	149
1986	700	360	210	1,070	600	141
1987	1,000	**604**	400	600	1,500	106
1988	1,900	492	2,500	406	800	162
1989	350	**302**	5,000	100	100	53
1990	750	150	4,600	500	1,150	107
1991	1,100	**436**	900	**657**	430	76
1992	600	200	2,550	220	450	153
1993	700	250	1,500	800	1,150	228
1994	600	**1,558**	800	4,000	3,050	272
1995	105	**1,194**	**3,265**	125	**1,388**	209
1996 [b]	850	2,400	10,000	5,900	5,700	931
1997	300	200	**3,542**	770	1,000	226
1998	100	**1,126**	2,000	1,025	1,100	197
1999	50	510	1,900	780	**2,115**	318
2000	550	72	200	250	2,979	443
2001	**959**	6,000	1,100	10,000	**1,527**	229
2002	2,800	1,200	3,000	3,400	**2,639**	397
2003	**878**	5,000	16,100	**1,811**	550	210
2004	1,800	**1,387**	2,400	1,950	1,000	242
2005	1,600	2,050	18,750	1,500	900	185
2006	**1,179**	**1,615**	2,000	5,400	450	282
2007	**623**	**853**	2,500	1,000	600	149
2008	**413**	100	500	5,800	500	99
Minimum=						53
Maximum=						931
Contrast=						17.6

[a] Bold values were interpolated.

Appendix A3.–Peak escapement index series for five Northern Southeast Outside summer-run chum salmon index streams.

Area	Sitka					
District	113					
Stream Name	Whale Bay Great Arm Head	W Crawfish NE Arm Hd	Sister Lake SE Head	Lake Stream Ford Arm	Black River	
Stream No.	113-22-015	113-32-005	113-72-005	113-73-003	113-81-011	
Year/ Survey Type	Aerial	Aerial	Aerial	Aerial	Aerial	Sum of Surveys (x 1,000)
1982	3,900	1,933	3,000	**541** [a]	500	10
1983	2,500	1,224	**4,903**	2,000	10,000	21
1984	1,500	30,000	25,000	**4,261**	17,000	78
1985	2,000	2,500	11,000	450	15,000	31
1986	5,500	18,000	3,500	400	3,000	30
1987	4,000	4,100	3,000	651	5,000	17
1988	6,500	3,500	5,000	1,033	3,000	19
1989	1,300	500	4,000	1,610	8,000	15
1990	4,000	3,000	18,000	959	2,500	28
1991	**7,873**	**8,816**	17,000	1,456	1,000	36
1992	4,000	1,000	18,000	1,140	500	25
1993	**3,475**	2,000	5,000	1,559	**3,922**	16
1994	3,400	3,000	4,000	3,000	1,000	14
1995	7,550	5,000	4,450	1,416	300	19
1996	4,200	10,500	12,650	1,271	1,000	30
1997	11,000	6,000	10,000	2,955	20,000	50
1998	1,300	7,000	5,750	2,631	2,400	19
1999	5,000	8,000	8,000	1,697	9,000	32
2000	27,000	33,000	4,041	844	31,000	96
2001	18,300	9,177	1,910	5,900	23,000	58
2002	1,000	3,500	6,550	1,927	6,000	19
2003	12,800	2,300	2,000	6,700	6,000	30
2004	11,800	13,000	22,300	1,560	37,150	86
2005	23,800	32,370	11,270	540	8,700	77
2006	24,000	9,000	8,000	4,055	11,920	57
2007	8,340	12,300	6,530	1,280	5,602	34
2008	4,200	4,300	14,900	8,475	14,500	46
Minimum=						10
Maximum=						96
Contrast=						9.7

[a] Bold values were interpolated.

Appendix A4.–Peak escapement index series for Cholmondeley Sound fall-run chum salmon index streams.

Area	Ketchikan		
District	102		
Stream Name	Disappearance Creek	Lagoon Creek	
Stream No.	102-40-043	102-40-060	
Year/ Survey Type	Aerial	Aerial	Sum of Surveys (x 1,000)
1978	**14,538** [a]	10,550	25
1979	**6,890**	5,000	12
1980	13,500	12,000	26
1981	21,000	5,000	26
1982	1,800	6,633	8
1983	4,000	11,100	15
1984	**23,401**	16,982	40
1985	26,000	13,632	40
1986	16,000	12,000	28
1987	32,500	13,500	46
1988	21,000	14800	36
1989	19,800	15,000	35
1990	22,000	8,300	30
1991	33,000	25,000	58
1992	21,000	15,500	37
1993	29,000	17000	46
1994	22,700	20,000	43
1995	20,000	15,000	35
1996	38,000	23,500	62
1997	18,000	12,800	31
1998	32,500	26,000	59
1999	50,000	50,000	100
2000	21,500	14,300	36
2001	22,000	23,000	45
2002	22,000	17,000	39
2003	45,000	30,000	75
2004	30,000	30,000	60
2005	7,600	7,000	15
2006	38,000	16,000	54
2007	9,500	8,500	18
2008	32,500	14,000	47
Minimum=			8
Maximum=			100
Contrast=			11.9

[a] Bold values were interpolated.

Appendix A5.–Peak escapement index series for Northern Southeast sub-region fall-run chum salmon index streams.

Area	Petersburg						
District	109					114	
Subdistrict	109-43			109-45		114-80	
Stream Name	Port Camden S Head	Port Camden W Head		Salt Chuck Security		Excursion River	
Stream No.	109-43-006	109-43-008		109-45-013		114-80-020	
Year/ Survey Type	Aerial	Aerial	Sum of Surveys (x 1,000)	Aerial	Sum of Surveys (x 1,000)	Aerial	Sum of Surveys (x 1,000)
1964	300	1,500	2	20,000	20	6,200	6
1965	50	1,200	1	12,500	13	34,500	35
1966	8,000	200	8	2,500	3	3,000	3
1967	10,000	3,500	14	2,500	3	22,500	23
1968	4,000	600	5	5,000	5	40,000	40
1969	2,100	**1,103** [a]	3	9,000	9	25,300	25
1970	5,000	1,300	6	13,000	13	12,000	12
1971	2,000	750	3	7,000	7	42,000	42
1972	2,500	20	3	12,300	12	65,000	65
1973	7,000	700	8	16,350	16	19,000	19
1974	2,630	1,400	4	18,001	18	2,050	2
1975	2,300	1,300	4	2,800	3	33,000	33
1976	1,450	450	2	6,810	7	10,200	10
1977	3,000	800	4	7,900	8	4,900	5
1978	6,100	1,235	7	5,875	6	450	0
1979	3,300	500	4	1,800	2	4,000	4
1980	4,100	2,220	6	13,800	14	34,500	35
1981	4,100	2,500	7	3,500	4	33,500	34
1982	3,800	1,550	5	12,000	12	1,640	2
1983	771	680	1	4,830	5	3,300	3
1984	6,800	3,200	10	19,000	19	7,750	8
1985	8,700	3,500	12	21,000	21	4,025	4
1986	8,200	6,070	14	12,000	12	9,150	9
1987	7,400	1,550	9	11,200	11	2,000	2
1988	4,100	3,250	7	15,500	16	3,700	4
1989	4,700	2,350	7	8,410	8	2,050	2
1990	3,000	960	4	20,040	20	5,100	5
1991	3,100	1,800	5	6,000	6	900	1
1992	2,900	**2,206**	5	19,300	19	2,700	3
1993	5,100	1,700	7	7,400	7	8,200	8
1994	3,800	1,150	5	4,900	5	4,300	4
1995	2,000	1,200	3	14,000	14	6,140	6
1996	3,400	1,350	5	19,000	19	9,200	9
1997	2,000	1,500	4	5,400	5	34,400	34
1998	3,600	2,200	6	31,500	32	8,000	8
1999	920	600	2	20,000	20	10,000	10
2000	1,400	1,100	3	12,500	13	17,000	17
2001				3,500	4	17,750	18
2002	300	150	0	6,000	6	4,680	5
2003	131	545	1	8,700	9	6,300	6
2004	1,700	1,600	3	13,100	13	5,200	5
2005	1,820	290	2	2,750	3	1,100	1
2006	2,250	170	2	15,000	15	2,203	2
2007	280	225	1	5,400	5	6,000	6
2008	1,150	250	1	11,700	12	8,000	8
Minimum=			0		2		1
Maximum=			14		32		34
Contrast=			31.7		21.0		38.2

[a] Bold values were interpolated.

Appendix A6.–Peak escapement index series for Lynn Canal fall-run chum salmon index streams.

Area	Juneau		
District	115		
Stream Name	Chilkat River	Klehini River	
Stream No.	115-32-025	115-32-046	
Year/ Survey Type	Aerial	Aerial	Sum of Surveys (x 1,000)
1969	17,500	**3,756**	21
1970	80,000	10,000	90
1971	73,000	6,000	79
1972	85,000	2,000	87
1973	65,000	11,000	76
1974			
1975	40,000	10,000	50
1976	120,000	15,000	135
1977			
1978			
1979	121,000	**25,967**	147
1980	28,000	12,350	40
1981	82,000	19,500	102
1982	98,000	16,104	114
1983	176,000	19,000	195
1984	61,000	38,500	100
1985	91,000	25,000	116
1986			
1987	**43,801**	9,400	53
1988	48,700	24,000	73
1989	37,700	1,250	39
1990	19,500	9,850	29
1991	**20,969**	4,500	25
1992	23,450	24,000	47
1993	**19,571**	4,200	24
1994	17,000	7,000	24
1995			
1996	12,300	3,600	16
1997	7,000	**1,502**	9
1998	**23,298**	5,000	28
1999	**38,070**	8,170	46
2000	61,200	16,900	78
2001	**7,222**	1,550	9
2002	61,800	1,500	63
2003	42,600	4,000	47
2004	45,703	13,000	59
2005	55,400	1,400	57
2006	**68,031**	14,600	83
2007	29,250	21,000	50
2008	25,500	2,650	28
Minimum=			9
Maximum=			195
Contrast=			22.9

Bold values were interpolated.

APPENDIX B

Since the early 1990s, a large proportion of the chum salmon catch in common property fisheries of Southeast Alaska have been composed of hatchery stocks, particularly during the summer-run period. The chum salmon releases from SSRAA facilities, have been coded-wire tagged (CWT) or thermal marked from the outset of their production. In addition, almost all of the common property chum salmon harvests in Southern Southeast Alaska fisheries (i.e., Districts 1–8) have been sampled for CWT or thermal marks since 1983. Thus, the catch of hatchery chum salmon in common property fisheries outside of hatchery terminal areas can be determined in Southern Southeast Alaska (Districts 1–8).

Standard methods (Clark and Bernard 1987) were used to expand the chum salmon CWT recoveries based on relevant information in the ADF&G Mark, Tag, and Age Laboratory coded-wire tag database. The catch was stratified by year (1983–2005), District (1–8), gear (drift gillnet and purse seine), and statistical week (23–42). Hatchery catch was estimated by expansion of tag recoveries appropriately expanded for tagging rate and sampling fraction. Generally, sampling fractions for catches sampled were sufficient (Clark and Bernard 1987) for precise estimation; however, not all of the catches over the period 1983–2005 were scanned for coded-wire tags (Appendix B2). To correct for the under-assessment of the hatchery catch in a year/gear/District stratum, the estimated catch based on the CWT recoveries was further expanded by respective fraction not examined for tags.

SSRAA implemented 100% thermal marking of their chum salmon releases beginning with the 2002 brood year. In addition, they implemented comprehensive thermal-mark sampling of the common property catches in Southern Southeast areas (Districts 1–8) in 2005 and thereafter. Hatchery/wild stock compositions of Southern Southeast Alaska chum catches were based on CWT sampling in 1983–2005 and on thermal mark sampling in 2006 and thereafter.

SSRAA marked the 2002 brood year release with both thermal marks and CWT. SSRAA also implemented a comprehensive sampling program of common property fisheries for both otolith and CWT recoveries in 2005 and 2006, the years when most of the 2002 brood year returned. Estimates of hatchery catch based on thermal mark recoveries and hatchery catch based on CWT recoveries were developed by brood year doubly-marked (2002), release site (Anita Bay, Nakat Inlet, Neets Bay, and Kendrick Bay), and catch year (2005 and 2006) (Appendix B3). The estimated hatchery catch based on CWT was the expanded CWT recoveries summed over the statistical weeks/gear strata that were sampled within the respective brood year, release site, and catch year. The estimated hatchery catch based on thermal mark recoveries was the thermal mark proportion applied to the respective statistical week/gear catch strata summed over the statistical weeks/gear strata that were sampled within the respective brood year, release site, and catch year.

The estimates of catch based on recovery of thermal marks were substantially higher than the catch based on recovery of CWT for all doubly-tagged release groups (Appendix B3). This indicates that adipose-clipped chum salmon were consistently being missed in the process of scanning the catch for CWTs; all CWT fish have their adipose fin removed when tagged so that they can be identified later. To correct for this bias, the CWT recoveries were further expanded by 1.70, which was the ratio of the estimated catch based on thermal marked and the estimated catch based on CWT, averaged over the two years where the hatchery catches were assessed

–continued–

from both CWT and thermal mark sampling. Harvest rates by combined drift gillnet and purse seine fisheries for returns in 2005–2007 are presented by release group (four hatchery stocks and three brood years) in Appendix B3. Harvest rates for combined release groups were 38%, 37%, and 49% for calendar years 2005, 2006, and 2007, respectively. These estimated harvest rates indicate that wild chum salmon are an incidental catch in Southern Southeast common property fisheries and are under moderate exploitation.

Catches of chum salmon throughout Southeast Alaska were tabulated by the indicator-stock run periods and areas. Northern Southeast Inside (NSEI; Appendix B5) includes Districts 9 to 12, 14 and 15, and Hoonah Sound portion of District 13 (subdistricts 51–59). The NSEI summer-run period includes the common property Districts 11 and 15, which have been composed mostly of hatchery fish since 1985; Districts 10, 12, 13 (Hoonah Sound), and 14 which have been composed of mixed hatchery and wild fish since 1985; and hatchery fish harvested in hatchery terminal areas. The Northern Southeast Alaska fall-run period includes terminal fishing areas appropriate to wild fall-run indicator stocks (Port Camden, Security Bay, Excursion River, Taku River, and Lynn Canal), and other catches during the fall-run period (Appendix B5). Catches during the fall-run season (statistical week 34 and later) are considered wild chum salmon as there are no significant hatchery runs of fall chum salmon in Northern Southeast Alaska. The Northern Southeast Outside (NSEO) area includes District 13 (except Hoonah Sound). The NSEO (Appendix B6) includes mixed catches of wild and hatchery fish in common property fisheries outside of hatchery terminal areas and known catches of hatchery fish inside hatchery terminal areas. The Southern Southeast areas (SSE) include Districts 1 to 8 (Appendix B7). The SSE summer-run period includes catches of hatchery fish in common property fisheries outside of hatchery terminal areas, catches of wild fish in common property fisheries outside of hatchery terminal areas, and catches of hatchery fish in hatchery terminal areas (Appendix B7). The SSE fall-run period includes catches of wild fall-run fish in common property fisheries outside of hatchery terminal areas, catches of fall-run hatchery fish in common property fisheries outside of hatchery terminal areas, catches of fall-run hatchery fish in hatchery terminal areas, and catches of wild fall-run fish in the Cholmondeley Sound terminal area (Appendix B7).

Appendix B2.–Sampling intensity for chum salmon coded-wire tag (CWT) recoveries in Southeast Alaska salmon fisheries, 1983–2006.

	Southern Southeast (Districts 101–108)		Northern Southeast (Districts 109–113)	
Year	Sampling Fraction for Catch Sampled for CWT	Proportion of Catch not Sampled for CWT	Sampling Fraction for Catch Sampled for CWT	Proportion of Catch not Sampled for CWT
1983	0.405	0.001	0.226	0.161
1984	0.256	0.022	0.271	0.091
1985	0.256	0.019	0.214	0.190
1986	0.276	0.045	0.426	0.149
1987	0.437	0.105	0.210	0.114
1988	0.342	0.038	0.253	0.045
1989	0.206	0.056	0.158	0.137
1990	0.268	0.041	0.332	0.002
1991	0.278	0.152	0.197	0.039
1992	0.347	0.060	0.256	0.078
1993	0.289	0.105	0.205	0.013
1994	0.262	0.142	0.115	0.088
1995	0.219	0.086	0.158	0.065
1996	0.195	0.052	0.069	0.287
1997	0.195	0.052	0.069	0.287
1998	0.167	0.161	0.093	0.074
1999	0.152	0.128	0.068	0.516
2000	0.159	0.058	0.076	0.308
2001	0.129	0.132	0.107	0.700
2002	0.143	0.070	0.124	0.778
2003	0.181	0.069	0.067	0.499
2004	0.168	0.088	0.089	0.781
2005	0.216	0.013	0.073	0.308
2006	0.194	0.049	0.048	0.661
Average	0.239	0.073	0.163	0.265

Appendix B3.–Estimated catch of SSRAA's 2002 brood year chum salmon based on thermal mark and coded-wire tag (CWT) sampling, and the ratio of thermal-mark catch estimate to CWT catch estimate, by release site and return year.

Return Year	Release Site	Catch Determined by Thermal-Mark Sampling	Catch Determined by CWT Sampling	Thermal Mark/CWT Catch Ratio
2005	Kendrick Bay	26,951	21,564	1.25
	Neets Bay	71,629	17,947	3.99
	Anita Bay	24,146	17,600	1.37
	Nakat Inlet	50,286	21,564	2.33
2006	Kendrick Bay	118,302	111,346	1.06
	Neets Bay	144,822	86,348	1.68
	Anita Bay	183,549	81,460	2.25
	Nakat Inlet	104,475	67,453	1.55
	Total	724,160	425,281	1.70

Appendix B4.–Harvest rate in combined common property drift gillnet and purse seine fisheries (outside of hatchery terminal harvest areas) on various SSRAA chum salmon, by release group, release site (Anita Bay summer, Kendrick Bay summer, Nakat Inlet combined run, Neets Bay combined run), brood year (2002–2004), and calendar year of return (2005–2007). Also shown are the harvest rates for combined release sites by brood year and calendar year of return; harvest rates for combined release sites and broods for calendar year of return; and combined release sites, brood years and calendar years.

	Release Site													
	Anita Bay Summer Run		Kendrick Bay Summer Run		Nakat Inlet Combined Run		Neets Bay Combined Run		Combined Release Sites		Combined Released Sites And Brood Years		Combined Release Sites, Brood Years, and Calendar Years	
Release Group	Catch or Run	Harvest Rate	Catch or Run	Harvest Rate	Catch or Run	Harvest Rate	Catch or Run	Harvest Rate	Catch or Run	Harvest Rate	Catch or Run	Harvest Rate	Catch or Run	Harvest Rate
2005 Calendar Year														
BY 2002 Age 3 TR	52,230		3,225		64,430		214,430		334,315					
BY2002 Age 3 CP Catch	51,623	0.497	29,852	0.902	50,286	0.438	72,268	0.252	204,029	0.379				
2006 Calendar Year														
BY 2003 Age 3 TR	85,945		207,650		89,440		518,770		901,805		2,154,238		3,682,902	
BY 2003 Age 3 CP Catch	71,052	0.453	307,839	0.597	56,464	0.387	155,543	0.231	590,898	0.396	1,263,170	0.370	2,734,490	0.426
BY 2002 Age 4 TR	234,810		76,405		259,635		681,583		1,252,433					
BY 2002 Age 4 CP Catch	251,820	0.517	125,850	0.622	109,225	0.296	185,377	0.214	672,272	0.349				
2007 Calendar Year														
BY 2004 Age 3 TR	3,735		13,715		0		41,645		59,095		1,528,664			
BY 2004 Age 3 CP Catch	9,270	0.713	47,206	0.775	10,177	1.000	9,357	0.183	76,009	0.563	1,471,320	0.490		
BY 2003 Age 4 TR	117,527		203,305		167,370		920,809		1,409,012					
BY 2003 Age 4 CP Catch	209,158	0.640	452,429	0.690	145,838	0.466	511,454	0.357	1,318,879	0.483				
BY 2002 Age 5 TR	12,408		2,620		2,266		43,264		60,557					
BY 2002 Age 5 CP Catch	23,053	0.650	12,601	0.828	9,619	0.809	31,159	0.419	76,431	0.558				

Appendix B5.–Catch of chum salmon in Northern Southeast Alaska inside areas.

Year	Summer Run			Fall Run						
	Common Property District 111 - 115	Common Property Districts 109-110,112-114	Hatchery Terminal Area (SHAs)	Port Camden 109-43	Security Bay 109-45	Excursion River 114 - 80	Taku River 111 - 32	Lynn Canal 115	Other Common Property Areas	Hatchery Terminal Areas (SHAs)
1960	35,120	269,198		22	1,993	0	28,720	53,658	26,163	
1961	31,295	974,576		1,435	1,745	0	14,876	115,835	134,378	
1962	15,205	619,237		127	1,272		11,812	108,137	21,781	
1963	39,491	556,477		0	409	0	7,071	99,232	25,128	
1964	7,796	468,098		316	14,239	16,767	7,822	100,712	73,704	
1965	12,239	680,728		0	5,501	54,308	7,691	198,784	81,387	
1966	16,756	1,192,331		47,324	45,293	345,427	27,327	229,754	619,519	
1967	9,264	979,287		36,668	23,466	114,606	20,463	159,057	144,056	
1968	15,106	991,569		28	9,891	65,780	15,597	164,245	88,172	
1969	9,895	289,087					9,926	157,972	441	
1970	28,880	977,618		11,711	11,308	74,585	77,026	267,964	309,646	
1971	55,574	480,459		646	0	132,249	54,720	249,881	248,058	
1972	92,727	1,063,659		20,304	0	109,257	60,513	333,305	212,695	
1973	55,187	512,751		7,850		78,031	61,025	188,980	29,089	
1974	21,279	252,357		3,959	979	50,749	51,063	435,941	127,201	
1975	5,720	9,573				32,320	31	235,729	721	
1976	13,062	387				51,510	42,843	367,782	34,513	
1977	15,842	6,523					43,432	195,487	11,568	
1978	20,036	25,093		10,005			18,101	107,631	18,602	
1979	25,431	103,639			0	3,453	46,142	223,742	18,165	
1980	44,057	90,333	752	24,413		189,084	131,272	158,671	131,717	
1981	39,760	92,012		9,418		101,351	40,212	100,195	20,304	
1982	26,956	84,387		15,171			18,393	296,238	53,443	0
1983	38,046	180,022	31			11,063	7,813	309,410	25,579	
1984	128,480	1,086,150	2	7,890	70,692	89,431	27,967	559,923	93,165	21
1985	147,734	346,862	376,817	15,506		26,106	40,610	611,732	105,554	0
1986	63,215	161,316	585,042	10,994	2,065	53,689	24,790	348,082	33,895	0
1987	92,113	233,543	443,347	5,183		88,376	30,019	359,692	52,873	144
1988	164,935	315,358	350,685	17,078	14,769	35,493	27,040	294,512	91,594	8381
1989	57,849	285,432	67,118	2,158	995		15,491	84,714	21,334	472
1990	217,207	318,464	468,450		10,984	14,538	29,131	107,343	21,011	310
1991	262,036	999,669	274,700	0		31,374	12,486	99,164	36,574	805
1992	260,537	739,727	984,963	51,311	6,729	39,383	11,649	84,385	150,660	354
1993	402,861	989,702	1,657,530	12,932	0	324	7,760	60,404	67,463	46841
1994	766,853	1,263,748	3,228,905	12,402	56		12,280	116,599	144,120	53692
1995	662,657	459,147	3,962,858	5,185	12,819	9,940	8,786	69,201	39,462	11856
1996	633,983	998,925	5,770,927	4,966	9,689		5,245	56,495	52,701	56381
1997	427,932	472,736	2,856,831			2,145	1,936	20,850	50,751	1131
1998	360,692	661,552	3,137,810	12,636	25,267		2,800	19,239	113,062	58399
1999	606,903	905,818	3,815,452	13,236	10,368	35,237	2,641	50,576	89,896	8619
2000	1,109,311	850,870	5,335,793	3,087	621	83,057	1,311	59,365	104,291	56725
2001	509,259	627,805	2,328,013	0	0	7,493	1,012	68,898	23,332	1719
2002	711,786	423,830	3,257,701		1,952	1,714	671	27,134	28,295	703
2003	455,464	845,333	5,030,242		0	2,360	894	36,640	60,771	42452
2004	655,350	1,467,478	3,607,636	0	13,849	1,413	3,546	52,755	201,508	700
2005	251,296	789,352	996,744	0			2,681	71,020	66,441	3336
2006	1,012,519	706,915	5,614,467		1,065	0	5,516	57,329	38,413	49097
2007	1,078,439	348,366	2,964,922	0	0	18,149	5,437	67,693	76,349	28046

Appendix B6.–Catch of summer-run chum salmon in Northern Southeast Outside areas.

	Summer Run	
Year	Traditional Harvest	Hatchery Terminal Harvest
1960	30,147	
1961	155,360	
1962	139,518	
1963	94,313	
1964	43,398	
1965	130,855	
1966	26,900	
1967	22,347	
1968	9,882	
1969	8,358	
1970	26,495	
1971	14,082	
1972	8,718	
1973	27,673	
1974	36,190	
1975	25,467	
1976	2,672	
1977	25,717	
1978	3,635	
1979	115,149	
1980	13,356	
1981	77,209	1
1982	13,226	
1983	61,483	90
1984	147,470	127
1985	165,841	56
1986	110,600	63,428
1987	84,398	128,110
1988	43,021	33,378
1989	20,697	93,505
1990	2,147	81,462
1991	14,893	41,132
1992	88,632	284,343
1993	62,653	1,186,357
1994	192,309	893,053
1995	129,974	1,070,238
1996	826,164	1,689,021
1997	851,290	1,461,790
1998	1,105,533	1,919,457
1999	653,943	3,108,554
2000	733,665	2,779,274
2001	512,852	633,936
2002	359,594	482,705
2003	325,676	814,746
2004	819,860	1,550,994
2005	490,084	1,357,009
2006	557,943	1,942,717
2007	389,982	554,466

Appendix B7.–Catch of chum salmon by hatchery and wild stocks in Southern Southeast areas.

	Summer Run				Fall Run				
Year	Wild Common Property	Hatchery Common Property	Common Property Total	Hatchery Terminal Area	Cholmondeley Sound Common Property	Wild Stocks in Other Common Property Areas	Hatchery Common Property	Common Property Total	Hatchery Terminal Area
1960	220,777		220,777	0	17,208	249,063		266,271	0
1961	274,310		274,310	0	0	731,039		731,039	0
1962	280,644		280,644	0	0	638,124		638,124	0
1963	341,744		341,744	0	32,847	259,620		292,467	0
1964	604,490		604,490	0	43,372	544,660		588,032	0
1965	104,598		104,598	0	2,688	181,776		184,464	0
1966	243,228		243,228	0	40,763	387,691		428,454	0
1967	151,008		151,008	0	93,223	45,588		138,811	0
1968	652,894		652,894	0	61,902	546,401		608,303	0
1969	53,823		53,823	0	9,537	5,899		15,436	0
1970	218,576		218,576	0	19,362	397,320		416,682	0
1971	77,428		77,428	0	88	625,903		625,991	0
1972	413,555		413,555	0	66,855	549,494		616,349	0
1973	412,769		412,769	0	31,684	347,220		378,904	0
1974	240,964		240,964	0	155,857	288,053		443,910	0
1975	133,249		133,249	0	30,635	209,775		240,410	0
1976	57,369		57,369	0	59,363	392,538		451,901	0
1977	244,173		244,173	0	41,677	139,563		181,240	0
1978	366,229		366,229	0	51,488	230,892		282,380	0
1979	277,928		277,928	0	194	51,268		51,462	0
1980	496,959		496,959	0	1,983	334,282		336,265	0
1981	252,300		252,300	0	0	90,292		90,292	0
1982	264,025		264,025	0	78,300	469,140		547,440	1,038
1983	230,507	56,301	286,808	838	1,203	199,747	6,302	207,252	17,310
1984	603,031	84,348	687,379	2	25,811	396,822	259,664	682,297	453,348
1985	361,935	158,617	520,552	420	15,071	506,829	127,733	649,633	223,983
1986	817,518	137,882	955,400	1,136	62,654	522,199	98,256	683,109	205,590
1987	127,206	104,358	231,564	2,007	37,213	328,058	3,190	368,461	581,654
1988	470,897	375,502	846,399	128,511	124,430	488,222	29,531	642,183	459,948
1989	313,388	395,281	708,669	38,196	48,739	228,813	142,082	419,634	89,840
1990	325,756	116,065	441,821	42,106	481	288,945	59,685	349,111	65,797
1991	619,332	136,850	756,182	55,361	99,543	496,068	67,093	662,704	74,302
1992	668,326	319,353	987,679	243,843	40,136	536,377	217,286	793,799	150,642
1993	827,057	471,807	1,298,864	181,469	81,414	580,961	234,438	896,813	560,442
1994	736,459	590,503	1,326,962	760,974	65,414	702,015	190,403	957,832	395,432
1995	1,209,064	645,325	1,854,389	1,151,169	105,342	845,801	303,247	1,254,390	322,859
1996	1,223,598	1,312,601	2,536,199	1,360,400	66,991	363,777	403,074	833,842	881,142
1997	387,500	1,590,182	1,977,682	1,960,202	153,833	172,601	272,132	598,566	811,158
1998	852,437	1,947,139	2,799,576	3,372,187	359,443	744,828	361,557	1,465,828	537,850
1999	1,284,351	1,372,720	2,657,071	1,635,596	215,214	602,929	76,402	894,545	374,750
2000	628,097	1,200,797	1,828,894	1,598,799	197,016	459,144	43,500	699,660	274,259

–continued–

Appendix B7.–Page 2 of 2.

	Summer Run				Fall Run				
Year	Wild Common Property	Hatchery Common Property	Common Property Total	Hatchery Terminal Area	Cholmondeley Sound Common Property	Wild Stocks Other Common Property Areas	Hatchery Common Property	Common Property Total	Hatchery Terminal Area
2001	938,276	968,765	1,907,041	960,461	127,265	635,330	126,521	889,116	281,264
2002	390,185	477,371	867,556	635,458	47,309	314,618	123,971	485,898	169,050
2003	372,603	1,053,097	1,425,700	1,082,297	93,200	154,621	401,202	649,023	342,118
2004	653,554	538,433	1,191,987	611,355	57,923	592,762	168,828	819,513	370,120
2005	286,587	781,901	1,068,488	885,758	2,850	177,991	148,595	329,436	115,267
2006	486,705	1,236,866	1,723,571	1,890,547	11,800	144,660	81,332	237,792	163,100
2007	628,179	1,354,302	1,982,481	1,278,119	389	328,440	117,018	445,847	173,022