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Stock Status and Escapement Goals for Salmon Stocks in Southeast Alaska

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and

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Editors

June 2004

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. 04-02

STOCK STATUS ESCAPEMENT GOALS FOR SALMON STOCKS IN SOUTHEAST ALASKA

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The Division of Sport Fish Special Publications series was established in 1991 for the publication of techniques and procedures manuals, informational pamphlets, special subject reports to decision-making bodies, symposia and workshop proceedings, application software documentation, in-house lectures, and other documents that do not fit in another publication series of the Division of Sport Fish. Since 2004, the Division of Commercial Fisheries has also used the same Special Publication series. Special Publications are intended for fishery and other technical professionals. Special Publications are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm. This publication has undergone editorial and peer review.

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b) for citation of a chapter, e.g., for coho salmon:
Shaul, L, S. McPherson, S., 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 Fish and Commercial Fisheries, Special Publication No. 04-02, Anchorage.

FORWARD

In early 2003, the Southeast Region of Alaska had its first Alaska Board of Fisheries meeting that incorporated the new salmon escapement goal and the sustainable salmon fisheries policies. Enclosed you will find detailed information on the status of Pacific salmon stocks in Southeast Alaska and the Yakutat area – current at the time of that Board meeting. All major stocks were reviewed for listing as *stocks of concern*, as defined by the new policies, and escapement goals were developed, reviewed, or revised for most major stocks or stock groups, following the guidelines of the new policies. Previously, escapement goals were documented one at a time in technical reports and memoranda, or not documented at all. This is our first attempt to assemble a complete collection of escapement goals in Southeast Alaska, together with complete documentation of the methods used to establish the goals and the data that underlie the goals. Of course, we look back wishing we could have done more. For example, there are several major sockeye systems left without escapement goals because of time constraints. Even so, we look forward to building on this initial effort for the 2006 Alaska Board of Fisheries meeting.

We decided to publish one report covering all five species of Pacific salmon in the Commercial Fisheries and Sport Fish Divisions' Special Publication series for completeness and to aid in citation. Three of the chapters were originally reported in the Commercial Fisheries Division's Regional Information Report Series, and two of the chapters were originally reported in the Sport Fisheries Division's Special Publication Series. The citations for the original five reports are included at the end of this forward.

The original reports for each species had undergone peer review by biologists and scientists within ADF&G, and all chapters were extensively modified prior to their original publication, based on review comments. Since the publication of the individual chapters, all chapters have been reviewed again, and we discovered many small errors that escaped us in our rush to meet our original deadline. The current publication differs from the original reports to the Board of Fisheries, for the chinook, pink, and chum chapters, in that we made minor editorial changes and corrections, and in some cases small changes to figures and graphs. In addition, to small editorial revisions to the coho chapter, we made extensive numeric changes, including updates to some of the escapement estimates.

For citation of the entire report, we suggest the following:

H.J. Geiger and S. McPherson, *editors*. 2004. Stock status and escapement goals for salmon stocks in Southeast Alaska. Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries, Special Publication 04-02.

For citation of a chapter, we suggest the following format:

L. Shaul, 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 Fish and Commercial Fisheries, Special Publication 04-02.

Finally, we thank Amy Carroll for her editorial advice and assistance, and we thank Robert Clark, Doug Eggers, and especially John H. Clark for their help with the extensive review.

The citations for the five original reports for each species are as follows:

Chinook salmon (McPherson et al. 2003)

McPherson, S., D. R. Bernard, J. Clark, K. Pahlke, E. Jones, J. Der Hovanisian, J. Weller, and R. Ericksen. 2003. Stock status and escapement goals for chinook salmon stocks in Southeast Alaska. Alaska Department of Fish and Game, Division of Sport Fish, Special Publication No. 03-01.

Sockeye salmon (Geiger et al. 2003)

Geiger, H.J., M.A. Cartwright, J.H. Clark, J. Conitz, S.C. Heinl, K. Jensen, B. Lewis, A.J. McGregor, R. Riffe, G. Woods, and T.P. Zadina. 2003. Sockeye salmon stock status and escapement goals in Southeast Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J03-04.

Coho salmon (Shaul et al. 2003)

Shaul, L., S. McPherson, E. Jones, and K. Crabtree. 2003. Stock status and escapement goals for coho salmon stocks in Southeast Alaska. Alaska Department of Fish and Game, Division of Sport Fish, Special Publication No. 03-02.

Pink salmon (Zadina et al. 2003)

Zadina, T.P., S.C. Heinl, A.J. McGregor, and H.J. Geiger. 2003. Pink Salmon stock status and escapement goals in Southeast Alaska and Yakutat. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J03-06.

Chum salmon (Heinl et al. 2003)

Heinl, S.C., Zadina, T.P., A.J. McGregor and H.J. Geiger. 2003. Chum Salmon stock status and escapement goals in Southeast Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J03-08.

—Hal Geiger and Scott McPherson

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Status and Escapement Goals for Stocks in Southeast Alaska

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ABSTRACT

The status of chinook salmon *Oncorhynchus tshawytscha* stocks in Southeast Alaska and transboundary rivers is presented in this document, based on results of the inriver stock assessment program in Southeast Alaska and Canada, and catch sampling programs of the Divisions of Sport and Commercial Fisheries. The stock assessment program for chinook salmon stocks is presented for each stock, along with primary results. Escapements in 11 drainages are evaluated for trends and tracking in relationship to *biological escapement goals* for each system. Escapement goals for chinook salmon stocks have been established for these 11 drainages in the Southeast region. Escapement goals were updated for 2 stocks in this document: the Situk and the Chilkat River stocks. Updated escapement goals for 4 other stocks are anticipated to be developed over the next few months. Methods for determining escapement goals currently in place are described briefly, and reports containing the detailed analyses are cited. Ten of the eleven regularly monitored systems are judged to be healthy. A potential management concern was identified for one of these stocks in October of 2002: the Blossom River, a relatively small stock originating on the mainland in Behm Canal near Ketchikan. Escapements for this stock have been slightly below the escapement goal developed for the stock in the early 1990s. Current available information indicates the Blossom River stock of chinook is lightly exploited and that the existing escapement goal is too high. Stock-recruit information collected over the past decade needs to be evaluated and used in combination with historic data to update the *biological escapement goal* for this stock of chinook salmon. Stock status of the other 3 Behm Canal chinook stocks is judged healthy, and no directed fishing on any of these stocks occurs. Given these facts, adjustments to fisheries to increase Blossom River escapements at this time would not be prudent.

Key words: chinook salmon, *Oncorhynchus tshawytscha*, escapement, escapement goals, escapement goal ranges, stock status, Taku River, Stikine River, Alsek River, Chilkat River, Unuk River, Chickamin River, Blossom River, Keta River, King Salmon River, Situk River, Andrew Creek, U.S./Canada Pacific Salmon Treaty, transboundary rivers

INTRODUCTION

Chinook salmon (*Oncorhynchus tshawytscha*) in Southeast Alaska are harvested primarily by the commercial troll fleet and recreational anglers. Chinook salmon are also harvested incidentally in U.S. commercial set gillnet, drift gillnet, and purse seine fisheries, and in subsistence fisheries in the region. In addition, chinook salmon are harvested in Canada in the transboundary Alsek, Taku and Stikine rivers.

Commercial and recreational fisheries are managed on an abundance-based approach, with an annual all-gear harvest target provided by the Pacific Salmon Commission, via its Chinook Technical Committee, prior to each fishing season. The annual Pacific Salmon Commission harvest target is based on a preseason forecast of the aggregate abundance of all chinook salmon stocks that are present in Southeast Alaska for the coming year (Chinook Technical Committee 2002a). The preseason abundance is estimated from the PSC chinook model run by the Chinook Technical Committee, with membership from Alaska, British Columbia, Washington, Oregon, and Idaho. Presently, the all-gear quota is allocated by the Alaska Board of Fisheries between commercial and recreational users as follows: (1) 8,600 chinook salmon to the gillnet fleet; (2) 4.3% of the total to the purse seine fleet; (3) 80% of the remainder to the troll fleet; and (4) 20% of the remainder to the recreational fleet.

Management of commercial troll harvests is described elsewhere. An accounting year of October through the following September is used for the troll fleet. This accounting year is separated into winter (October through the following April 14), spring (April 15 to June 30), and summer (July 1 to September 30) seasons. Inseason tracking of troll fishery harvests is accomplished by returns of fish tickets, inseason fishing effort counts, and fishery performance data, as well as analysis of coded wire tag returns.

Management of the recreational fishery is covered in the management plan for this fishery. Inseason tracking of harvests is accomplished by on-site creel survey programs to estimate harvest and fishing effort, and analysis of coded wire tag returns.

Management of the gillnet and purse seine fleets is covered under management plans for those gear types. Harvests of chinook salmon in the net fisheries is largely incidental to harvest of sockeye, coho, pink, and chum salmon.

Chinook salmon harvests in Southeast Alaska are known to be composed of stocks originating from as far north as the Yakutat area to the southern coast of Oregon. This includes local Southeast Alaska and transboundary wild stocks. Chinook salmon are known to occur in 34 rivers in, or draining into, the Southeast region of Alaska from British Columbia or Yukon Territory, Canada, (Kissner 1977). Local Alaska hatchery stocks contribute a sizeable portion of Southeast Alaska chinook harvests each year (Table 1.1).

STOCK STATUS

Stock status for chinook salmon stocks in the Southeast region was judged primarily by performance in meeting escapement requirements; these are local wild stocks that contribute to harvests in Southeast Alaska fisheries. Harvest levels are also addressed for many of the larger stocks. A description of the stock assessment program is presented to provide an understanding of the tools that are available for management of these stocks, and performance in relationship to the principles and criteria in the Sustainable Salmon Fisheries Policy (ADF&G/Alaska Board of Fisheries 2000).

Non-local stocks that contribute to harvests in Southeast Alaska fisheries are wild and hatchery chinook salmon that originate from waters south of Dixon Entrance. Principal contributing stock groups include several large wild stocks in British Columbia (e.g., Nass, Skeena and Fraser rivers), hatchery stocks in British Columbia from the West Coast of Vancouver Island and Georgia Strait, the wild Upriver Bright stock from the Columbia River, hatchery stocks from the Columbia River, and wild stocks from the Oregon and Washington coastal rivers. A listing of recent escapements for non-local wild stocks which contribute to Southeast Alaska fisheries is provided in this section to provide a measure of the health of these stocks.

Stock Assessment Program

In the mid-1970s it became apparent that many of the local chinook salmon stocks in this region were depressed relative to historical levels of production (Kissner 1974). A fisheries management program was implemented to rebuild stocks in Southeast Alaska streams and in transboundary rivers (rivers that originate in Canada and flow into Southeast Alaska coastal waters; ADF&G 1981). Initially, under this management program, commercial and recreational fisheries in terminal and near-terminal areas in U.S. waters were closed. The troll fishery was also modified extensively by 1982 to reduce exploitation on local wild stocks and later to target Alaska hatchery stocks.

In 1981, this program was formalized and expanded into a 15-year (roughly 3 life-cycles) rebuilding program for eleven key streams: the transboundary Taku, Stikine, Alsek, Unuk, Chickamin, and Chilkat rivers and the non-transboundary Blossom, Keta, Situk, and King Salmon rivers and Andrew Creek (ADF&G 1981) (Figure 1.1). The program used region-wide, all-gear catch ceilings for chinook salmon, designed to rebuild spawning escapements by 1995. ADF&G established interim point escapement goals in 1981 for all 11 systems, based on the highest observed escapement count prior to 1981. In 1985, the Alaskan program was incorporated into a comprehensive, coastwide rebuilding program for all wild stocks of chinook salmon, under the auspices of the U.S./Canada Pacific Salmon Treaty. In 1999, the U.S./Canada Pacific Salmon Treaty was re-signed after extensive negotiations. The chinook chapter of the new agreement specified coastwide, abundance-based management of chinook salmon stocks, and called for more comprehensive stock and fishery monitoring.

The major components of the stock assessment program in Southeast Alaska are listed in Table 2, and an explanation of the stock assessment program is provided in the following narrative. Further details for each stock are provided in the appendices to this chapter.

Escapement Estimation

To track the spawning escapement, the Alaska Department of Fish and Game (ADF&G), the CDFO, the Taku River Tlingit First Nation, and the Tahltan First Nation count spawning chinook salmon in a designated set of eleven watersheds (Appendix 1). These systems were selected on the basis of their historical importance to fisheries, size of the population, geographic distribution, extent of the historical database, and ease of data collection.

Initially, the escapement estimation program consisted of conducting aerial helicopter counts (peak single-day survey counts) annually in 10 of the 11 primary systems and a weir on one—the Situk River. The peak survey counts represented an unknown fraction of the total escapement, which was adequate to track escapement trends, but inadequate for intensive fishery management and population assessment, such as that now in place in the Pacific Salmon Commission forum.

Over time, the chinook stock assessment program was expanded to estimate total escapement on all 11 of these streams (see Table 1.3, Appendix 1). Long-term programs to estimate total escapement annually are in place on the 6 largest chinook-producing rivers in the region: the Situk (Scott McPherson, unpublished), Alsek (Pahlke and Etherton 2001), Chilkat (Ericksen 2002), Taku (McPherson et al. 1999), Stikine (Der Hovanisian et al. 2001) and Unuk (Jones and McPherson 2002) rivers. A weir is operated on the Situk River, and mark–recapture tagging projects are used to estimate escapement in the 5 larger glacial systems. Short-term (1 to 10 years) projects were used to estimate expansion factors for the other 5 smaller systems: weirs on the King Salmon River and in Andrew Creek, and mark–recapture tagging studies on the Chickamin, Keta and Blossom rivers. These programs have allowed us to estimate expansion factors for past and future survey counts, when annual estimates of escapement are not possible because of budgetary constraints. *Expansion factor* refers to the numeric multiplier that converts the survey counts into estimates total escapement; e.g., for a survey count of 1,000 with an expansion factor of 5.0, the estimated total escapement is 5,000 spawners.

In addition to escapement estimation, biological sampling is conducted annually to collect samples to estimate age, sex, and size structure of each population. These data are used to estimate brood-year production, survival, and to construct annual preseason forecasts of returning abundance. Escapement data are used annually by ADF&G for management purposes and are also provided annually to the Joint Chinook Technical Committee of the Pacific Salmon Commission, who use them to evaluate the status of escapement indicator stocks and fishery management regimes (Chinook Technical Committee 2002a).

Table 1.1 Southeast Alaska chinook salmon harvest levels and Alaska hatchery contributions in Southeast Alaska harvests, from 1965 to 2002, in thousands of chinook salmon (2002 data and some recent harvests subject to revision).

Year	Commercial harvest	Sport harvest	Total all gear Southeast Alaska harvest	Alaska hatchery contribution	Southeast Alaska harvest minus AK hatchery contribution
1965	337	13	350	0	350
1966	308	13	321	0	321
1967	301	13	314	0	314
1968	331	14	345	0	345
1969	314	14	328	0	328
1970	323	14	337	0	337
1971	334	15	349	0	349
1972	286	15	301	0	301
1973	344	16	360	0	360
1974	346	17	363	0	363
1975	300	17	317	0	317
1976	241	17	258	0	258
1977	285	17	302	0	302
1978	400	17	417	0	417
1979	366	17	383	0	383
1980	324	20	344	7	337
1981	268	21	289	2	287
1982	289	26	315	1	315
1983	289	22	311	2	309
1984	268	22	290	5	285
1985	250	25	275	13	262
1986	259	23	282	17	265
1987	258	24	282	24	258
1988	253	26	279	30	249
1989	260	31	291	29	262
1990	318	51	369	59	310
1991	299	60	359	66	293
1992	216	43	259	44	215
1993	254	49	304	41	263
1994	221	42	264	37	227
1995	186	50	236	67	169
1996	178	58	236	88	148
1997	272	71	343	62	281
1998	216	55	271	33	238
1999	179	72	251	58	163
2000	200	63	263	84	179
2001	192	72	264	79	185
2002	357	87	444	81	363

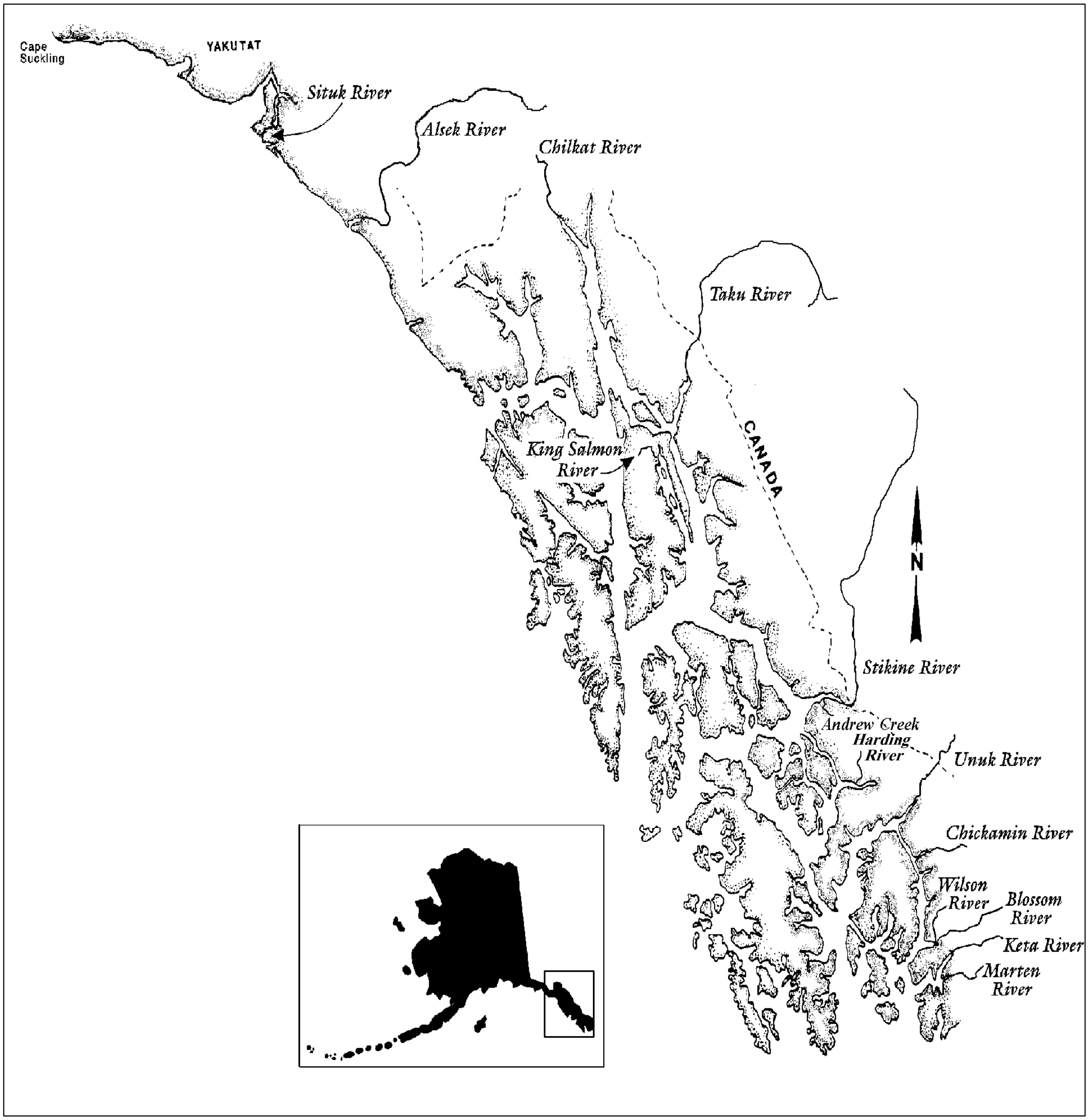

Figure 1.1 Location of selected chinook salmon systems in Southeast Alaska, Yakutat, and transboundary rivers.

Radiotelemetry Studies

Many of our chinook salmon producing rivers are large and glacially occluded, and it is impossible to see fish unless they spawn in smaller clearwater tributaries. Radio telemetry provides a tool to determine the distribution of spawning fish, to validate our aerial survey program, and to provide independent verification of our mark–recapture tagging studies to estimate escapement. The first radio-telemetry study on chinook salmon in Southeast Alaska was completed in 1989 and 1990 on the Taku River (John Eiler, NMFS, Auke Bay Laboratory, unpublished, personal communication). Since then, we have used radio telemetry to estimate the spawning distribution of chinook salmon in all of Southeast Alaska's major chinook-producing large glacial rivers, including the Alsek (Pahlke et al. 1999), Chilkat (Johnson et al. 1992), Stikine (Pahlke and Etherton 1999), Unuk (Pahlke et al. 1996), and Chickamin (Pahlke 1997) rivers. On the Chilkat River, telemetry studies resulted in major changes in the escapement estimation methods for that river, and a revision of the ADF&G's perception of the status of the Chilkat River stock from weak to healthy and stable. Telemetry results from the other rivers have supported the findings of the mark–recapture estimates and confirmed that the escapement surveys are valid indices of total escapement.

Harvest Estimation

Commercial harvests are reported on fish tickets, and sport harvests are estimated by creel surveys. These provide estimates of the total harvest in a fishery, but not the stock composition. Harvests of specific stocks, including hatchery fish, can be estimated using coded wire tags. These estimates have added value in Southeast because the Pacific Salmon Treaty provides Alaska fisheries a special add-on to the catch ceiling, allowing an additional harvest of local hatchery production. Currently, estimates of stock composition in Southeast Alaska fisheries that harvest chinook salmon has been somewhat limited and is being addressed by 2 programs, coded wire tagging of wild chinook stocks in the region and a genetic stock identification program. The combination of these 2 programs will significantly improve stock identification in Southeast Alaska chinook catches in the near future.

To maximize harvest of hatchery stocks and of wild stocks in excess of escapement requirements, information is needed on the distribution and harvest of individual stocks in various fisheries. For stocks such as the Situk and Alsek rivers, harvests of chinook salmon occur primarily within the river itself or in the lagoon where the river enters the ocean, and harvest estimation programs on those rivers can be used to estimate harvest and total production. For stocks where much of the harvest occurs in mixed-stock fisheries in the ocean, coded wire tagging projects can provide estimates of harvest for individual stocks, and genetic stock identification programs can provide estimates of harvest for individual stocks or stock groups.

Coded wire tagging of wild chinook salmon stocks was initiated in 1977 on the Taku River and continued until 1983 (McPherson et al. 2000). Stikine River juvenile salmon were tagged from 1978 to 1981. In 1983, tagging was started on the Unuk and Chickamin stocks and was continued through 1988. Situk River chinook smolt were tagged in 1984, and tagging occurred on the Alsek and Chilkat rivers from 1988 to 1990. Coded wire tagging was reinstituted in the Unuk and Taku rivers in 1993, and is continuing with increased effort compared to the earlier levels of tagging. Coded wire tagging was reinstituted on the Stikine and Chilkat rivers in spring 2000, and in the Chickamin River in fall 2001.

These programs, along with hatchery releases using local brood stocks, have documented the ocean migratory patterns of Southeast Alaska and transboundary chinook salmon stocks. Two major patterns are apparent: *outside rearing* stocks (Taku, Stikine, Alsek, Situk) which rear as immature fish in waters outside (west and north) of Southeast Alaska, and *inside rearing* Stocks (all the rest) which generally rear in inside waters from Prince William Sound to Northern B.C. All releases of chinook salmon from Southeast Alaska hatcheries are coded-wire-tagged at a rate of about 10% annually, a good mark rate for estimating harvests of these fish. Most of the hatchery production does not count toward the annual all-gear harvest limit in the region's fisheries.

Table 1.2. Summary of key stock assessment components for Southeast Alaska chinook salmon stocks, through 2002.

	INSIDE REARING STOCKS							
	Chilkat	**King SR**	**Andrew**	**Unuk**	**Chickamin**	**Blossom**	**Keta**	**Subtotal**
1. 1997 to 2001 esc. average [a]	4,120	215	1,263	5,486	3,058	696	819	15,656
2. Years of index counts	NA	32	23	26	28	28	28	165
3. Years of total escapement	1991–2002	1983–1992	1976–1984	1994 and 1997–2002	1995–1996, 2001–2002	1998	1998–2000	
4. Total esc. methodology	mark–recap	weir	weir	mark–recap	mark–recap	mark–recap	mark–recap	
No. yrs. total esc. estimated	12	10	8	7	4	1	3	45
5. Radiotelemetry	1991–1992	NA	NA	1994	1996	None	None	
6. Expansion factor [b]	NA	1.5	2.0	5.0	5.17	4.0	3.0	
7. Years age/sex/size data	17	16	12	21	14	6	7	93
8. Broods coded wire tagged	7	None	None	15	6	None	None	28
9. Used for hatchery stock	Yes	Yes	Yes	Yes	Yes	No	No	

	OUTSIDE REARING STOCKS					
	Situk	**Alsek**	**Taku**	**Stikine**	**Subtotal**	**TOTAL**
1. 1997–2001 esc. average	1,341	10,157	47,543	33,005	92,045	**107,701**
2. Years of index counts	NA	27	30	28	85	**250**
3. Years of total escapement	1976–2002	1998–2002	1989–1990, 1995–2002	1996–2002		
4. Total esc. methodology	weir	mark–recap	mark–recap	mark–recap		
No. yrs. total esc. estimated	27	5	9	7	48	**93**
5. Radiotelemetry	NA	1998, 2002	1989–1990	1997		
6. Expansion factor	NA	~5.0	5.20	5.15		
7. Years age/sex/size data	21	27	30	22	100	**193**
8. Broods coded wire tagged	2	2	17	8	29	**57**
9. Used for hatchery stock	No	No	No	No	No	

[a] Estimates of large (3- to 5-ocean-age) fish only; does not include 1- and 2-ocean-age male jacks.

[b] The expansion factor is the multiplier to convert peak survey or weir index counts to total escapement of large spawners, based years when both survey/index counts and total escapement (mark–recapture or weir) projects were implemented.

Table 1.3. Estimated total escapements of chinook salmon to escapement indicator systems and to Southeast Alaska and transboundary rivers, from 1975 to 2002. Numbers in bold type are weir counts or mark–recapture total estimates.

	MAJOR SYSTEMS			MEDIUM SYSTEMS							MINOR	
Year	Alsek (Klukshu) [a]	Taku	Stikine	Situk	Chilkat	Andrew	Unuk[a]	Chickamin[a]	Blossom[a]	Keta[a]	King Salmon	Total [b]
1975		12,920	7,571			520		1,914	584	609	63	NA
1976	5,320	24,582	5,723	**1,421**		**404**		810	272	252	98	43,584
1977	13,490	29,497	11,445	**1,732**		**456**	4,870	1,875	448	690	201	67,687
1978	12,650	17,124	6,835	**808**		**388**	5,530	1,594	572	1,176	86	48,886
1979	15,520	21,617	12,610	**1,284**		**327**	2,880	1,233	216	1,278	113	59,725
1980	12,435	39,239	30,573	**905**		**282**	5,080	2,299	356	576	104	96,113
1981	9,815	49,559	36,057	**702**		**536**	3,655	1,985	636	987	139	108,923
1982	9,845	23,848	40,488	**434**		**672**	6,755	2,952	1,380	2,262	354	93,065
1983	11,185	9,794	6,424	**592**		**366**	5,625	3,099	2,356	2,466	**245**	44,000
1984	7,860	20,778	13,995	**1,726**		**389**	9,185	5,697	2,032	1,830	**265**	66,577
1985	6,415	35,916	16,037	**1,521**		638	5,920	4,943	2,836	1,872	**175**	79,709
1986	13,035	38,111	14,889	**2,067**		1,414	10,630	9,022	5,112	2,070	**255**	100,874
1987	12,455	28,935	24,632	**1,379**		1,576	9,865	5,041	5,396	2,304	**196**	95,857
1988	9,970	44,524	37,554	**868**		1,128	8,730	4,064	1,536	1,725	**208**	115,360
1989	11,010	**40,329**	24,282	**637**		1,060	5,745	4,829	1,376	3,465	**240**	97,217
1990	8,490	**52,142**	22,619	**628**		1,328	2,955	2,916	1,028	1,818	**179**	98,468
1991	11,115	51,645	23,206	**889**	**5,897**	800	3,275	2,518	956	816	**134**	101,251
1992	6,215	55,889	34,129	**1,595**	**5,284**	1,556	4,370	1,789	600	651	**99**	112,177
1993	16,105	66,125	58,962	**952**	**4,472**	2,120	5,340	2,011	1,212	1,086	263	158,648
1994	18,100	48,368	33,094	**1,271**	**6,795**	1,144	**4,623**	2,006	644	918	210	117,173
1995	26,985	**33,805**	16,784	**4,330**	**3,790**	686	3,860	**2,309**	868	525	146	94,088
1996	17,995	**79,019**	**28,949**	**1,800**	**4,920**	670	5,835	**1,587**	880	891	288	142,834
1997	**15,250**	**114,938**	**26,996**	**1,878**	**8,100**	586	**2,970**	1,406	528	738	357	173,747
1998	**4,621**	31,039	**25,968**	**924**	**3,675**	974	**4,132**	2,021	**364**	**446**	132	74,296
1999	**11,597**	**20,545**	**19,947**	**1,461**	**2,271**	1,210	**3,914**	2,544	848	**968**	300	65,605
2000	**8,295**	**30,014**	**27,531**	**1,785**	**2,035**	1,380	**5,872**	4,141	924	**913**	137	83,027
2001	**11,022**	**41,179**	**63,523**	**656**	**4,517**	2,108	**10,541**	**5,177**	816	1,029	147	140,715
2002	**11,410**	**48,848**	**50,000**	**1,014**	**4,050**	1,752	**6,988**	**5,378**	896	1,233	153	131,722
Goals[b]												
Lower		30,000	14,000	450	1,750	650					120	NA
Point		36,000	17,500	734	2,200	800					150	NA
Upper		55,000	28,000	1,100	3,500	1,500					240	NA

[a] Escapements for the 4 Behm Canal systems are shown here for total escapement, to provide comparisons of magnitude across systems. Escapement goals for these 4 systems are for survey counts at present and are shown in Table 3 and Figure 4. Likewise, the escapement goal for the Alsek River is 1,100 to 2,300 chinook salmon past the Klukshu River weir, which represents approximately 20% of the chinook salmon production in the Alsek River.

[b] Total includes the estimated totals of large spawning chinook across all 11 systems. Escapements for the Chilkat River were approximated from 1976 to 1990 to make the totals comparable across years.

The recovery of adult chinook salmon harvested in fisheries is dependent on sampling coverage in the various fisheries. Currently, about 40% and 20% of all recreational harvests of chinook salmon are sampled for coded wire tags.

In 1998, a pilot project was used to demonstrate that genetic-based sampling of chinook salmon from the summer troll fishery could be used to estimate the stock composition of harvests in that fishery, either to individual stocks or stock groups. In 1999 and 2000, both the summer and winter troll fishery were sampled for genetic electrophoretic analysis of stock composition. This genetic-based stock composition sampling and estimation program continued to make steady progress in the 2001 and 2002 seasons, and plans are underway to include the sport and net fisheries in the near future (2003 and 2004), using funding from the Southeast Alaska Sustainable Salmon Fund.

Stock Status Assessment

In this section, the status of wild chinook stocks are evaluated through 2002. In the ADF&G/ Alaska Board of Fisheries Sustainable Salmon Fisheries Policy (SSFP–ADF&G/ABF 2000: 5AAC 39.222), some guidelines are provided to manage salmon stocks for sustainability. Our stock assessment and management program for chinook salmon in Southeast Alaska should provide a sustained resource; e.g., follow the Fisheries Sustainable Salmon Fisheries Policy. A brief excerpt from that policy is:

Management of salmon fisheries by the State of Alaska should be based on the following principles and criteria:

- *Wild salmon stocks and their habitats should be maintained at levels of resource productivity that assure sustained yields.*
- *Fisheries shall be managed to allow escapements within ranges necessary to conserve and sustain potential salmon production and maintain normal ecosystem functioning.*
- *Effective salmon management systems should be established and applied to regulate human activities that affect salmon.*
- *Public support and involvement for sustained use and protection of salmon resources shall be sought and encouraged.*
- *In the face of uncertainty, salmon stocks, fisheries, artificial propagation and essential habitats shall be managed conservatively.*

Escapement goals for the eleven key stocks of chinook salmon have been established (see Escapement Goal section below and associated references). These *biological escapement goal* ranges are designed to maintain wild stocks at high levels of productivity and to maintain yields near the theoretical average maximum sustained level. Management plans and regimes are structured for Southeast Alaska fisheries to achieve escapements within the *biological escapement goal* ranges wherever possible, and are developed with significant input from the public and users. Escapements have been evaluated in the 11 key stocks of chinook salmon against the *biological escapement goal* ranges established for each stock, to determine stock status. Escapements were assessed retrospectively back to 1975, as if the *biological escapement goal* currently being used had been in place since 1975.

Ten of the eleven chinook salmon stocks are judged to be healthy and achieving escapements which will produce returns near the estimated maximum (see Table 1.4 and Figures 1.2, 1.3, and

1.4). Of the escapements past Klukshu weir on the Alsek River since counts began in 1976, 14 have been within, 11 have been above, and one (1976) has been below the *biological escapement goal* range; since 1997, all 5 escapements have been within or above the *biological escapement goal* range. On the Situk River since 1976, 10 escapements have been within, 15 above, and one (1982) below the *biological escapement goal* range; since 1997, all 5 escapements have been within or above the *biological escapement goal* range. Escapements on the Taku and Stikine have rebounded since recruitment overfishing and poor survival reduced returns in the 1970s. Four of the 5 estimated escapements in the Taku River since 1997 have been within or above the *biological escapement goal* range, and the escapement in 1997 of about 115,000 was the highest on record since estimation began in 1973. All 5 escapements in the Stikine River since 1997 have been within or above the *biological escapement goal* range, and the 2001 escapement of about 63,000 large spawners was the highest on record.

The Chilkat and King Salmon rivers and Andrew Creek are considered *inside rearing* stocks, and stock status is judged healthy for all 3 systems. Escapement trends in the King Salmon River and Andrew Creek follow similar patterns to those seen on the Taku and Stikine rivers. Escapements have increased since the 1970s, to fall within or above the *biological escapement goal* ranges. All escapements in the King Salmon River since 1997 have been within or above the *biological escapement goal* range. All escapements in Andrew Creek since 1997 have been within or above the *biological escapement goal* range, and the 2001 escapement of 2,260 was the highest on record. A revised *biological escapement goal* was established for the Chilkat River stock in 2003; this stock has been within or exceeded this new range in each of the past 5 years.

The Unuk, Chickamin, Blossom and Keta rivers are all mainland stocks near Ketchikan and are considered *inside rearing* stocks. Peak survey goal ranges were developed for all 4 Behm Canal stocks in 1997. Stock status is judged to be healthy for 3 of the 4 systems (Unuk, Chickamin and Keta rivers). All 5 escapements in the Unuk River since 1998 have been within or above the 1997 *biological escapement goal* range, and the escapement in 2001 was near the highest on record. In the Chickamin River, escapements increased each year from 1998 to 2002, with the last 4 within or above the 1997 *biological escapement goal* range. Similarly, 4 of the last 5 escapements have been within the 1997 *biological escapement goal* range in the Keta River.

Escapements in the Blossom River have been below the 1997 *biological escapement goal* range all 5 years since 1998, averaging about 77% of the lower end of the 1997 *biological escapement goal* range. The escapements from 1998 to 2002 were 52%, 85%, 92%, 82%, and 90%, respectively, of the lower end of the 1997 *biological escapement goal* range. Escapements did increase over the last 5 years, but not into the 1997 *biological escapement goal* range. This led the ADF&G to: (1) identify the Blossom River chinook salmon stock as a candidate *stock of concern* to the Alaska Board of Fisheries, at the *management concern* level, in October 2002, and (2) to take a closer look at the Blossom River stock statistics, given its less-than-optimal performance and the good performance of the other 3 nearby chinook salmon stocks since 1998.

ADF&G has begun the process of analyzing the escapement survey data and age structure data for the Blossom River stock and the exploitation levels for the nearby Unuk River and Chickamin River stocks that are used as a surrogate for exploitation of the Blossom River stock. We anticipate being able to complete the analysis and thereby update the *biological escapement goal* for the Blossom River stock of chinook salmon over the next few months. Our initial review of these data leads us to believe that the existing goal of 250 to 500 large index spawners is an overestimate of the escapement level that will provide *maximum sustained yield*. This is because the harvest rate is relatively low, escapements over the past 10 years are stable under this relatively low exploitation rate, and, as a result, the *maximum sustained yield* escapement level is likely less than the prior analysis indicated. Given this preliminary analysis, we do not, at this time, consider the Blossom River to be a *stock of concern*. ADF&G does not consider that additional management action is needed to sustain the Blossom River chinook stock at this time. The 1998 to 2002 average survey count was 192 large chinook, which is about double the average escapement counts from 1975 to 1980 (102 large chinook), the base period used by the Pacific Salmon Commission. This stock has obviously sustained itself and is likely to do so in the future. ADF&G will continue the aerial survey program for this stock to maintain our ability to monitor escapement trends for this small stock. Additionally, results from the recently funded genetic stock identification program may assist ADF&G in identifying stock contributions of Behm Canal chinook salmon in key fisheries in the region. Fishery management actions have already been taken to provide additional escapement. No fisheries are open at present in terminal marine waters within 25 miles of the Blossom River. Spring troll and spring recreational fisheries are managed to reduce impacts on chinook salmon returning to spawn in the Blossom River. No fisheries are permitted for chinook salmon within the Blossom River drainage. We believe that these protective measures will maintain escapements and the sustainability of chinook salmon in the Blossom River in future years.

Table 1.4. Estimated *biological escapement goal* ranges for 11 chinook salmon stocks in Southeast Alaska. These escapement goals include large spawners of approximate legal retention size (28 inches total length) and do not include smaller 1- and 2-ocean age males.

	Chinook salmon stock	*Biological escapement goal* range for large spawners in survey count	1998–2002 survey count average	Present survey expansion factor	*Biological escapement goals* range for large spawners estimated in total escapement	1998–2002 total escapement average
1	Chilkat River [a]	NA	NA	NA	1,750–3,500	3,310
2	King Salmon River [b]	80–160	116	1.50	120–240	174
3	Andrew Creek [b]	375–750	748	2.00	650–1,500	1,485
4	Blossom River [a, b]	250–500	192	4.00	NA	770
5	Keta River [a, b]	250–500	302	3.00		918
6	Unuk River [a, b]	650–1,400	1,155	5.00		6,289
7	Chickamin River [a, b]	450–900	741	5.17		3,852
8	Situk River [a]	NA	NA	NA	450–1,100	1,168
9	Klukshu (Alsek) River [c]	1,100– 2,300	1,803	~5.0		9,389
10	Taku River [c]	5,800– 10,600	5,837	5.20	30,000–55,000	34,325
11	Stikine River [c]	2,700– 5,300	6,979	5.15	14,000–28,000	35,802

[a] The above *biological escapement goal* ranges have been approved by review teams from ADF&G as of February, 2003. The analysis and goals for these 2 systems along with an updated analysis for the 4 Behm Canal stocks will be presented to the Chinook Technical Committee of the Pacific Salmon Commission for review for Pacific Salmon Commission purposes by June 2003.

[b] The above *biological escapement goal* ranges have been approved by review teams from ADF&G and the Chinook Technical Committee of the Pacific Salmon Commission. *Biological escapement goals* for the Blossom, Keta, Unuk and Chickamin rivers are expressed as survey count goals because expansion factors for these systems have just been developed. Analysis will be completed and presented to an ADF&G review team and the Chinook Technical Committee, for total escapement goals for the Blossom, Unuk, Chickamin and Keta Rivers by June 2003.

[c] The above *biological escapement goal* ranges for the 3 transboundary rivers have been approved by review teams from ADF&G, the Department of Fisheries and Oceans Canada, and the Chinook and Transboundary Technical Committees of the Pacific Salmon Commission. The Klukshu River goal includes all sizes of chinook salmon.

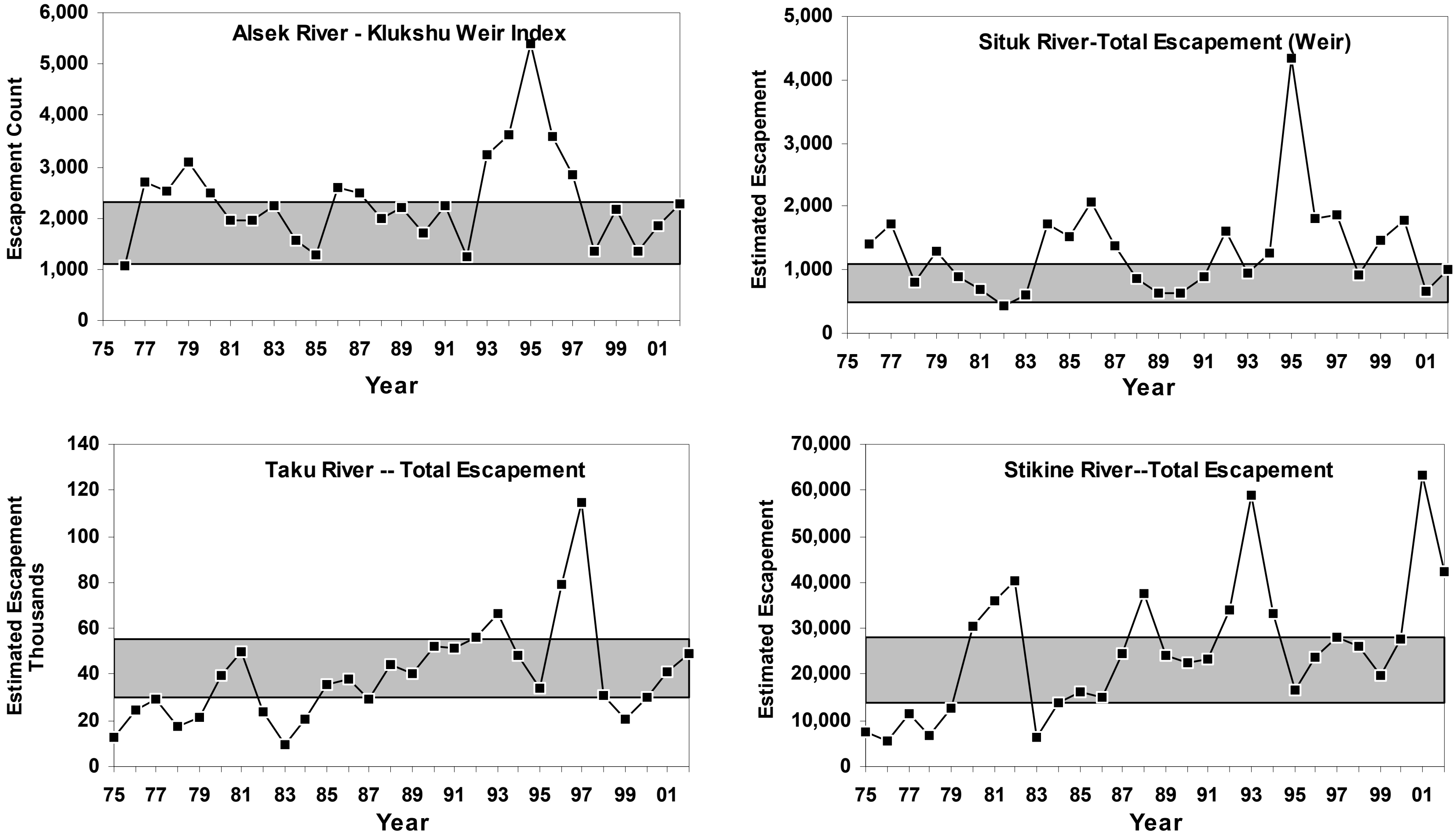

Figure 1.2. Estimated escapements of chinook salmon in the Alsek, Situk, Taku, and Stikine rivers from 1975 to 2002. All values represent the total escapement of large (3- to 5-ocean-age) chinook salmon except in the Alsek, which are total escapements past Klukshu weir, an index for the Alsek River.

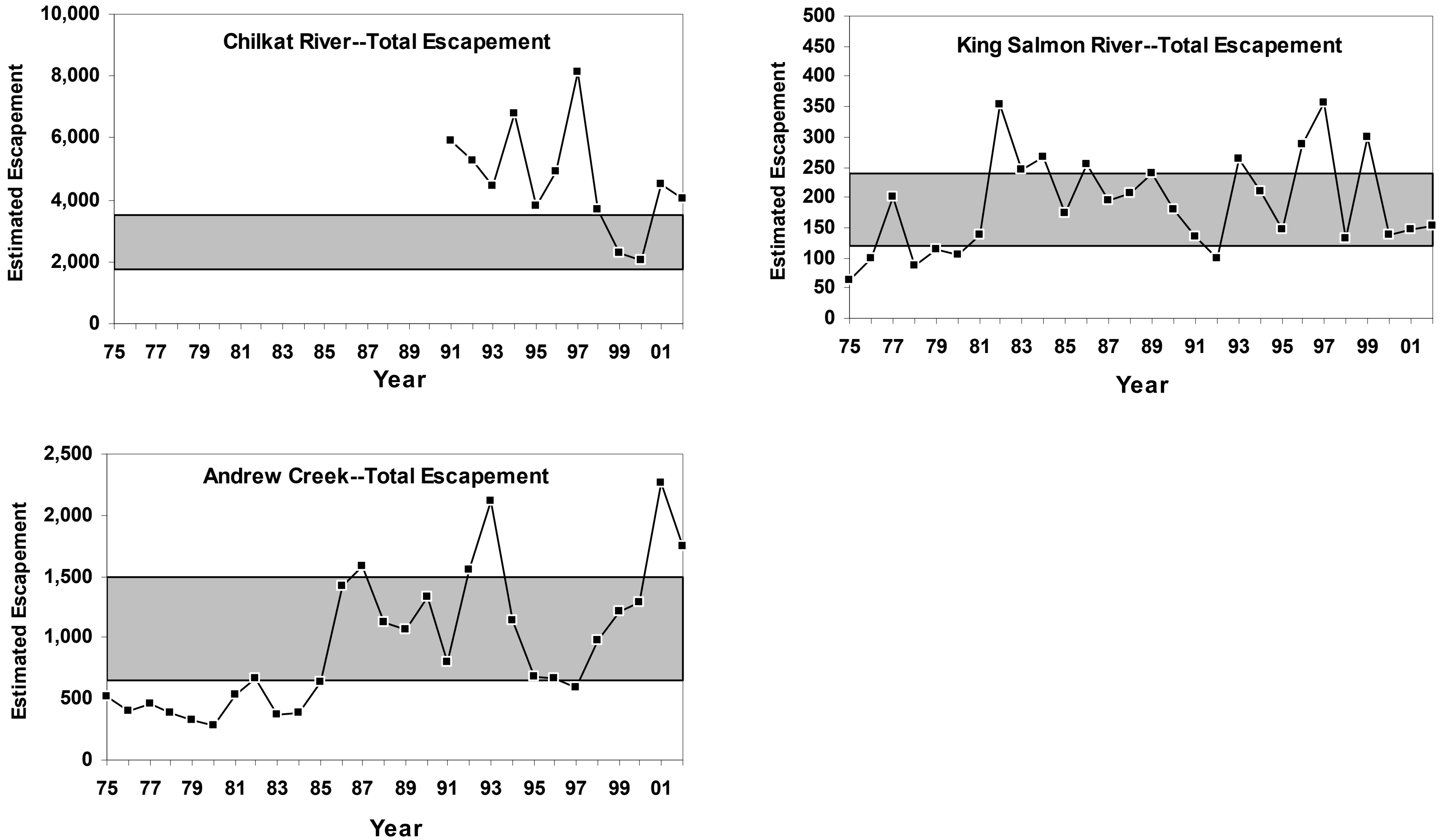

Figure 1.3. Estimated escapements of chinook salmon in the Chilkat and King Salmon rivers and in Andrew Creek from 1975 to 2002. All values represent the total escapement of large (3- to 5-ocean-age) chinook salmon.

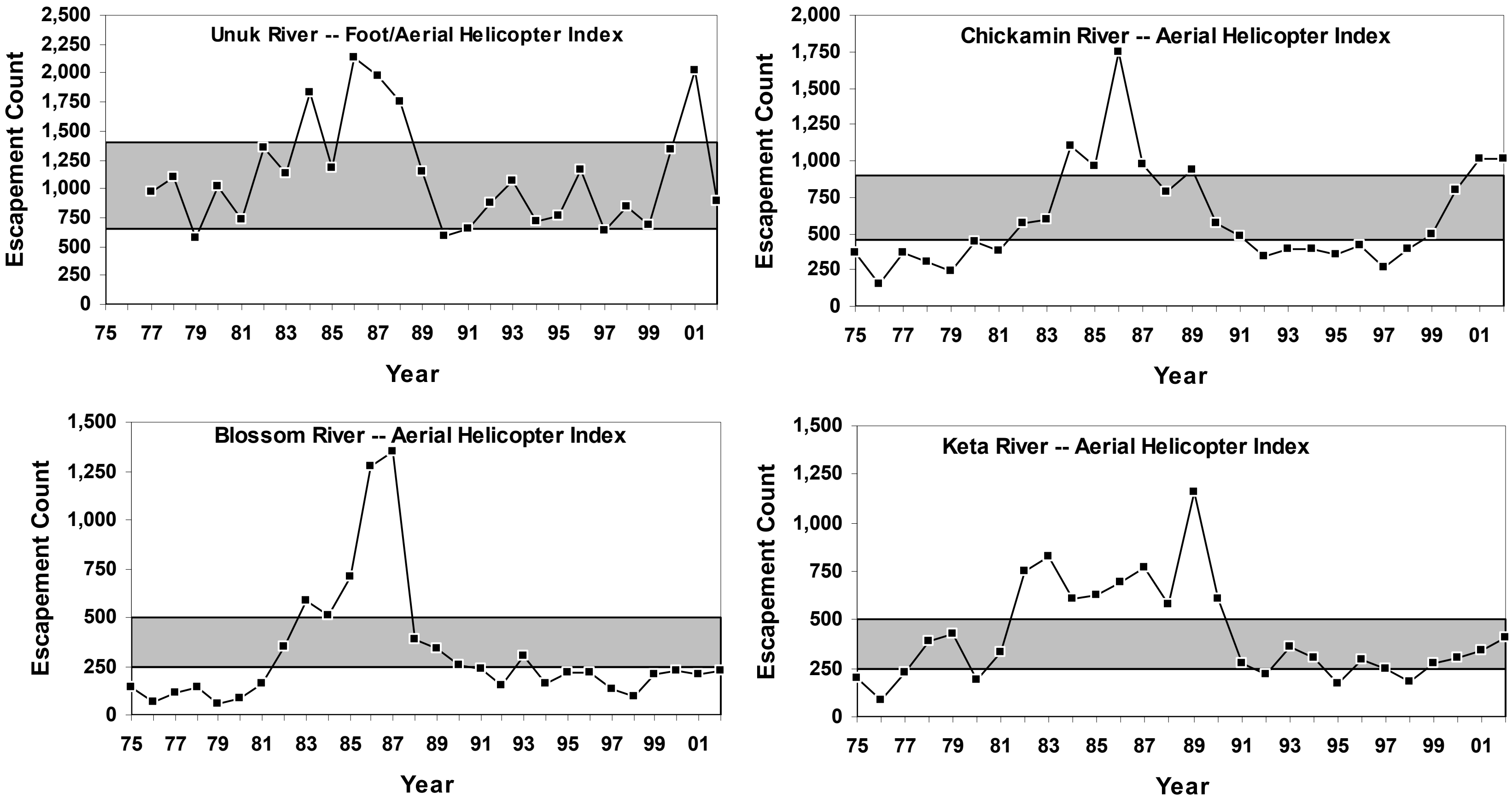

Figure 1.4. Peak survey counts of escapements of chinook salmon in the Unuk, Chickamin, Blossom, and Keta rivers from 1975 to 2002. All values represent the peak survey count of large (3- to 5-ocean-age; ≥ 660 mm MEF) chinook salmon.

ESCAPEMENT GOALS

At the 2000 Alaska Board of Fisheries meeting for Southeast Region finfish, it was reported that *biological escapement goal* ranges had been established for ten of the eleven key chinook systems in Southeast Alaska. Since that time, we have established an escapement goal for the Chilkat River—the eleventh stock. In addition, *biological escapement goal* analyses for 5 of the ten other chinook salmon stocks were outdated; hence, efforts were initiated to update *biological escapement goals* for this Alaska Board of Fisheries cycle (i.e., for the Situk, Unuk, Chickamin, Blossom, and Keta rivers). We have not yet completed the required analysis for the 4 Behm Canal stocks of chinook salmon (Table 1.3). In this section, for each of the eleven systems, we provide a brief history of the escapement goals since interim goals were established in 1981, the current escapement goal range, and a reference for the detailed analysis used to develop each of the goals. In Appendix 1, a section is included for each stock, which describes the stock and fisheries that harvest it, key numeric data, and graphs of the spawner-recruit relationship and the time series of escapements in relationship to the current goal range.

Taku River

In 1981, ADF&G set the index goal at 9,000 fish in the Nakina River (the largest chinook salmon producing tributary), based upon the count in 1952, the highest historical survey count for this tributary. The first system-wide goals were expressed in about 1985 as a range from 25,600 (U.S. estimate) to 30,000 (Canadian estimate), both estimates were based on professional judgment. In 1991, the Transboundary Technical Committee, a subcommittee of the Pacific Commission for the Alsek, Taku and Stikine rivers, revisited the goal and agreed on an index goal of 13,200 counted in aerial surveys. This goal was implemented in 1992 (Pacific Salmon Commission 1991). All of these earlier goals were based on limited data. Staff of ADF&G and CDFO cooperatively developed a new escapement goal range of 30,000 to 55,000 large spawners (not an index) in an analysis of adult and smolt production, which was reviewed and accepted by the Chinook Technical Committee (Chinook Technical Committee 1999), ADF&G, CDFO, which included the Pacific Scientific Advice and Review Committee, and the Transboundary Technical Committee, in 1999 (McPherson et al. 2000).

The current escapement goal range in McPherson et al. (2000) was based on a stock-recruit relationship, based on the number of smolt produced per female spawner (see graph in Appendix 1.1). In short, the highest number of smolt were produced from a range of approximately 15,000 to 27,500 females. Because the number of females to large males averages about 1:1 on the spawning grounds in the Taku River, this range was doubled to develop the current *biological escapement goal* range of 30,000 to 55,000 large spawners.

Stikine River

In 1981, ADF&G set an index escapement goal at 3,360 large fish, counted from the air over the Little Tahltan River, based upon an aerial count of 2,137 fish in 1980 expanded by a factor of 1.6. The first joint system-wide goal, developed by the Transboundary Technical Committee in about 1985, was expressed as a range from 19,800 (U.S. estimate) to 25,000 (Canadian estimate) and was in effect through 1991. In 1991, the Transboundary Technical Committee agreed on an index goal of 5,300 large spawners counted through the Little Tahltan River weir (Pacific Salmon Commission 1991). These earlier goals were all based on limited data. In a cooperative analysis by ADF&G and CDFO, recent results from mark–recapture experiments were used to expand aerial counts and weir counts into inriver returns to the watershed prior to 1996. In 1999, these data along with estimated harvests were used in a stock-recruit analysis to establish an escapement goal range for the Stikine River of 14,000 to 28,000 large chinook salmon (Bernard et al. 2000; Appendix 1.2). This *biological escapement goal* range has been reviewed and accepted by the Chinook Technical Committee, ADF&G, and the joint Transboundary Technical Committee.

Alsek River

In 1981, ADF&G set the Alsek River goal at 5,000 chinook salmon, based on the 1979 Klukshu River weir count of 3,200 and a guessed expansion factor of 1.56 for the remainder of the drainage. The Transboundary Technical Committee developed an initial system-wide escapement goal range, developed circa 1985, which was 7,200 (U.S. estimate) to 12,500 (Canadian estimate). This goal was in effect through 1991. In 1991, the joint goal was revised to an index goal of 4,700 (Klukshu weir count of escapement; Pacific Salmon Commission 1991). A stock-recruit analysis was initially developed in 1996 but underwent review by the ADF&G, CDFO (including Pacific Scientific Advice Review Committee), Transboundary Technical Committee, and Chinook Technical Committee, with subsequent revision through 1998. In the final technical report, McPherson, Etherton, and Clark (1998) recommended a revised Klukshu River chinook salmon escapement goal of 1,100 to 2,300 chinook salmon, and this revised goal was reviewed and accepted by ADF&G, the Transboundary Technical Committee, and the Chinook Technical Committee in 1998 (Appendix 1.3).

The current escapement goal was based on an analysis of the stock-recruitment relationship of parent year spawners and returning adults, using a Ricker[a] model to estimate stock-recruitment parameters. Note that the *biological escapement goal* range of 1,100 to 2,300 chinook salmon spawners counted past the Klukshu River weir is an index for the Alsek River drainage. Mark–recapture studies conducted jointly with Canada since 1997 indicate that the Klukshu River supports about one-fifth of the total spawners in the Alsek River drainage (Pahlke and Etherton 2001). It is anticipated that by 2006 a drainage-wide escapement goal for the Alsek River will be developed.

Situk River

The 1981 escapement goal was set at 5,100 fish. In 1982, the goal was revised to 2,000 large fish. In 1991, ADF&G revised the Situk River chinook salmon escapement goal to 600 large spawners based upon a spawner-recruit analysis (Unpublished memorandum available from Scott McPherson, ADF&G), which was reviewed and used by the Chinook Technical Committee. The Alaska Board of Fisheries directed ADF&G to manage the stock for a range of 600 to 750 large spawners in 1991. In 1997, ADF&G revised the Situk River escapement goal range to 500 to 1,000 large spawners, to conform to the Department's escapement goal policy and to provide a more realistic *maximum sustained yield* range for management. The Chinook Technical Committee reviewed and accepted this change in 1998.

Because the *biological escapement goal* analysis for the Situk River stock was done over 10 years ago and substantial new information has accumulated since that time, the *biological escapement goal* analysis was updated for this Alaska Board of Fisheries cycle (see Appendix 1.4). We estimated parent spawners and subsequent recruitment for the 1977 to 1994 brood

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[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable. α is defined as Rickers productivity parameter. β is defined as Ricker's carrying capacity parameter.

years. Statistical testing revealed that time series autocorrelation was present in the residuals output from a Ricker model.

We corrected for the autocorrelation and estimated stock size (S) that maximizes sustained yield (S_{MSY}, point estimate) to be 730 large spawners, and a range predicted to produce 90% of *maximum sustainable yield* of 450 to 1,050 large spawners (Scott McPherson, unpublished). This range is not substantially different from the prior *biological escapement goal* range. This analysis will be presented to the Chinook Technical Committee for review before June 2003.

Chilkat River

The 1981 escapement goal was set at 2,000 large fish, based on a guess of the fraction of the total escapement represented by the survey counts. ADF&G compiled available escapement, age, and harvest data for this stock, and a review team recommended a *biological escapement goal* range of 1,750 to 3,500 large spawners for the Chilkat River chinook salmon stock (Appendix 1.5) as measured in the annual mark–recapture program (the authors' unpublished data). This analysis has been accepted by ADF&G and will be presented to the CTC for review before June 2003.

King Salmon River

In 1981, ADF&G set the index goal at 200 large fish, based upon the prior highest survey counts of 200 spawners in 1957 and 211 spawners in 1973. In the mid-1980s, ADF&G revised the King Salmon River chinook escapement goal to 250 large spawners counted through the weir (total escapement). In 1997, ADF&G revised the goal to 120 to 240 total large fish, based upon a spawner-recruit analysis for the 1971 to 1991 brood years (McPherson and Clark 2001). This range is ADF&G's most current estimate of *maximum sustained yield* escapement and has been accepted by an ADF&G review team and the Chinook Technical Committee as a biologically based escapement goal (Appendix 1.6).

Andrew Creek

In the early 1980s, ADF&G set the Andrew Creek chinook salmon escapement goal at 750 large fish total escapement. In 1997, an initial stock-recruit analysis was developed that underwent review by ADF&G and the Chinook Technical Committee. This analysis was completed in 1998, and the technical report (Clark et al. 1998) recommended a revised *biological escapement goal* range of 650 to 1,500 large chinook salmon, which was accepted and adopted by the ADF&G and the CTC (Appendix 1.7).

Unuk River

The 1981 ADF&G goal was 1,800 large index spawners. This goal was mistakenly based upon a 1978 count thought to be 1,765 fish, which was revised downward in 1985 to 1,106 fish upon discovery that some tributary counts were entered twice. The corrected count was still the largest pre-1981 index count. In 1994, ADF&G revised the goal to 875 large index spawners, based upon a spawner-recruit analysis (McPherson and Carlile 1997), which the Chinook Technical Committee reviewed and accepted. In 1997, ADF&G revised the goal to a range of 650 to 1,400 large index spawners as recommended in the McPherson and Carlile (1997) report and in compliance with the ADF&G Escapement Goal Policy. The Chinook Technical Committee reviewed and accepted this change in 1998 (Appendix 1.8). This stock is one of those that ADF&G anticipated being updated for the current Alaska Board of Fisheries cycle. Analysis is currently underway, and it is anticipated that revised escapement goals for the 4 Behm Canal stocks of chinook salmon will be complete in the next few months.

Chickamin River

In 1981, ADF&G set the escapement goal at 900 large fish index, based upon a count of 860 chinook salmon in 1972. In 1994, ADF&G revised the goal to 525 large index spawners, based upon a spawner-recruit analysis (McPherson and Carlile 1997), which the Chinook Technical Committee reviewed and accepted. In 1997, ADF&G revised the goal to 450 to 900 large index spawners as recommended in the McPherson and Carlile (1997) report and in compliance with the ADF&G Escapement Goal Policy. The Chinook Technical Committee reviewed and accepted this change in 1998 (Appendix 1.9). This stock is one of those that ADF&G anticipated being updated for the current Alaska Board of Fisheries cycle. Analysis is currently underway, and it is anticipated that revised escapement goals for the 4 Behm Canal stocks of chinook salmon will be complete in the next few months.

Keta River

In 1981, ADF&G set the index goal at 500 large fish, based upon counts of 500 spawners in 1948 and 462 spawners in 1952 (ADF&G 1981). In 1994, ADF&G revised the escapement goal to 300 large index spawners, based upon a spawner-recruit analysis (McPherson and Carlile 1997), which the Chinook Technical Committee reviewed and accepted in 1994. In 1997, ADF&G revised the escapement goal to a range of 250 to 500 large index spawners, in conformance with the McPherson and Carlile (1997) report and in compliance with the ADF&G Escapement Goal Policy. The Chinook Technical Committee reviewed and accepted this change in 1998 (Appendix 1.10). This stock is one of those that ADF&G anticipated being updated for the current Alaska Board of Fisheries cycle. Analysis is currently underway, and it is anticipated that revised escapement goals for the 4 Behm Canal stocks of chinook salmon will be complete in the next few months.

Blossom River

In 1981, ADF&G set an index escapement goal, as a combined count of 800 large fish from the Blossom and Wilson rivers, based upon a 1963 count of 825 fish, 450 in the Blossom and 375 in the Wilson. In 1985, the Wilson surveys were dropped for budgetary reasons, but the goal of 800 continued to be applied to the Blossom. In 1994, ADF&G revised the Blossom goal to 300 large index spawners, based upon a spawner-recruit analysis (McPherson and Carlile 1997), which the Chinook Technical Committee reviewed and accepted in 1994. In 1997, ADF&G revised the goal to a range of 250 to 500 large index spawners in conformance with the McPherson and Carlile (1997) report and in compliance with the ADF&G Escapement Goal Policy. This stock is one of those that ADF&G anticipated being updated for the current Alaska Board of Fisheries cycle. Analysis is currently underway, and it is anticipated that revised escapement goals for the 4 Behm Canal stocks of chinook salmon will be complete in the next few months.

NON-LOCAL STOCKS

Chinook salmon stocks originating from outside Southeast Alaska are harvested in Southeast Alaska fisheries. Here we provide a brief summary of the principal stocks or stock groups that are harvested, and escapement trends in recent years (Table 1.5).

The principal non-Alaskan stock groups of chinook salmon, from Canada, Washington, Oregon, and the Columbia River, which contribute to Southeast Alaska (SEAK) fisheries are: (1) West

Coast of Vancouver Island (WCVI), (2) North/Central British Columbia (NBC and CBC), (3) summer and fall stocks from the Columbia River (COL), (4) spring and summer stocks from the Fraser River, (5) Oregon coastal (OR) stocks from the north and mid-Oregon coasts), and (6) Washington coastal (WC) stocks. The remainder of the non-Southeast Alaska stocks listed in Table 1.5 cumulatively make up less than 10% of the Southeast Alaska harvests of chinook salmon. These 6 stock groups are all made up of both wild and hatchery stocks.

The escapements of these 6 stock groups were relatively high from 1999 to 2001, with the exception of WCVI hatchery and wild stocks. The WCVI stocks experienced a downturn in survival, especially in 2000 and 2001 returns. Preliminary estimates of 2002 returns for WCVI show an improvement. The 2000 and 2001 estimated escapements for the Nass and Skeena rivers (NBC) were high, 2002 being some of the highest on record. The Columbia River escapements of summer and fall chinook salmon have been high in recent years, with 2001 and 2002 returns the highest seen for several decades. Oregon coastal stocks have met or exceeded all existing escapement goals, with the exception of the Nehalem stock in 2000. Washington coastal stocks do not have agreed goals set, but escapements have been relatively stable for these stocks in recent years.

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Table 1.5. Summary of Chinook Technical Committee escapement indicator stocks, those with Chinook Technical Committee accepted biologically based goals as of December 2002, escapements from 1999 to 2001. Data source: Chinook Technical Committee (2002b), Chinook Technical Committee notes, and internet for 2001 Columbia spring and summer escapements.

Stock no.	Stock name	Area	CTC accepted goal	Goal	1999 Escapement	2000 Escapement	2001 Escapement
1.	Situk	SEAK	**Yes**	500–1,000	1,461	1,785	656
2.	K. Salmon	SEAK	**Yes**	120–140	300	137	147
3.	Andrew	SEAK	**Yes**	650–1,500	1,210	1,286	2,260
4.	Blossom [a]	SEAK	**Yes**	250–500	212	231	204
5.	Keta [a]	SEAK	**Yes**	250–500	276	300	343
6.	Klukshu	SEAK	**Yes**	1,100–2,300	2,166	1,363	1,843
7.	Taku	SEAK	**Yes**	30,000–55,000	20,545	30,014	41,179
8.	Stikine	SEAK	**Yes**	14,000–28,000	19,947	27,531	66,523
9.	Unuk [a]	SEAK	**Yes**	650–1,400	680	1,341	2,019
10.	Chickamin [a]	SEAK	**Yes**	450–900	492	801	1,010
11.	Chilkat	SEAK	No	–	2,271	2,035	4,517
12.	Yakoun	NBC	No	–	3,200	3,600	4,000
13.	Nass	NBC	No	–	11,538	20,406	34,315
14.	Skeena	NBC	No	–	43,775	51,720	84,642
15.	Dean	NBC	No	–	1,800	1,200	3,795
16.	Rivers Inlet	NBC	No	–	2,739	6,700	5,062
17.	Smith Inlet	NBC	No	–			
18.	WCVI	WCVI	No	–	12,256	5,175	3,041
19.	Up Georgia	GS	No	–	8,481	7,933	5,315
20.	Lw Georgia	GS	No	–	9,181	8,500	8,280
21.	Spr Fraser 1.3	Fraser	No	–	9,500	12,850	9,885
22.	Spr Fraser 1.2	Fraser	No	–	8,751	11,731	10,607
23.	Sum Fraser 1.3	Fraser	No	–	20,740	26,773	31,269
24.	Sum Fraser 0.3	Fraser	No	–	53,204	45,161	74,132
25.	Harrison	Fraser	**Yes**	75,100–98,500	107,016	77,035	78,098

-continued-

Table 1.5. (Page 2 of 2).

Stock no.	Stock name	Area	CTC accepted goal	Goal	1999 Escapement	2000 Escapement	2001 Escapement
26.	Skagit Spring	PS	No	–	471	1,021	1,856
27.	Skagit SU/Fall	PS	No	–	4,924	16,930	13,233
28.	Stillaguamish	PS	No	–	1,098	1,622	1,269
29.	Snohomish	PS	No	–	4,803	6,092	8,164
30.	Green	PS	No	–	11,025	6,170	7,975
31.	Nooksack SP	PS	No	–	213	432	2,185
32.	L Wash. Fall	PS	No	–	240	300	1,269
33.	Quillayute SU	WC	No	–	713	992	1,225
34.	Quillayute Fall	WC	No	–	3,334	3,730	3,800
35.	Queets SP/SU	WC	No	–	373	248	545
36.	Queets Fall	WC	No	–	1,933	3,572	2,106
37.	Grays Spring	WC	No	–	1,285	2,867	2,860
38.	Grays Fall	WC	No	–	9,196	9,260	9,483
39.	Hoh SP/SU	WC	No	–	1,027	492	1,200
40.	Hoh Fall	WC	No	–	1,924	1,748	1,870
41.	Hoko Fall	WC	No	–	1,550	730	838
42.	Col Upr SP	COL	No	–	10,682	51,308	about 100,000
43.	Col Upr.Sum	COL	**Interim**	17,857	23,057	27,073	about 75,000
44.	Col Upr Bright	COL	**Interim**	40,000	72,089	73,024	104,946
45.	Lewis	COL	**Yes**	5,700	3,184	9,820	13,900
46.	Deschutes	COL	No	–	3,641	3,728	11,057
47.	Nehalem	OR	**Yes**	6,989	8,063	5,257	9,459
48.	Siletz	OR	**Yes**	2,944	4,166	4,982	10,582
49.	Siuslaw	OR	**Yes**	12,925	29,610	12,999	29,748
50.	Umpqua	OR	No	–	1,804	3,140	6,510
51.	Mid S OR	OR	No	–	83	62	74

[a] Blossom, Keta, Unuk and Chickamin goals are for index surveys which represent one-third to one-fifth of total escapement.

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APPENDIX A1. CHINOOK SALMON STOCK

Appendix 1.1. Taku River Chinook Salmon Stock

Stock Description

The Taku River, which originates in northwestern British Columbia, produces the largest local population of chinook salmon on average in Southeast Alaska (McPherson et al. 2000). Prior to the mid-1970s (1880s to 1975), these fish were exploited in directed commercial (troll and gillnet) and recreational fisheries, with annual commercial harvests estimated in excess of 15,000 chinook salmon (Kissner 1976).

This stock underwent a downward trend in abundance and survival in the 1960s and 1970s. Various restrictions were placed on all Southeast Alaska fisheries (troll, gillnet and recreational) beginning in 1976, as part of a program to rebuild stocks of chinook salmon in Southeast Alaska by ADF&G. Presently, migrating chinook salmon from the Taku River are caught incidentally in the late winter and spring troll fisheries—a commercial gillnet fishery located in U.S. waters near the river—and in inriver commercial and aboriginal gillnet fisheries in Canada. Chinook salmon from the Taku River are also caught in directed recreational fisheries in Alaska and in northwestern British Columbia, and constitute a large portion of the spring chinook harvest near Juneau (McPherson et al. 2000). Exploitation of the terminal run is jointly managed by the U.S. and Canada through the Pacific Salmon Commission process.

Chinook salmon from the Taku River are a spring run of salmon, with returning adults present in terminal marine areas from late April through early July. Spawning occurs from late July to mid-September, in clearwater tributaries. Yearling smolt are produced and migrate after a year in fresh water. After entering salt water, the juveniles spend anywhere from a couple of months to a year in nearshore waters of Southeast Alaska, and then migrate north and west into the Gulf of Alaska, out of reach of fisheries in Southeast Alaska and British Columbia; hence the classification as an *outside rearing* stock. Returning mature fish that are 4 to 6 years old dominate the annual spawning population.

The stock assessment program for Taku River chinook salmon consists of a smolt coded wire-tagging program, coded wire tag recovery on adults in marine fisheries and inriver, a mark–recapture tagging program to estimate escapement both inseason via a test fishery in the lower river and postseason via sampling upriver on the spawning grounds, and aerial survey counts to refine expansion factors (McPherson et al. 1999, 2000). This is a joint program that ADF&G runs in cooperation with CDFO and the Taku River Tlingit First Nation. This program produces annual estimates of smolt production, total adult production, exploitation rates and harvest rates, as well as age structure to evaluate brood year returns and escapement requirements. The coded wire tagging program for the Taku stock has marked fish from the 1975 to 1981 and 1991 to 2000 broods.

Escapements since 1990 have averaged over 50,000 large chinook and exploitation rates are estimated to have averaged less than 15%, ranging from about 12% to 22% (Table 1.1.1). The smolt and female spawner data used to develop the current *biological escapement goal* is shown in Table 1.1.2 and Figure 1.1.2. The estimated escapements of large spawners versus the current *biological escapement goal* is shown in Figure 1.1.1.

System:	Taku River
Species:	Chinook salmon

Outline of stock management, assessment and escapement goal analysis

Management Division:	Sport and Commercial Fisheries Divisions
Management Jurisdictions:	Joint management ADF&G and CDFO through Pacific Salmon Commission
Fisheries:	U.S. recreational, gillnet, troll; Canadian gillnet, First Nations, recreational
Escapement Goal Type:	*Biological Escapement Goal*
Escapement Goal:	30,000 to 55,000 range; 35,938 point estimate
Population for Goal:	Large spawners (3- to 5-ocean-age) in entire drainage
Optimal Escapement Goal:	None
Inriver Goal:	None
Action Points:	None
Escapement Enumeration:	Aerial helicopter surveys: 1973 to 2002, conducted in 6 major tributaries—the Nahlin, Nakina, Dudidontu, Tatsamenie and Kowatua rivers, and Tseta Creek and standardized since 1973 Mark–recapture estimates: 1989, 1990, 1995 to 2002.
Index Count Expansion Factor:	5.20 (multiplier for cumulative helicopter peak survey count in 5 tributaries—Nahlin, Nakina, Dudidontu, Tatsamenie and Kowatua rivers)
Brood years in analysis:	8
Data in analysis:	Estimated total escapement of large female spawners and subsequent smolt production
Data Quality:	Good
Contrast in escapements:	NA
Model[a] used for escapement goal:	Empirical observation of optimal smolt production range and associated number of female spawners
Criteria for range:	Highest smolt production
Value of alpha[b] parameter:	4.406
Value of beta[c] parameter:	0.00001643
Document supporting goal:	McPherson, S. A., D. R. Bernard, and J. H. Clark. 2000. Optimal production of chinook salmon from the Taku River. Alaska Department of Fish and Game, Division of Sport Fish, Fisheries Manuscript No. 00-2, Anchorage.

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Table 1.1.1. Estimated harvests, escapements, and total runs by year of chinook salmon bound for the Taku River, from 1973 to 2001.

Year	Escapement [a]	U.S. gillnet	U.S. sport	U.S. troll	U.S. PU	U.S. Total	Canada GN	Canada FN	Total harvest	Total run size [b]	Expl. rate
1973	14,564	5,064	936	519		6,519		NE	6,519	21,083	30.9%
1974	16,015	2,381	885	526		3,792		NE	3,792	19,807	19.1%
1975	12,920	1,899	800	NE		2,699		NE	2,699	15,619	17.3%
1976	24,582	1,369	800	NE		2,169		NE	2,169	26,751	8.1%
1977	29,497	539	2,450	NE		2,989		NE	2,989	32,486	9.2%
1978	17,124	1,333	1,673	NE		3,006		NE	3,006	20,130	14.9%
1979	21,617	2,078	1,853	5,375		9,306	97		9,403	31,020	30.3%
1980	39,239	1,289	2,512	5,352		9,153	225	85	9,463	48,702	19.4%
1981	49,559	960	1,703	5,276		7,939	159		8,098	57,657	14.0%
1982	23,848	1,690	1,359	2,709		5,758	54		5,812	29,660	19.6%
1983	9,794	353	1,089	419		1,861	556	9	2,426	12,220	19.9%
1984	20,778	869	1,210	2,754		4,833	515	0	5,348	26,126	20.5%
1985	35,916	1,410	1,863	749		4,022	350	4	4,376	40,292	10.9%
1986	38,111	1,133	755	808		2,696	352	10	3,058	41,169	7.4%
1987	28,935	1,004	1,019	399		2,422	233	0	2,655	31,590	8.4%
1988	44,524	591	765	NE		1,356	741	27	2,124	46,648	4.6%
1989	40,329	1,278	1,857	NE	62	3,197	1,034	6	4,237	44,566	9.5%
1990	52,142	2,395	2,039	NE	57	4,491	1,386	0	5,877	58,019	10.1%
1991	51,645	2,330	4,199	NE	47	6,576	1,609	0	8,185	59,830	13.7%
1992	55,889	1,082	3,099	NE	34	4,215	1,592	121	5,928	61,817	9.6%
1993	66,125	3,567	5,860	NE	17	9,444	1,790	25	11,259	77,384	14.5%
1994	48,368	2,012	2,672	NE	36	4,720	2,300	119	7,139	55,507	12.9%
1995	33,805	3,056	1,920	NE	37	5,013	1,875	70	6,958	40,763	17.1%
1996	79,019	2,187	4,121	1,605	87	8,000	3,475	63	11,538	90,557	12.7%
1997	114,938	2,437	4,648	1,479	33	8,597	2,816	103	11,516	126,454	9.1%
1998	31,039	504	1,840	656	31	3,031	1,334	60	4,425	35,464	12.5%
1999	19,734	1,299	2,110	811	22	4,242	1,165	50	5,457	25,191	21.7%
2000	30,529	528	892	1,484	21	2,925	1,663	50	4,638	35,167	13.2%
2001	44,000	1,162	1,001	1,917		4,080	1,701	50	5,831	49,831	11.7%
Averages:											
1979-01	42,604	1,531	2,191	2,120	40	5,125	1,175	43	6,337	48,941	14.1%
1979-89	32,059	1,150	1,453	2,649	62	4,777	392	18	5,182	37,241	15.0%
1990-01	52,269	1,880	2,867	1,325	38	5,445	1,892	59	7,396	59,665	13.2%

[a] Escapement: Escapement estimates shown here are for large chinook (3- to 5-ocean age; 5- and 6-year total age), are from mark–recapture estimates in 1989 to 1990 and 1995 to 1997 (McPherson et al. 2000), are preliminary mark–recapture estimates for 1999 to 2001, and for 1973 to 1988, 1991 to 1994 and 1998 are expanded survey counts of large spawners. No estimates are available prior to 1973.

[b] Total run and exploitation rate estimates are underestimated for 1973 to 1978 because troll harvest estimates are lacking or incomplete. Exploitation rates were likely 30% or greater in these years. Exploitation rates are also under-estimated from 1987 to 1996 because troll harvest estimates are lacking or incomplete, but likely averaged about 1,500 fish per year.

Table 1.1.2. Estimated abundance of females, smolts, subsequent production of adult salmon, and estimated mean fork length for smolts for several year classes of chinook salmon in the Taku River. Standard errors for ratios (in parentheses) were approximated with the delta method (Seber 1982:7–9).

Year class	Females	Smolts	Mean smolt FL (mm)	Smolts / female	Recruits	Adult / smolt
1975	4,593	1,189,118	79	258.9	87,450	0.074
	(2,139)	(174,197)		(126)	(23,384)	(0.0224)
1976	15,165	1,549,052	71	102.1	65,457	0.042
	(6,478)	(374,227)		(50)	(16,615)	(0.0148)
1979	10,997	661,150	74	60.1	39,833	0.060
	(4,991)	(97,648)		(29)	(9,288)	(0.0166)
1991	27,435	2,098,862	80	76.5	196,114	0.093
	(11,842)	(295,390)		(35)	(14,153)	(0.0148)
1992	22,935	1,968,167	73	85.8	79,307 [a]	0.0403
	(10,391)	(438,569)		(43)		
1993	29,976	1,267,907	78	42.3	19,114 [b]	0.0151
	(13,573)	(564,432)		(27)		
1994	31,553	1,328,553	76	42.1		
	(13,565)	(352,068)		(21)		
1995	19,705	1,898,233	77	96.3		
	(2,644)	(626,335)		(34)		

[a] Estimate is based on final estimate of spawning abundance and preliminary statistics on harvest.
[b] Estimate is based on inputting production of age-1.4 and -1.5 salmon as the average (34% of production) over all age groups for the 1973 to 1991 year classes.

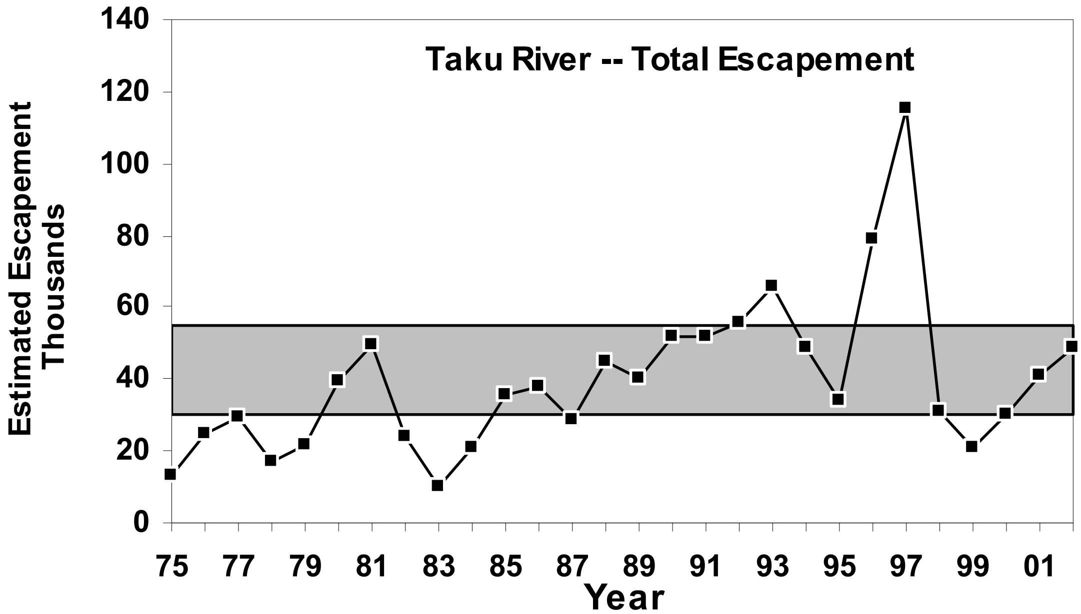

Figure 1.1.1. Estimated escapements of large spawners in the Taku River from 1975 to 2002, with the 1999 *biological escapement goal* range.

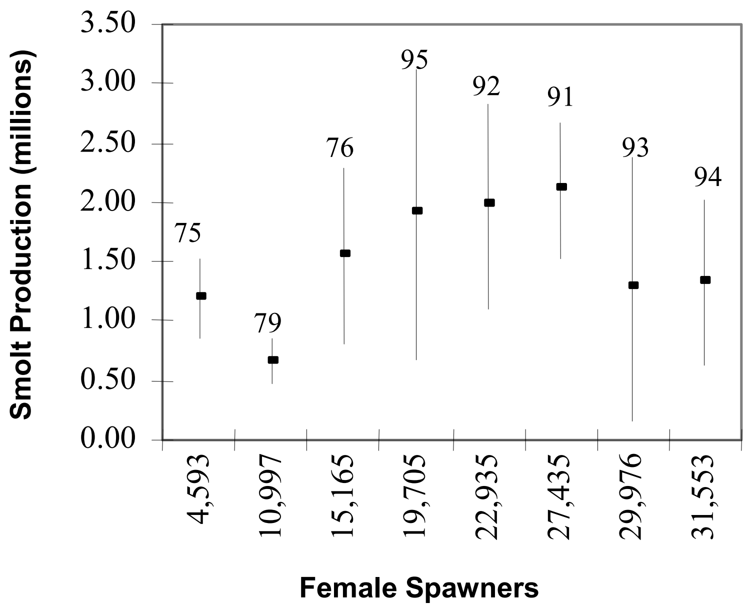

Figure 1.1.2. Estimated smolt production and estimated abundance of female parents for the 1975, 1976, 1979, and 1991 to 1995 year classes. Intervals on smolt production are approximate 95% confidence intervals (from McPherson et al. 2000).

Appendix 1.2. Stikine River Chinook Salmon Stock

Stock Description

The Stikine River, which is a glacial transboundary river like the Taku, produces the second largest population of local chinook salmon, on average, in Southeast Alaska (Bernard et al. 2000). This stock underwent a downward trend in abundance and survival in the 1960s and 1970s. Various restrictions were placed on all intercepting fisheries (troll, gillnet, and recreational) beginning in 1976, as part of a ADF&G program to rebuild stocks of chinook salmon in Southeast Alaska. Presently, migrating chinook salmon from the Stikine River are caught incidentally in the troll fishery, a commercial gillnet fishery located in U.S. waters near the river, and in inriver commercial and aboriginal gillnet fisheries in Canada. Chinook salmon from the Stikine River are also caught in directed recreational fisheries near Wrangell and Petersburg in Alaska and on the Tahltan River in British Columbia. Exploitation of the terminal run is jointly managed by the U.S. and Canada through the Pacific Salmon Commission process.

Chinook salmon from the Stikine River are a spring run and yearling smolt are produced. Ocean rearing patterns are similar to that of the Taku and, hence the classification as an *outside rearing* stock. Returning mature fish that are 4 to 6 years old dominate the annual spawning population, with 6-year-old fish being the most abundant age class.

The stock assessment program for Stikine River chinook salmon presently consists of a smolt coded wire tagging program, coded wire tag recovery on adults in fisheries and inriver, a mark–recapture tagging program to estimate escapement both inseason via a test fishery in the lower river and postseason via sampling upriver on the spawning grounds, and the index spawner counts at Little Tahltan River (Der Hovanisian et al. 2001). This is a joint program that ADF&G runs in cooperation with CDFO and the Tahltan First Nation. This program produces annual estimates of smolt production, total adult production, exploitation rates and harvest rates, as well as age structure to evaluate brood year returns and escapement requirements. The smolt coded wire tagging project was reinstituted in 2000 and the first returns of 5-year-old fish will occur in 2003; coded wire tag coverage for this stock is much less extensive than that for the Taku and Unuk River stocks.

Escapements over the most recent 5 years of estimates (1997 to 2001) have averaged 33,000 large spawners (Figure 1.2.1). All of these 5 escapements, and all estimated escapements since 1985, have been within or above the 1999 *biological escapement goal*. Exploitation rates are estimated to have averaged 18% for 1997 to 2001 and have ranged from about 10% to 40% since 1983 (Table 1.2.1). The adult spawner-recruit data used to develop the current *biological escapement goal* is shown in Table 1.2.2 and Figure 1.2.2.

System: Stikine River
Species: Chinook salmon

Outline of stock management, assessment and escapement goal analysis

Management Division:	Sport and Commercial Fisheries Divisions
Management Jurisdictions:	Joint management ADF&G and CDFO through Pacific Salmon Commission
Fisheries:	U.S. recreational, gillnet, troll; Canadian gillnet, First Nations, recreational
Escapement Goal Type:	*Biological Escapement Goal*
Escapement Goal:	14,000 to 28,000 range; 17,368 point estimate
Population for Goal:	Large spawners (3- to 5-ocean-age) in entire drainage
Optimal Escapement Goal:	None
Inriver Goal:	None
Action Points:	None
Escapement Enumeration:	Aerial helicopter surveys: 1975 to present Index weir counts, Little Tahltan River: 1985 to present Mark–recapture estimates: 1996 to present
Index Count Expansion Factor:	5.15 (multiplier for weir count on Little Tahltan River)
Brood years in analysis:	15 (1977 to 1991)
Data in analysis:	Estimated total escapement of large spawners, all terminal and near terminal harvests, age structure all years
Data Quality:	Excellent
Contrast in escapements:	6.3
Model used for escapement goal:	Ricker model[a] incorporating measurement error in escapements and returns.
Criteria for range:	S_{MSY} times 0.8 (lower) and 1.6 (upper), per Eggers (1993)
Value of alpha parameter[b]:	2.61
Value of beta parameter[c]:	0.000026592
Document supporting goal:	Bernard, D. R., S. A. McPherson, K. A. Pahlke, and P. Etherton. 2000. Optimal production of chinook salmon from the Stikine River. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Manuscript No. 00-1, Anchorage.

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.

[b] α is defined as Rickers productivity parameter.

[c] β is defined as Ricker's carrying capacity parameter.

Table 1.2.1. Escapement index counts, spawning escapement estimates, harvests, run sizes, and exploitation rates for Stikine River chinook salmon, from 1975 to 2001. Escapement estimates in bold are from mark–recapture estimates (1996 to 2001), estimates in italics (1975 to 1984) are from expansions of aerial counts and estimates from 1985 to 1995 are from expansions of Little Tahltan River weir counts.

Year	Aerial counts	Little Tahltan weir count	Spawning escapement	U.S. sport harvest	U.S. gillnet harvest	Canadian harvest	Total harvest	Total run size	Expl. rate
1975	700		*7,571*		1,534	1,202	2,736	10,307	26.5%
1976	400		*5,723*		1,123	1,160	2,283	8,006	28.5%
1977	800		*11,445*	2,282	1,443	162	3,887	15,332	25.4%
1978	632		*6,835*	1,743	531	500	2,774	9,609	28.9%
1979	1,166		*12,610*	1,759	91	1,562	3,412	16,022	21.3%
1980	2,137		*30,573*	2,498	631	2,231	5,360	35,933	14.9%
1981	3,334		*36,057*	2,022	283	1,404	3,709	39,766	9.3%
1982	2,830		*40,488*	2,929	1,033	2,387	6,349	46,837	13.6%
1983	594		*6,424*	2,634	47	1,418	4,099	10,523	39.0%
1984	1,294		*13,995*	2,171	14	643	2,828	16,823	16.8%
1985	1,598	3,114	16,037	2,953	20	1,111	4,084	20,121	20.3%
1986	1,201	2,891	14,889	2,475	102	1,963	4,540	19,429	23.4%
1987	2,706	4,783	24,632	1,834	149	2,390	4,373	29,005	15.1%
1988	3,796	7,292	37,554	2,440	207	2,629	5,276	42,830	12.3%
1989	2,527	4,715	24,282	2,776	310	2,886	5,972	30,254	19.7%
1990	1,755	4,392	22,619	4,283	557	2,481	7,321	29,940	24.5%
1991	1,768	4,506	23,206	3,657	1,336	1,678	6,641	29,847	22.3%
1992	3,607	6,627	34,129	3,322	967	2,454	6,743	40,872	16.5%
1993	4,010	11,449	58,962	4,227	1,628	2,371	8,226	67,188	12.2%
1994	2,422	6,426	33,094	2,140	1,996	2,085	6,221	39,315	15.8%
1995	1,117	3,259	16,784	1,218	1,702	1,894	4,814	21,598	22.3%
1996	1,920	4,840	**28,949**	2,464	1,717	2,769	6,950	35,899	19.4%
1997	1,907	5,613	**26,996**	3,475	2,566	4,513	10,554	37,550	28.1%
1998	1,385	4,879	**25,968**	1,438	460	2,160	4,050	30,026	13.5%
1999	1,379	4,738	**19,947**	3,567	1,078	3,769	8,414	28,361	29.7%
2000	2,720	6,640	**27,531**	2,581	1,692	2,770	7,043	34,574	20.4%
2001	4,158	9,738	**63,523**	3,005	7	3,123	6,135	69,658	8.8%

Table 1.2.2. Estimated total returns of Stikine River chinook salmon for brood years 1977 to 1996.[a]

Brood year	Parent escapement	Age-1.2 return	Age-1.3 return	Age-1.4 return	Age-1.5 return	Total return
1977	*11,445*	866	8,254	6,000	102	15,222
1978	*6,835*	1,356	4,004	1,999	161	7,520
1979	*12,610*	3,981	14,809	16,006	311	35,107
1980	*30,573*	1,560	4,094	12,757	1,026	19,437
1981	*36,057*	963	6,289	21,225	768	29,245
1982	*40,488*	1,692	6,215	37,809	5,853	51,569
1983	*6,424*	1,657	3,914	13,415	1,588	20,574
1984	*13,995*	1,079	10,716	25,534	956	38,285
1985	16,037	828	2,264	16,832	76	20,000
1986	14,889	3,049	11,183	31,251	1,649	47,132
1987	24,632	2,440	8,517	57,900	3,135	71,992
1988	37,554	770	6,249	30,800	2,372	40,191
1989	24,282	644	4,324	13,268	116	18,352
1990	22,619	1,204	5,049	8,182	223	14,658
1991	23,206	4,859	21,264	28,700	641	55,464
1992	34,129	2,212	8,645	22,377	901	34,136
1993	58,962	1,315	7,185	15,905	556	24,961
1994	33,094	2,522	11,409	14,883	212	29,026
1995	16,784	5,731	18,663	16,109		40,503 [a]
1996	**28,949**	14,391	53,366			67,757 [a]

[a] Total returns for brood years 1995 and 1996 are incomplete.

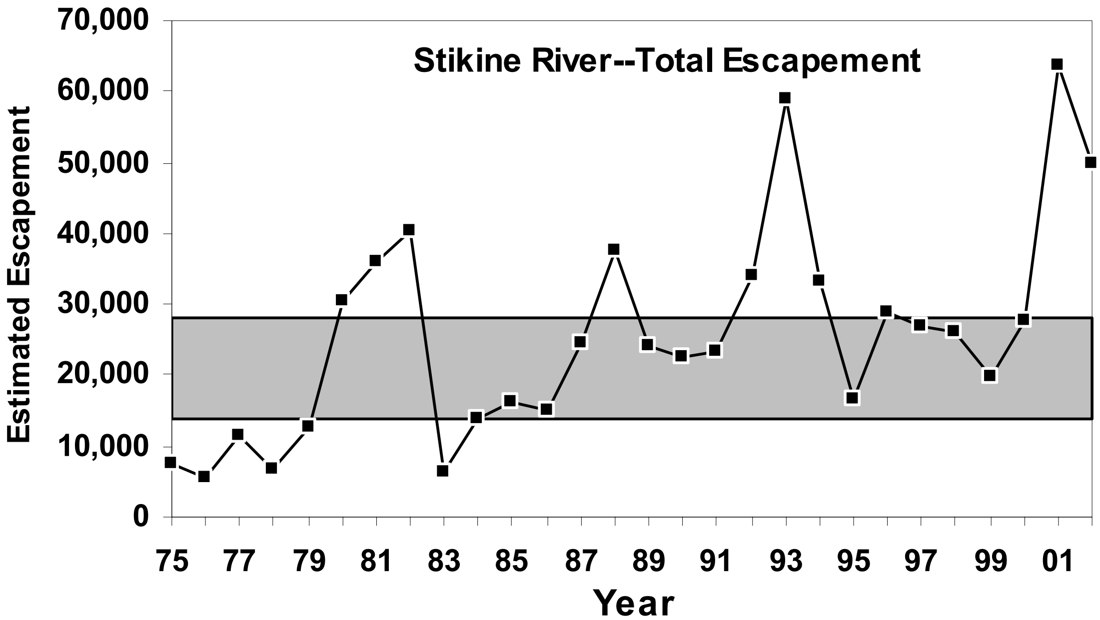

Figure 1.2.1. Estimated escapements of large spawners in the Stikine River from 1975 to 2002, with the 1999 *biological escapement goal* range.

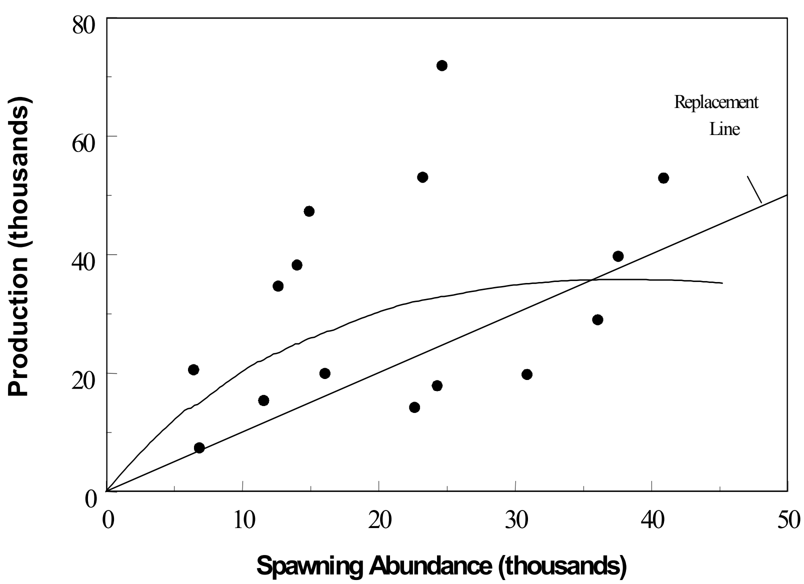

Figure 1.2.2. Estimated production of age 1.2 to 1.5 chinook salmon in year classes 1977 to 1991 against the estimated spawning abundance of their parents age 1.3 and older for the population in the Stikine River. (Extracted from Bernard et al. 2000. The curve represents production predicted with Ricker's model.)

Appendix 1.3. Alsek River Chinook Salmon Stock

Stock Description

The Alsek River produces the third or fourth largest chinook run in Southeast Alaska. The Alsek River originates in the Yukon Territory, Canada, and flows in a southerly direction into the Gulf of Alaska, southeast of Yakutat, Alaska. From 1941 to 1980 there were fishery openings directed at Alsek River chinook salmon with average catches of about 1,500 fish (McPherson et al. 1998). Chinook salmon returning to this river are caught primarily in U.S. commercial and subsistence set gillnet fisheries in the lower Alsek River in Dry Bay, and in recreational and aboriginal fisheries on the upper Tatshenshini River in Canada. Small harvests of this stock are also probably taken in marine recreational and commercial set gillnet and troll fisheries near Yakutat. Early season openings of the U.S. commercial fishery have been severely restricted since 1980, primarily in the attempt to reach the high escapement goals set in 1981 and 1991 for Klukshu River chinook, and in response to conservation concerns for the early sockeye run. The escapement goal was revised in 1998 to a range of 1,100 to 2,300 chinook through the Klukshu weir and that goal has been met or exceeded every year since 1976.

Chinook salmon from the Alsek are a spring run of salmon, with returning adults present in terminal marine areas from late April through early July. Spawning occurs from late July to late August. Yearling smolt are produced and migrate after a year in fresh water. Ocean migration patterns are similar to Taku and Stikine stocks, hence the classification as an *outside rearing* stock. Returning mature fish that are 4 to 6 years old dominate the annual spawning population.

Since 1976, the CDFO has operated a weir at the mouth of the Klukshu River to count chinook, sockeye, and coho salmon. The weir count is used as the index for the Alsek River. Prior to 1997, the proportion of the total chinook salmon escapement to the Alsek River drainage counted at the Klukshu River weir was unknown. Mark–recapture studies conducted annually since 1997 indicate that Klukshu River chinook salmon account for approximately 15% to 20% of the total run (Pahlke 2001; Pahlke and Etherton 2001). This is a cooperative program run by ADF&G and CDFO along with the Champagne-Aishihik First Nation that provides annual estimates of escapement as well as age structure to evaluate brood year returns and escapement requirements.

Klukshu River escapements averaged about 2,800 large chinook salmon in the 1990s and exploitation rates are estimated to have averaged 23%, ranging from about 12% to 45% (Table 1.3.1). The estimated escapements of large spawners versus the current *biological escapement goal* is shown in Figure 1.3.1. The adult spawner-recruit data used to develop the current *biological escapement goal* is shown in Table 1.3.2 and Figure 1.3.2 (McPherson et al 1998).

Appendix 1.3. Alsek River Chinook Salmon Stock

System: Alsek River and Klukshu River tributary
Species: Chinook salmon

Outline of stock management, assessment and escapement goal analysis

Management Division:	Sport and Commercial Fisheries Divisions
Management Jurisdictions:	Joint management ADF&G and CDFO through Pacific Salmon Commission
Fisheries:	U.S. subsistence/personal use, gillnet, troll; First Nations, Canadian recreational
Escapement Goal Type:	*Biological Escapement Goal*
Escapement Goal:	1,100 to 2,300 range; no point estimate
Population for Goal:	All spawners counted past the Klukshu River Weir, a clearwater tributary of the Alsek
Optimal Escapement Goal:	None
Inriver Goal:	None
Action Points:	None
Escapement Enumeration:	Aerial helicopter surveys: 1981 to 2002 Index weir counts Klukshu River: 1976 to 2002 Mark–recapture estimates for Alsek: 1998 to 2002
Index Count Expansion Factor:	Approx. 5.0 (multiplier for weir count on Klukshu River)
Brood years in analysis:	16 (1976 to 1991)
Data in analysis:	Estimated total escapement of all spawners, all terminal, near terminal harvests, and age structure all years.
Data Quality:	Very good to excellent
Contrast in escapements:	2.9
Model used for escapement goal:	Ricker model[a] and empirical inspection of the spawner-recruit relationship
Criteria for range:	Range producing largest total returns
Value of alpha parameter[b]:	7.44
Value of beta parameter[c]:	0.00081
Document supporting goal:	McPherson, S. A., P. Etherton, and J. H. Clark. 1998. Biological escapement goal for Klukshu River chinook salmon. Alaska Department of Fish and Game, Division of Sport Fish, Fisheries Manuscript 98-2, Anchorage.

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Table 1.3.1. Spawning escapement, estimated harvests, run size, and exploitation rates for chinook salmon in Klukshu River, a tributary of Alsek River, from 1976 to 2002.

	Klukshu River						Alsek River total escapement[d]
Year	Spawning escapement [a]	Total Canada harvest [b]	Total U.S. harvest [c]	Total harvest	Total Run size	Exploitation rate	
1976	1,064	354	154	508	1,572	32%	
1977	2,698	656	421	1,077	3,775	29%	
1978	2,530	656	732	1,388	3,918	35%	
1979	3,104	1,755	758	2,513	5,617	45%	
1980	2,487	290	415	705	3,192	22%	
1981	1,963	430	234	664	2,627	25%	
1982	1,969	633	160	793	2,762	29%	
1983	2,237	518	28	546	2,783	20%	
1984	1,572	415	14	429	2,001	21%	
1985	1,283	322	64	386	1,669	23%	
1986	2,607	218	151	368	2,975	12%	
1987	2,491	476	112	589	3,080	19%	
1988	1,994	312	71	383	2,377	16%	
1989	2,202	486	74	560	2,762	20%	
1990	1,698	722	49	771	2,469	31%	
1991	2,223	822	42	864	3,087	28%	
1992	1,243	253	95	348	1,591	22%	
1993	3,221	332	101	433	3,654	12%	
1994	3,620	500	260	760	4,380	17%	
1995	5,397	1,316	216	1,532	6,929	22%	
1996	3,382	893	249	1,143	4,525	25%	
1997	2,829	437	182	619	3,448	18%	
1998	1,347	286	184	470	1,817	26%	4,621
1999	2,166	349	158	507	2,673	19%	11,597
2000	1,319	114	217	331	1,650	20%	8,295
2001	1,738	189	168	357	2,095	17%	11,022
2002	2,282	na	210	210	2,492		pending
Average	2,497	518	164	642	3,139	23%	8,884

[a] Klukshu River spawning escapement = weir count minus above weir harvest.
[b] Total Canada harvest Klukshu stock = above weir harvest plus 70% Dalton Post sport and 95% Aboriginal Food Fishery.
[c] Total U.S. Harvest of Klukshu stock = 30% Dry Bay commercial, subsistence and personal use gillnet harvest.
[d] Alsek River total escapement from mark–recapture estimates.

Table 1.3.2. Estimated brood year returns of Klukshu River chinook salmon by age, calculated by using the 30% assumption to apportion U.S. Alsek fishery harvests for brood year 1971 to 1991 (per McPherson et al. 1998).

Brood year	Estimated escapement	Estimated returns by age					Estimated total return
		Age 3	Age 4	Age 5	Age 6	Age 7	
1971	unknown			498	1,153	0	1,651
1972	unknown		122	1,357	1,235	0	2,714
1973	unknown	0	1,068	2,121	2,414	0	5,603
1974	unknown	43	421	2,655	2,008	73	5,199
1975	unknown	0	412	1,085	1,299	2	2,799
1976	1,064	0	67	813	1,125	0	2,005
1977	2,698	0	276	1,156	696	28	2,156
1978	2,530	0	371	1,941	991	0	3,302
1979	3,104	29	77	739	661	0	1,506
1980	2,487	1	91	812	513	16	1,433
1981	1,963	30	156	1,955	1,086	10	3,238
1982	1,969	16	479	1,656	1,293	6	3,450
1983	2,237	1	196	674	1,329	9	2,209
1984	1,572	2	295	853	768	87	2,006
1985	1,283	10	493	1,265	1,645	2	3,415
1986	2,607	0	246	1,242	871	17	2,376
1987	2,491	4	73	456	1,412	49	1,994
1988	1,994	7	197	1,635	1,461	1	3,301
1989	2,202	47	387	1,514	992	5	2,945
1990	1,698	155	1,279	5,095	1,791		8,320
1991	2,223	11	511	1,773			3,958[a]
Statistics for 1976 to 1990:							
Averages	2,127	20	312	1,454	1,109	16	2,911
Minimum	1,064	0	67	456	513	0	1,433
Maximum	3,104	155	1,279	5,095	1,791	87	8,320

[a] Brood year 1991 total return estimated as the average of 58% of total return at age 3 to 5 for brood years 1976 to 1990.

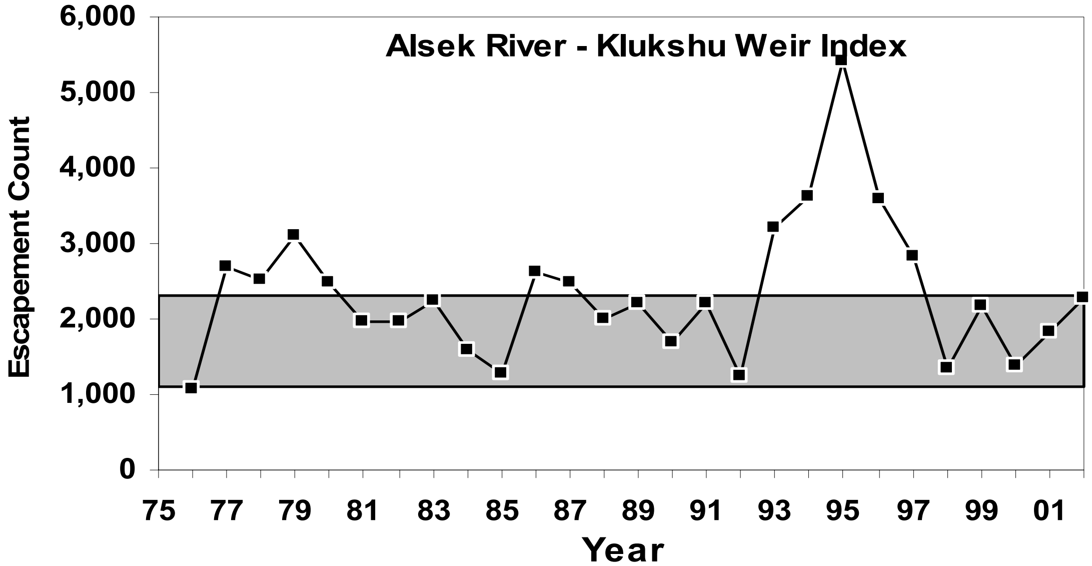

Figure 1.3.1. Estimated escapements of chinook spawners in the Klukshu River from 1976 to 2002, with the 1998 *biological escapement goal* range.

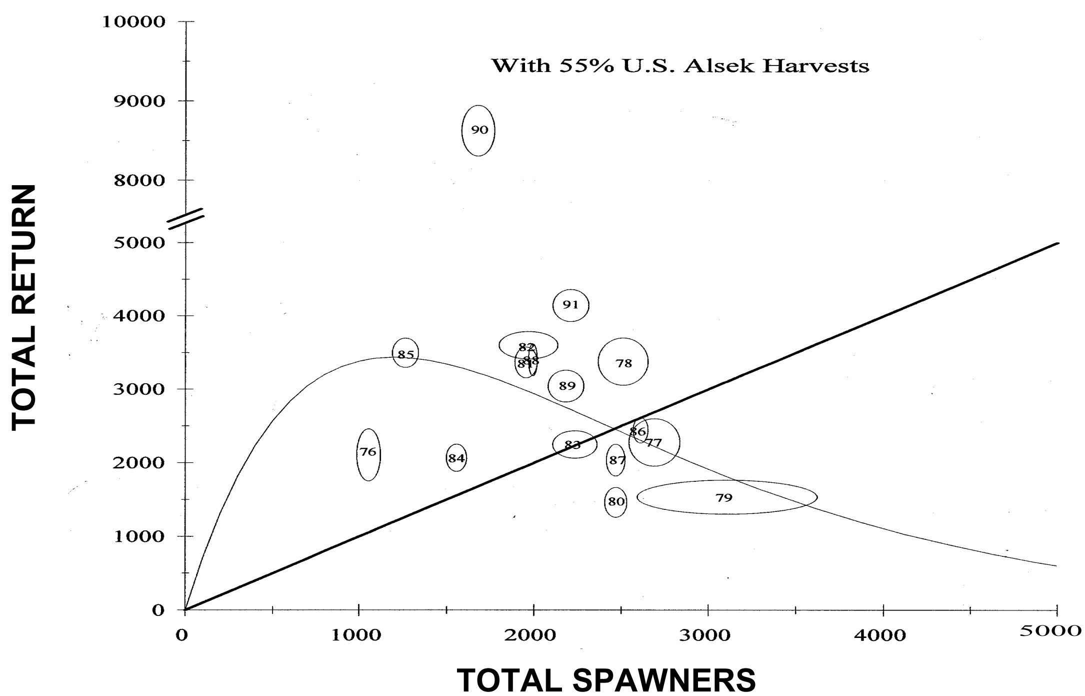

Figure 1.3.2. Estimated production of chinook salmon in year classes 1976 to 1991 against the estimated spawning abundance of their parents for the population in the Klukshu River (McPherson et al. 1998). The curve represents production predicted with Ricker's model. The ovals represent 95% confidence values for the point estimates.

Appendix 1.4. Situk River Chinook Salmon Stock

Stock Description

The Situk River is a relatively small productive drainage, located near Yakutat. It usually produces runs of chinook salmon in the 2,000 to 5,000 fish range, but runs have been as large as 15,000 (Table 1.4.1). These statistics do not include 1-ocean-age jack males, which generally number between 500 to 3,000 fish in a calendar year.

Chinook salmon from the Situk River are a spring run of salmon, with returning adults migrating into the lower Situk River from late May to early August. Spawning occurs from mid-August to early September, in the mainstem above Nine Mile Bridge. The Situk chinook population is very productive; the number of adults produced per spawner is greater than the other Southeast Alaska chinook stocks. The majority (60% to 95%) of the smolt in most years are age-0., or subyearling smolt that emigrate to sea the year after spawning, verified by fry and coded wire tag studies. This bypasses mortality that would occur for most other stocks (Chilkat, Taku, Stikine, Unuk, etc.) during the year spent in freshwater as fry. Other Yakutat Forelands stocks, like the Akwe and Italio, produce a high percentage of subyearling smolt as well; this seems to be a function of the lagoons available for rearing in these systems. These are all clearwater systems. The only other locations where we have observed subyearling smolt are the Keta and Blossom Rivers, 2 clearwater rivers in the far southern end of the region.

After entering saltwater, the juveniles appear to migrate west and north into the Gulf of Alaska, out of reach of fisheries in Southeast Alaska and British Columbia; hence the classification as an *outside rearing* stock. Two broods of chinook salmon were coded wire tagged historically and no coded wire tags were recovered south of Yakutat; almost all coded wire tag recoveries occurred in the Situk-Ahrnklin Lagoon and upstream in the Situk River. Returning mature fish that are 4 and 5 years old dominate the annual spawning population.

This stock is primarily exploited in or near the river by commercial set gillnet, subsistence, and recreational fishers. This stock can support a higher exploitation rate than other Southeast Alaska stocks because it is more productive per spawner. Exploitation rates have average 62% since the 1991 management plan was put into place (Table 1.4.1); the escapements since 1991 have all been within or above the escapement goal range during that period (Figure 1.4.1). Brood year returns have averaged about 4,000 fish for the 1977 to 1997 broods, and have been very productive recently, averaging 7,500 age-.2 to age-.5 fish for the 1990 to 1996 broods (Table 1.4.2). The stock-recruit relationship used to develop the 2003 *biological escapement goal* goal range is shown in Figure 1.4.2.

The stock assessment program for Situk River chinook salmon consists of weir counts, direct fishery enumeration for the commercial, subsistence and recreational fisheries, and age, sex, and size sampling in the commercial gillnet and recreational fisheries and in the escapement. This information, along with the Situk River management plan, provides the tools for preseason forecasts, inseason run strength assessment and intensive inseason management.

Appendix 1.4. Situk River Chinook Salmon Stock

System:	Situk River
Species:	Chinook salmon

Outline of stock management, assessment and escapement goal analysis

Management Division:	Sport and Commercial Fisheries Divisions
Management Jurisdictions:	ADF&G
Fisheries:	U.S. recreational, gillnet, subsistence, troll
Escapement Goal Type:	*Biological Escapement Goal*
Escapement Goal:	450 to 1,050 range; 730 point estimate
Population for Goal:	Large spawners (3- to 5-ocean-age) in entire drainage
Optimal Escapement Goal:	None
Inriver Goal:	None
Action Points:	See Situk River management plan
Escapement Enumeration:	Weir counts: 1976 to 2002
Brood years in analysis:	18 (1977 to 1994)
Data in analysis:	Escapement of large spawners, all terminal and near terminal harvests, age structure all years.
Data Quality:	Excellent
Contrast in escapements:	4.8
Model used for escapement goal:	Ricker model[a] incorporating correction for autocorrelation seen in the spawner-recruit relationship
Criteria for range:	Range predicted to produce 90% of
Value of alpha parameter[b]:	14.806, corrected
Value of beta parameter[c]:	0.0011135
Document supporting goal:	McPherson, S. A., R. E. Johnson, and G. F. Woods. 2003. *In press*. Optimal Production of Chinook salmon from the Situk River. Alaska Department of Fish and Game, Division of Sport Fisheries, Fisheries Manuscript, Anchorage.

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S\exp\{-\beta S+\varepsilon\}$, for ε a random variable.

[b] α is defined as Rickers productivity parameter.

[c] β is defined as Ricker's carrying capacity parameter.

Table 1.4.1. Weir counts, harvests, run size and exploitation rates for Situk River chinook salmon, 1976 to 2001. The Situk weir count and spawning escapement includes large chinook (3–5-ocean-age), whereas the remainder of the statistics include 2-ocean-age fish as well as large chinook salmon. One-ocean-age jack males are not included in this table, but annual returns of these fish often number over 1,000.

Year	Situk weir count	Spawning escapement	Sport harvest	Gillnet harvest	Subsistence harvest [a]	Total harvest	Total run size	Expl. rate
1976	1,421	1,421	200	1,002	41	1,243	3,184	39.0%
1977	1,732	1,732	244	833	24	1,101	2,981	36.9%
1978	808	808	210	382	50	642	1,745	36.8%
1979	1,284	1,284	282	1,028	25	1,335	3,089	43.2%
1980	905	905	353	969	57	1,379	2,504	55.1%
1981	702	702	130	858	62	1,050	1,857	56.5%
1982	434	434	63	248	27	338	949	35.6%
1983	592	592	42	349	50	441	1,290	34.2%
1984	1,726	1,726	146	512	89	747	2,948	25.3%
1985	1,521	1,521	294	484	156	934	2,916	32.0%
1986	2,067	2,067	0	202	99	301	2,873	10.5%
1987	1,379	1,379	75	891	24	990	2,874	34.4%
1988	885	868	185	299	90	574	1,596	36.0%
1989	637	637	0	1	496	497	1,377	36.1%
1990	628	628	0	0	516	516	1,643	31.4%
1991	897	889	88	784	220	1,092	2,095	52.1%
1992	1,618	1,595	172	1,504	341	2,017	3,819	52.8%
1993	980	952	137	790	202	1,129	2,558	44.1%
1994	1,311	1,271	400	2,656	367	3,423	6,085	56.3%
1995	4,700	4,330	1,407	8,107	578	10,092	14,987	67.3%
1996	2,175	1,800	1,529	3,717	559	5,805	8,100	71.7%
1997	2,690	1,878	1,598	2,339	352	4,289	6,601	65.0%
1998	1,353	924	1,156	2,101	594	3,851	5,420	71.1%
1999	1,947	1,461	1,160	3,810	588	5,558	7,208	77.1%
2000	2,518	1,785	1,143	1,318	594	3,055	4,941	61.8%
2001	696	656	75	1,087	375	1,537	2,290	67.1%
2002	1,024							

[a] Subsistence harvests include 400 fish in 1989, 415 in 1990 and 109 in 1991 taken home during commercial openings in those years with nonretention for chinook salmon.

Table 1.4.2. Estimated total returns of Situk River chinook salmon for brood years 1977 to 1997.

Brood year	Parent escapement	Age-3 return	Age-4 return	Age-5 return	Age-6 return	Age-7 return	Total return	Return/ spawner
1977	1,421	399	801	199	6	0	1,405	0.8
1978	1,732	150	438	313	180	29	1,110	1.4
1979	808	156	703	1,289	606	0	2,755	2.1
1980	1,284	268	1,118	895	556	0	2,838	3.1
1981	905	137	1,068	1,019	315	0	2,539	3.6
1982	702	318	973	1,299	439	0	3,028	7.0
1983	434	324	1,181	836	93	0	2,434	4.1
1984	592	79	290	440	222	3	1,035	0.6
1985	1,726	35	619	488	67	0	1,208	0.8
1986	1,521	225	394	260	305	4	1,187	0.6
1987	2,067	540	1,267	1,963	314	0	4,084	3.0
1988	1,379	491	988	904	289	0	2,672	3.1
1989	868	544	821	1,314	79	0	2,758	4.3
1990	637	497	2,366	2,849	461	0	6,173	9.8
1991	628	2,103	11,104	3,090	197	0	16,493	18.6
1992	889	934	3,468	2,379	29	0	6,810	4.3
1993	1,595	1,071	2,793	893	60	0	4,816	5.1
1994	952	1,223	2,744	1,034	49	0	5,050	4.0
1995	1,271	1,674	4,569	906	67		7,217	1.7
1996	4,330	1,496	3,705	1,286	689		7,175	4.0
1997	1,800	281	563				*1,547*	0.8

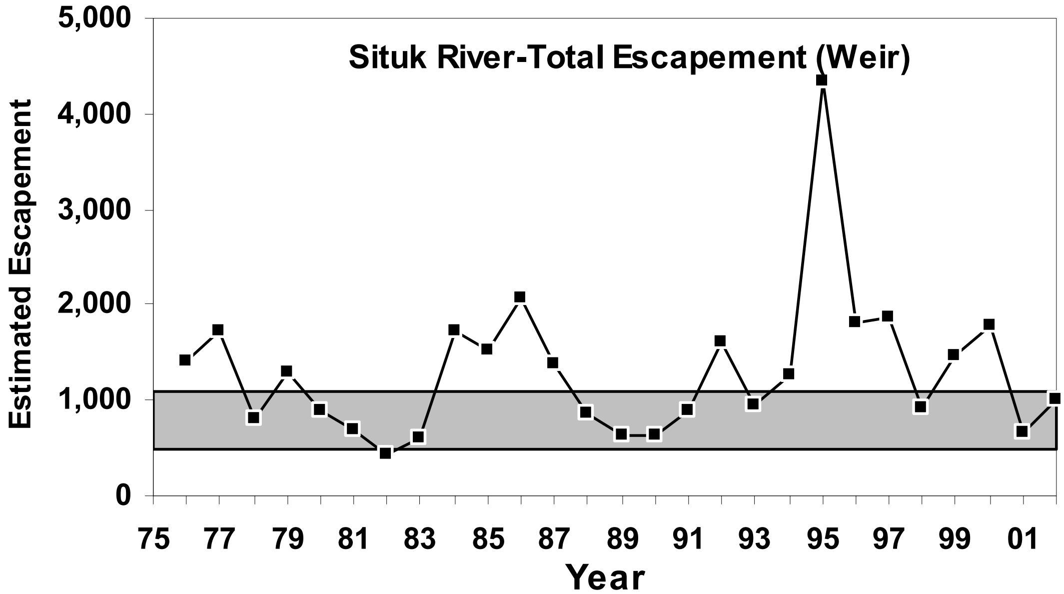

Figure 1.4.1. Escapements of large spawners in the Situk River from 1976 to 2002. Escapement goal shown reflects the revised range adopted in 2003.

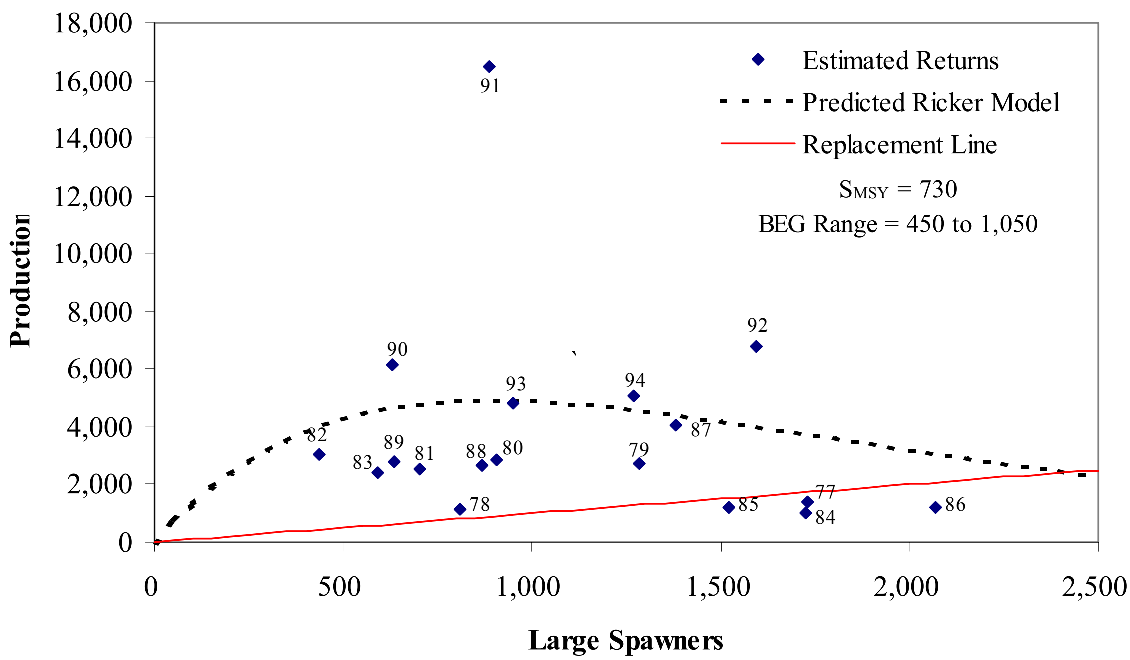

Figure 1.4.2. Estimated production of age-.2 to -.5 chinook salmon in year classes 1977 to 1994 against the estimated spawning abundance of their parents age-.3 and older for the population in the Situk River. The curve represents production predicted with Ricker's model, corrected for autocorrelation.

Appendix 1.5. Chilkat River Chinook Salmon Stock

Stock Description

The Chilkat River is a large glacial system that originates in northwestern British Columbia, Canada, flows through rugged, dissected, mountainous terrain, and terminates in Chilkat Inlet near Haines, Alaska. The Chilkat River produces the third or fourth largest local population of chinook salmon in Southeast Alaska (Pahlke 2001). Prior to 1991, escapement was monitored through helicopter surveys of 2 clearwater tributaries, which were found to represent less than 5% of the escapement (Johnson et al. 1992).

Chinook salmon from the Chilkat River are a spring run of salmon, with returning adults present in terminal marine areas from late April through early July. Spawning occurs from late July to early September. Yearling smolt migrate after a year in fresh water. After entering saltwater, the juveniles rear predominately in the inside waters of northern Southeast Alaska, hence the classification as an *inside rearing* stock. Returning mature fish that are 4 to 6 years old dominate the annual spawning population.

A spring sport fishery occurs annually in Chilkat Inlet and targets mature chinook salmon returning to the Chilkat River. A creel survey has been used to estimate harvest in this fishery since 1984. The harvest in this fishery peaked at over 1,600 chinook salmon in 1985 and 1986 (Ericksen 2002).

Concern about Chilkat River chinook salmon developed when aerial survey counts declined in 1985 and 1986. This decline coincided with increasing marine harvests of chinook in the commercial troll, commercial drift gillnet, and sport fisheries in the area. In 1987, ADF&G began to restrict fisheries in upper Lynn Canal, and recreational fisheries were closed entirely in 1991 and 1992. The Haines King Salmon Derby was closed between 1988 and 1994.

Because of these concerns, the Division of Sport Fish conducted a coded wire tagging program on wild juvenile chinook salmon in 1989 and 1990 to identify migratory patterns and to estimate contributions to sport and commercial fisheries. The Division of Sport Fish also conducted radiotelemetry experiments in 1991 and 1992 to estimate spawning distribution. Annual mark–recapture studies have been used to estimate escapement of large (age-1.3 and older) chinook salmon in the river since 1991. Results of this research indicate that escapements have ranged between 2,035 (SE = 334) and 8,100 (SE = 1,193) fish since 1991 (Ericksen 2002, Johnson et al. 1992). Most of the chinook spawn in 2 major tributaries of the Chilkat River, the Kelsall and Tahini rivers, and immature fish are harvested as they rear primarily in the inside waters of Southeast Alaska (Johnson et al. 1992, Ericksen and McPherson 2001).

The stock assessment program for Chilkat River chinook salmon consists of a juvenile coded wire tagging program, coded wire tag recovery on adults in fisheries and inriver, and a mark–recapture tagging program to estimate escapement postseason via sampling upriver on the spawning grounds. This program will produce annual estimates of smolt production, total adult production, exploitation rates and harvest rates, as well as age structure to evaluate brood year returns and escapement requirements.

Escapements since 1991 have averaged over 4,000 large chinook and limited results indicate total exploitation rates average less than 15%, ranging from about 10% to 19% for the 3 years we have estimates. Exploitation by terminal fisheries is estimated annually and averages less than 10%, ranging from about 2% to 19% (Table 1.5.1). The spawner-recruitment data used to develop the current *biological escapement goal* is shown in Table 1.5.2 and Figure 1.5.2. The estimated escapements of large spawners versus the current *biological escapement goal* is shown in Figure 1.5.1.

Appendix 1.5. Chilkat River Chinook Salmon Stock

System:	Chilkat River
Species:	Chinook salmon

Outline of stock management, assessment and escapement goal analysis

Management Division:	Sport and Commercial Fisheries Divisions
Management Jurisdictions:	ADF&G
Fisheries:	U.S. recreational, subsistence, gillnet, troll
Escapement Goal Type:	*Biological Escapement Goal*
Escapement Goal:	1,750 to 3,500 range; point estimate 2,200
Population for Goal:	Large spawners (3- to 5-ocean-age)
Optimal Escapement Goal:	None
Inriver Goal:	None
Action Points:	None
Escapement Enumeration:	Aerial helicopter surveys: 1981 to 1992 (not used and discontinued in 1992 because deemed not representative of population trends in escapement). Mark–recapture estimates: 1991 to 2002, annually
Brood years in analysis:	7 (1991 to 1997)
Data in analysis:	Estimated total escapement of large spawners, all terminal and near terminal harvests, age structure all years.
Data Quality:	Very good escapement data, but limited to a short time series and low contrast; harvest and exploitation rate data limited but current coded wire tag program will address this shortfall in the next 3 to 5 years.
Contrast in escapements:	2.1 (1991 to 1997)
Model used for escapement goal:	Empirical inspection to determine replacement level and appropriate escapement goal range, supported with Ricker model[a] to estimate replacement level. The optimal escapement level (S_{MSY}) was estimated from the relationship between spawners at replacement and S_{MSY} in 10 other Southeast Alaska chinook stocks.
Criteria for range:	S_{MSY} times 0.8 (lower) and 1.6 (upper), per Eggers (1993)
Value of alpha parameter[b]:	NA
Value of beta parameter[c]:	NA
Document supporting goal:	Ericksen, R. P., and S. A. McPherson. *In prep.* Optimal production of chinook salmon from the Chilkat River. Alaska Department of Fish and Game, Sport Fish Division, Fishery Manuscript, Anchorage.

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.

[b] α is defined as Rickers productivity parameter.

[c] β is defined as Ricker's carrying capacity parameter

Table 1.5.1. Spawning escapement estimates, terminal harvests, terminal run size and exploitation rates for Chilkat River chinook salmon, from 1991 to 2002. Escapement estimates are from mark–recapture estimates (1991 to 2002).

Year	Spawning escapement	Subsistence harvest	Sport harvest	D115 Gillnet harvest	Terminal harvest[a]	Terminal Run size	Exploitation rate
1991	5,897	0	0	262	262	6,159	0.04
1992	5,284	0	0	129	129	5,413	0.02
1993	4,472	2	314	232	548	5,020	0.11
1994	6,795	10	220	96	326	7,121	0.05
1995	3,790	38	228	41	307	4,097	0.07
1996	4,920	44	354	58	456	5,376	0.08
1997	8,100	18	381	167	566	8,666	0.07
1998	3,675	17	215	177	409	4,084	0.10
1999	2,271	31	184	301	516	2,787	0.19
2000	2,035	34	49	58	141	2,176	0.06
2001	4,517	60	185	71	316	4,833	0.07
2002	4,050	50	337	40	427	4,477	0.10

[a] Chilkat Inlet was closed to all fishing during the springs of 1991 and 1992 because of conservation concerns.

Table 1.5.2. Estimated total returns of Chilkat River chinook salmon for brood years 1991 to 1997.

Brood year	Parent escapement	Age-1.2 return	Age-1.3 return	Age-1.4 return	Age-1.5 return	Total return
1991	5,897	1,676	4,613	6,424	219	12,932
1992	5,284	552	2,281	2,628	81	5,542
1993	4,472	222	1,193	1,784	32	3,321
1994	6,795	314	627	704	0	1,645
1995	3,790	592	1,584	2,141	30	4,348
1996	4,920	872	2,969	1,795		5,637
1997	8,100	1,047	2,763	3,271[a]		7,081
1998	3,675	517				
1999	2,271					
2000	2,035					
2001	4,517					
2002	4,050					

[a] The return of age-1.4 fish from the 1997 brood is forecasted using a sibling regression.

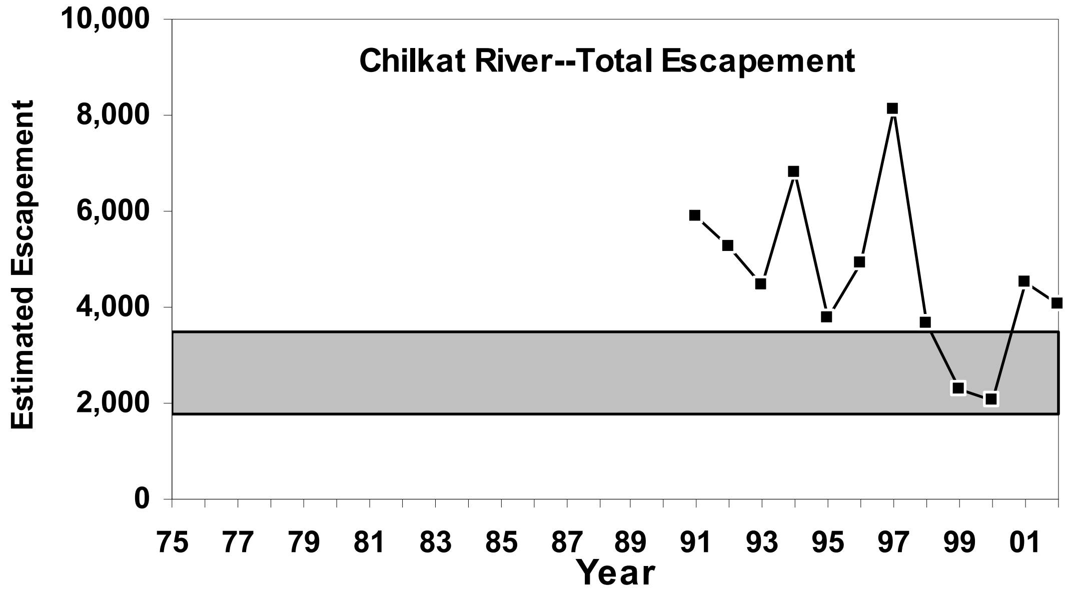

Figure 1.5.1. Escapements of large spawners in the Chilkat River from 1991 to 2002, with the recently adopted *biological escapement goal* range.

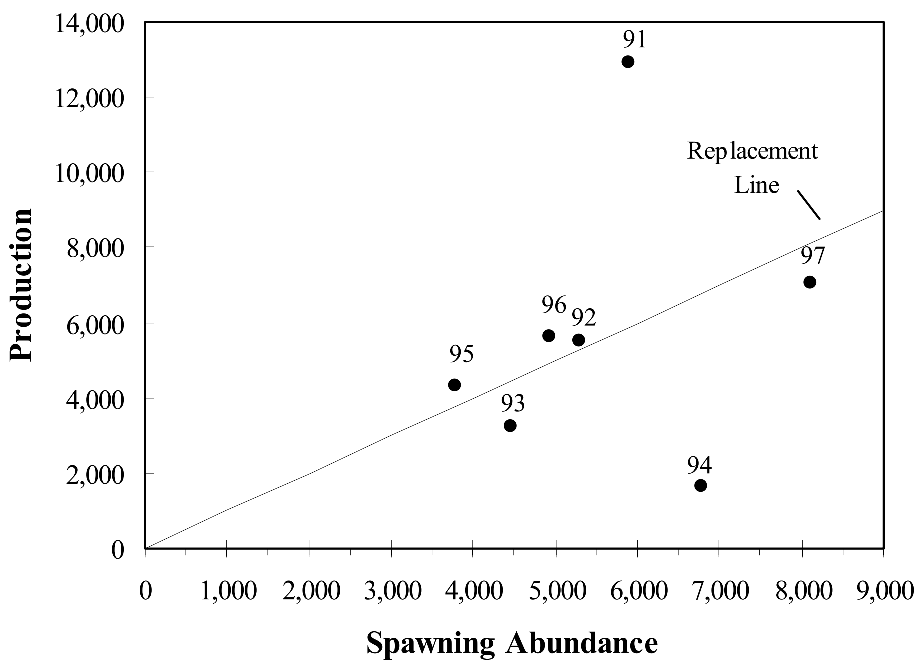

Figure 1.5.2. Estimated production of age-1.2 to -1.5 chinook salmon in year classes 1991 to 1997 against the estimated spawning abundance of their parents age-1.3 and older for the population in the Chilkat River.

Appendix 1.6. King Salmon River Chinook Salmon Stock

Stock Description

The King Salmon River, located on Admiralty Island in northern Southeast Alaska, produces a small run of chinook salmon (McPherson and Clark 2001). This stock supports no directed fisheries, but is taken incidentally in recreational, drift gillnet, and troll fisheries in marine waters in the region.

Chinook salmon from the King Salmon River are a spring run and yearling smolt are produced. Ocean rearing takes place primarily in Southeast Alaska, based on coded wire tag recoveries from hatchery releases of this stock (Josephson et al. 1993). Hence, this stock is classified as an *inside rearing* stock; distribution in the ocean appears to be primarily in northern and central Southeast Alaska. Returning mature fish are 4 to 6 years total age and most females are 6 years old.

The stock assessment program has consisted of peak survey counts, weir counts, and age/sex/length data in the escapement. Helicopter or foot surveys to count peak spawning abundance has occurred annually since 1971. A weir was operated from 1983 to 1992 to collect viable gametes for use in hatchery production, collect age/sex/length data, and to estimate the expansion factor that expands survey counts of large spawning chinook salmon to estimates of total abundance. At present, survey counts and age/sex/length sampling occurs on an annual basis.

Escapements since 1971 have averaged 190 large chinook salmon (Appendix Table 1.6.1). Lower escapements were seen in the late 1970s, but since 1981 have remained relatively consistent (Figure 1.6.1). The present *biological escapement goal* is 120 to 240 large spawners in total escapement; the adult spawner-recruit data used to develop the *biological escapement goal* is shown in Table 1.6.2 and Figure 1.6.2. Retrospectively, the 22 escapement counts since 1981 have been below the *biological escapement goal* range once, within the range 14 times, and exceeded the range 7 times.

Appendix 1.6. King Salmon River Chinook Salmon Stock

System:	King Salmon River
Species:	Chinook salmon

Management Division:	Sport and Commercial Fisheries Divisions
Management Jurisdictions:	ADF&G
Fisheries:	U.S. recreational, drift gillnet, and troll
Escapement Goal Type:	*Biological Escapement Goal*
Escapement Goal:	Weir count: 120 to 240 range; 150 point estimate Survey count: 80 to 160 range; 100 point estimate
Population for Goal:	Large spawners (3- to 5-ocean-age)
Optimal Escapement Goal:	None
Inriver Goal:	None
Action Points:	None
Escapement Enumeration:	Aerial helicopter or foot surveys: 1971 to 2002, standardized over the duration. Weir counts: 1983 to 1992
Index Count Expansion Factor:	1.52 (SE = 0.26; multiplier for peak survey count)
Brood years in analysis:	21 (1971 to 1991)
Data in analysis:	Estimated total escapement of large spawners, exploitation assumed similar to nearby hatchery stock, age structure 1982 to 1992 extrapolated to all years.
Data Quality:	Excellent
Contrast in escapements:	5.7:1
Model used for escapement goal:	Ricker model[a]
Criteria for range:	S_{MSY} times 0.8 (lower) and 1.6 (upper)
Value of alpha parameter[b]:	7.8
Value of beta parameter[c]:	0.0054
Document supporting goal:	McPherson, S. and J. H. Clark. 2001. Biological escapement goal for King Salmon River chinook salmon. Alaska Department of Fish and Game, Regional Information Report No. 1J-0140, Juneau.

[a] for *R* (run size) and *S* (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter
[c] β is defined as Ricker's carrying capacity parameter

Table 1.6.1. Escapement index counts, spawning escapement estimates, and survey expansion factors for King Salmon River chinook salmon, from 1971 to 2002. Escapement estimates are from expansions of survey counts in 1971 to 1982 and 1993 to 2002, using an expansion factor of 1.52 (SE = 0.26).

Year	Survey counts	Spawning escapement [a]	Expansion factor
1971	94	141	
1972	90	135	
1973	211	317	
1974	104	156	
1975	42	63	
1976	65	98	
1977	134	201	
1978	57	86	
1979	71	113	
1980	70	104	
1981	90	139	
1982	229	354	
1983	183	**245**	1.17
1984	184	**265**	1.37
1985	105	**175**	1.57
1986	190	**255**	1.25
1987	128	**196**	1.38
1988	94	**208**	2.02
1989	133	**240**	1.59
1990	98	**179**	1.74
1991	91	**134**	1.38
1992	58	**99**	1.71
1993	175	259	
1994	140	207	
1995	97	144	
1996	192	284	
1997	238	353	
1998	88	130	
1999	200	296	
2000	92	136	
2001	98	145	
2002	102	141	

[a] Estimates in bold are years in which the weir was in place to count chinook salmon.

Table 1.6.2. Estimated total returns of King Salmon River chinook salmon for brood years 1971 to 1991 (from McPherson and Clark 2001).

	Estimated population statistics [a]				
Brood year	Parent escapement	Inriver return	Exploitation rate	Total return	Return/ spawner
1971	141	206	0.436	366	2.63
1972	135	159	0.436	281	2.11
1973	317	147	0.436	261	0.83
1974	156	149	0.436	264	1.71
1975	63	184	0.436	326	5.24
1976	98	431	0.436	765	7.94
1977	201	397	0.436	704	3.55
1978	86	396	0.436	702	8.32
1979	113	**166**	0.350	256	2.25
1980	104	**429**	0.515	885	8.53
1981	139	**255**	0.527	539	3.89
1982	354	**391**	0.696	1,285	3.63
1983	**245**	**266**	0.566	612	2.50
1984	**265**	**228**	0.580	543	2.05
1985	**175**	**317**	0.613	820	4.68
1986	**255**	**89**	0.580	212	0.83
1987	**196**	348	0.413	593	3.02
1988	**208**	251	0.427	437	2.10
1989	**240**	220	0.326	326	1.36
1990	**179**	308	0.436	546	3.05
1991	**134**	404	0.436	717	5.35

[a] Parent escapement is the estimated number of large spawners, total return is the estimated number of chinook salmon that returned in subsequent years in the escapement, were used for brood stock, or were fishing mortalities (landed catch or incidental mortalities) of age-.2 to -.5 fish. Estimates in bold are years in which the weir was in place to count chinook salmon.

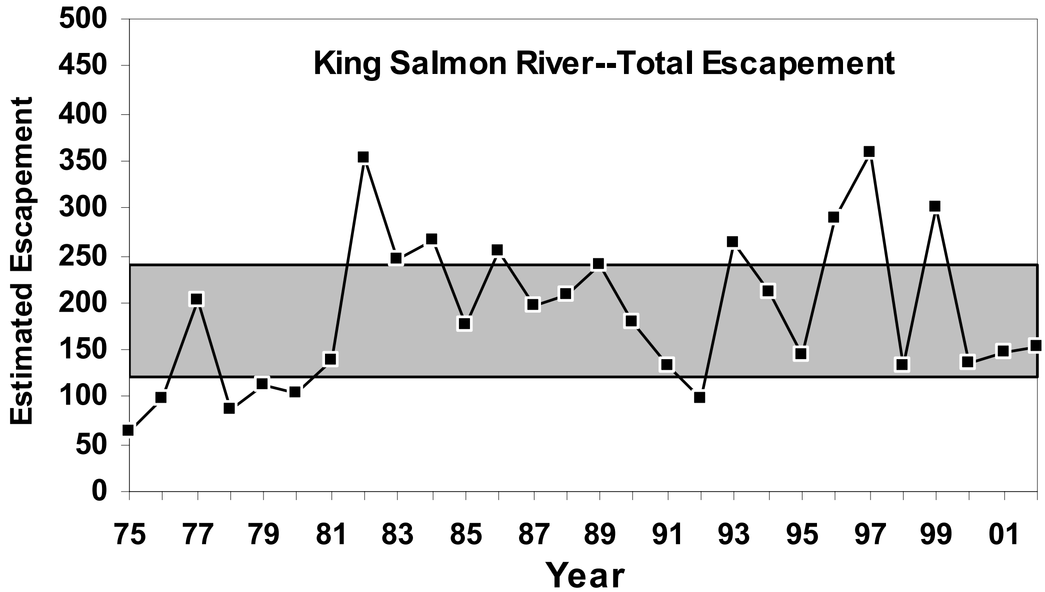

Figure 1.6.1. Estimated escapements of large spawners in the King Salmon River from 1975 to 2002, with the 1997 *biological escapement goal* range.

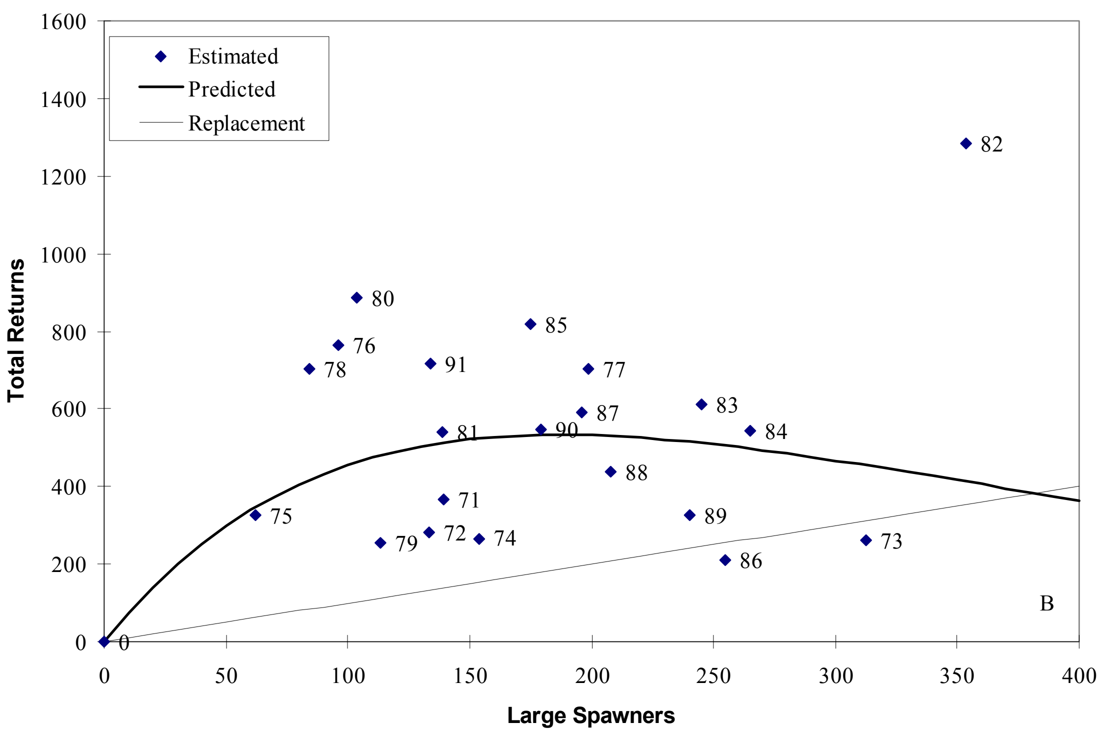

Figure 1.6.2. Estimated production of age-1.2 to age-1.5 chinook salmon in year classes 1971 to 1991 against the estimated spawning abundance of their parents age-1.3 and older for the population in the King Salmon River. The curve represents production predicted with Ricker's model (from McPherson and Clark 2001).

Appendix 1.7. Andrew Creek Chinook Salmon Stock

Stock Description

Andrew Creek is a lower drainage and U. S. tributary to the transboundary Stikine River that supports a moderate-sized run of chinook salmon (Clark et al. 1998). Prior to the mid 1970s, this stock was harvested in directed U.S. drift gillnet and recreational fisheries near the river mouth, near Petersburg and Wrangell, similar to the upper Stikine River stock. Significant, but not quantified, harvests likely occurred in the troll fishery during the same period. Presently, chinook salmon from Andrew Creek are harvested in a directed U.S. marine recreational fishery out of Petersburg and Wrangell and are caught incidentally in drift gillnet (primarily Districts 106 and 108) and troll fisheries (regionwide).

The stock assessment program for Andrew Creek chinook salmon has consisted of survey counts, weir counts and age/sex/length data in the escapement. Helicopter, fixed-wing or foot surveys to count peak spawning abundance has occurred most years since 1975, annually since 1984 and 1975, 1979, 1981, and 1982, prior to 1984. A weir was operated from 1976 to 1984 to take brood stock for initiating the hatchery program in the region, to collect age/sex/length data and to estimate the expansion factor for survey counts. The weir was also operated in 1997. At present, the survey count and age/sex/length programs occur on an annual basis.

Chinook salmon from Andrew Creek are a spring run and yearling smolt are produced. Ocean rearing takes place primarily in Southeast Alaska, based on coded wire tag recoveries from hatchery releases of this stock. Hence, this stock is classified as an *inside rearing* stock. Distribution of hatchery coded wire tag recoveries, from Crystal Lake Hatchery near Petersburg, occur throughout the region, but are more concentrated in central Southeast Alaska. Returning mature fish are primarily 4 to 6 years total age; most females are 5 and 6 years old.

Like many other stocks in the region, escapements in Andrew Creek were lower in the late 1970s and early 1980s, and have rebounded since that time. Escapements since 1975 have averaged 950 large chinook salmon, in weir counts and survey counts expanded to be weir-count equivalents (Appendix Table 1.7.1). Escapements from 1975 to 1984 averaged 434 large spawners, and from 1985 to 2002 have averaged 1,233 or a 3-fold increase.

The present *biological escapement goal* is 650 to 1,500 large spawners; the adult spawner-recruit data used to develop the *biological escapement goal* are shown in Table 1.7.2 and Figure 1.7.2. Retrospectively, the escapement estimates from 1975 to 1986 were below the range 10 times and were within or above the *biological escapement goal* range 16 times since (Figure 1.7.1). Sporadic survey counts from 1959 to 1974 indicated that escapements of large spawners were 200 to 1,000 large spawners per year. Escapements in the last 5 years (1998 to 2002) have averaged about 1,500 large spawners.

System:	Andrew Creek River
Species:	Chinook salmon

Outline of stock management, assessment and escapement goal analysis

Management Division:	Sport and Commercial Fisheries Divisions
Management Jurisdictions:	ADF&G
Fisheries:	U.S. recreational, gillnet, and troll
Escapement Goal Type:	*Biological Escapement Goal*
Escapement Goal:	650 to 1,500 range; 800 point estimate
Population for Goal:	Large spawners (3- to 5-ocean-age); total escapement or expanded survey count.
Optimal Escapement Goal:	None
Inriver Goal:	None
Action Points:	None
Escapement Enumeration:	Aerial, foot and/or fixed-wing helicopter surveys: 1975 to 2002, in standardized area and time.
Index Count Expansion Factor:	2.0 (multiplier for peak survey count).
Brood years in analysis:	17 (1975 to 1991)
Data in analysis:	Estimated total escapement of large spawners, assumed annual harvest rates from nearby hatchery stock, age structure measured or inferred from sampled age structure data in 8 years.
Data Quality:	Good
Contrast in escapements:	5.10
Model used for escapement goal:	Ricker[a]
Criteria for range:	S_{MSY} times 0.8 (lower) and 1.6 (upper) per Eggers (1993)
Value of alpha parameter[b]:	6.07
Value of beta parameter[c]:	0.0008426
Document supporting goal:	Clark, J. H., S. A. McPherson, and D. M. Gaudet. 1998. Biological escapement goal for Andrew Creek chinook salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 5J98-08, Juneau.

[a] for *R* (run size) and *S* (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Table 1.7.1. Escapement peak survey counts, spawning escapement estimates, and expansion factors for Andrew Creek River chinook salmon, from 1975 to 2002. Escapement estimates are from expansions of survey counts in 1975 and 1985 to 2002, using an expansion factor of 2.0.

Year	Survey counts	Spawning escapement [a]	Expansion factor
1975	260	520	
1976		**404**	
1977		**456**	
1978		**388**	
1979	221	**327**	1.48
1980		**282**	
1981	300	**536**	1.79
1982	332	**672**	2.02
1983		**366**	
1984	154	**389**	2.53
1985	319	638	
1986	707	1,414	
1987	788	1,576	
1988	564	1,128	
1989	530	1,060	
1990	664	1,328	
1991	400	800	
1992	778	1,556	
1993	1,060	2,120	
1994	572	1,144	
1995	343	686	
1996	335	670	
1997	293	586	
1998	487	974	
1999	605	1,210	
2000	690	1,380	
2001	1,054	2,108	
2002	876	1,752	

Table 1.7.2. Estimated total returns of Andrew Creek chinook salmon for brood years 1975 to 1991 (from Clark et al. 1998).

	Estimated population statistics				
Brood year	Parent escapement	Inriver return	Exploitation rate	Total return	Return/ spawner
1975	474	**575**	0.431	1,011	2.13
1976	**404**	**1,430**	0.431	2,513	6.22
1977	**456**	**375**	0.431	659	1.45
1978	**388**	**568**	0.431	998	2.57
1979	**327**	**641**	0.346	980	3.00
1980	**282**	**1,165**	0.510	2,378	8.43
1981	**536**	1,767	0.525	3,720	6.94
1982	**672**	1,492	0.697	4,924	7.33
1983	**366**	1,232	0.527	2,605	7.12
1984	**389**	1,346	0.502	2,703	6.95
1985	**584**	1,183	0.555	2,658	4.55
1986	1,292	1,379	0.564	3,163	2.45
1987	1,438	2,075	0.419	3,571	2.48
1988	1,029	1,769	0.427	3,087	3.00
1989	967	1,002	0.320	1,474	1.52
1990	1,212	752	0.603	1,894	1.56
1991	730	692	0.525	1,457	2.00

[a] Parent escapement is the estimated number of large spawners, total return is the estimated number of chinook salmon that returned in subsequent years in the escapement, were used for brood stock, or were fishing mortalities (landed catch or incidental mortalities) of age-.2 to -.5 fish. Numbers in bold are from years with weir operations.

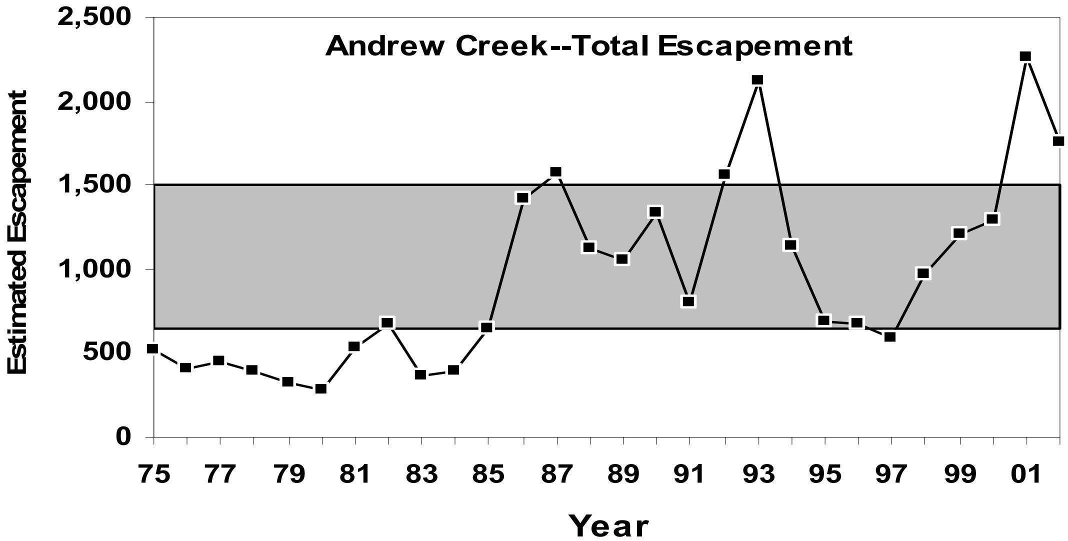

Figure 1.7.1. Estimated escapements of large spawners in the Andrew Creek from 1975 to 2002, with the 1998 *biological escapement goal* range.

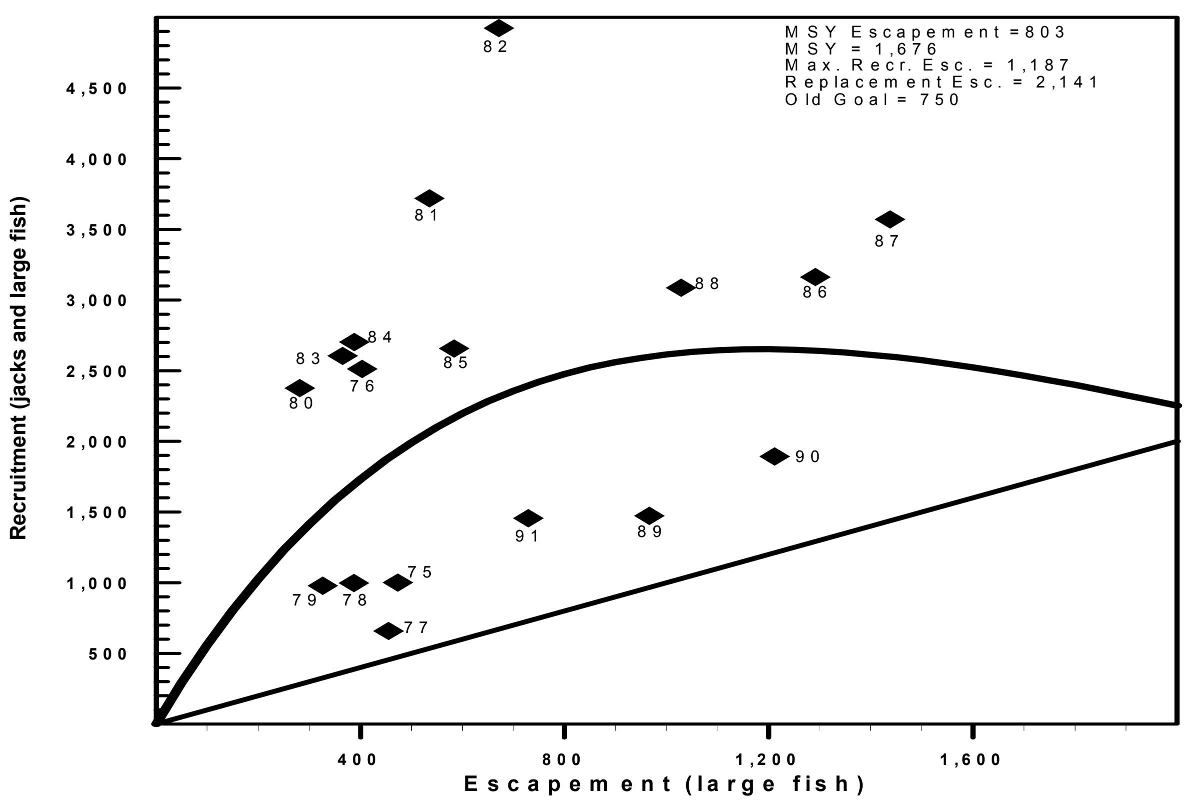

Figure 1.7.2. Estimated production of age-1.2 to age-1.5 chinook salmon in year classes 1975 to 1991 against the estimated spawning abundance of their parents age-1.3 and older for the population in the Andrew Creek. The curve represents production predicted with Ricker's model (from Clark et al. 1998).

Appendix 1.8. Unuk River Chinook Salmon Stock

Stock Description

The Unuk River originates in a heavily glaciated area of northern British Columbia and flows for 129 km where it traverses Misty Fjords National Monument and empties into Burroughs Bay, 85 km northeast of Ketchikan, Alaska. The drainage encompasses an area of approximately 3,885 km^2 (Jones and McPherson 2002), with the lower 39 km flowing through Alaska. In most years, the Unuk River is the fourth or fifth largest producer of chinook salmon in Southeast Alaska.

Unuk River chinook salmon are a spring run that produces yearling (age-1) fish almost exclusively. Juvenile coded wire tagging studies indicate that the majority of chinook salmon rear in the U.S. portion of the river. Survey counts of large chinook salmon have been made on the Unuk River since 1977. Indices of escapement on the Unuk River are determined annually by summing the peak observer aerial and foot survey counts of large spawners seen in 6 tributaries: Cripple, Gene's Lake, Kerr, Clear, and Lake creeks plus the Eulachon River (Pahlke 2001). When plotted over time, these indices are roughly dome-shaped with peak values occurring between 1987 and 1990, and since 2000.

Several consecutive years of low survey counts in the early 1990s generated concern for the health of the Unuk River chinook salmon stock. In response, the Division of Sport Fish began a full stock assessment program on the Unuk River to estimate smolt production, escapement, total run size, exploitation rates, harvest distribution, overwinter survival, and marine survival. In 1994, mark–recapture and radio telemetry studies were conducted, and mark–recapture studies have occurred since 1997 (e.g., Jones and McPherson 2002) on Unuk River chinook salmon. The 1994 radio telemetry study indicated that 83% (SE = 9%) of all spawning occurred in the 6 tributaries surveyed.

Coded wire tagging studies on the 1982 to 1986 (Pahlke 1995) and on the 1992 to present brood years indicate that harvest rates for Unuk River chinook salmon (age-1.1 to 1.5) average about 17% in landed catch. This information, coupled with similar data on chinook salmon from the nearby Chickamin River, provide strong evidence that Unuk River fish are mostly *inside rearing* in nature, but a few recoveries have been recorded as far north as Kodiak and several coded wire tags each year are recovered in northern British Columbia fisheries in Canada.

The current stock assessment program for adult chinook salmon returning to the Unuk River has 3 primary goals: (1) to estimate escapement; (2) to estimate age, sex, and length distribution in the escapement; and (3) to sample escapement for the fraction of fish possessing coded wire tags by brood year. The results are essential to estimate the marked fraction of each brood for coded wire tagged fish and to estimate harvest of this stock in current and future sport and commercial fisheries. These harvest and escapement data will enable us to estimate total run size, exploitation rates, harvest distribution, and marine survival for this important chinook salmon indicator stock in southern Southeast Alaska.

Survey escapement counts for the Unuk stock show a relatively stable pattern over the duration of 1977 to 2002. Escapements over the most recent 5 years of estimates (1998 to 2002) have averaged 6,300 total large spawners, and 1,200 large spawners in peak survey counts (Table 1.8.1 and Figure 1.8.1). All 5 of these escapements were within or above the current (1997) goal range. The estimated escapements in survey counts of large spawners versus the 1997 *biological escapement goal* is shown in Figure 1.8.1. Our most current set of spawner-recruit estimates is summarized in Table 1.8.2. Exploitation rates for the 1982 to 1986 and 1992 to 1997 broods has averaged about 17%. The adult spawner-recruit data used to develop the 1997 *biological escapement goal* is shown in Figure 1.8.2.

Appendix 1.8. Unuk River Chinook Salmon Stock

System: Unuk River
Species: Chinook salmon

Outline of stock management, assessment and escapement goal analysis

Management Division:	Sport and Commercial Fisheries Divisions
Management Jurisdictions:	ADF&G
Fisheries:	U.S. recreational, gillnet, and troll
Escapement Goal Type:	*Biological Escapement Goal*
Escapement Goal:	650 to 1,400; 800 point estimate
Population for Goal:	Large spawners (3- to 5-ocean-age) as counted in **peak survey counts** in the standardized survey areas on 6 clear water tributaries: Eulachon River and Clear, Lake, Kerr, Genes Lake and Cripple Creeks.
Optimal Escapement Goal:	None
Inriver Goal:	None
Action Points:	None
Escapement Enumeration:	<u>Helicopter and foot peak survey counts</u>: 1977 to 2002 in standard time and areas on: Eulachon River and Clear, Lake, Kerr, Genes Lake and Cripple Creeks. <u>Mark–recapture estimates</u>: 1994, 1997 to 2002
Index Count Expansion Factor:	5.0: multiplier for the sum of peak survey counts in a calendar year. Based on 4 years (1997 to 2001).
Brood years in analysis:	13 (1977 to 1989), as in McPherson and Carlile (1997).
Data in analysis:	Survey counts, expanded by 4:1 and 6.7:1 to estimate total escapement of large spawners, marine harvest by age for 5 wild broods with adjusted hatchery harvest data for the remainder, age structure sampled directly in most years, estimated for all broods.
Data Quality:	Fair, in McPherson and Carlile (1997)
Contrast in escapements:	2.9, in McPherson and Carlile (1997)
Model used for escapement goal:	Ricker model[a]
Criteria for range:	Bootstrapping (simulation) of spawner-recruit data to estimate lower and upper levels of S_{MSY}
Value of alpha parameter[b]:	6.36
Value of beta parameter[c]:	0.0002148
Document supporting goal:	McPherson, S. A. and J. Carlile. 1997. Spawner-recruit analysis of Behm Canal chinook salmon stocks. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report 1J97-06, Juneau.
Additional comments:	The ADF&G is in the process of analyzing the additional spawner-recruit data for this stock and plans to provide an escapement goal for total large spawners, as measured in the annual mark–recapture program, by July 2003.

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Table 1.8.1. Escapement survey counts, spawning escapement estimates of large chinook, expansion factors and available age/sex composition for Unuk River chinook salmon, from 1977 to 2002. Escapement estimates in bold are from mark–recapture studies, the remainder are from expanded survey counts.

Year	Survey count	Spawning escapement	Expansion factor [a]	Age 1.2	Age 1.3	Age 1.4	Age 1.5	Age-.2-.5 total	Large females
1977	974	4,870							
1978	1,106	5,530							
1979	576	2,880							
1980	1,016	5,080							
1981	731	3,655							
1982	1,351	6,755		233	1,067	5,688	0	6,988	NE
1983	1,125	5,625							
1984	1,837	9,185		1,077	6,236	3,020	0	10,333	NE
1985	1,184	5,920		2,505	4,987	683	0	8,175	NE
1986	2,126	10,630		5,341	5,557	4,704	100	15,702	NE
1987	1,973	9,865		4,952	4,577	4,907	52	14,488	NE
1988	1,746	8,730		3,102	3,112	5,225	66	11,505	NE
1989	1,149	5,745		1,676	2,331	3,158	163	7,328	NE
1990	591	2,955		1,023	646	1,903	150	3,722	NE
1991	655	3,275		872	2,420	638	52	3,982	1,528
1992	874	4,370		1,132	1,762	2,546	47	5,487	3,008
1993	1,068	5,340		586	2,297	2,917	101	5,901	2,928
1994	711	**4,623**	6.5	**432**	**1,343**	**3,082**	**154**	**5,011**	**3,359**
1995	772	3,860		1,673	1,029	2,445	0	5,147	2,059
1996	1,167	5,835		484	3,097	2,471	194	6,246	3,602
1997	636	**2,970**	**4.7**	**920**	**1,235**	**1,408**	**59**	**3,622**	**1,658**
1998	840	**4,132**	**4.9**	**1,275**	**2,589**	**1,207**	**35**	**5,106**	**2,087**
1999	680	**3,914**	**5.8**	**2,427**	**1,918**	**1,581**	**16**	**5,942**	**1,998**
2000	1,341	**5,872**	**4.4**	**3,140**	**3,499**	**1,447**	**50**	**8,136**	**2,506**
2001	2,019	**10,541**	**5.2**	**946**	**6,923**	**3,337**	**21**	**11,227**	**5,697**
2002	897	**6,988**	7.8	**2,485**	**2,887**	**3,199**	**55**	**8,626**	**3,330**

[a] The expansion factor is 5.0 (SE = 0.53) to convert peak survey counts to total escapement of large spawners, based on the 1997 to 2001 mark–recapture estimates.

Table 1.8.2. Estimated parent escapements, harvests, total returns, exploitation rates and smolt production of Unuk River chinook salmon for brood years 1980 to 1997. Estimates for escapement data in bold are from mark–recapture studies, the remainder are from expanded survey counts.

Brood year	Parent escapement	Inriver total return [a]	Marine harvest [b]	Total return	Return/ spawner	Exploitation rate	Smolt production
1980	5,080	10,820					
1981	3,655	13,035					
1982	6,755	15,306	2,824	18,130	2.7	15.6%	510,516
1983	5,625	11,372	3,039	14,411	2.6	21.1%	425,577
1984	9,185	7,388	1,375	8,763	1.0	15.7%	344,772
1985	5,920	3,007	726	3,733	0.6	19.4%	300,767
1986	10,630	6,090	1,782	7,872	0.7	22.6%	174,173
1987	9,865	5,705					
1988	8,730	6,511					
1989	5,745	4,568					
1990	2,955	3,991					
1991	3,275	6,213					
1992	4,370	2,942	337	3,279	0.8	10.3%	384,702
1993	5,340	**5,140**	894	6,034	1.1	14.8%	197,052
1994	**4,623**	**4,661**	767	5,428	1.2	14.1%	250,370
1995	3,860	**9,318**	1,892	11,210	2.9	16.9%	321,961
1996	5,835	**13,262**	2,274	15,536	2.7	14.6%	478,914
1997	**2,970**	**5,587**	1,070	6,657	2.2	16.1%	283,718

[a] Inriver total returns include 2 to 5-ocean-age fish (total age 4 to 7 years).
[b] Marine harvest includes estimated landed catch; it does not include incidental mortality and is not converted to adult equivalents.

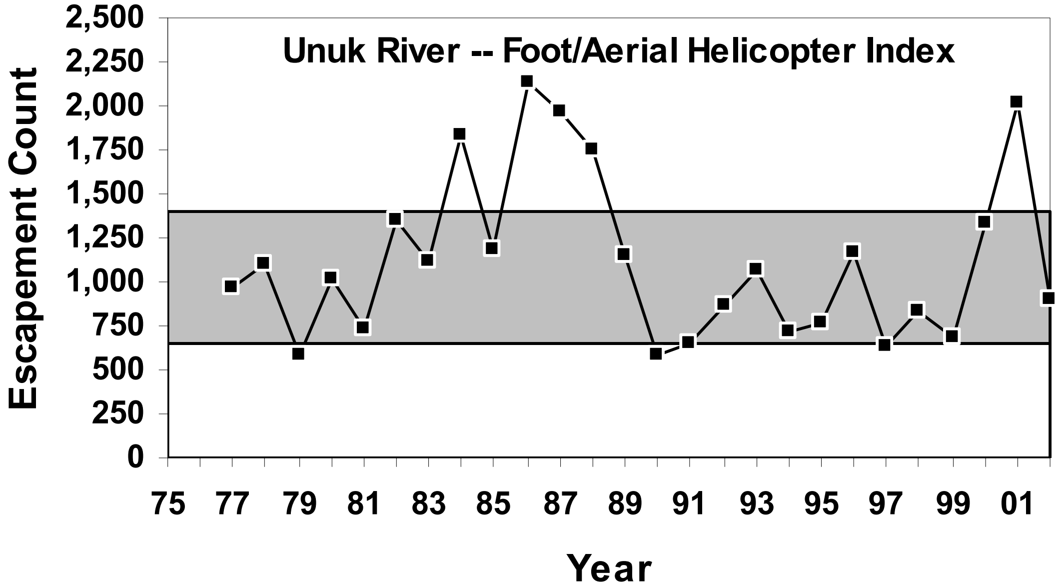

Figure 1.8.1. Estimated escapements of large spawners in the Unuk River from 1977 to 2002, with the 1997 survey goal *biological escapement goal* range.

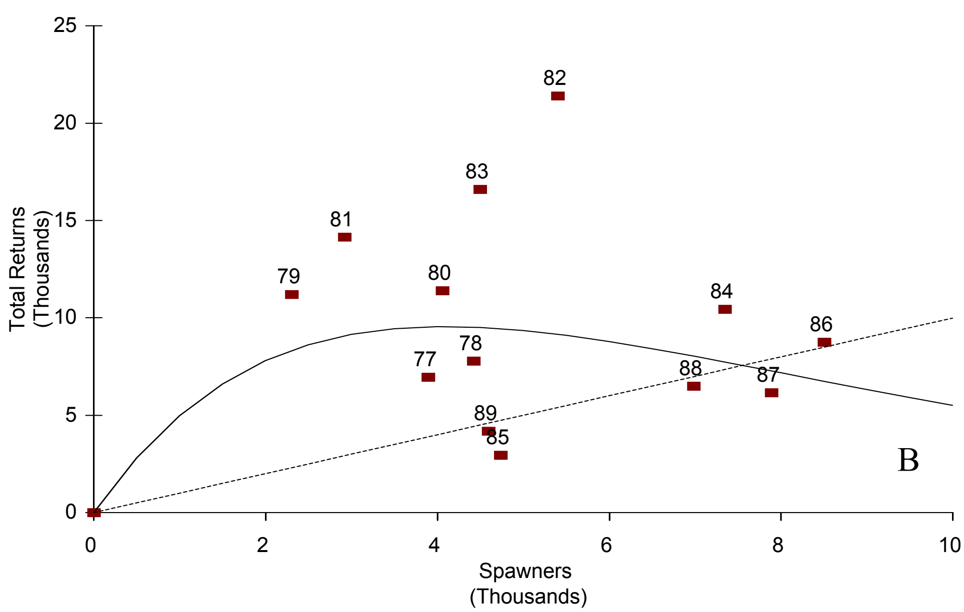

Figure 1.8.2. Estimated production of age-1.2 to age-1.5 chinook salmon in year classes 1977 to 1989 against the estimated spawning abundance of their large chinook parents for the population in the Unuk River. The curve represents production predicted with Ricker's model, from McPherson and Carlile (1997).

Appendix 1.9. Chickamin River Chinook Salmon Stock

Stock Description

The Chickamin River is located on the mainland in southern Southeast Alaska, approximately 45 miles northeast of Ketchikan. Chinook from the Chickamin River, along with fish from the Keta, Unuk, Blossom, and 7 other small stocks, make up what are collectively known as the Behm Canal stocks, named for the long narrow body of water that they all flow into. The Unuk River is the largest stock, with peak annual production estimated at over 15,000 chinook. The Chickamin is next with production of between 5,000 and 10,000 fish, and the Keta and Blossom follow with estimated production of less than 5,000 fish. All of the Behm Canal stocks are small relative to the 3 major chinook stocks in Southeast Alaska: the transboundary Taku, Stikine and Alsek river stocks.

All of the Behm Canal chinook systems are located completely within the Misty Fiords National Monument Wilderness Area, and as such access is limited and habitat is essentially pristine. The Chickamin River is a muddy, glacial system, and most chinook spawn in smaller clearwater tributaries. Chinook start to enter the river in June and complete spawning by early September.

Annual surveys of escapement have been conducted in a systematic manner since 1975. Mark–recapture tagging experiments were conducted in 1995, 1996, 2001 and 2002 (e.g. Freeman and McPherson 2003) which provided alternative estimates of escapement and indicated that the aerial survey counted about 20% of the total escapement. In the 1997 *biological escapement goal* report we assumed the surveys counted between 15% and 25% of the total escapement. Since 1985 we have attempted to sample the escapement for age, sex and size data. We have had mixed results due to the small stock spread over a large area and the difficulties of logistics in such a remote location.

Juvenile chinook salmon from the Chickamin River were marked with coded wire tags from 1983 to 1988. Recoveries from 1986 to 1992 of returning adults with coded wire tags provided the first information on ocean migration patterns, fishery contributions and exploitation rates for this stock. Several hatcheries in southern Southeast release coded wire tagged chinook salmon of Chickamin River origin. Recoveries of wild and hatchery fish released with coded wire tags have shown that Unuk and Chickamin River chinook are *inside rearing* stocks, with most fish rearing in the waters of Southeast Alaska. Harvest is spread throughout the fisheries of southern and central Southeast Alaska, with occasional recoveries in outside waters as far north as Prince William Sound and as far south as northern British Columbia. Harvest is not concentrated in any particular fishery and exploitation rate does not appear excessive, rarely exceeding 50%. Results from the coded wire tagging study in the 1980s indicated that the Chickamin stock was exploited at a slightly higher rate than the Unuk River stock. A new project tagging juvenile chinook on the Chickamin was started in 2001, and recoveries from that project along with the ongoing Unuk River tagging project will provide revised estimates of exploitation for both stocks.

Survey counts show low escapement in the 1970s, a high period in the 1980s, dropping to a low but stable period through the 1990s with steady increases since 1998. Escapements over the most recent 5 years of estimates (1998 to 2002) have averaged 3,900 total large spawners, and 741 large spawners in peak survey counts (Table 1.9.1 and Figure 1.9.1). Of these 5 recent escapements, the first was below, the next 2 were within and the last 2 were above the goal range. The estimated escapements of survey counts of large spawners versus the 1997 *biological escapement goal* is shown in Figure 1.9.1. Our most current set of spawner-recruit estimates is summarized in Table 1.9.2. The adult spawner-recruit data used to develop the 1997 *biological escapement goal* is shown in Figure 1.9.2.

Appendix 1.9. Chickamin River Chinook Salmon Stock

System:	Chickamin River
Species:	Chinook salmon

Outline of stock management, assessment and escapement goal analysis

Management Division:	Sport and Commercial Fisheries Divisions
Management Jurisdictions:	ADF&G
Fisheries:	U.S. recreational, gillnet, and troll
Escapement Goal Type:	*Biological Escapement Goal*
Escapement Goal:	450 to 900 range; 525 point estimate
Population for Goal:	Large spawners (3- to 5-ocean-age) as counted in **peak survey counts** in the standardized survey areas on 8 clearwater tributaries: South Fork, Barrier, Butler, Leduc, Indian, Humpy, King, and Clear Falls.
Optimal Escapement Goal:	None
Inriver Goal:	None
Action Points:	None
Escapement Enumeration:	Helicopter and foot peak survey counts: 1975 to 2002 in standard time and areas on: South Fork, Barrier, Butler, Leduc, Indian, Humpy, King and Clear Falls tributaries. Mark–recapture estimates: 1995 to 1996, and 2001 to 2002
Index Count Expansion Factor:	5.17: multiplier for the sum of peak survey counts in a calendar year. Based on 4 years (1995 to 1996, and 2001 to 2002).
Brood years in analysis:	15 (1975 to 1989), as in McPherson and Carlile (1997).
Data in analysis:	Survey counts, expanded by 4:1 and 6.7:1 to estimate total escapement of large spawners, marine harvest by age for 5 wild broods with adjusted hatchery harvest data for the remainder, age structure estimated directly in about half of the years, estimated for all broods.
Data Quality:	Fair, in McPherson and Carlile (1997)
Contrast in escapements:	11.1, in McPherson and Carlile (1997)
Model used for escapement goal:	Ricker model[a]
Criteria for range:	S_{MSY} times 0.8 (lower) and 1.6 (upper) based on the suggestion of Eggers (1993)
Value of alpha parameter[b]:	7.46
Value of beta parameter[c]:	0.0003446
Document supporting goal:	McPherson, S. A. and J. Carlile. 1997. Spawner-recruit analysis of Behm Canal chinook salmon stocks. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report 1J97-06, Juneau.
Additional comments:	The ADF&G is in the process of analyzing the additional spawner-recruit data for this stock and plans to provide an escapement goal for total large spawners, as measured by mark–recapture, by July, 2003.

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S\exp\{-\beta S+\varepsilon\}$, for ε a random variable.

[b] α is defined as Rickers productivity parameter.

[c] β is defined as Ricker's carrying capacity parameter.

Table 1.9.1. Escapement survey counts, spawning escapement estimates of large chinook, expansion factors and available age/sex composition for Chickamin River chinook salmon, from 1975 to 2002. Escapement estimates in bold are from mark–recapture studies, the remainder are from expanded survey counts.

Year	Survey count	Spawning escapement	Expansion factor [a]	Age 1.2	Age 1.3	Age 1.4	Age 1.5	Age-.2-.5 total	Large females
1975	370	1,914							
1976	157	810							
1977	363	1,875							
1978	308	1,594							
1979	239	1,233							
1980	445	2,299							
1981	384	1,985							
1982	571	2,952							
1983	599	3,099							
1984	1,102	5,697							
1985	956	4,943		287	2,914	1,845	0	5,046	NE
1986	1,745	9,022		1,301	6,354	2,762	0	10,417	NE
1987	975	5,041		2,099	3,095	1,660	61	6,915	NE
1988	786	4,064		601	2,432	1,724	49	4,807	NE
1989	934	4,829		335	1,853	2,720	278	5,185	NE
1990	564	2,916		745	659	1,936	114	3,454	NE
1991	487	2,518		1,013	2,057	595	48	3,714	NE
1992	346	1,789		392	795	1,044	19	2,250	NE
1993	389	2,011		400	813	1,227	42	2,483	NE
1994	388	2,006		272	552	1,431	72	2,327	NE
1995	356	**2,309**	6.5	**383**	**582**	**1,704**	**80**	**2,748**	**1,369**
1996	422	**1,587**	3.8	**342**	**1,015**	**527**	**46**	**1,930**	**890**
1997	272	1,406		334	808	562	35	1,740	791
1998	391	2,021		594	1,783	238	0	2,615	1,070
1999	492	2,544		669	1,219	868	15	2,771	1,234
2000	801	4,141		1,083	2,391	1,152	0	4,626	1,949
2001	1,010	**5,177**	5.1	**577**	**3,766**	**1,190**	**32**	**5,565**	**2,841**
2002	1,013	**5,378**	5.3	**1,818**	**2,411**	**1,865**	**27**	**6,121**	**2,448**

[a] The expansion factor is 5.17 (SE=1.12) to convert peak survey counts to total escapement of large spawners, based on the 1995 to 1996 and 2001 to 2002 mark–recapture estimates.

Table 1.9.2. Estimated parent escapements, harvests, total returns, exploitation rates, and smolt production of Chickamin River chinook salmon for brood years 1980 to 1997. Estimates for escapement data in bold are from mark–recapture studies, the remainder are from expanded survey counts.

Brood year	Parent escapement	Inriver total return [a]	Inriver return/ spawner	Marine harvest [b]	Total return	Exploitation rate	Smolt production
1980	2,299	6,979	3.0				
1981	1,985	8,350	4.2				
1982	2,952	6,398	2.2	1,918	8,316	23.1%	182,727
1983	3,099	7,365	2.4	3,464	10,829	32.0%	320,068
1984	5,697	4,439	0.8	4,102	8,541	48.0%	261,723
1985	4,943	1,608	0.3	1,325	2,933	45.2%	
1986	9,022	3,888	0.4	2,291	6,179	37.1%	142,524
1987	5,041	3,107	0.6				
1988	4,064	2,715	0.7				
1989	4,829	2,702	0.6				
1990	2,916	1,416	0.5				
1991	2,518	1,960	0.8				
1992	1,789	1,403	0.8				
1993	2,011	2,985	1.5				
1994	2,006	2,996	1.5				
1995	**2,309**	4,277	1.9				
1996	**1,587**	6,714	4.2				
1997	1,406	4,185	3.0				

[a] Inriver total returns include 2 to 5-ocean-age fish (total age 4 to 7 years).

[b] Marine harvest includes estimated landed catch; it does not include incidental mortality and is not converted to adult equivalents.

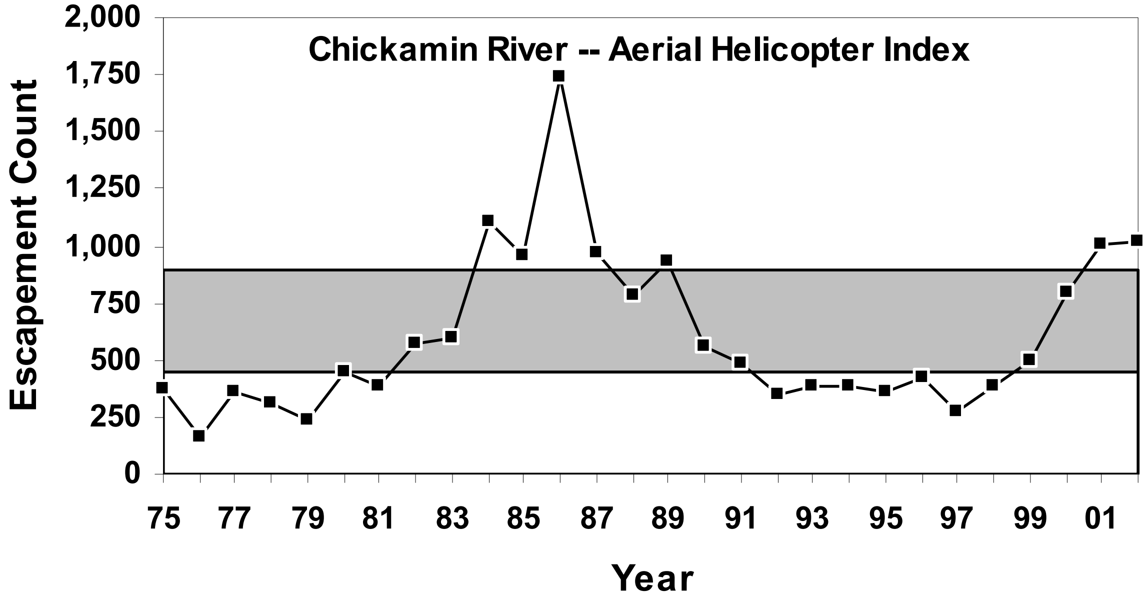

Figure 1.9.1. Estimated escapements of large spawners in the Chickamin River from 1975 to 2002, with the 1997 survey goal *biological escapement goal* range.

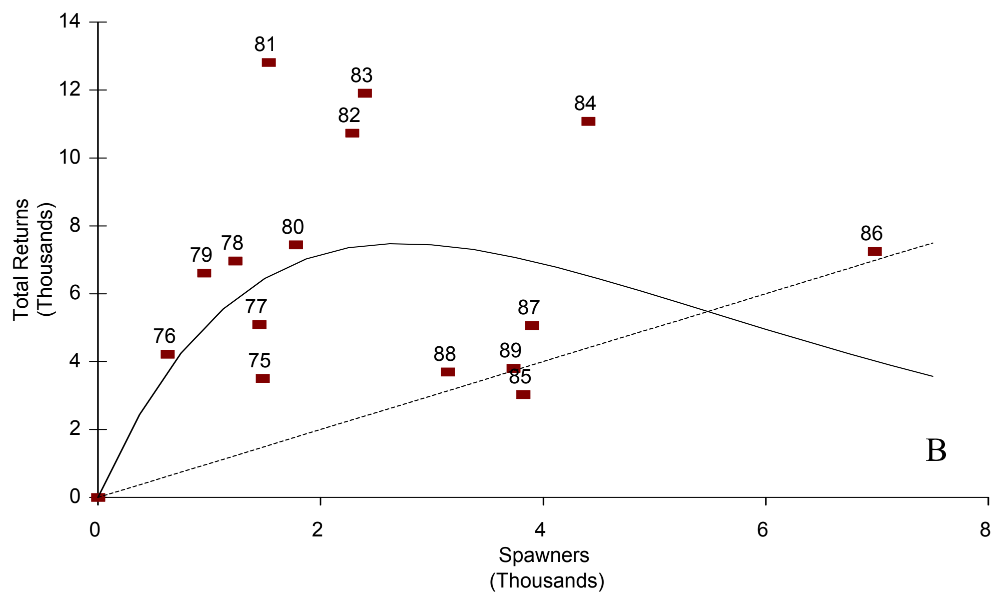

Figure 1.9.2. Estimated production of age-1.2 to age-1.5 chinook salmon in year classes 1975 to 1989 against the estimated spawning abundance of their large chinook parents for the population in the Chickamin River. The curve represents production predicted with Ricker's model, from McPherson and Carlile (1997).

Appendix 1.10. Keta River Chinook Salmon Stock

Stock Description

The Keta River enters Boca de Quadra Inlet in the Misty Fjords National Monument about 75 km east of Ketchikan, Alaska. The Keta River produces a small run of chinook salmon representing about 1% of the wild stock production in Southeast Alaska. Like other chinook salmon found in the region, these fish are a spring run. This stock produces yearling (age-1.) smolt primarily with about 10% subyearling fish (age-0.). Information inferred from coded wire tagging studies in the nearby Chickamin and Unuk rivers suggests that Keta River chinook salmon are *inside rearing* in behavior, spending most of their lives in Southeast Alaska and perhaps northern British Columbia. Keta River chinook salmon are very robust, attaining lengths and weights rarely seen elsewhere in the region. The Keta River itself has many exposed gravel bars with intermittent large pools and logjams. This river is typified by large sediments, probably the result of extremely high flows common to the system. Habitats of this nature are suited for the larger, more robust fish common to the Keta River.

Exploitation of Keta River chinook salmon is unknown but inferred from the Unuk River and Chickamin River projects. Although we have better stock assessment coverage in the nearby Chickamin and Unuk rivers, the stock assessment program on the Keta River has been greatly improved using monies attained in 1998 to 2002 from the U.S. Congress to support abundance-based management of chinook salmon. Since that time, 3 successful mark–recapture studies have been performed and sample sizes for age, sex, and length composition have been increased dramatically.

This river is one of 4 Behm Canal index systems in which chinook are counted annually (Pahlke 2001). Peak counts of chinook salmon in the Keta River have increased from the average seen during the base period (1975 to 1980), and in recent years have steadily increased towards the upper end of the *biological escapement goal* range. Temporal trends in chinook salmon abundance are reasonably consistent among the 4 Behm Canal index systems. In general, counts were at or above escapement goal ranges for most of the 1980s, but a significant downward trend began for all 4 systems near the end of the decade. Although this decline is apparent for the Keta River, counts have been near or above the lower end of the range since 1990. In recent years, escapements have been about double the values seen during the base years (Figure 1.10.1).

The ADF&G Division of Sport Fish performed 3 mark–recapture studies to estimate chinook salmon escapement in the Keta River, from 1998 to 2000 (Brownlee et al. 1999; Freeman et al. 2001). The estimated escapement of large chinook salmon in 2000 was 914, about the same as the 968 estimated in 1999, and up from the 446 estimated in 1998. Expansion factors for the peak aerial survey counts were 3.0 in 2000, 2.5 in 1998 and 3.5 in 1999. The expansion factor used to expand index counts to estimates of total escapement is 3.0, the mean value seen during the 3 years of mark–recapture study (Table 1.10.1). Escapements from 1975 to 2000 averaged 1,282 large (Table 1.10.1) spawners. The estimated escapements of large spawners versus the 1997 *biological escapement goal* is shown in Figure 1.10.1. The adult spawner-recruit data used to develop the 1997 *biological escapement goal* is shown in Figure 1.10.2.

Appendix 1.10. Keta River Chinook Salmon Stock

System:	Keta River
Species:	Chinook salmon

Outline of stock management, assessment and escapement goal analysis

Management Division:	Sport and Commercial Fisheries Divisions
Management Jurisdictions:	ADF&G
Fisheries:	U.S. recreational, gillnet, and troll; non directed
Escapement Goal Type:	*Biological Escapement Goal*
Escapement Goal:	250 to 500 range; 300 point estimate
Population for Goal:	Large spawners (≥ 660 mm MEF, or 2- to 5-ocean-age) as counted in **peak survey counts** under standardized survey conditions (time and area).
Optimal Escapement Goal:	None
Inriver Goal:	None
Action Points:	None
Escapement Enumeration:	Aerial helicopter surveys: 1975 to 2002, standardized by time and area. Mark–recapture estimates: 1998 to 2000
Index Count Expansion Factor:	3.0: multiplier for helicopter peak survey count in the standardized survey area on the Keta River.
Brood years in analysis:	15 (1975 to 1989), as in McPherson and Carlile (1997).
Data in analysis:	Survey counts, expanded by 2.5:1 and 4.0:1 to estimate total escapement of large spawners, harvest rates assumed from Unuk and Chickamin, age structure limited, but estimated for all broods.
Data Quality:	Fair, in McPherson and Carlile (1997)
Contrast in escapements:	13.8, in McPherson and Carlile (1997)
Model used for escapement goal:	Ricker model[a]
Criteria for range:	S_{MSY} times 0.8 (lower) and 1.6 (upper) per Eggers (1993)
Value of alpha parameter[b]:	8.23
Value of beta parameter[c]:	0.0009923
Document supporting goal:	McPherson, S. A. and J. Carlile. 1997. Spawner-recruit analysis of Behm Canal chinook salmon stocks. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report 1J97-06, Juneau.
Additional comments:	The ADF&G is in the process of analyzing the additional spawner-recruit data for this stock and plans to provide a revised escapement goal by July, 2003.

[a] for *R* (run size) and *S* (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.

[b] α is defined as Rickers productivity parameter.

[c] β is defined as Ricker's carrying capacity parameter.

Table 1.10.1. Escapement survey counts, spawning escapement estimates of large chinook, expansion factors and available age/sex composition for Keta River chinook salmon, from 1975 to 2002. Escapement estimates in bold are from mark–recapture studies, the remainder are from expanded survey counts.

Year	Survey count	Spawning escapement	Expansion factor [a]	Total age 3	Total age 4	Total age 5	Total age 6	Age-.2-.5 total	Large Females
1975	203	609							
1976	84	252							
1977	230	690							
1978	392	1,176							
1979	426	1,278							
1980	192	576							
1981	329	987							
1982	754	2,262							
1983	822	2,466							
1984	610	1,830							
1985	624	1,872							
1986	690	2,070							
1987	768	2,304							
1988	575	1,725							
1989	1,155	3,465							
1990	606	1,818							
1991	272	816							
1992	217	651							
1993	362	1,086							
1994	306	918							
1995	175	525							
1996	297	891							
1997	246	738							
1998	180	**446**	2.5	**54**	**110**	**153**	**231**	**503**	**240**
1999	276	**968**	3.5	**9**	**271**	**558**	**166**	**1,007**	**462**
2000	300	**914**	3.0	**62**	**643**	**377**	**206**	**1,289**	**377**
2001	343	1,029		214	339	721	77	1,177	464
2002	411	1,233		40	561	528	393	1,500	464

[a] The expansion factor is 3.00 (SE = 0.52) to convert peak survey counts to total escapement of large spawners, based on the 1998 to 2000 mark–recapture estimates.

Table 1.10.2. Estimated parent escapements and available inriver brood year return estimates of Keta River chinook salmon for brood years 1994 to 1998.

Brood year	Parent escapement	Inriver total return [a]	Inriver return/ spawner
1994	918	911	1.0
1995	525	779	1.5
1996	891	1,767	2.0
1997	738	*1,105*	*1.5*
1998	446	*1,987*	*4.5*

[a] Inriver total returns include 2 to 5-ocean-age fish. The 1997 inriver total return was estimated by assuming that the returns for this brood to date were 84% complete, and the 1998 inriver returns to date being 19% complete.

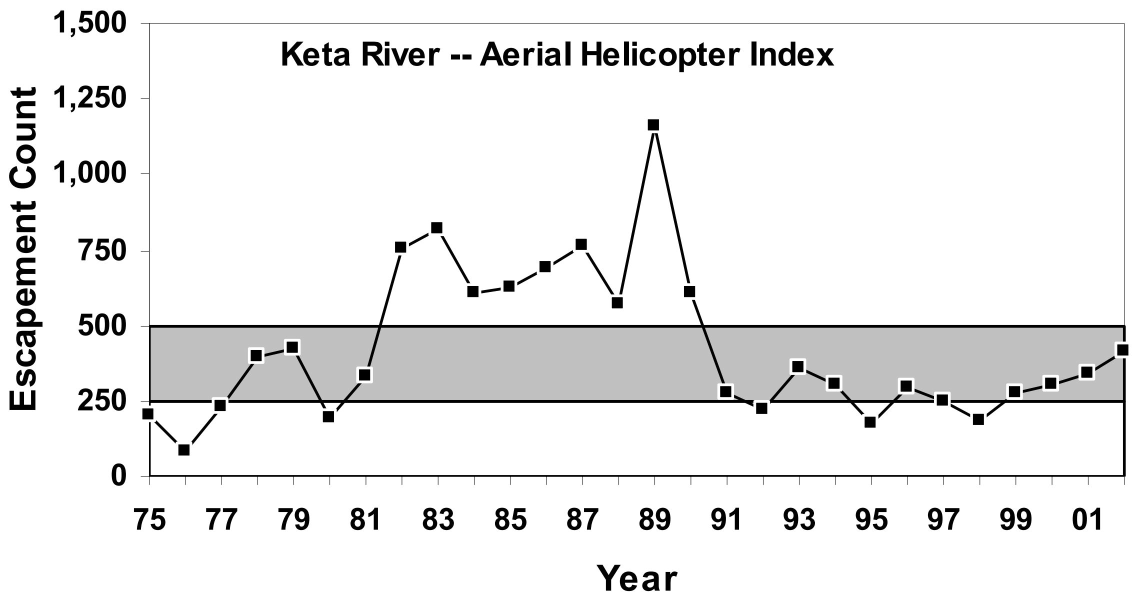

Figure 1.10.1. Estimated escapements of large spawners in the Keta River from 1975 to 2002 with the 1997 *biological escapement goal* range.

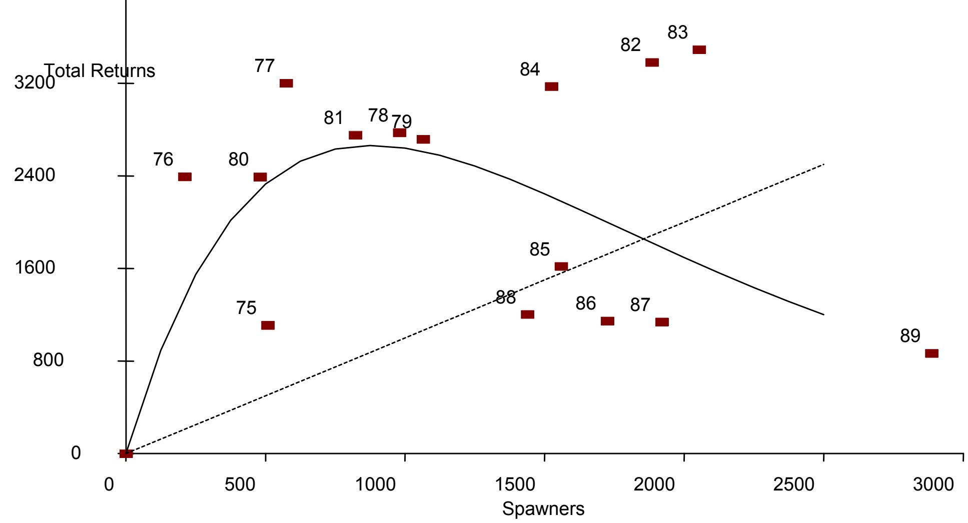

Figure 1.10.2. Estimated production of age-.2 to age-.5 chinook salmon in year classes 1975 to 1989 against the estimated spawning abundance of their large chinook parents for the population in the Keta River. The curve represents production predicted with Ricker's model, from McPherson and Carlile (1997).

Appendix 1.11. Blossom River Chinook Salmon Stock

Stock Description

The Blossom River is a clearwater river on the mainland in southern Southeast Alaska, approximately 40 miles east of Ketchikan. Chinook salmon from the Blossom River, along with fish from the Keta, Unuk, Chickamin and about 7 other small stocks make up what are collectively known as the Behm Canal stocks, named for the long narrow body of water that they all flow into. Although the Blossom and nearby Keta River are located within the Misty Fiords National Monument, they are both within an area of the Monument excluded from the Wilderness designation to allow the potential development of the Quartz Hill Molybdenum Project, located on a mountain between the 2 drainages; this development project is inactive at present and these drainages are pristine.

Chinook spawn in the main channel of the river. They start to enter the river in late June and complete spawning by early September. The stock produces primarily yearling smolt (age-1.), but returns have comprised as much as 15% subyearling fish (age-0.), which is unusual in Southeast Alaska (Pahlke 2001). The only other stocks which produce subyearling smolt, to any degree, are the Keta River stock and those in the Yakutat Forelands area, such as the Situk River. Based on coded wire tagging of Unuk and Chickamin chinook wild and hatchery stocks, we believe the ocean distribution of this stock is primarily in Southeast Alaska waters and to a lesser extent in northern British Columbia.

The stock assessment program for the Blossom River stock consisted solely of standardized helicopter surveys from 1975 to 1998 (Pahlke 2001). In 1998, ADF&G received special funding from the U.S. Congress to improve abundance-based management for chinook salmon in the Pacific Salmon Treaty area. ADF&G directed a portion of the money received to improving stock assessment by addressing the lack of information of Southeast Alaska chinook stocks. Projects to collect age, sex, and size information and to estimate total escapement have been implemented on the Blossom, Keta, and Chickamin rivers in specific years since 1998. Annual surveys of escapement have continued in the Blossom River. A mark–recapture tagging experiment was conducted in 1998, which provided the expansion factor of 4.0, i.e. 25% of the total escapement of large spawners is counted in the helicopter surveys (Brownlee et al. 1999). Tagging studies were conducted from 1998 to 2000 on the Keta River, which indicated that about one third of the escapement in that river was counted in aerial surveys (Freeman et al. 2001).

Since 1998, we have sampled the escapement for age, sex, and size data with adequate results in 3 of 5 years; the age data indicate that large chinook in this stock are composed of returns of 3 ocean ages (3 different year classes) annually, fish that are 2-, 3- and 4-ocean-age (Pahlke 2001). The 2-ocean fish (primarily 4-year-old total age) are larger than in most other systems (but similar to the Chickamin and Keta), and about 75% of the 2-ocean-age spawners in the Blossom River are of legal size. We have also found that the Chickamin, Keta, and Blossom River stocks produce the largest chinook salmon at age in the region.

Survey counts have been relatively stable since 1975, with the exception of 3 years (Table 1.11.1 and Figure 1.11.1). Survey counts were the lowest in the period from 1975 to 1980, rose for a few years to unprecedented levels, and then have been relatively stable since 1989. The high counts from 1985 to 1987 are the result of an exceptionally high survival from one particular brood, a phenomena that has occurred at least once in the last 28 years for most Southeast Alaska chinook stocks. The remainder of the survey counts have been relatively stable over the duration. The 1998 to 2002 average survey count was 192 large chinook, which is about double the average escapement counts (102 large chinook) from 1975 to 1980, the base period used by the PSC.

As mentioned in the body of the report above, a *biological escapement goal* range was established in 1997 for the Blossom River stock, based on limited data through the 1989 brood year (calendar year data through 1995), shown in Figure 1.11.2. That escapement goal range was a survey count of 250 to 500 large spawners. The escapements in the Blossom River have been below the 1997 *biological escapement goal* range from 1988 to 2002, or 52%, 85%, 92%, 82% and 90%, respectively, of the lower end of the 1997 *biological escapement goal* range. This led ADF&G to identify the Blossom River chinook as a candidate for *stock of concern* status to the Alaska Board of Fisheries, at the *management concern* level, in October, 2002. ADF&G has not yet completed the spawner-recruit analysis update for the Blossom River and the other 3 Behm Canal chinook stocks. We will complete this analysis over the next 2 months, specifically for the Blossom stock, using all survey, age structure and the exploitation rate data available. This analysis has proven more cumbersome and complicated than originally anticipated because of time series effects in the data and staff workload. In addition, we need time to present any revisions to escapement goals to the Chinook Technical Committee.

Our initial review of these data suggest that the existing goal of 250 to 500 large spawners counted in helicopter surveys is an overestimate of the escapement level that will provide *maximum sustained yield* for this stock. Given this preliminary analysis, we do not, at this time, consider the Blossom River stock to be a *stock of concern* nor in need of an action plan. Our reasons for this conclusion and recommendation are:

1. Escapement levels have been very stable for this stock since 1988 (15 consecutive years). The stock has proven to sustain itself over a 28-year period.
2. The high escapements from 1985 to 1987 are unusual events from abnormally high survival of one or 2 broods.
3. Escapements in the most recent 5 years (1998 to 2002) have been double those seen from 1975 to 1980. Note in Figure 1. 11.1 that escapements in the 6 years after the low counts from 1975 to 1980 were the highest in the time series.
4. Exploitation rates, inferred from the Unuk River wild stock nearby, and from time series analysis of the Blossom survey counts, are low. There are no directed fisheries on this stock. Except for a small spring fishery that targets Neets Bay hatchery returns, Behm Canal is closed to salmon fishing by regulation prior to July 13 and fishing in the Blossom River is closed year round to chinook salmon retention.
5. Low exploitation rates and relatively stable escapement counts are usually indicative of a stock at equilibrium, bouncing around replacement.
6. The 3 nearby stocks, the Unuk, Chickamin and Keta stocks, are performing well in recent years and it is therefore unlikely that an environmental or fisheries problem exists for the Blossom River stock.
7. The 1997 *biological escapement goal* for the Blossom River was based on the belief, in 1994, that the expansion factor for the Keta and Blossom River helicopter survey counts were the same. In fact, they are not, and it is more difficult to count chinook salmon in the Blossom River because of deep pools, etc.
8. If the 1997 *biological escapement goal* range for the Blossom River is truly the escapement range that produces *maximum sustainable yield*, and fisheries were restricted in order to increase Blossom River escapements, the escapements in all other Behm Canal stocks would end up well above their *biological escapement goal* ranges, and substantial harvests for the combination of all chinook stocks would decrease.

Appendix 1.11. Blossom River Chinook Salmon Stock

System:	Blossom River
Species:	Chinook salmon

Outline of stock management, assessment and escapement goal analysis

Management Division:	Sport and Commercial Fisheries Divisions
Management Jurisdictions:	ADF&G
Fisheries:	U.S. recreational, gillnet, and troll; non directed
Escapement Goal Type:	*Biological Escapement Goal*
Escapement Goal:	250 to 500 range; 300 point estimate
Population for Goal:	Large spawners (≥ 660 mm MEF, or 2- to 5-ocean-age) as counted in **peak survey counts** under standardized survey conditions (time and area).
Optimal Escapement Goal:	None
Inriver Goal:	None
Action Points:	None
Escapement Enumeration:	Aerial helicopter surveys: 1975 to 2002, standardized by time and area. Mark–recapture estimate: 1998
Index Count Expansion Factor:	4.0: multiplier for helicopter peak survey count, based on one year (1998).
Brood years in analysis:	15 (1975 to 1989), as in McPherson and Carlile (1997).
Data in analysis:	Survey counts, expanded by 2.5:1 and 4.0:1 to estimate total escapement of large spawners, harvest rates assumed from Unuk and Chickamin, age structure limited, but estimated for all broods.
Data Quality:	Fair, in McPherson and Carlile (1997)
Contrast in escapements:	25.0, in McPherson and Carlile (1997)
Model used for escapement goal:	Ricker model[a]
Criteria for range:	S_{MSY} times 0.8 (lower) and 1.6 (upper) per Eggers (1993)
Value of alpha parameter[b]:	9.207
Value of beta parameter[c]:	0.0010217
Document supporting goal:	McPherson, S. A. and J. Carlile. 1997. Spawner-recruit analysis of Behm Canal chinook salmon stocks. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report 1J97-06, Juneau.
Additional comments:	The ADF&G is in the process of analyzing the additional spawner-recruit data for this stock and plans to provide a revised escapement goal by July, 2003.

[a] for *R* (run size) and *S* (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S+\varepsilon\}$, for ε a random variable.

[b] α is defined as Rickers productivity parameter.

[c] β is defined as Ricker's carrying capacity parameter.

Table 1.11.1. Escapement index counts and spawning escapement estimates for large spawners in the Blossom River chinook salmon population, from 1975 to 2002. Escapement estimates are from expansions of aerial survey counts from 1975 to 2002, except 1998, which is from a mark–recapture project.

Year	Survey counts	Spawning escapement [a]
1975	146	584
1976	68	272
1977	112	448
1978	143	572
1979	54	216
1980	89	356
1981	159	636
1982	345	1,380
1983	589	2,356
1984	508	2,032
1985	709	2,836
1986	1,278	5,112
1987	1,349	5,396
1988	384	1,536
1989	344	1,376
1990	257	1,028
1991	239	956
1992	150	600
1993	303	1,212
1994	161	644
1995	217	868
1996	220	880
1997	132	528
1998	91	**364: mark recapture estimate**
1999	212	848
2000	231	924
2001	204	816
2002	224	896
Average	319	1,274

[a] Based on an expansion factor of 4.0 observed in 1998.

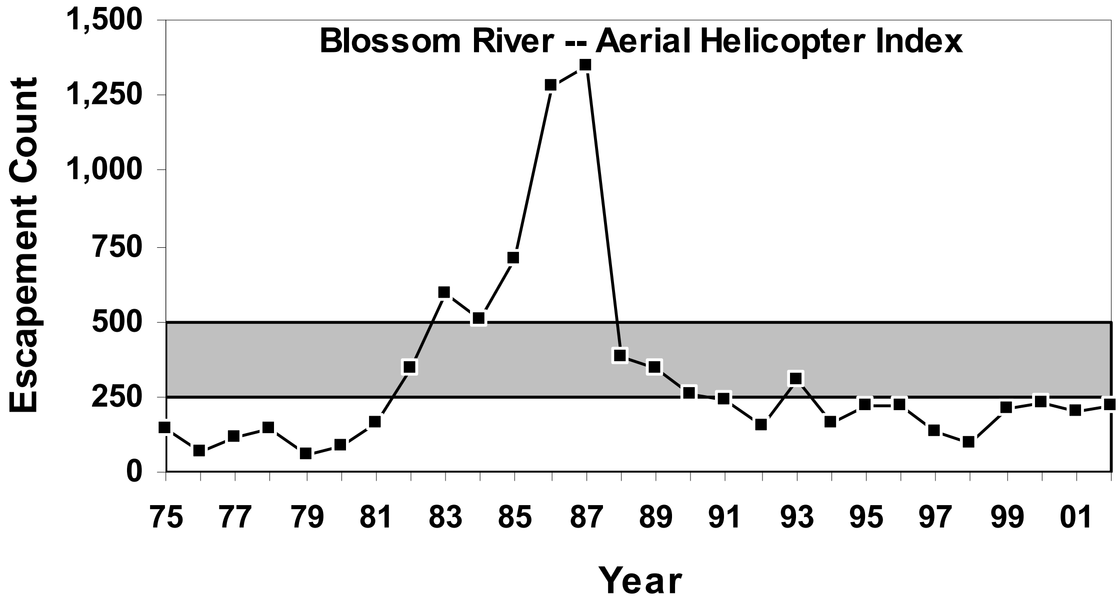

Figure 1.11.1. Estimated escapements of large spawners in the Blossom River from 1975 to 2002, with the 1997 survey goal *biological escapement goal* range.

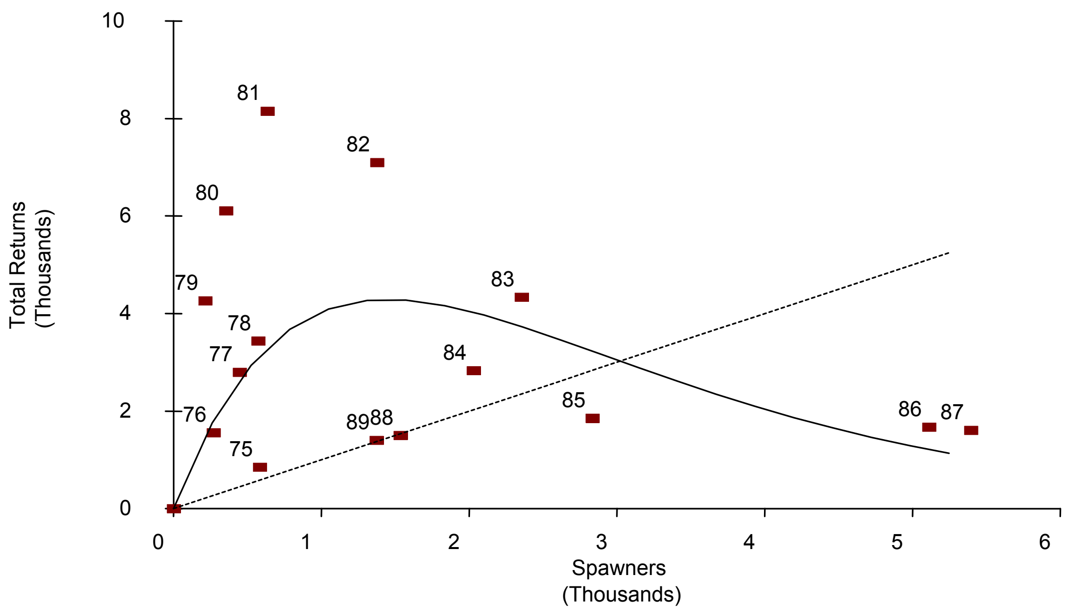

Figure 1.11.2. Estimated production of age-.2 to age-.5 chinook salmon in year classes 1975 to 1989 against the estimated spawning abundance of their large chinook parents for the population in the Blossom River. The curve represents production predicted with Ricker's model, from McPherson and Carlile (1997).

Chapter 2: Sockeye Salmon
Stock Status and Escapement Goals in Southeast Alaska

by

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ABSTRACT

In Southeast Alaska and the Yakutat area, sockeye salmon spawn in over 200 coastal lakes and in several large transboundary river systems (rivers that flow through Canada into Alaska). We have extensive stock assessment information and escapement goals for 15 systems, including most of the largest sockeye salmon producers. Six escapement goals have been generated or reevaluated within the last year. Currently there are 14 escapement goals, not including the escapement goal for the Italio River, which was rescinded in 2002 due to major physical and hydrologic change in the drainage. In the Yakutat area, escapement goals are currently in place for the Situk, Lost, Akwe, and the East Alsek-Doame Rivers. Escapement goals are established for the following transboundary rivers: Klukshu River (Alsek River drainage), the Taku River, Tahltan Lake, and Mainstem Stikine (Stikine River drainage). Escapement goals are established for 6 additional systems in Southeast Alaska, including Chilkat, Chilkoot, Redoubt, Speel, McDonald and Hugh Smith lakes. We identified 1 candidate *stock of concern*: the Hugh Smith Lake sockeye salmon stock. Escapements to this system have been declining for 2 decades and in the last decade the escapements have been consistently below the lower end of the previous escapement goal range for this system. The escapement goal for Hugh Smith Lake was reevaluated, and ADF&G is in the process of reviewing the stock assessment, management, and enhancement options for this system. In 2001, ADF&G and several cooperators, including tribal governments and the U.S. Forest Service, initiated field projects on 12 lakes that are important to the residents of Klawock, Hydaburg, Wrangell, Kake, Angoon, Hoonah, and Sitka. Additionally, ADF&G has other monitoring projects in place that have not yet produced enough information for long-term comparisons. Although yields have declined somewhat in the Yakutat area, probably due to hydrological changes in several rivers, yields have been generally stable or increasing in Southeast Alaska. In both areas, escapements have generally been within established escapement goal ranges. At this time, we consider the status of the sockeye salmon stocks in Southeast Alaska and the Yakutat area to be in a favorable condition.

Key words: Sockeye salmon, Oncorhynchus nerka, escapement, escapement goals, escapement goal ranges, stock status, Yakutat, Situk River, Lost River, Italio River, Akwe River, Klukshu River, East Alsek-Doame River, Chilkoot Lake, Chilkat Lake, Redoubt Lake, Taku River, Speel Lake, Tahltan Lake, Mainstem Stikine, Hugh Smith, McDonald Lake, Klawock Lake, Hetta Lake, Sitkoh Lake, Kanalku Lake, Falls Lake, Gut Bay Lake, Luck Lake, Thoms Lake, Salmon Bay, Kook Lake, Hoktaheen Lake, Klag Lake.

INTRODUCTION

Sockeye salmon (*Oncorhynchus nerka*) harvested in Southeast Alaska come primarily from 3 sources: coastal Alaskan lakes and rivers, transboundary rivers (rivers that flow through Canada and into Alaska), and Canadian river systems whose returning adult salmon migrate through U.S. waters (e.g., Skeena and Nass rivers). Most producers are lakes in which juvenile sockeye salmon rear, but there is also substantial production from riverine areas within the region's large mainland glacial systems. Van Alen (2000) reports over 200 sockeye salmon-producing systems in Southeast Alaska and the Yakutat area. Most are small producers, but their combined production is substantial. There is considerable variation in return timing among runs throughout the region, and within individual stocks in several of the larger drainages. Sockeye salmon are available to fisheries in the region between early June and mid-September. Peak abundance occurs during the month of July. Spawn timing is also highly variable, with most occurring between early August through late October.

ADF&G has collected extensive stock assessment data for the largest runs in the region, including the transboundary Alsek, Taku, and Stikine Rivers, Chilkat and Chilkoot Lakes in northern Lynn Canal, the Situk River near Yakutat, and McDonald Lake near Ketchikan (Figure 2.1a). Long-term stock assessment data were collected from several smaller producers in the Yakutat area including the Lost, Italio, Akwe and East Alsek-Doame River, at Redoubt Lake near Sitka, Speel Lake near Juneau and Hugh Smith Lake near Ketchikan. Escapement monitoring of many other systems has occurred throughout the region on a less intensive or sporadic basis. Recently, ADF&G initiated several new studies funded by the federal government. Harvest information is recorded on a district specific basis (Figure 2.1b).

Prior to the industrialization of the salmon fisheries in the 1800s by European Americans, sockeye salmon provided food resources and one of the most important economic inputs into the aboriginal economies in Southeast Alaska. Tlingit peoples in Southeast Alaska had a well developed system of management and property rights that favored sockeye salmon more than other species of salmon (Goldschmidt and Haas 1942; George and Bosworth 1988; Thornton et al. 1990).

Sockeye salmon were the first salmon species to be commercially exploited in Southeast Alaska, beginning in the late 1800s (Figure 2.2). The first records of substantial commercial sockeye salmon catches dates to 1883, when just over 100,000 fish were reported in the commercial harvest, although there was some level of commercial activity before that year (Byerly et al. 1999). Catch records show commercial harvests in the Yakutat area in the early 20th century, with a peak of 453,000 in 1914.

Before statehood, the sockeye salmon fisheries went through 3 periods of development. Several authors describe 1900 to 1925 as the buildup period, when there was very little regulation of the fishery. Many small local sockeye salmon stocks were mined out in Southeast Alaska, especially in the vicinity of processing facilities (e.g., Moser 1899; Crutchfield and Pontecorvo 1969). Annual commercial catches in Southeast Alaska and the Yakutat area were consistently in excess of 2 million fish from 1902 to 1920, peaking at 3.5 million in 1914. The second period, from 1925 to 1945, was a time when major fishing districts were defined, and a number of management measures and weekend fishing closures were introduced. Catches began a slow decline during this period, and ranged from 1.1 million to 2.5 million per year through the mid-1940s. By the end of this period, many runs were severely overfished and catch trends were on their way down. In the final period from 1946 to statehood—the period of decline—the fishery had lost much of its value through depletion. Until the 1940s, harvests of sockeye salmon in southern Southeast were more stable and consistent than in northern portions of the region. However, catches dropped in both areas at that time (Figure 2.2). The region’s commercial catch of sockeye salmon reached a trough of 490,000 in 1949 and generally remained below 1 million fish annually through the 1960s.

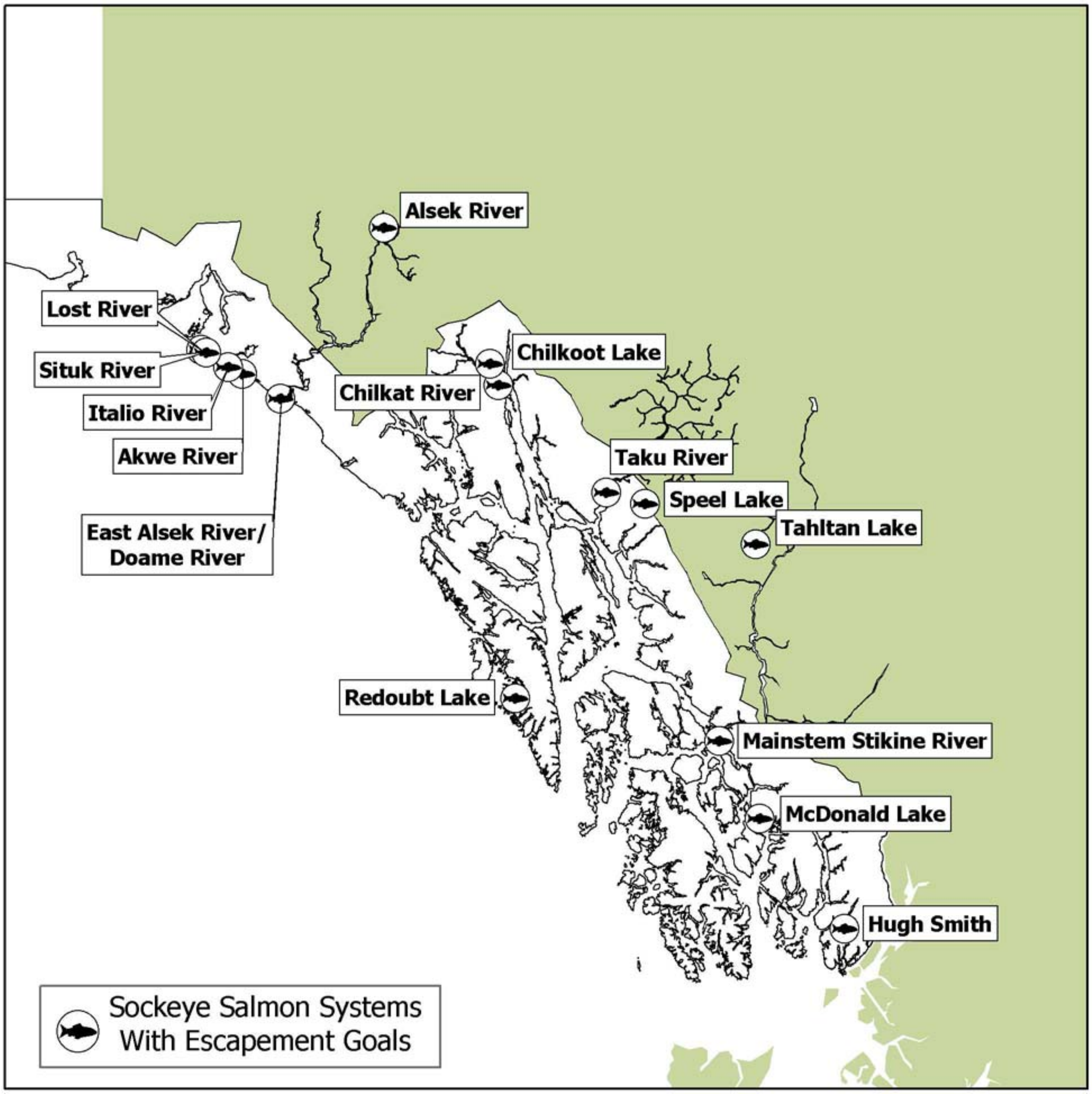

Figure 2.1a. Sockeye salmon systems with long-term stock assessment programs and escapement goals in Southeast Alaska and the Yakutat area.

Throughout Alaska, many salmon stocks declined in the early 1970s and then increased in the mid- to late-1970s— partially due to ocean-climate effects that are sometimes called the "regime shift" (Quinn and Marshall 1989; Beamish and Bouillon 1993; Adkison et al. 1996; Mantua et al. 1997; Beamish et al. 1998; and many others). This was also true for sockeye salmon in Southeast Alaska. Harvest levels began increasing in the late 1970s, especially in southern Southeast Alaska, and consistently exceeded 2 million fish between the late 1980s and late 1990s. Van Alen (2000) and others cite the spawning channels on the Skeena River and other enhancement activities in Canada as a large part of the reason for the recent increased catch of sockeye salmon in southern Southeast Alaska.

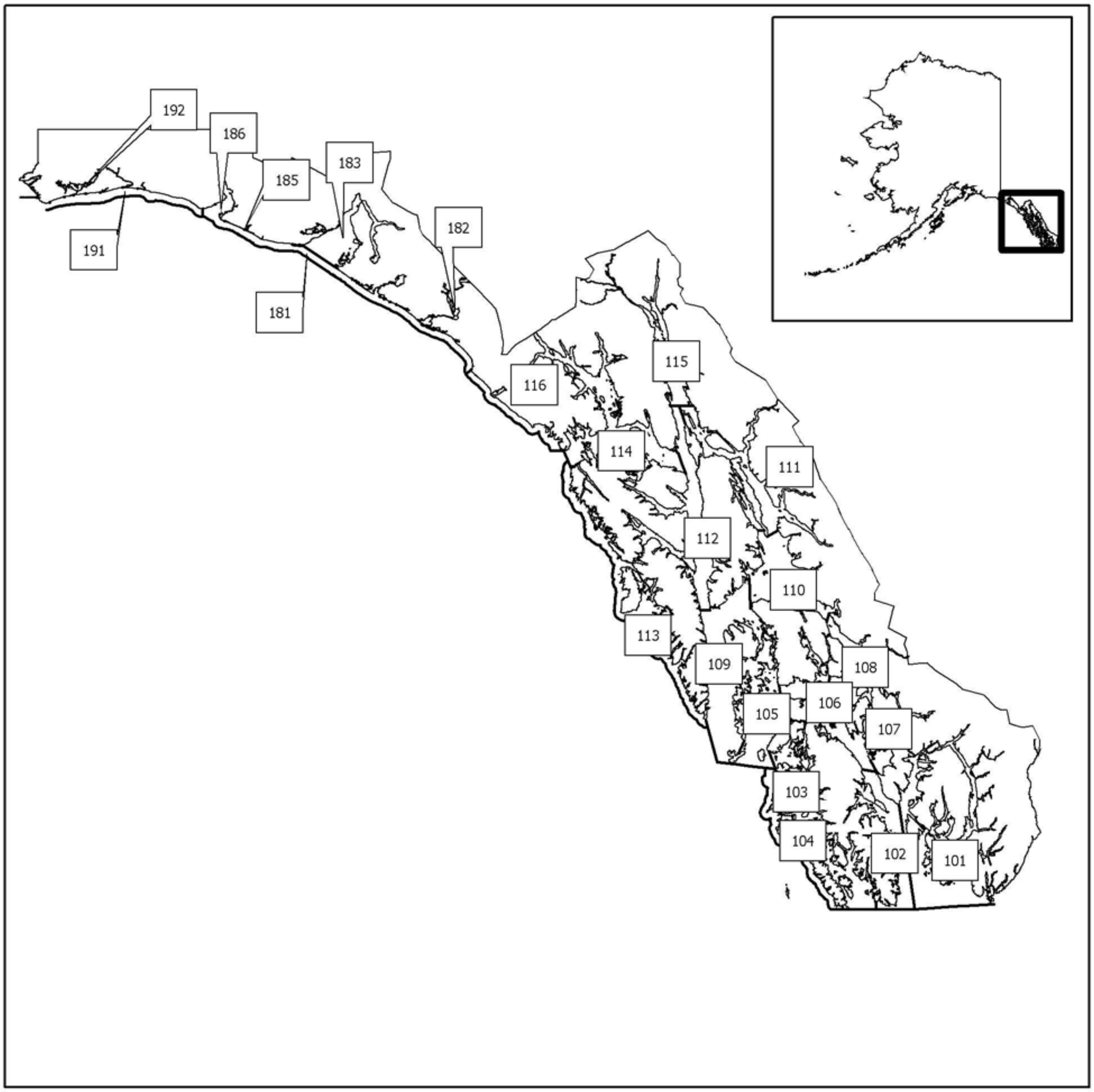

Figure 2.1b. Fishing districts in Southeast Alaska and the Yakutat area.

Among commercial users, harvests by gear type since statehood were dominated by purse seine (47%), drift gillnet (38%), and set gillnet (12%), with small amounts taken by troll gear (1%), in fisheries in the Annette Island Reserve (2%), and hatchery cost recovery fisheries (ADF&G 2003).

Sockeye salmon is the primary species in the region's drift gillnet fisheries during the summer months of June through late August, although substantial harvests of summer chum, pink, and coho salmon occur as well in the fisheries. During September and early October the fisheries target coho and fall-run chum salmon. There are 5 traditional drift gillnet fishing areas in Southeast Alaska: District 101 (Tree Point and Portland Canal), District 106 (Sumner and Clarence Strait), District 108 (Stikine), District 111 (Taku-Snettisham), and District 115 (Lynn

Canal). In addition, there is a terminal harvest area near the Snettisham Hatchery where drift gillnet gear is allowed to harvest returns of Snettisham Hatchery sockeye salmon. Each of the traditional fisheries harvests mixed stocks of sockeye salmon. ADF&G publishes an annual management plan for the fisheries each year containing expected returns, management issues, and harvest strategies for the individual districts (ADF&G 2002a).

Management of the District 101, 106, 108, and 111 fisheries is governed by specific agreements with Canada in the Pacific Salmon Treaty as well as consideration of domestic stocks. The Tree Point fishery (in District 101) is constrained by the current Pacific Salmon Treaty agreement to harvest 13.8% of the annual allowable harvest[a] of Nass River sockeye salmon. The District 106 and 108 fisheries are managed to abide by harvest-sharing agreements for transboundary Stikine River sockeye salmon; the current agreement specifies equal sharing of the total allowable catch[1] of Stikine River sockeye salmon in the 2 countries' fisheries. Harvest sharing of transboundary Taku River sockeye salmon is a major consideration in the District 111 fishery, with the U.S. entitled to 82% of the total allowable catch of wild Taku River sockeye salmon and 50% of the total allowable catch of sockeye salmon resulting from joint U.S./Canada enhancement programs on the river. The District 115 fishery, which targets sockeye salmon returns to the Chilkat and Chilkoot Rivers, is the only drift gillnet fishery not directly affected by the Pacific Salmon Treaty. ADF&G operates intensive stock identification programs in order to effectively manage the stocks harvested in the fisheries and to abide by Pacific Salmon Treaty agreements. These programs have been operated since the early 1980s and are integral to the assessment of the region's sockeye salmon runs.

Although purse seine fisheries are frequently the largest harvester of sockeye salmon in the region, the primary targets of the fisheries are pink salmon and hatchery returns of chum salmon. The District 104 fishery, on the outer coast of southern Southeast Alaska, is where most sockeye salmon are taken by the purse seine fleet. Pacific Salmon Treaty provisions currently limit the District 104 harvest of sockeye salmon prior to Statistical Week 31 (approximately mid-July) to 2.45% of the annual allowable harvest of the combined Nass and Skeena River sockeye salmon runs. Directed purse seine fisheries on sockeye salmon occasionally occur in terminal areas when surpluses to spawning needs are identified; examples include Yes Bay (McDonald Lake run) in southern Southeast Alaska, and Redfish Bay and Necker Bay along the outside coast of northern Southeast Alaska near Sitka. Sockeye harvests in most other purse seine fisheries in the region are incidental to directed fishing on other species. To abide by Pacific Salmon Treaty agreements, contributions of Nass and Skeena sockeye salmon runs and a conglomerate of Alaska sockeye runs are estimated annually in southern Southeast Alaska purse seine fisheries. At present, these programs do not provide stock-specific data useful in estimating harvests of individual sockeye salmon runs in the region, thereby limiting efforts to develop detailed brood tables and escapement goals for many systems. More detailed information on management of the region's purse seine fisheries can be found in annual preseason management plans published by ADF&G (2002b).

Set gillnet gear is allowed in the Yakutat area; there are no other commercial set gillnet fisheries in the rest of the region. Moreover, set gillnets are the only net gear allowed for commercial harvest of salmon in the Yakutat area. Sockeye salmon are the primary species targeted by Yakutat area fisheries during June through late August. The fisheries occur at or near the mouths of streams draining into the Gulf of Alaska, and thus are managed according to developing

[a] AAH (annual allowable harvest) and TAC (total allowable catch) are terms defined in the Pacific Salmon Treaty that represent the harvestable surplus in excess of the agreed upon escapement goal.

returns to each specific river. The exception to this is the Yakutat Bay fishery. This fishery harvests mixed stocks returning to all the systems in the area. The stock-specific nature of most of the fisheries has proven advantageous in developing brood year tables of returns and is the main reason escapement goals have been developed for all the major stocks in that area. More information on management of the Yakutat set gillnet fisheries can be found in annual pre-season management plans published by ADF&G (2002c).

Other users also harvest sockeye salmon in Southeast Alaska, including subsistence, personal use, and sport fishers. Subsistence and personal use harvests are monitored through returned harvest permits. From 1992 through 2001 (data from 2002 is considered preliminary), reported catches have averaged 47,100 in Southeast Alaska and 4,200 in the Yakutat area (ADF&G 2003). Since all permits are not returned, reported subsistence and personal use harvest estimates are less than actual catches in these fisheries. Sport harvests of sockeye salmon occur throughout the region. The sport harvest is estimated throughout Alaska by means of a household-based postal survey. From 1992 through 2001, ADF&G estimated the average annual sport harvest of sockeye salmon to be approximately 19,000 fish for the entire region, including the Yakutat area (Mike Jaenicke, Alaska Department of Fish and Game, unpublished data). Additionally, in Southeast Alaska, the sport harvest in several large ports is also monitored by on-site creel surveys.

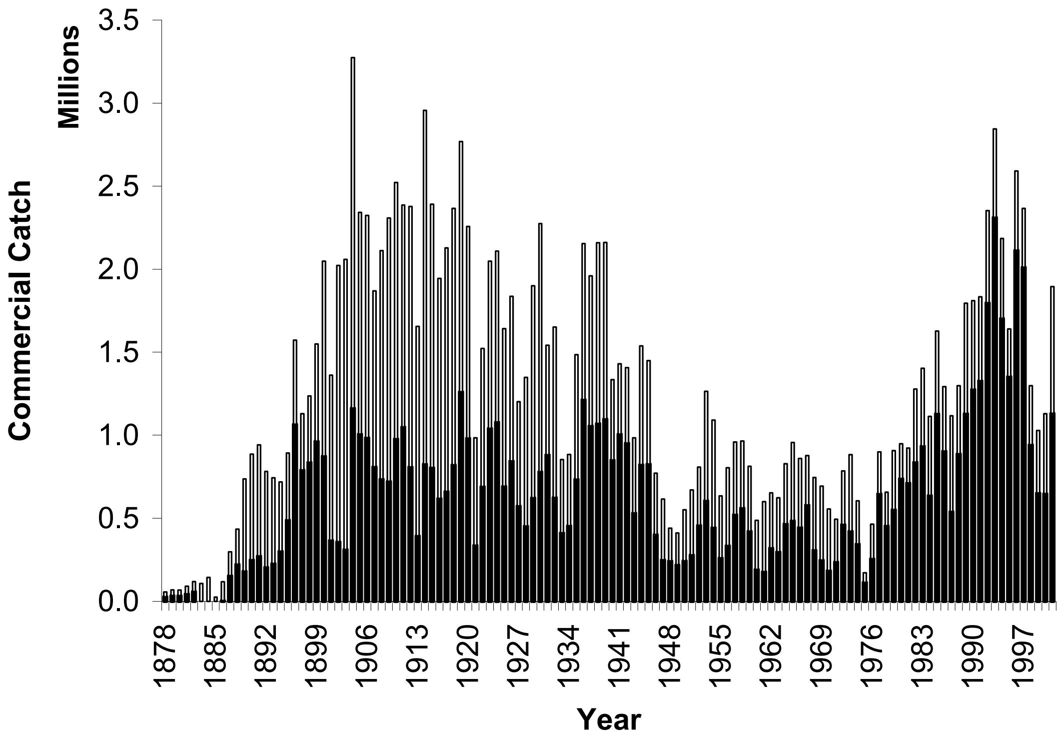

Figure 2.2. Commercial catch of sockeye salmon in Southeast Alaska (not including the Yakutat area) from 1878 to 2001. Top, lighter bars show the catch in Northern Southeast Alaska, while dark, lower bars denote catch in Southern Southeast Alaska.

STOCK STATUS

This section provides a summary of stock assessment programs used to develop data series for establishing escapement goals and monitoring stocks. Status of the stocks is then reviewed by comparing measured escapements relative to established escapement goals.

Harvest Estimation

Commercial harvest is recorded on a legal document called a *fish ticket*. The total weight of the harvest is the primary measure, and serves as the basis of payment on the part of the processors to the fishers. Fish tickets contain temporal and spatial information about the harvest, as well as information about the vessel making the catch and sale. Catch, in units of weight, is converted into units of fish numbers by the processors based on their own individual methods of determining the average weight of individual fish.

Subsistence and personal use harvests have traditionally been estimated by means of returned permits. Since there are no important disincentives for non-reporting, harvests in these categories are usually underreported and underestimated. Probability based surveys of subsistence harvest have been conducted for 2 years at Falls, Klag, Hetta, and Klawock Lakes. Sport harvest is assessed by means of a household based postal survey.

Biological sampling is conducted in most commercial net fisheries that harvest sockeye salmon in Southeast Alaska and the Yakutat area. Age, sex, and size data are collected, analyzed, and summarized annually. Stock composition of harvests in most of the major fisheries is estimated for important stock groups; a variety of techniques are used, including analysis of scale patterns, brain parasites, DNA, coded wire tags, and thermal otolith marking of hatchery releases (Van Alen 2000). Virtually all releases of sockeye salmon from hatchery programs have been otolith marked in recent years. These stock identification programs are described in Appendices 2.1–2.16.

Escapement Estimation

A variety of methods are used to estimate escapements throughout the region, including mark–recapture programs, counting weirs, aerial and foot surveys. Weirs are operated on several clear-water streams, and mark–recapture studies are frequently used to provide verification of weir counts. Mark–recapture programs are operated on several large glacial systems where fish cannot be visually enumerated. Aerial surveys are also used, particularly in the small Yakutat area streams, to provide a measure of escapement. A relationship between repeated foot surveys and weir counts was developed for McDonald Lake, and expansions of foot surveys have been used to estimate escapements to this system since the mid-1980s.

ADF&G is assisted by a large number of other organizations in monitoring escapements in the region. The Canadian Department of Fisheries and Oceans (CDFO), the Taku River First Nation, and the Tahltan First Nation help with monitoring escapements into the transboundary rivers. The Douglas Island Pink and Chum Corporation, Northern and Southern Southeast Regional Aquaculture Associations, U.S. Forest Service, U.S. Fish and Wildlife Service, Sitka Tribe of Alaska, and others each provide support for projects operated in the region.

In the Yakutat area, sockeye escapement is assessed with a weir on the Situk River. Escapement is measured by means of a peak-count aerial index in the Italio, Akwe, East Alsek, and Doame Rivers and peak foot or boat surveys in the Lost River; peak-count series for these systems go back to the 1970s. Beginning in 2003 ADF&G will conduct detailed studies on several Yakutat systems to provide information on the proportion of the escapement represented by these survey counts. In the Alsek River system there has been a counting weir on the Klukshu River, a tributary, to index escapement since 1976. The proportion of the Klukshu stock within the larger Alsek was evaluated with mark–recapture and radio telemetry studies in 2001 and 2002.

In Upper Lynn Canal, a fish-wheel based mark–recovery study provides information on run strength, run timing, and many other biological features of sockeye salmon returning to the Chilkat River. Historically, ADF&G operated a weir at Chilkat Lake as the primary escapement assessment tool for the drainage, but operation of the weir was discontinued in the mid-1990s, due to funding cuts and reprogramming of the assessment project into mark–recapture studies. Northern and Southern Regional Aquaculture Associations resumed operation of the weir in the late 1990s. Although a complete count of fish is not obtained at the weir, large numbers of fish are counted and examined for marks, enabling mark–recapture estimates of escapement to be generated. The other major Upper Lynn Canal stock, Chilkoot Lake sockeye salmon, is monitored by means of a counting weir, which is verified by a backup mark–recapture study.

Weekly inseason estimates of the sockeye salmon escapement to Canadian portions of the Taku River have been generated since 1984 through a joint U.S./Canada fish wheel mark recapture project. A number of weirs have been operated on systems within the Taku drainage and systems that produce fish that co-mingle with Taku stocks, including Tatsamenie Lake (from 1985 to the present), Trapper Lake (1983 to the present), Kuthai Lake (1992 to the present), Nahlin Lake (most years between 1988 and 1998), Crescent Lake (1982 to 1993), and Speel Lake (1982 to 1993, and 1995 to the present). The National Marine Fisheries Service-Auke Bay Lab conducted extensive radio telemetry studies on Taku River sockeye in the 1980s that provided valuable information on spawning distribution in the drainage (Eiler et al. 1992).

Escapement to the Stikine River is estimated by several methods. A weir has been operated annually at Tahltan Lake, the largest spawning stock into the drainage, but counts are not available on a timely basis for inseason management. Total escapement to the drainage has been estimated by the Transboundary Technical Committee of the Pacific Salmon Commission, through an indirect method that relies on stock-composition data, catch-per-unit-effort data from Canadian inriver fisheries and the Tahltan Lake escapement. Methods were further refined in recent years, using the presence of otolith marked returns of enhanced fish to Tahltan and Tuya Lakes. An inseason management model has been used by ADF&G and CDFO to provide in-season estimates of escapement, but the model produced inaccurate estimates in some recent years. As a result, the 2 agencies began mark–recapture studies on the river in 2001 to provide an alternate method for estimating escapement. The U.S. Forest Service operates a weir on Redoubt Lake, a large meromictic system about 11 km south of Sitka. The weir has operated since 1982, with the exception of 1998.

Because of the dispersed production of sockeye salmon in coastal lakes in southern Southeast Alaska, there are very few long-term monitoring projects, except at large systems associated with enhancement projects. Escapement into McDonald Lake is assessed by a series of standardized foot surveys. Escapement into Hugh Smith Lake is assessed by means of a weir, which has been operated since 1980, with mark–recapture studies to verify the weir estimates since 1992.

Biologists experimented with coded wire tagging sockeye salmon in southern Southeast Alaska the 1980s, especially in Hugh Smith, Klawock, and the McDonald systems.

Subsistence Monitoring Projects

In 1999, the federal government expanded federal subsistence fisheries management to water systems adjacent to federal lands in Alaska. Because sockeye salmon are one of the most important subsistence foods in Southeast Alaska, this expanded role gave the federal government a new interest in sockeye salmon stock status in Alaska, and they set out to fund salmon research projects important to Alaskan subsistence users. In conjunction with tribal and federal cooperators in the U.S. Forest Service, ADF&G developed a subsistence sockeye stock assessment program for small lake systems.

ADF&G initiated short-term field projects on 12 lakes in 2001. The goal of this effort was to measure or index adult sockeye salmon escapement and collect other biological and lake-productivity measurements on sockeye salmon-producing lakes important to the residents of Klawock, Hydaburg, Wrangell, Kake, Angoon, Hoonah, and Sitka. An important additional goal was to accurately and precisely estimate the subsistence harvest on the fishery grounds in the Falls, Klawock, Hetta, and Klag lake projects, using probability-based creel survey methods. Detailed summaries of the work on these 12 lake systems and the creel survey results are found in Lewis and Zadina (2001), Conitz and Cartwright (2002a, 2002b, and 2002c), Conitz et al. (2002), and Lewis and Cartwright (2002a, 2002b, and 2002c). A brief summary of information on each of these 12 lakes is found in Appendix 2.16.

Stock Status Assessment

Escapement goals have been established for 14 systems in Southeast Alaska and the Yakutat area (although 1 of those goals has been withdrawn). These goals are described in the Escapement Goal section that follows. Within the last year, 1 new goal was established, 3 existing goals were changed, and 1 goal was rescinded. Most of the goals are *biological escapement goals* (as defined in the Sustainable Salmon Fisheries Policy 5 AAC 39.222). These goals represent our best estimates of escapements that will produce *maximum sustainable yields*. *Sustainable escapement goals* are presented for several systems, for which detailed stock recruitment analyses have yet to be conducted. In this section, we provide a brief summary of how escapements in recent years have compared to goals for these systems (the goals are found in Table 1). A more detailed summary of the available information for each of these stocks is contained in Appendices 1 to 15.

Yakutat Stocks: Escapement goals exist for 4 stocks in the Yakutat area, including the Situk, Lost, Akwe, and the East Alsek River. The goal for the Italio River was rescinded. The goal for the East River was lowered based on a new analysis. One additional stock in the Yakutat area (Klukshu River) is a transboundary river stock, and this stock is discussed in the section on transboundary stocks. Escapements have been within or above the *biological escapement goal* range for all 4 Yakutat systems every year for which data is available, with the exception of 1 year on the Lost River. Escapement data are available for only 1 of the last 5 years on the Akwe River.

Transboundary River Stocks: Transboundary river stocks are managed jointly with Canada. Escapement goals exist for the Klukshu index tributary of the Alsek River, for the Taku River drainage as a whole, and for the Tahltan and Mainstem stocks in the Stikine River drainage. Klukshu escapements were within the goal range twice, above the goal range once, and below the goal range twice during the last 5 years. Escapements to the Taku River have been within or above the goal of 71,000 to 80,000 every year since 1984. Taku escapements were well above the goal range in 2001 and 2002, partially as a result of coordinated actions of Alaska and Canadian managers to allow adequate escapement of particular temporal segments of the run (Tatsamenie Lake). Escapements to Tahltan Lake were below the escapement goal range for each of the last 5 years. This is a major concern to Alaskan and Canadian managers who have developed coordinated management and assessment responses to improve escapements. The District 108 drift gillnet fishery was closed for the last 2 years during the period when Tahltan fish were available and Canada has reduced its inriver fisheries. As a result, exploitation rates were reduced significantly and the bottom end of the escapement goal was missed by only several hundred fish in 2002. Due to the close, coordinated management of this stock with Canada, and indications of very large smolt outmigrations during the last 2 years from Tahltan Lake, ADF&G has not recommended this stock be considered a candidate for *stock of concern* status. Escapements of Mainstem Stikine River sockeye were within goal or above in 7 of the last 10 years.

Southeast Alaska Stocks: Escapement goals have been established for 6 additional systems in Southeast Alaska, including 4 systems in northern Southeast Alaska (Chilkat and Chilkoot Lakes, Redoubt Lake, and Speel Lake), and 2 in southern Southeast Alaska (McDonald and Hugh Smith Lakes). Recently, the Redoubt Lake goal was established and existing goals for Speel and Hugh Smith Lakes were changed.

Management of sockeye salmon runs to Lynn Canal have presented a major challenge to ADF&G over the last decade. The Chilkoot Lake sockeye salmon run crashed in the mid 1990s after 2 decades of very large returns and large escapements, concurrent with a severe crash in zooplankton populations in the lake. ADF&G took extensive fishery management actions since 1995 to reduce exploitation rates on the Chilkoot sockeye salmon run. The escapement goal for the lake was achieved in 2001 and 2002, after escapements were below the escapement goal range for 6 of the previous 7 years. Zooplankton populations in the lake rebounded to high levels during the last several years and improved runs are expected in upcoming years. A consequence of the conservative management of the Lynn Canal gillnet fishery has been the inability to adequately harvest Chilkat Lake returns. Managers exceeded their goal annually for the last 5 years at Chilkat Lake. Complicating assessment of this run has been the change from weir counts to mark–recapture estimates as the method of estimating escapement.

An escapement goal was established for Redoubt Lake for the 2002 fishing season. Escapements have been within or above this new *biological escapement goal* range in 3 of the last 5 years.

A revised escapement goal was developed for Speel Lake. Estimated escapements have been within or exceeded the revised goal since 1995.

We have not updated the McDonald Lake escapement goal in the last several years, and the current goal of 65,000 to 85,000 has not been adequately documented. McDonald Lake escapements were above or within the present goal range 3 of the last 6 years.

A revised escapement goal was developed for Hugh Smith Lake. Although escapements have been increasing since 1998, they have been below the previous escapement goal range of 15,000 to 35,000 since 1993, and below the lower end of the new goal range of 8,000 to 18,000 each year since 1997. ADF&G has recommended the Hugh Smith Lake stock as a candidate *stock of concern*.

Stocks of Concern

The Hugh Smith Lake sockeye salmon stock is the only candidate *stock of concern* that we identified in Southeast Alaska or the Yakutat area. Escapement has been generally declining over the past 2 decades. There are many factors that may have influenced the current state of this stock. Although we have an imperfect measure of the harvest of this stock, it is apparent that harvest rates exerted on the stock have been high and have contributed to its decline. Direct management action to reduce the harvest of this stock is very difficult, as there is no large directed harvest on these fish. Rather, the fish are taken in low numbers as an incidental harvest in large and lucrative commercial fisheries, particularly in District 101. Efforts to enhance the system through a fry stocking program during the years 1986 through 1997 appear to have failed to add significant production, although the recent stockings of pre-smolts have been more successful in producing smolts. There are several aspects of the Hugh Smith Lake stock assessment program that may have negatively affected the run to some degree. In particular, coded wire tagging procedures followed in the 1980s during the early years of that program may have caused reduced survival of tagged smolts. More detailed information on the escapements and run timing of this stock can be found in Appendix 2.14, and a detailed report on development of the Hugh Smith escapement goal and stock status may be found in Geiger et al. (2003).

ESCAPEMENT GOALS

There are 14 escapement goals for sockeye stocks in Southeast Alaska and the Yakutat area (Table 1), not including the escapement goal for the Italio River, which was withdrawn. In most cases, these goals were established by a Ricker analysis. We consider 12 of these goals to be *biological escapement goals*. In the case of the Taku and Mainstem Stikine Rivers, systems with joint jurisdiction with Canada, the goals must be established by international agreement. The current goals for these 2 systems were established by professional judgment, and we consider them to be *sustainable escapement goals*.

Table 1. Escapement goals for sockeye salmon stocks or stock groups in Southeast Alaska and the Yakutat area.

System	Additional Material in Appendix	Escapement Goal	Year Established	If Recently Revised, Previous Goal
Situk River[a]	2.1	30,000–70,000	2003	30,000 –70,000
Lost River	2.2	1,000–2,300	1995	
Italio River	2.3	No goal at present	2003	2,500–7,000
Akwe River	2.4	600–1500	1995	
Klukshu River	2.5	7,500–15,000	2000	
East Alsek-Doame River	2.6	13,000–26,000	2003	26,000–57,000
Chilkoot Lake	2.7	50,500–91,500	1990	
Chilkat Lake	2.8	52,000–106,000	1990	
Redoubt Lake	2.9	10,000–25,000	2003	No previous goal
Taku River	2.10	71,000–80,000	1986	
Speel Lake	2.11	4,000 –13,000	2003	5,000
Tahltan Lake	2.12	18,000–30,000	1993	
Mainstem Stikine River	2.13	20,000–40,000	1987	
Hugh Smith	2.14	8,000–18,000	2003	15,000–35,000
McDonald Lake	2.15	65,000–85,000	1993	

[a] A new analysis in 2003 produced the same escapement goal.

Situk River

ADF&G managed the Situk-Ahrnklin Inlet and inriver fisheries to achieve an escapement goal of 45,000 to 55,000 sockeye salmon past the Situk River weir for several years prior to 1995. In 1995, ADF&G adopted an escapement goal of 30,000 to 70,000 sockeye salmon (weir count minus upstream sport harvest; Clark, McPherson and Burkholder 1995). At that time the authors recommended the goal be reviewed in 5 years. A new Situk River stock-recruit analysis was recently completed using data from the 1976 through 1997 brood years (Clark, McPherson, and Woods 2002). The authors recommended that the Situk River sockeye salmon *biological escapement goal* be maintained at 30,000 to 70,000 spawning sockeye salmon (Appendix 2.1).

Lost River

In 1995, ADF&G established a *biological escapement goal* for the Lost River of 1,000 to 2,300 peak survey counts, based on a stock-recruit analysis using data from the 1972 to 1983, 1986 and 1988 brood years (Clark, Burkholder, and Clark 1995; Appendix 2.2). The goal has not been updated since then.

Italio River

In 1995, ADF&G established a *biological escapement goal* for the Italio River of 2,500 to 7,000 peak survey counts, based on a stock-recruit analysis using data from brood years 1972 to 1981 (Clark, Burkholder and Clark 1995). Based on a new analysis just completed (Clark and Woods *in press*), this goal was withdrawn because the productivity of this system changed. Currently there is no goal for this system. ADF&G is waiting for productivity to stabilize before recommending a new escapement goal for the Italio River. (Appendix 2.3).

Akwe River

ADF&G adopted a *biological escapement goal* of 600 to 1,500 peak aerial survey counts for this system in 1995. The escapement goal has not been updated and remains in effect (Clark, Burkholder and Clark 1995; Appendix 2.4). ADF&G was unable to evaluate escapements in this system in recent years due to poor water visibility.

Klukshu River (in the Alsek River System)

The Klukshu River is a major sockeye salmon producing tributary of the transboundary Alsek River system. A *biological escapement goal* of 7,500 to 15,000 sockeye salmon spawning upstream of the Klukshu River weir was established in 2000, based on a stock-recruit analysis of data from the 1976 through 1992 brood years (Clark and Etherton 2000; Appendix 2.5). This goal was adopted later by the ADF&G, CDFO, and Transboundary Technical Committee. Expanded stock assessment work is being conducted to improve estimates of total escapement to the entire Alsek River drainage.

East Alsek-Doame Rivers

A *biological escapement goal* of 26,000 to 57,000 peak aerial survey counts was established for the East Alsek-Doame River in 1995 (Clark, Burkholder, and Clark 1995). The escapement goal was derived from stock-recruit data collected in the 1970s and 1980s, when spawning habitat was in excellent condition. The *biological escapement goal* was recently revised downward to 13,000 to 26,000 peak aerial survey counts as a result of deteriorated spawning habitat since about 1990 (Clark, Fleishchman, and Woods 2003; Appendix 2.6). The goal will be reexamined in 3 years.

Chilkoot Lake

An adult weir has been operated at the Chilkoot Lake outlet since 1976. The escapement goal range was established in 1990 on the basis of a stock-recruit analysis of catches and weir counts from the 1976 to 1984 brood years (McPherson 1990). An extremely low weir count in 1995 prompted ADF&G to check the weir counts with mark–recapture estimates. Mark–recapture estimates are considerably higher than the weir counts. The escapement goal has not been updated since the discrepancy in the weir counts was discovered, although it will be in the next several years. The overall *biological escapement goal* is 50,500 to 91,500 sockeye salmon. For early stocks, the escapement goal range is 16,500 to 31,500. For late run stocks, the escapement goal range is 34,000 to 60,000 (Appendix 2.7).

Chilkat Lake

Like the Chilkoot system, the escapement goal in this system was established in 1990 on the basis of a stock-recruit analysis of data from the 1976 to 1984 brood years (McPherson 1990). Like the Chilkoot system, recent mark–recapture studies have shown the weir counts in recent years to be biased low. The current goal appears to be sustaining the run and providing for yield, but we expect to update this escapement goal for the next Board of Fisheries cycle. The overall *biological escapement goal* is 52,000 to 106,000 sockeye salmon. For early-run stocks (age-1. fish), the escapement goal range is 14,000 to 28,000. For late-run stocks (age-2. fish), the escapement goal range is 52,000 to 78,000 (Appendix 2.8).

Redoubt Lake

A *biological escapement goal* of 10,000 to 25,000 spawners was recently established for Redoubt Lake based on stock-recruit analysis of data from the 1982 to 1996 brood years (Geiger 2003; Appendix 2.9).

Taku River

An escapement goal of 71,000 to 80,000 sockeye salmon into Canadian spawning areas of the transboundary Taku River was established by the Transboundary Technical Committee (TTC 1986) in 1985 (Appendix 2.10). The escapement goal was established based on professional judgment and the technical committee considers it an interim goal until a formal scientifically based goal is developed. ADF&G considers this goal to be a *sustainable escapement goal*.

Speel Lake

The Speel Lake sockeye salmon escapement has been monitored with a weir in all but 2 years since 1983. The stock has been managed for an escapement goal of 5,000 fish in recent years. A stock-recruit analysis of historic catch and escapement data for the stock was recently completed. The authors of the study concluded that the historic weir counts are problematic because the weir was removed too soon in most years (Riffe and Clark 2003). They used several methods to adjust weir counts for years when the weir was removed early. The authors concluded a wide escapement goal range was the best way to deal with the uncertainty in historical weir counts. The new *biological escapement goal* for Speel Lake is 4,000 to 13,000 spawners (Appendix 2.11).

Tahltan Lake Sockeye Salmon

Tahltan Lake is a major sockeye producing tributary of the transboundary Stikine River. The Transboundary Technical Committee of the Pacific Salmon Commission adopted the current escapement goal of 18,000 to 30,000 spawners for Tahltan Lake in 1993, based on a stock-recruit analysis conducted by CDFO staff (Humphreys et al. 1994). We consider this goal to be a *biological escapement goal*. It represents a mix of naturally spawning fish and a maximum of approximately 4,000 fish used for hatchery broodstock for stocking into Tahltan and Tuya Lakes. Further review of this goal is scheduled to occur in the near future within the Transboundary Technical Committee (Appendix 2.12).

Mainstem Stikine River

The escapement goal of 20,000 to 40,000 was established by the Transboundary Technical Committee in 1987, based on professional judgment “of the quantity and quality of available spawning and rearing habitat, observed patterns in the distribution and abundance of spawners, and historical patterns of the near terminal area gill net harvest" (TTC 1990). We consider the goal to be a *sustainable escapement goal* (Appendix 2.13).

Hugh Smith Sockeye Salmon

An escapement goal of 15,000 to 35,000 spawners was established for Hugh Smith Lake in the 1990s, largely based on professional judgment. A *biological escapement goal* range of 8,000 to 18,000 was recently adopted based on the analysis of Geiger et al. (2003; Appendix 2.14).

McDonald Lake Sockeye Salmon

The ADF&G monitors escapements in McDonald Lake by means of a calibrated series of foot surveys. The escapement goal for McDonald Lake was lowered in 1993 to the current range of 65,000 to 85,000 sockeye salmon. This goal is based on a Ricker analysis, which was not formally documented. The 1993 goal can be considered a *biological escapement goal*, although this goal will be updated prior to the next Board of Fisheries cycle (Appendix 2.15).

DISCUSSION

In their review of salmon stock status in Southeast Alaska, Baker et al. (1996) concluded that they had enough information to evaluate long-term escapement trends in 13% of the sockeye salmon spawning aggregations. They further concluded that escapement was increasing in 1 system, stable in 24 systems, and declining in 1 system (which they did not identify). They found no instances of what they called "precipitous declines." Halupka et al. (2000) identified 230 spawning aggregations of sockeye salmon in Southeast Alaska, and they evaluated trends in escapement for 103 stocks from 1962 to 1992. They identified 14 stocks with statistically significant increasing escapement trends, and 10 stocks with statistically significant decreasing trends.

Our emphasis was very different than that of Baker et al. or Halupka et al. We examined the stock-recruit history of the 15 systems listed in Table 1, which are the systems with sufficient information for high-quality comparisons through time. Rather than simply look at escapement trends, we compared escapements with the established escapement goals. For instance, McDonald Lake has a downward trend in escapement over the last 15 years, but that trend is partially caused by an intentional increase in harvest rate and an intentional lowering of the escapement goal to increase the sustainable yield. Baker et al. or Halupka et al. may have flagged that system as one of concern. Even though the McDonald Lake escapement was below the lower end of the escapement goal several years after 1993, on balance, we consider management as having largely succeeded in McDonald Lake. Although we have formal escapement goals for less than 10% of the region's sockeye systems, goals have been established for most of the major sockeye salmon-producing systems.

Escapements are monitored in many more sockeye salmon systems in the region than those with established escapement goals. In general, monitoring of the additional systems was recently implemented (such as the 12 systems described in Appendix 2.16), or the monitoring has been conducted on a more limited time scale or less intensive basis. Weirs are currently operated by various organizations at Kuthai, Little Trapper and Tatsamenie lakes (Taku River drainage), Auke Creek, Salmon Lake (Sitka), Redfish Lake, Neva Lake and Pavlof Lake. Mark–recapture estimates of escapement, were generated in recent years for the Chilkat River Mainstem spawning stock and at Ford Arm Lake. In 2002, a sonar to monitor sockeye salmon escapements into Crescent Lake was operated in a research mode; we hope to have that project moved into full operation in the coming years. Aerial and foot surveys are conducted on many other systems. Historically, weirs have been sporadically operated on many other systems in the region as well. These monitoring efforts play an important role in management of the sockeye salmon resource in Southeast Alaska. We have not formally analyzed the information those studies have provided, but we expect that these projects will result in escapement goals for additional systems in the near future. Efforts are also being made to improve estimates of subsistence harvests in various areas of the region.

We have identified 1 candidate as a *stock of concern*: The Hugh Smith Lake stock has been declining for at least 2 decades, and escapements have been below the management objective for this system for a decade. ADF&G is in the process of developing a complete review of this system, examining the stock assessment program, enhancement options, and a review of management measures that could reduce the harvest rate on this stock.

Overall, the biological underpinnings of the sockeye salmon fisheries in Southeast Alaska appear to be in favorable condition. Even though yields in the Yakutat area, especially in the Alsek River, have declined, yields are still at high levels. The overall yields from these stocks have been increasing, while escapements goals have generally been met. As previously mentioned, the last 2 decades have been a period of high marine survival for Alaskan and British Columbia salmon (Quinn and Marshall 1989; Beamish and Bouillon 1993; Adkison et al. 1996; Mantua et al. 1997; Beamish et al. 1998; and many others), but the fact that these harvests have been sustained is the most important part of the stock assessment picture. ADF&G will continue to develop and update escapement goals were possible. By the next Alaska Board of Fisheries meeting in Southeast Alaska we expect to have a broader examination of sockeye salmon in Southeast Alaska and the Yakutat area, and a larger number of escapement goals.

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APPENDICES

Appendix 2.1. Situk River Sockeye Salmon

System: Situk River
Species: Sockeye Salmon
Stock Unit: Situk River sockeye salmon

Management Jurisdiction: Alaska Department of Fish and Game

Area Office: Yakutat

Primary Fishery: Set gillnet commercial fishery

Secondary Fisheries: Sport, and set gillnet subsistence fishery

Escapement Goal Type: *Biological Escapement Goal*

Basis for Goal: Stock-recruit analysis using brood years 1976 to 1997

Documentation:

Clark, J. H., S. A. McPherson, and G. Woods. 2002. Biological escapement goal for sockeye salmon in the Situk River, Yakutat, Alaska. Alaska Department of Fish and Game, Division of Sport Fish, Special Publication 02-03. Anchorage.

Clark, J. H., S. A. McPherson, and A. Burkholder. 1995. Biological escapement goal for Situk River sockeye salmon. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report 1J95-22. Douglas.

Inriver Goal: None

Action Points: None

Escapement Goal: 30,000 to 70,000 fish

Escapement Measures: Weir counts minus upstream sport catch, 1976 to present

Stock-Recruit Analysis Summary

Model: Ricker[a]
Number of years in model: 22
Ratio of highest escapement to lowest escapement: 5.7
Parameter estimates: α-parameter[b] = 4.04 (adjusted), $1/\beta \approx 92{,}000$,
(β-parameter[c] =1.09 10^{-5})
Basis of range of escapement goal: Escapement level is 0.8 to 1.6 times the escapement that forecasts the *maximum sustainable catch*

[a] for *R* (run size) and *S* (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Summary

The Situk River is a Yakutat forelands stream located near the town of Yakutat, Alaska. It supports a major run of sockeye salmon as well as several other species of anadromous salmonids. Documented spawning locations for sockeye salmon returning to the Situk River system include tributaries and beaches of Situk and Mountain Lakes, the Situk River below Situk Lake, the Old Situk River, the West Fork of the Situk River, and Redfield Lake. Most of the spawning population of sockeye salmon is believed to return to the portion of the drainage located upstream of the outlet of Situk Lake.

Sockeye salmon returning to the Situk River support commercial set gillnet, sport, and subsistence/personal use fisheries. The major commercial set gillnet fishery (fishing District 182-70) takes place in the Situk-Ahrnklin Inlet where the Situk, Ahrnklin, and Lost Rivers all presently drain into the Gulf of Alaska. Commercial harvests of sockeye salmon in the Situk-Ahrnklin Inlet set gillnet fishery have been estimated using fish tickets since statehood. Sockeye salmon harvested in this fishery have been sampled for age, sex, and size composition annually since 1982. The sport fishery takes place in freshwater, predominantly in the Situk River below the Forest Highway 10 bridge that crosses the Situk River. Sport fishery harvests of sockeye salmon in the Situk River have been directly monitored since 1977 through a postal questionnaire. The subsistence/personal use fishery takes place both in the inlet and in the river itself. The harvest of sockeye salmon in the Situk River subsistence/personal use fishery has been directly monitored since 1985, based upon returned subsistence fishing permits that document harvests. Situk River origin sockeye salmon comprise a significant, and largely undocumented proportion of the mixed-stock Yakutat Bay commercial/subsistence harvest. A recent analysis assumed 50% of the annual catches of sockeye salmon in the Yakutat Bay fishery were Situk origin sockeye salmon.

In 1971 and in every year since 1976, the escapement of sockeye salmon into the Situk River system has been enumerated with the aid of a weir. Prior to 1988, the weir was located just downstream of Forest Highway 10; since 1988, the weir was installed just above the area of tidewater influence. The escapements of sockeye salmon into the Situk River have been sampled for age, sex, and size composition annually since 1982.

ADF&G managed the Situk-Ahrnklin Inlet and inriver fisheries to achieve an escapement goal of 45,000 to 55,000 sockeye salmon past the Situk River weir for several years prior to 1995. In 1995, ADF&G adopted 30,000 to 70,000 sockeye salmon counted past the Situk River weir as a management goal. A more recent analysis recommends that the Situk River sockeye salmon *biological escapement goal* be maintained at 30,000 to 70,000 spawning sockeye salmon (Clark, McPherson, and Woods 2002).

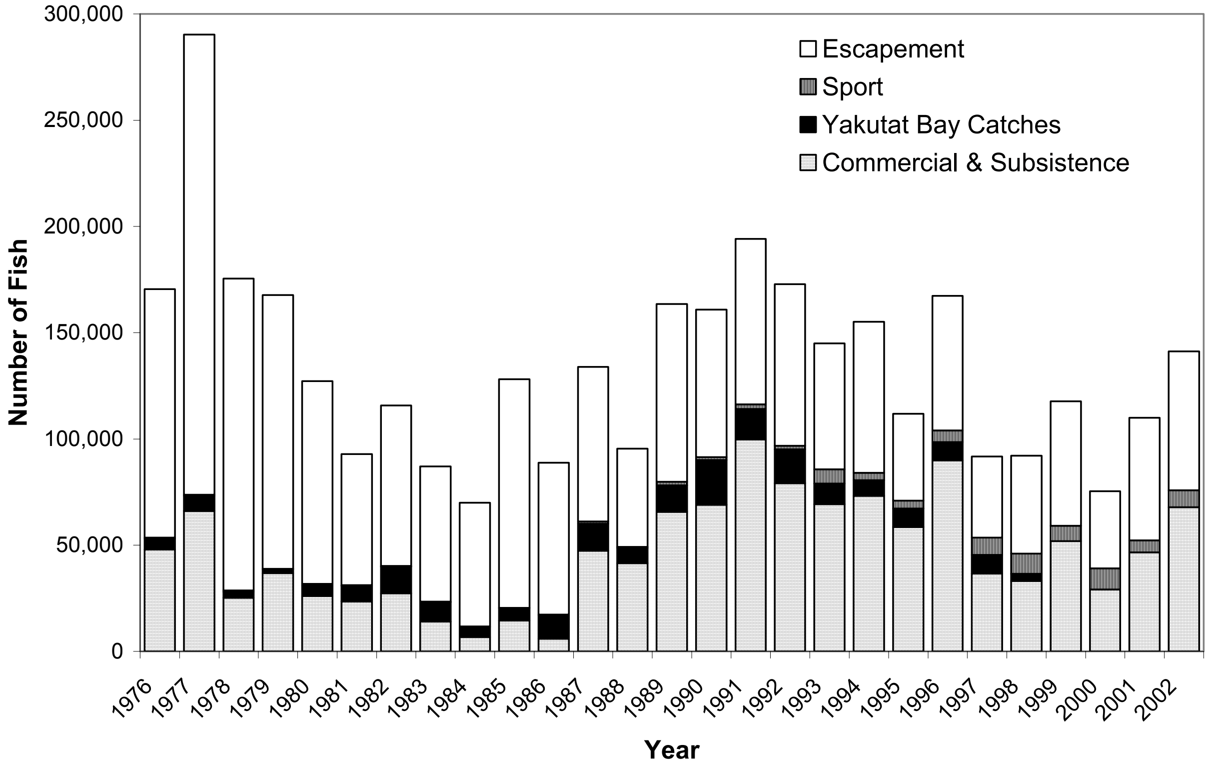
While the Situk River sockeye salmon stock is considered healthy and well managed, in order to achieve the desired annual *biological escapement goal*, improved information concerning stock composition of the mixed stock catches in the Situk-Ahrnklin Inlet fishery are needed. A research effort to provide such information is being planned for implementation in 2003.

Appendix 2.1.1. Estimated escapements, harvests, run sizes and exploitation rates for Situk River system sockeye salmon, from 1976 to 2002. Escapement estimates are weir counts minus upstream sport harvest estimates. Estimated commercial and subsistence harvests are terminal harvest estimates of Situk origin fish in the Situk-Ahrnklin lagoon. Estimated interception of Situk origin fish in the Yakutat Bay fishery are based on the assumption that 50% of the Yakutat Bay catch are fish of Situk origin.

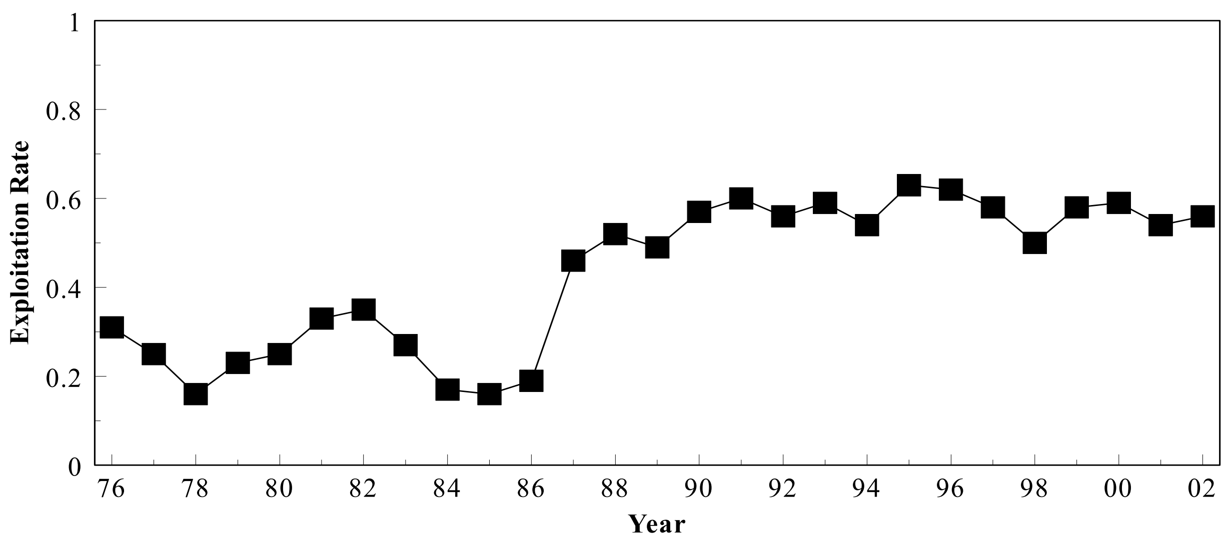
Year	Estimated Escapements	Estimated Sport Harvests	Estimated Commercial & Subsistence Harvests in Situk-Ahrnklin Lagoon	Estimated Yakutat Bay Interceptions of Situk Origin Fish	Estimated Total Harvests	Estimated Total Runs	Estimated Exploitation Rates
1976	116,989	466	47,954	5,111	53,530	170,519	31%
1977	216,631	497	66,014	7,201	73,712	290,343	25%
1978	146,884	578	25,264	2,800	28,641	175,525	16%
1979	128,879	145	36,874	1,854	38,873	167,752	23%
1980	95,424	818	26,122	4,827	31,767	127,191	25%
1981	61,774	292	23,516	7,306	31,113	92,887	33%
1982	75,501	419	27,329	12,495	40,243	115,744	35%
1983	63,645	274	14,064	9,047	23,384	87,029	27%
1984	58,188	346	6,712	4,707	11,765	69,953	17%
1985	107,586	61	14,506	5,933	20,500	128,086	16%
1986	71,543	306	5,936	11,078	17,320	88,863	19%
1987	72,720	1,105	47,350	12,769	61,224	133,944	46%
1988	46,160	582	41,472	7,205	49,259	95,418	52%
1989	83,676	1,683	65,757	12,448	79,887	163,563	49%
1990	69,372	1,403	69,008	21,023	91,434	160,805	57%
1991	77,922	2,134	99,781	14,321	116,235	194,157	60%
1992	76,015	1,709	79,152	15,925	96,786	172,801	56%
1993	59,282	6,727	69,310	9,671	85,708	144,989	59%
1994	70,984	3,548	73,218	7,363	84,129	155,113	54%
1995	40,911	3,696	58,481	8,767	70,944	111,855	63%
1996	63,285	5,475	89,974	8,571	104,020	167,305	62%
1997	38,182	8,121	36,591	8,845	53,557	91,739	58%
1998	46,078	9,448	33,162	3,399	46,009	92,087	50%
1999	58,632	7,199	51,906	20,909	80,014	138,646	58%
2000	36,322	9,853	29,222	12,556	51,631	87,953	59%
2001	57,692	5,677	46,590	15,591	67,858	125,550	54%
2002	65,383	8,000	67,861	9,025	84,886	150,269	56%

Appendix 2.1.2. Estimated total returns (recruits) of Situk River sockeye salmon, brood years 1976 to 2002.

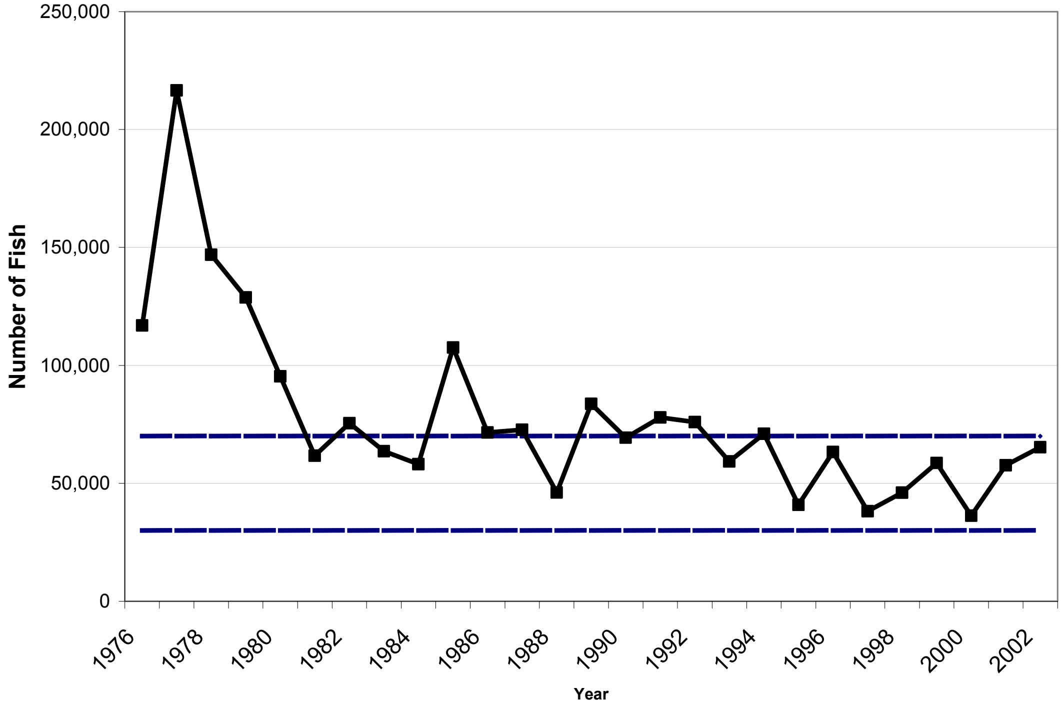
Brood Year	Estimated Total Escapement	Age-2 Returns (recruits)	Age-3 Returns (recruits)	Age-4 Returns (recruits)	Age-5 Returns (recruits)	Age-6 Returns (recruits)	Age-7 Returns (recruits)	Estimated Total Returns	Return Per Spawner
1976	116,989	0	2,047	36,542	51,880	37,306	0	127,775	1.09
1977	216,631	0	1,552	26,687	64,196	8,261	163	100,859	0.47
1978	146,884	0	1,133	14,030	60,676	8,486	1,026	85,351	0.58
1979	128,879	0	0	16,463	37,968	19,488	0	73,920	0.57
1980	95,424	0	1,513	23,227	66,158	16,093	142	107,133	1.12
1981	61,774	116	109	41,285	59,912	21,659	893	123,974	2.01
1982	75,501	0	128	12,857	104,875	31,806	985	150,652	2.00
1983	63,645	0	0	7,267	40,957	19,509	0	67,734	1.06
1984	58,188	0	0	20,200	59,710	13,611	213	93,734	1.61
1985	107,586	0	1,562	78,037	83,531	7,025	0	170,156	1.58
1986	71,543	0	5,321	62,895	149,237	25,473	603	243,529	3.40
1987	72,720	0	768	37,469	130,346	26,225	365	195,173	2.68
1988	46,160	0	213	16,684	77,669	33,726	0	128,292	2.78
1989	83,676	0	298	39,287	86,079	14,429	0	140,093	1.67
1990	69,372	0	1,206	34,091	40,827	8,365	0	84,489	1.22
1991	77,922	0	852	55,480	127,821	12,935	0	197,088	2.53
1992	76,015	0	1,119	27,103	35,228	10,130	0	73,579	0.97
1993	59,282	0	4,015	39,540	27,074	6,378	0	77,006	1.30
1994	70,984	0	3,853	50,924	85,128	16,975	251	157,132	2.21
1995	40,911	183	3,960	44,644	50,221	5,273	0	104,281	2.55
1996	63,285	0	2,496	19,526	80,101	11,452	228	113,801	1.80
1997	38,182	0	1,231	39,674	60,610	16,564	237	118,316	3.10



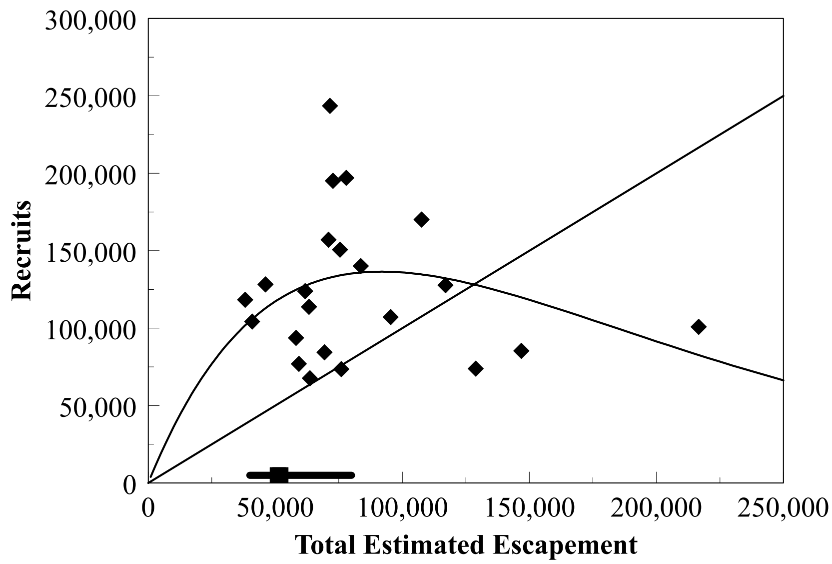
Appendix 2.1.3. Estimated total annual runs of Situk River sockeye salmon, from 1976 to 2002.



Appendix 2.1.4. Estimated exploitation rates for Situk River sockeye salmon, from 1976 to 2002.



Appendix 2.1.5. Estimated total escapements of Situk River sockeye salmon, from 1976 to 2002. The region between the 2 horizontal lines, 30,000 to 70,000 total spawners, represents the *biological escapement goal* range adopted by ADF&G.



Appendix 2.1.6. Estimated stock-recruit relationship for Situk River sockeye salmon, brood years 1976 to 1997. The curve represents production predicted with Ricker's model; solid diamonds are brood year data points. The square just above the *x*-axis represents the point estimate of maximum-sustained-yield escapement (50,000). The *biological escapement goal* range of 30,000 to 70,000 is shown just above the *x*-axis. The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to *x* axis).

Appendix 2.2. Lost River Sockeye Salmon.

System: Lost River
Species: Sockeye Salmon
Stock Unit: Lost River sockeye salmon

Management Jurisdiction: Alaska Department of Fish and Game

Area Office: Yakutat

Primary Fishery: Set gillnet commercial fishery

Secondary Fisheries: Sport, and subsistence fisheries

Escapement Goal Type: *Biological Escapement Goal*

Basis for Goal: Stock-recruit analysis using brood years 1972 to 1983, 1986, and 1988

Documentation: Clark, J. H., A. Burkholder, and J. E. Clark. 1995. Biological escapement goals for 5 sockeye salmon stocks returning to streams in the Yakutat area of Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report Number 1J95-16. Douglas.

Inriver Goal: None

Action Points: None

Escapement Goal: 1,000 to 2,300 peak counts

Escapement Measures: Foot and boat surveys from 1972 to present

Stock-Recruit Analysis Summary

Model: Ricker[a]
Number of years in model: 14
Ratio of highest escapement to lowest escapement: 5.0
Parameter estimates: α-parameter[b] = 6.34 (adjusted), $1/\beta \approx 3{,}600$ (β-parameter[c] = 0.000279)
Basis of range of escapement goal: Expected yield is at least 90% of *maximum sustainable catch*

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Summary

The Lost River is a small stream located on the Yakutat Forelands near Yakutat, Alaska. Sockeye salmon and other anadromous salmon spawn in the Lost River system. Tributaries of the Lost River supporting sockeye populations include Ophir Creek, Tawah Creek, and Coast Guard Lake. The Lost River drained into its own lagoon before entering the Gulf of Alaska prior to the winter of 1999 to 2000. In that year, the Lost River changed channel and migrated into the Situk-Ahrnklin Lagoon.

A commercial set gillnet fishery took place in the Lost River lagoon prior to the year 2000. From 1972 to 1999, harvests of sockeye salmon in that fishery ranged from about 500 fish in 1986 to almost 7,000 fish in 1977, averaging about 2,800 fish over that 27-year period.

The Situk-Ahrnklin lagoon fishery targets Situk and Ahrnklin origin sockeye salmon. Although there are no scientifically based catch allocation methods in place for that fishery, it is assumed that some Lost River origin sockeye salmon were harvested in that fishery in the years 2000 to 2002. The 5-year average (1994 to 1999) harvest of Lost River sockeye salmon in the Lost River lagoon was about 1,500, and this figure was used as a surrogate estimate of the harvest of this stock in the Situk-Ahrnklin fishery in the years 2000 to 2002.

A subsistence fishery for Lost River origin sockeye salmon also takes place. Harvests in that fishery have been monitored through a permit system since 1989. Harvests from 1989 to 2001 ranged from 0 in the years 1988, 1989, 1994 to 1998, 2000, and 2001 to 38 fish harvested in 1991. It is assumed that subsistence harvests from 1972 to 1988 were negligible. The 2002 annual subsistence fishery harvest estimate is not yet available; however, that harvest is also assumed negligible.

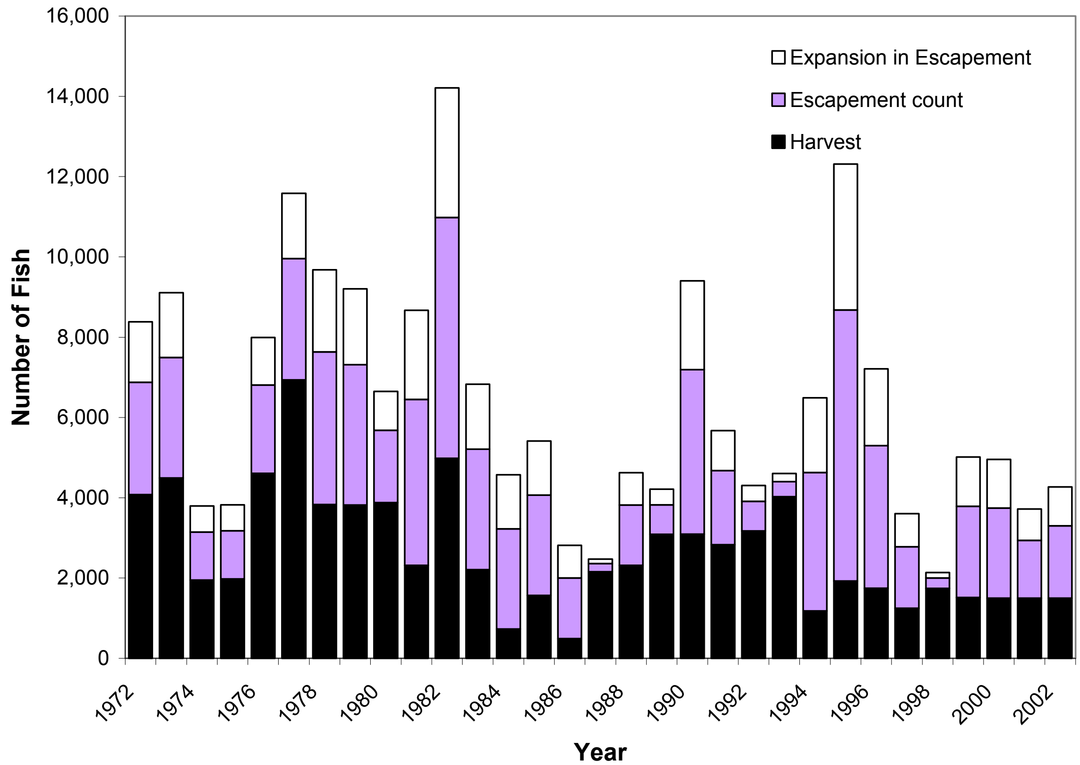
Total exploitation of Lost River origin sockeye salmon since 1972 is estimated to have ranged from 16% in 1995, to 60% in 1977, averaging about 40% in the 24 years for which estimates have been developed. A *biological escapement goal* was defined and adopted by ADF&G in 1995 as 1,000 to 2,300 sockeye salmon counted during a peak survey of the Lost River system. Since 1972, in years when survey counts were deemed adequate by ADF&G, all annual escapements have exceeded the lower end of the escapement goal range.

ADF&G staff count spawning or migrating sockeye salmon in the Lost River system during foot or boat based escapement surveys. The annual peak survey count is used as an index of the annual escapement strength. Successfully implemented peak annual counts of sockeye salmon in the Lost River system are assumed to represent 65% of the total annual escapements. This assumption is based entirely on professional opinion; a scientifically based total estimate of the escapement of sockeye salmon in the Lost River system has never taken place. However, plans are underway to scientifically estimate total escapement of Lost River sockeye salmon in 2003. Surveys were not successfully completed in the years 1984 and 1985. In brood table development, an average value of 2,500 was used as a surrogate value for these 2 years. Additionally, escapement surveys in the years 1987, 1989, 1992, 1993, and 1998 are not considered adequately reflective of spawner abundance.

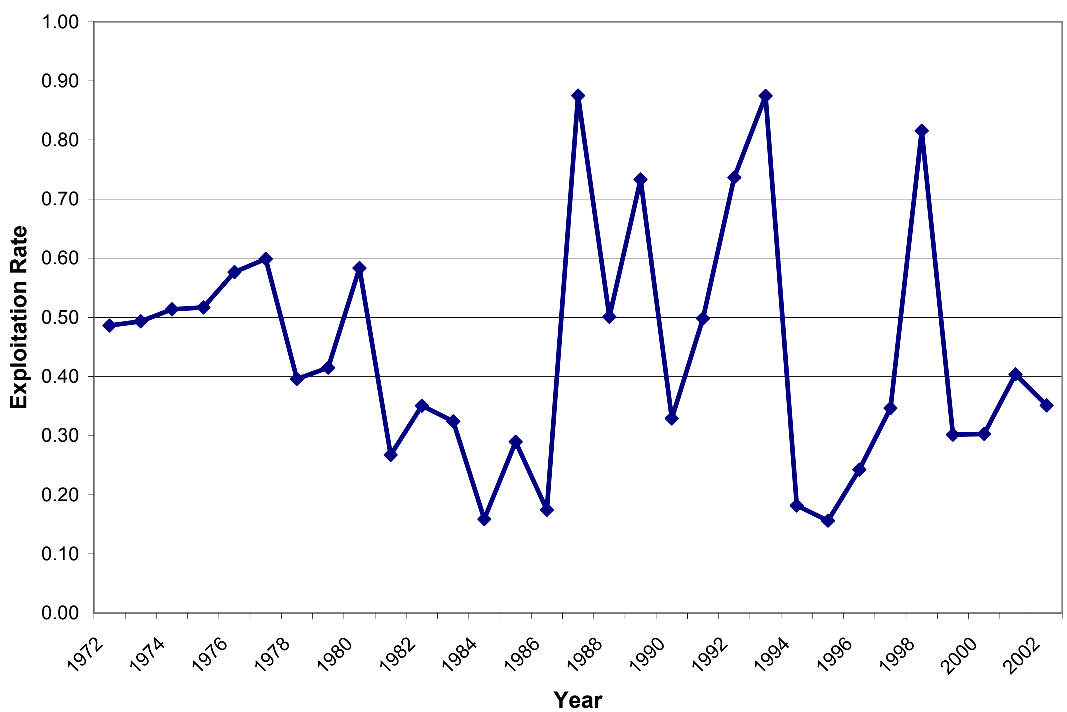
Improvements in the annual stock assessments for Lost River sockeye salmon are planned and are primarily intended to provide direct estimates of total escapement. A second challenge, however, is management of the Situk-Ahrnklin fishery such that adequate escapements of Lost River origin fish, Situk origin fish, and Ahrnklin origin fish all occur on an annual basis.

Appendix 2.2.1. Estimated escapements, harvests, run sizes, and exploitation rates for Lost River system sockeye salmon, from 1972 to 2002. Peak spawner counts are aerial, foot, and boat surveys of the Lost River, Tawah Creek, Ophir Creek, and Coast Guard Lake. Peak spawner counts are assumed to represent 65% of the total escapement based only upon professional judgment. Surveys were not successfully completed in 1984 and 1985; the long-term average value of 2,500 was used as a surrogate value for these years. Surveys in 1987, 1989, 1992, 1993, and 1998 are not considered indicative of total abundance and are considered under-estimated. Commercial harvests from 1999 to 2002 are assumed interceptions of Lost River origin fish in the Situk fishery since the Lost River changed channels. Subsistence catches were directly monitored from 1989 to 2002. Subsistence catches were assumed to be zero from 1972 to 1988. Subsistence harvest estimate for 2002 was not available, this harvest is assumed to be zero.

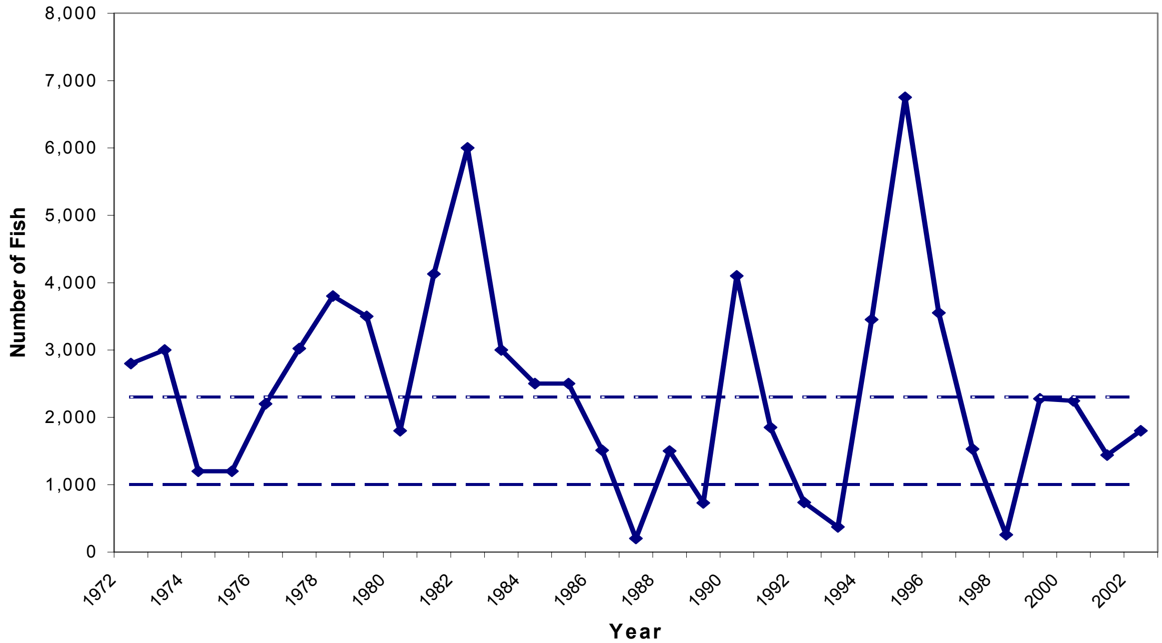
Year	Peak Spawner Count	Assumed Expansion	Estimated Total Escapement	Commercial Set Gillnet Harvest	Subsistence Harvest	Total Harvests	Estimated Total Runs	Estimated Exploitation Rates
1972	2,800	0.65	4,308	4,076	*0*	4,076	8,384	49%
1973	3,000	0.65	4,615	4,495	*0*	4,495	9,110	49%
1974	1,200	0.65	1,846	1,948	*0*	1,948	3,794	51%
1975	1,200	0.65	1,846	1,976	*0*	1,976	3,822	52%
1976	2,200	0.65	3,385	4,607	*0*	4,607	7,992	58%
1977	3,022	0.65	4,649	6,936	*0*	6,936	11,585	60%
1978	3,800	0.65	5,846	3,831	*0*	3,831	9,677	40%
1979	3,500	0.65	5,385	3,818	*0*	3,818	9,203	41%
1980	1,800	0.65	2,769	3,880	*0*	3,880	6,649	58%
1981	4,130	0.65	6,354	2,316	*0*	2,316	8,670	27%
1982	6,000	0.65	9,231	4,980	*0*	4,980	14,211	35%
1983	3,000	0.65	4,615	2,212	*0*	2,212	6,827	32%
1984	*2,500*	0.65	3,846	726	*0*	726	-	-
1985	*2,500*	0.65	3,846	1,566	*0*	1,566	-	-
1986	1,510	0.65	2,323	491	*0*	491	2,814	17%
1987	*200*	0.65	308	2,160	*0*	2,160	-	-
1988	1,500	0.65	2,308	2,316	*0*	2,316	4,624	50%
1989	*730*	0.65	1,123	3,091	0	3,091	-	-
1990	4,100	0.65	6,308	3,093	0	3,093	9,401	33%
1991	1,850	0.65	2,846	2,789	38	2,827	5,673	50%
1992	*737*	0.65	1,134	3,170	1	3,171	-	-
1993	*375*	0.65	577	3,999	25	4,024	-	-
1994	3,452	0.65	5,311	1,178	0	1,178	6,489	18%
1995	6,752	0.65	10,388	1,924	0	1,924	12,312	16%
1996	3,551	0.65	5,463	1,749	0	1,749	7,212	24%
1997	1,530	0.65	2,354	1,248	0	1,248	3,602	35%
1998	*256*	0.65	394	1,744	0	1,744	-	-
1999	2,276	0.65	3,502	*1,500*	12	1,512	5,014	30%
2000	2,245	0.65	3,454	*1,500*	0	1,500	4,954	30%
2001	1,440	0.65	2,215	*1,500*	0	1,500	3,715	40%
2002	1,800	0.65	2,769	*1,500*	*0*	1,500	4,269	35%



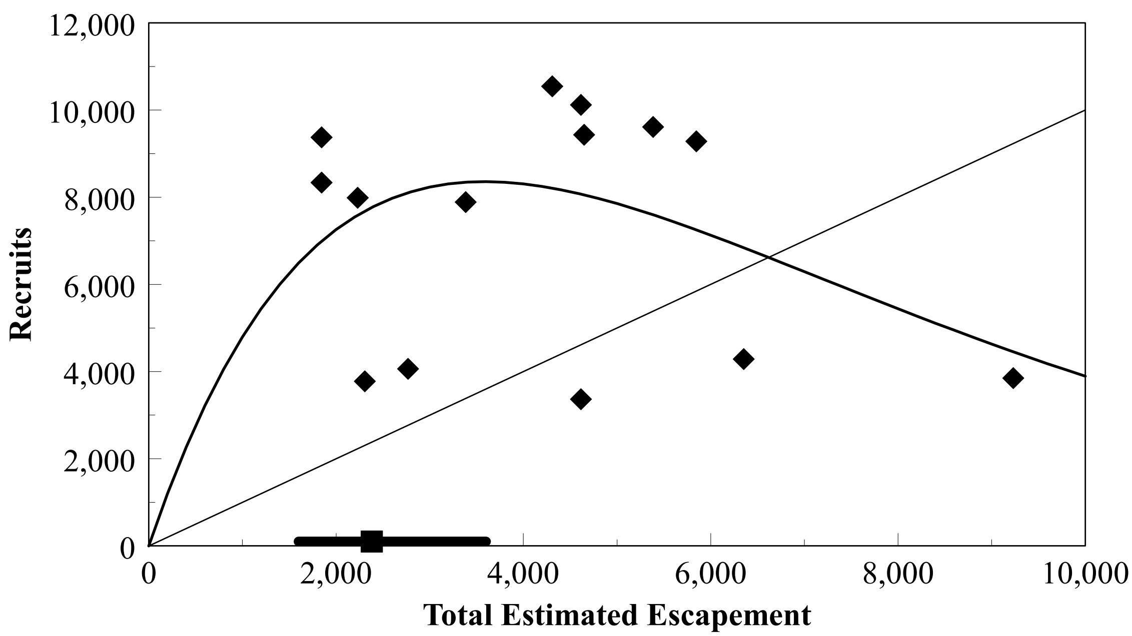
Appendix 2.2.2. Estimated total runs of Lost River sockeye salmon, from 1972 to 2002. The peak escapement count is assumed to be 65% of total escapement. Adequate peak escapement surveys were not completed in 1984, 1985, 1987, 1989, 1992, 1993, and 1998. Harvests from 2000 to 2002 are assumed to be 1,500 fish per year, from the Situk-Ahrnklin Lagoon.



Appendix 2.2.3. Estimated exploitation rate of Lost River sockeye salmon, from 1972 to 2002.



Appendix 2.2.4. Peak escapements of Lost River sockeye salmon, from 1972 to 2002. The dotted lines denote lower (1,000 peak counts) and upper (2,300 peak counts) bounds of the peak escapement counts, and represents the *biological escapement goal* range adopted in 1995 by ADF&G.



Appendix 2.2.5. Estimated stock-recruit relationship for Lost River sockeye salmon, estimated with brood years 1972 to 1983, 1986, and 1988. The curve represents production predicted with Ricker's model; solid diamonds are brood year 1972 to 1983, 1986, and 1988 data points. The square above the *x*-axis represents the point estimate of maximum-sustained-yield escapement (2,382 total spawners or 1,548 measured as a peak survey). The *biological escapement goal* range is shown just above the *x*-axis (1,538 to 3,538 total spawners or 1,000 to 2,300 measured as a peak survey). The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to *x* axis).

Appendix 2.3. Italio River Sockeye Salmon Stock

System: Italio River
Species: Sockeye Salmon
Stock Unit: Italio River sockeye salmon

Management Jurisdictions: Alaska Department of Fish and Game

Area Office: Yakutat

Primary Fishery: Set gillnet commercial fishery

Secondary Fishery: Subsistence and sport

Escapement Goal Type: There is currently no goal for this system. A *Biological Escapement Goal* was rescinded in late 2002

Basis for Goal: Stock-recruit analysis, using brood years 1972 to 1981

Documentation:

Clark, J. H., A. Burkholder, and J. E. Clark. 1995. Biological escapement goals for 5 sockeye salmon stocks returning to streams in the Yakutat area of Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report Number 1J95-16.

Clark, J. H. and G. Woods. *In press*. Run reconstructions for the years 1972 to 2001 and recommendation concerning revision of the escapement goal for the sockeye salmon stock returning to the Italio River system of Yakutat, Alaska. Special Publication. Sport Fish Division, Anchorage.

Inriver Goal: None

Action Points: None

Escapement Goal: None. Prior goal of 2,500 to 7,000 peak counts was rescinded

Escapement Measures: Aerial surveys: 1972 to present

Stock-Recruit Analysis Summary (goal now rescinded)

Model: Ricker[a]
Number of years in model: 10
Ratio of highest escapement to lowest escapement: 5.4
Parameter estimates: α-parameter[b] = 5.2 (adjusted), $1/\beta \approx 14{,}300$, β-parameter[c] = $(6.984 \cdot 10^{-5})$
Basis of range of escapement goal: Expected yield at least 90% of *maximum sustainable catch*

[a] for *R* (run size) and *S* (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Summary

The Italio River is a clear water stream located southeast of Yakutat. Prior to 1986, the Italio River entered a brackish water lagoon that paralleled the beach for a few miles, and subsequently entered the ocean. Since 1986, both the Akwe and Italio Rivers have shared the Akwe lagoon.

Sockeye salmon are believed to spawn in Italio Lake, in small tributaries to the lake, and in the Italio River itself and its other tributaries. A falls located about one-half mile below the lake has historically interfered with upstream salmon migration, and may be partially responsible for a continued decline in stock productivity. In December of 1986, the Italio River changed course and broke into the Akwe River lagoon.

In the years prior to 1987, commercial and subsistence fishers set gillnets in the Italio lagoon and presumably harvested predominantly Italio sockeye salmon. Before the fishing season in 1987, ADF&G redefined set gillnet fishing boundaries in response to the Italio River changing course during the prior winter. The lower boundary of the Italio fishing area was moved upstream above the confluence of the 2 rivers. Management intent was to continue to allow fishing, while minimizing interception of non-target stocks. Due to the limited geographic area available, the boundary change has resulted in a fishing area that is small and difficult to fish. Only minor levels of commercial and subsistence fishing effort have been exerted in this area since 1987.

Peak annual harvests of Italio sockeye salmon were as high as 7,500 fish in 1984 and averaged about 1,800 fish from 1972 to 1986. Since 1987, peak annual harvest was 900 fish in 1987, and mean annual harvest has been about 70 fish from 1987 to 2001. Thus, the average harvest since 1987 is only about 4% of the mean harvest between 1972 and 1986. A minor sport fishery in 1993, 1998, 2000, and 2001 harvested 35, 107, 80, and 183 sockeye salmon, respectively.

The stock assessment program for the Italio River system sockeye salmon population consists of flying aerial surveys of the Italio River to count spawners, as well as collecting and tabulating fish tickets and subsistence catch reports. The sport fishery is monitored through a postal questionnaire. Sampling of the commercial catch and the escapement for age, sex, and length information has been limited. The intent of the active management for the commercial fishery is to conduct periodic aerial surveys of spawning escapements and set variable weekly openings of the commercial fishery. The management objective has been to achieve a peak escapement count of 2,500 to 7,000 sockeye salmon in the Italio River system on an annual basis. ADF&G adopted the *biological escapement goal* in 1995 based on stock-recruit analysis of the 1972 to 1989 brood years (Clark, Burkholder, and Clark 1995).

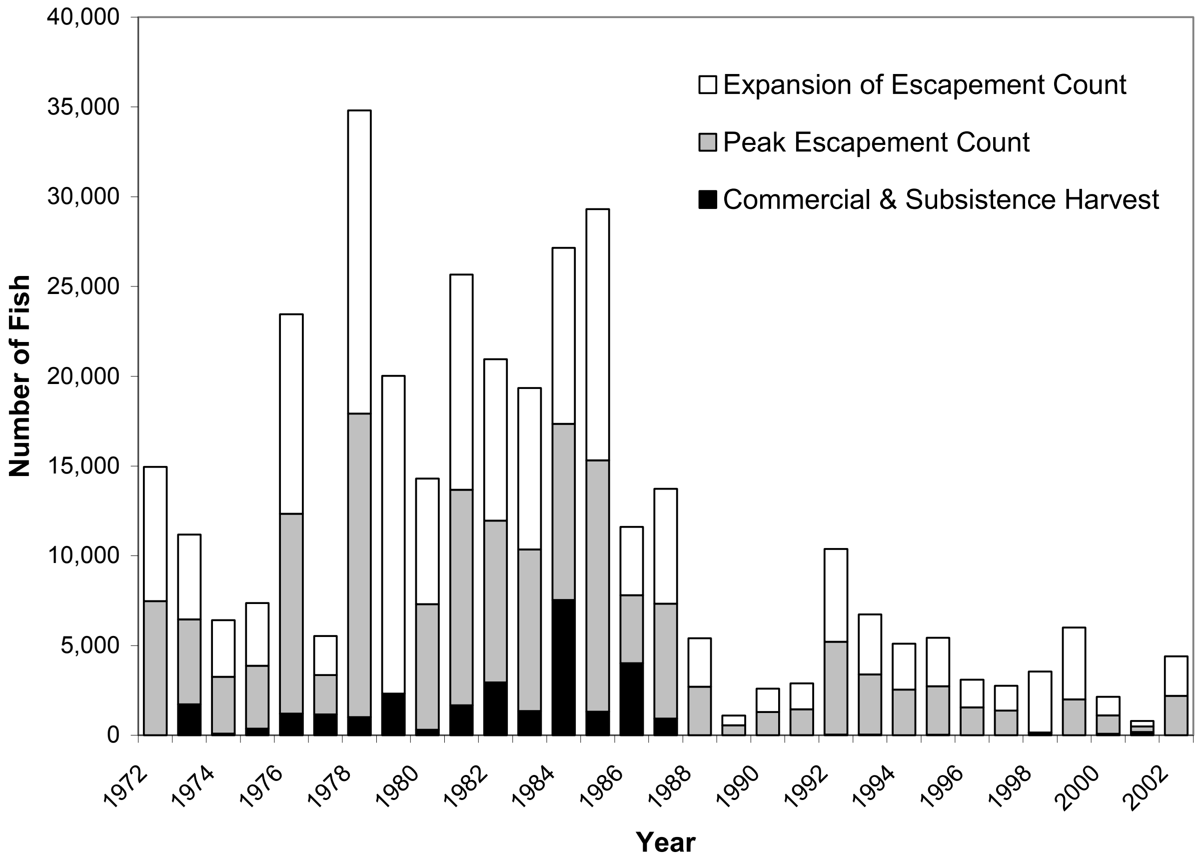
A recent analysis demonstrated that productivity of the stock markedly decreased after the Italio River changed channels, indicating that the escapement objective of 2,500 to 7,000 is no longer germane. Further, productivity has continued to decline since 1986, indicating that use of the recent data to develop a revised escapement goal was not prudent. ADF&G rescinded the *biological escapement goal* of 2,500 to 7,000 and will not define a replacement escapement goal until stock productivity stabilizes. Only insignificant fishing effort has been applied to the stock since 1987 and ADF&G plans to continue this pattern until stock productivity stabilizes. Meanwhile, very significant information gaps pertaining to this stock exist and ADF&G plans to implement an improved stock assessment effort to address the major data gaps.

Appendix 2.3.1. Peak escapement counts, peak escapement counts adjusted for timing, total spawning escapement estimates, harvests, run sizes, and exploitation rates for Italio River system sockeye salmon, from 1972 to 2002. Total escapement estimates were calculated by adjusting peak counts by average timing and then multiplying those adjusted counts by a factor of 2. Estimates of 1979 and 1998 escapements were calculated by mean escapement estimates (1972 to 1986), and 1997 and 1999, respectively. The subsistence harvest estimate for 2002 was not available, but is assumed to be zero. Sport fishery catches in 1993, 1998, 2000, and 2001 are included in total harvest.

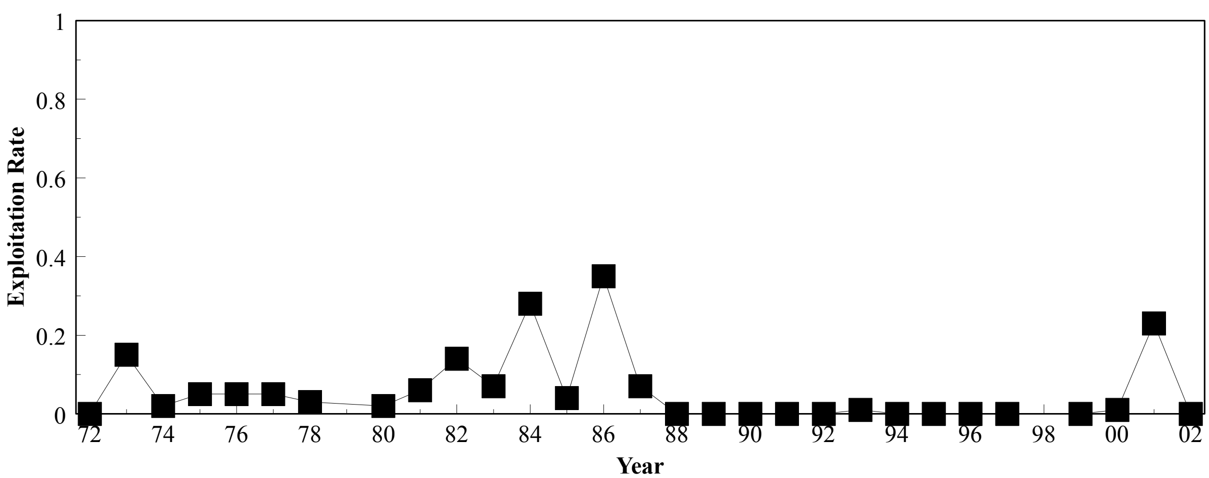
Year	Peak Count	Adjusted Peak Count	Estimated Total Escapement	Comm. Set Gillnet Harvest	Subsistence Harvest	Total Harvest	Estimated Total Run	Estimated Exploitation Rate
1972	7,000	7,473	14,946	0		0	14,946	0%
1973	4,200	4,732	9,463	1,723		1,723	11,186	15%
1974	2,800	3,154	6,309	99		99	6,408	2%
1975	3,500	3,500	7,000	365		365	7,365	5%
1976	8,000	11,125	22,250	1,206		1,206	23,456	5%
1977	7,800	2,179	24,358	1,167		1,167	25,525	5%
1978	15,000	16,899	33,797	1,012		1,012	34,809	3%
1979	*None*		*17,700*	2,315		2,315	20,015	
1980	7,000	7,000	14,000	302		302	14,302	2%
1981	12,000	12,000	24,000	1,668		1,668	25,668	6%
1982	9,000	9,000	18,000	2,945		2,945	20,945	14%
1983	9,000	9,000	18,000	1,349		1,349	19,349	7%
1984	8,150	9,802	19,604	7,543		7,543	27,147	28%
1985	14,000	14,000	28,000	1,314		1,314	29,314	4%
1986	3,800	3,800	7,600	4,010		4,010	11,610	35%
1987	6,400	6,400	12,800	932		932	13,732	7%
1988	2,700	2,700	5,400	5		5	5,405	0%
1989	550	550	1,100	0	0	0	1,100	0%
1990	1,300	1,300	2,600	0	0	0	2,600	0%
1991	950	1,442	2,884	0	0	0	2,884	0%
1992	4,500	5,169	10,338	0	40	40	10,378	0%
1993	3,350	3,350	6,700	1	0	36	6,736	1%
1994	2,550	2,550	5,100	0	0	0	5,100	0%
1995	2,700	2,700	5,400	24	2	26	5,426	0%
1996	1,350	1,551	3,101	0	0	0	3,101	0%
1997	1,200	1,378	2,757	0	0	0	2,757	0%
1998	*None*		*3,400*	0	50	157	3,557	
1999	2,000	2,000	4,000	0	0	0	4,000	0%
2000	400	1,030	2,061	0	0	80	2,141	1%
2001	200	304	607	0	2	185	792	23%
2002	2,200	2,200	4,400	0	*0*	0	4,400	0%

Appendix 2.3.2. Estimated total returns (recruits) of Italio River system sockeye salmon, brood years 1972 to 2002. Only limited directed age sampling of the escapements and the harvests of this stock have occurred (only 4 of the 31 annual escapements and 6 of the 21 annual non-zero harvests were directly sampled for age composition). The limited age sampling indicates that about half of the returns are age-4 and about half are age-5 with only small proportions being other ages; hence, the assumption of 50% age-4 and 50% age-5 was used.

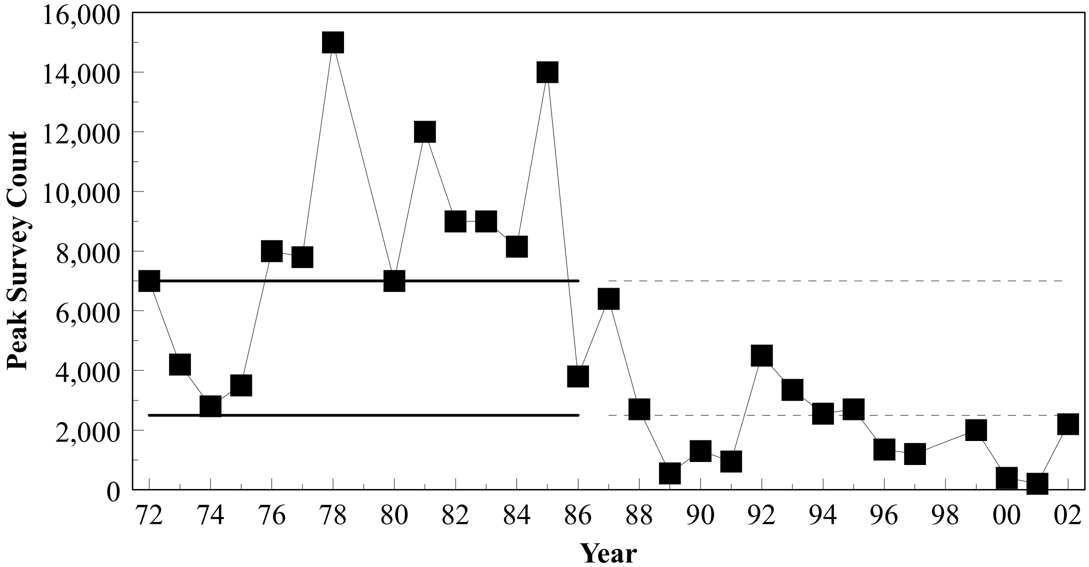
Brood Year	Parent Escapement	Age 4 Return	Age 5 Return	Estimated Total Return	EstimatedReturn Per Spawner
1972	14,946	11,728	12,762	24,490	1.64
1973	9,463	12,762	17,405	30,167	3.19
1974	6,309	17,405	10,008	27,412	4.35
1975	7,000	10,008	7,151	17,159	2.45
1976	22,250	7,151	12,834	19,985	0.90
1977	24,358	12,834	10,473	23,307	0.96
1978	33,797	10,473	9,675	20,147	0.60
1979	*17,700*	9,675	13,574	23,248	
1980	14,000	13,574	14,657	28,231	2.02
1981	24,000	14,657	5,805	20,462	0.85
1982	18,000	5,805	6,866	12,671	0.70
1983	18,000	6,866	2,703	9,569	0.53
1984	19,604	2,703	550	3,253	0.17
1985	28,000	550	1,300	1,850	0.07
1986	7,600	1,300	1,442	2,742	0.36
1987	12,800	1,442	5,189	6,631	0.52
1988	5,400	5,189	3,351	8,539	1.58
1989	1,100	3,351	2,550	5,901	5.36
1990	2,600	2,550	2,713	5,263	2.02
1991	2,884	2,713	1,551	4,264	1.48
1992	10,338	1,551	1,378	2,929	0.28
1993	6,700	1,378	1,725	3,103	0.46
1994	5,100	1,725	2,000	3,725	0.73
1995	5,400	2,000	1,030	3,030	0.56
1996	3,101	1,030	305	1,335	0.43
1997	2,757	305	2,200	2,505	0.91
1998	*3,400*	2,200		*incomplete*	
1999	4,000			*incomplete*	
2000	2,061			*incomplete*	
2001	607			*incomplete*	
2002	4,400			*incomplete*	



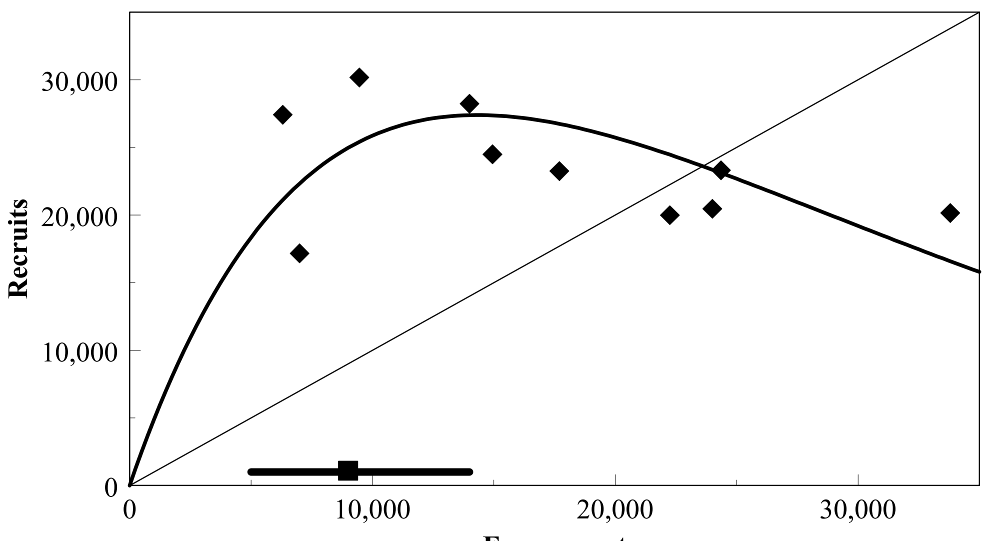
Appendix 2.3.3. Estimated annual runs of Italio River sockeye salmon, from 1972 to 2002.



Appendix 2.3.4. Estimated exploitation rates for Italio River sockeye salmon, from 1972 to 2002.



Appendix 2.3.5. Peak survey counts of sockeye salmon escapements in the Italio River, from 1972 to 2002. The region between the 2 horizontal lines, peak survey counts of 2,500 to 7,000, represents the *biological escapement goal* range adopted in 1995. This *biological escapement goal* range was rescinded in 2002 and is only appropriate for the stock before productivity changed. Productivity declined after 1985. The decline is likely due to disruption to the homing ability of sockeye salmon because of the channel change and likely also due to declining upstream passage success through the partial velocity barrier located below Italio Lake.



Appendix 2.3.6. Estimated stock-recruit relationship for Italio River system sockeye salmon, based on brood years 1972 to 1981. The curve represents production predicted with Ricker's model; the diamonds are brood year 1972 to 1981 data points. The square (and line) just above the *x*-axis represents the point estimate of maximum-sustained-yield escapement (and *biological escapement goal* range) for production through brood year 1985. The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to *x* axis).

Appendix 2.4. Akwe River Sockeye Salmon

System: Akwe River
Species: Sockeye salmon
Stock Unit: Akwe River sockeye salmon

Management Jurisdictions: Alaska Department of Fish and Game

Area Office: Yakutat

Primary Fishery: Set gillnet commercial

Secondary Fishery: Subsistence fishery

Escapement Goal Type: *Biological Escapement Goal*

Basis for the Goal: Stock-recruit analysis using brood years 1973 to 1987, not including 1975 and 1981

Documentation: Clark, J. H., A. Burkholder, and J. E. Clark. 1995. Biological escapement goals for 5 sockeye salmon stocks returning to streams in the Yakutat area of Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report Number 1J95-16. Douglas.

Inriver Goal: None

Action Points: None

Escapement Goal: 600 to 1,500 peak counts

Escapement Measures: Peak aerial count of sockeye in Akwe River system, 1973 to present

Stock-Recruit Analysis Summary

Model: Ricker[a]
Number of years in model: 13

Ratio of highest escapement to lowest escapement: 20

Parameter estimates: α-parameter[b] = 4.31 (adjusted), $1/\beta \approx 20{,}200$ (β-parameter[c] = $4.96\ 10^{-5}$)
Basis of range of escapement goal: Expected yield is at least 90% of *maximum sustainable catch*

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[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Summary

The Akwe River is located southeast of Yakutat, midway between the Alsek and Italio River drainages. The Akwe River experiences some glacial influences. The Ustay River is a glacial stream that splits, and subsequently feeds into both the Alsek and the Akwe Rivers. A geological change in 1985 resulted in a larger portion of the Ustay River entering the Akwe River. Additionally, the color of the Akwe River's water has become more greenish. As a result, the ability to observe salmon during surveys in the Akwe River has deteriorated since 1985. In December of 1986, the Italio River changed course and flowed into the Akwe River lagoon. Prior to 1986, the Italio River entered its own lagoon; since 1986, both the Akwe and Italio Rivers have shared the Akwe lagoon.

The Akwe River supports a moderately sized spawning population of sockeye salmon. Sockeye salmon are believed to spawn primarily in tributaries to Akwe Lake. Presumably, the lake provides limited rearing habitat for juveniles, although the majority of the sockeye salmon smolt as "zero-checks."

In the years prior to 1987, commercial and subsistence fishers set gillnets in the Akwe Lagoon and presumably harvested predominantly the Akwe stock of sockeye salmon. Before the 1987 fishing season, ADF&G redefined set gillnet fishing boundaries to mitigate for the course change of the Italio River. The lower boundaries of the Akwe and Italio fishing areas were moved upstream above the confluence of the 2 rivers. Management intent was to continue to allow fishing, but at the same time, to preserve the management objective of only allowing fishing on target stocks to the extent practical, while minimizing interception of non-target stocks.

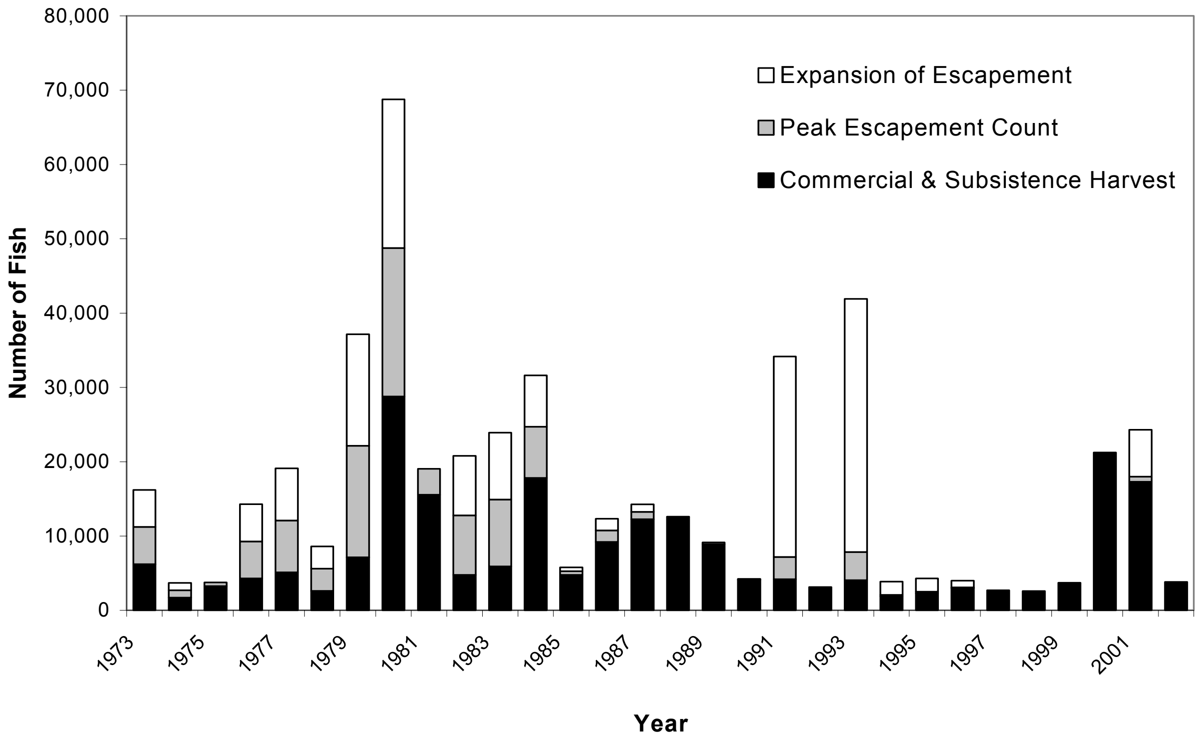
Annual harvests of sockeye salmon in the Akwe fishery were as high as about 28,700 fish in 1980 and averaged about 8,000 fish during the 15-year period of 1972 to 1986. Since 1987 when fishing boundaries were altered, peak annual harvest of sockeye salmon in the Akwe fishery was about 21,000 fish in 2000, and the average annual harvest from 1985 to 2001 was about 7,000 fish. Thus, Akwe fishery harvests have not altered appreciably since the change in the Italio River's course.

The stock assessment program for the Akwe River system sockeye salmon population consists of flying aerial surveys to count spawners, as well as collecting and tabulating fish tickets and subsistence catch reports. Peak survey counts are assumed to represent about one-half of the total escapement in the years from 1973 to 1984, prior to the increased impact of Ustay River waters on survey conditions. Since then, surveys are assumed to represent only about a tenth of the total escapement. Surveys were not successfully implemented in the years 1992, 1997 to 2000, and 2002 due to exceptionally poor water visibility. Sampling of the escapements for age and sex composition has been limited and since 1973, only 5 of the 30 annual escapements have been directly sampled (1982 to 1986). Sampling of the harvests for age and sex composition has occurred in most years since 1982. Significant information gaps pertaining to this stock exist and ADF&G plans to implement an improved stock assessment effort to address the major data gaps.

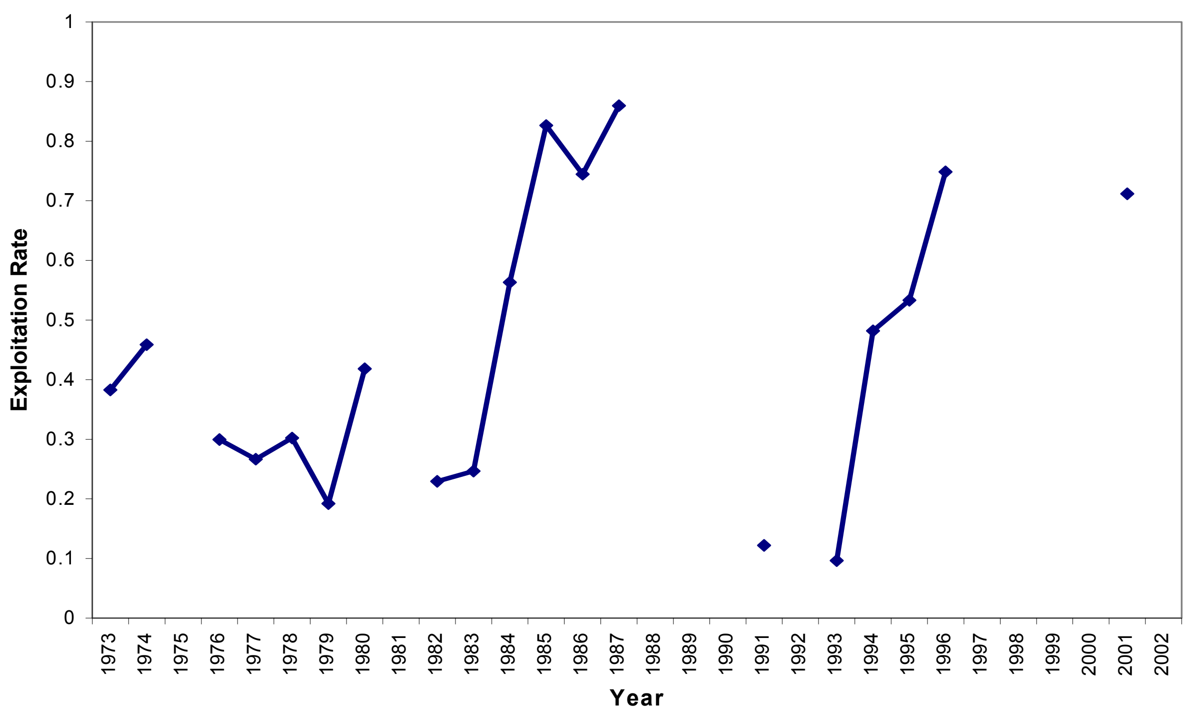
ADF&G adopted a *biological escapement goal* range of 600 to 1,500 fish counted during a peak survey (current water conditions) in 1995 (Clark, Burkholder, and Clark 1995). This escapement goal has not been updated. The inability of ADF&G to successfully implement surveys over the past several years has been a major setback both to management and the evaluation of the management program.

Appendix 2.4.1. Peak escapement counts, total spawning escapement estimates, harvests, run sizes, and exploitation rates for Akwe River system sockeye salmon, from 1973 to 2002. Total escapement estimates are assumed to be two-fold of peak counts in the years from 1973 to 1984 and ten-fold peak counts after 1984. Peak escapement counts in 1975, 1981, 1988, 1989, and 1990 are not considered to be representative of spawner abundance in those years. Subsistence harvests were not estimated for the years from 1973 to 1988; estimated mean of 75 fish from 1989 to 2001 was used as proxy estimates for these years. Subsistence harvest estimate for 2002 not yet available, approximate average of 75 fish from 1989 to 2001 was used as proxy estimate for 2002.

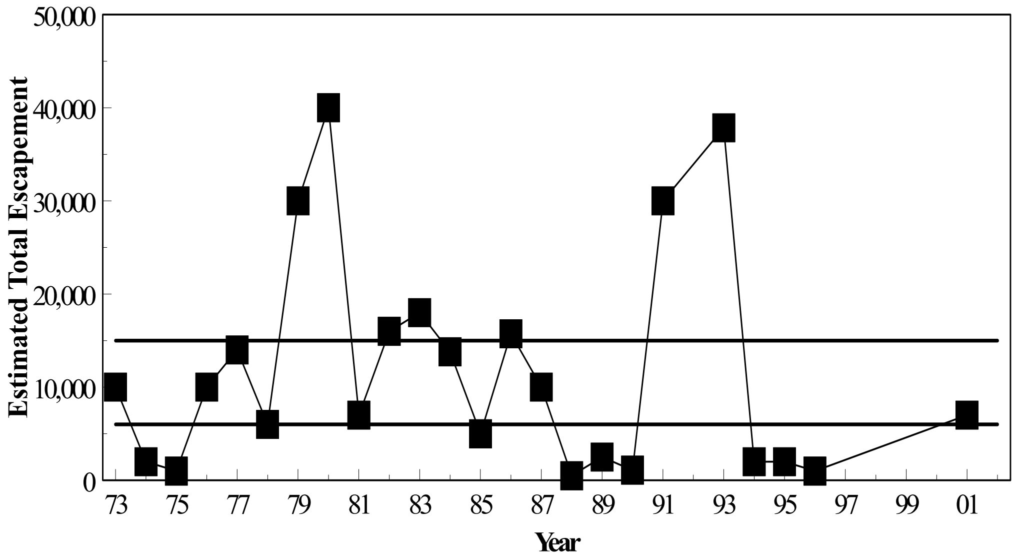
Year	Peak Count	Estimated Total Escapement	Commercial Set Gillnet Harvest	Subsistence Harvest	Total Harvest	Estimated Total Runs	Estimated Exploitation Rate
1973	5,000	10,000	6,132	*75*	6,207	16,207	38%
1974	1,000	2,000	1,620	*75*	1,695	3,695	46%
1975	*500*	1,000	3,177	*75*	3,252	*Unknown*	*Unknown*
1976	5,000		4,199	*75*	4,274	14,274	30%
1977	7,000	14,000	5,014	*75*	5,089	19,089	27%
1978	3,000	6,000	2,524	*75*	2,599	8,599	30%
1979	15,000	30,000	7,055	*75*	7,130	37,130	19%
1980	20,000	40,000	28,687	*75*	28,762	68,762	42%
1981	*3,500*		15,467	*75*	15,542	*Unknown*	*Unknown*
1982	8,000	16,000	4,694	*75*	4,769	20,769	23%
1983	9,000	18,000	5,822	*75*	5,897	23,897	25%
1984	6,900	13,800	17,729	*75*	17,804	31,604	56%
1985	500	5,000	4,686	*75*	4,761	9,761	49%
1986	1,574	15,740	9,107	*75*	9,182	24,922	37%
1987	1,000	10,000	12,175	*75*	12,250	22,250	55%
1988	*50*		12,476	*75*	12,551	*Unknown*	*Unknown*
1989	*250*		8,653	231	8,884	*Unknown*	*Unknown*
1990	*110*		3,996	130	4,126	*Unknown*	*Unknown*
1991	3,000	30,000	4,172	0	4,172	34,172	12%
1992	*None*	*Unknown*	3,034	85	3,119	*Unknown*	*Unknown*
1993	3,786	37,860	3,973	74	4,047	41,907	10%
1994	200	2,000	1,798	62	1,860	3,860	48%
1995	200	2,000	2,200	84	2,284	4,284	53%
1996	100	1,000	2,975	0	2,975	3,975	75%
1997	*None*	*Unknown*	2,671	0	2,671	*Unknown*	*Unknown*
1998	*None*	*Unknown*	2,439	138	2,577	*Unknown*	*Unknown*
1999	*None*	*Unknown*	3,648	52	3,700	*Unknown*	*Unknown*
2000	*None*	*Unknown*	21,129	108	21,237	*Unknown*	*Unknown*
2001	700	7,000	17,294	0	17,294	24,294	71%
2002	*None*	*Unknown*	3,754	*75*	3,829	*Unknown*	Unknown



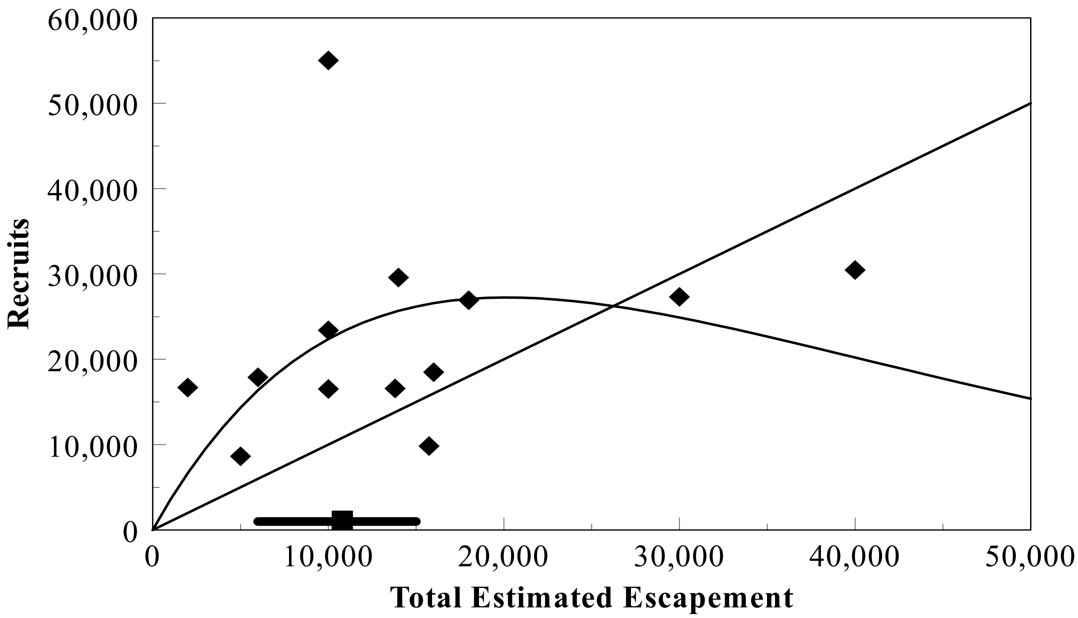
Appendix 2.4.2. Estimated annual runs of Akwe River sockeye salmon, from 1973 to 2002.



Appendix 2.4.3. Estimated exploitation rates for Akwe River sockeye salmon, from 1973 to 2002.



Appendix 2.4.4. Estimated total escapements of Akwe River system sockeye salmon, from 1972 to 2002. The region between the 2 horizontal lines, 6,000 to 15,000 total spawners or a peak count of 600 to 1,500 under current conditions, represents the *biological escapement goal* range.



Appendix 2.4.5. Estimated stock-recruit relationship for Akwe River sockeye salmon. The curve represents production predicted with Ricker's model using brood years 1973 to 1987, not including brood years 1975 and 1981. The diamonds are brood years 1972 to 1974, 1976 to 1980, and brood year 1982 to 1987 data points. The square above the *x*-axis represents the point estimate of *maximum-sustained-yield* escapement (10,790 total spawners or 1,079 spawners counted during a peak survey). The *biological escapement goal* range is shown just above the *x*-axis (6,000 to 15,000 total spawners or 600 to 1,500 measured as a peak survey. The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to *x* axis).

Appendix 2.5. Klukshu River Sockeye Salmon

System:	Alsek River
Species:	Sockeye salmon
Stock Unit:	Klukshu River sockeye salmon
Management Jurisdictions:	Alaska Department of Fish and Game, Department of Fisheries and Oceans, Canada (CDFO): joint management through the Pacific Salmon Commission
Area Office:	Yakutat (ADF&G), Whitehorse, Y.T. (CDFO)
Primary Fisheries:	U.S. set gillnet commercial and Canadian aboriginal fishery
Secondary Fisheries:	U.S. subsistence and Canadian sport
Escapement Goal Type:	*Biological Escapement Goal*
Basis for the Goal:	Stock-recruit analysis, using brood years 1976 to 1992
Documentation:	Clark, J. H. and P. Etherton. 2000. Biological escapement goal for Klukshu River system sockeye salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report Number 1J00-24. Douglas.
Inriver Goal:	None
Action Points:	None
Escapement Goal:	7,500 to 15,000 fish
Escapement Measures:	Klukshu weir counts minus upstream removals, 1976 to present

Stock-Recruit Analysis Summary

Model: Ricker[a]

Number of years in model: 17

Ratio of highest escapement to lowest escapement: 4.1

Parameter estimates: α-parameter[b] = 4.586, $1/\beta \approx 15{,}800$ (β-parameter[c] = $6.332 \cdot 10^{-5}$)

Basis of range of escapement goal: Escapement goal range is 0.8 to 1.6 times the escapement that forecasts the *maximum sustainable catch*

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[a] for *R* (run size) and *S* (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.

[b] α is defined as Rickers productivity parameter.

[c] β is defined as Ricker's carrying capacity parameter.

Summary

The Klukshu River is a tributary of the Tatshenshini River that in turn flows into the Alsek River. The Alsek River originates in Canada and flows through the U.S. terminating in the Gulf of Alaska, southeast of Yakutat, Alaska. The Alsek drains about 28,000 km^2, much of which is inaccessible to Pacific salmon due to velocity barriers. The Klukshu and upper Tatshenshini Rivers are accessible by road.

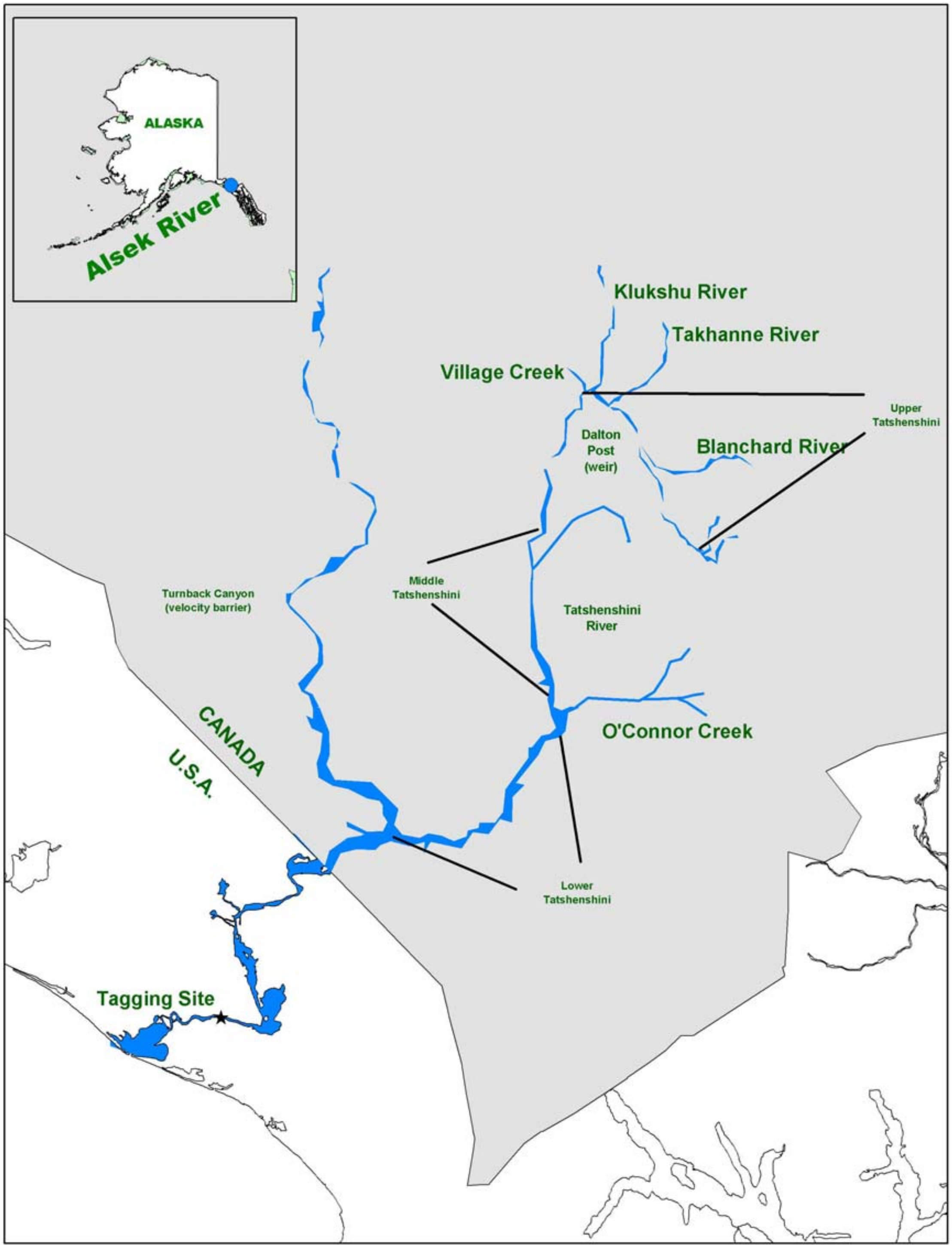
Alsek River salmon stocks provide the basis for U.S. commercial and subsistence fisheries prosecuted inriver with set gillnets. No commercial fishery exists in the Canadian portion of the Alsek River drainage, although both aboriginal (Indian food) and recreational (sport) fisheries occur in the Tatshenshini River and some of its headwater tributaries. Management of salmon returning to the Alsek River drainage has been under the auspices of the Pacific Salmon Commission since the signing of the U.S.–Canada Pacific Salmon Treaty in 1985.

U. S. harvests of Alsek sockeye salmon since 1976 have ranged from about 5,900 to 50,700 fish and have averaged about 21,000 fish. Only a portion of the sockeye salmon harvested in the U.S. fishery is of Klukshu origin, the rest are sockeye bound for other parts of the Alsek drainage. Canadian harvests of Klukshu origin sockeye are estimated to have ranged from about 500 to 10,500 fish per year since 1976 and have averaged about 3,000 fish.

Sockeye salmon migrating past the U.S. fishery in the Alsek River have been tagged to estimate the proportion that are of Klukshu origin. A small study conducted by ADF&G in 1985 estimated the proportion at 37%. A research program to more thoroughly estimate this statistic was initiated in 2000 and is continuing. The year-2000 pilot study produced an estimate of 15% contribution, but with a low sample size. Research in 2001 provided 2 estimates, both with increased sample sizes; a radio tag estimate was 23% and a standard tagging estimate was 27%. For the purposes of this document, the proportion of 25% was assumed each year; that is an approximate average of the 4 available estimates to date. Total exploitation of Klukshu origin sockeye salmon since 1976 is estimated to have ranged from 14% to 72%, averaging 35%.

Sockeye salmon have been counted with the aid of a weir located on the Klukshu River, just upstream of its confluence with the Tatshenshini River, each year since 1976 by the CDFO. This is the only consistent, long term, sockeye salmon escapement enumeration program in the Alsek River drainage. Escapement estimates are weir counts of sockeye salmon minus fish removed upstream of the weir by the Canadian aboriginal fishery or used for brood stock. Sockeye salmon escapements from 1976 to 2002 ranged from about 5,100 to 28,900 fish and averaged about 14,900 fish per year.

A *biological escapement goal* was defined in 2000 as 7,500 to 15,000 sockeye salmon spawning upstream of the Klukshu River weir, and was adopted by the Transboundary Technical Committee of the Pacific Salmon Commission, the CDFO, and ADF&G. The intent of international management is to achieve escapements within this defined range each year. The CDFO stock assessment program consists of operating the Klukshu weir, monitoring the Canadian sport and aboriginal fisheries, and sampling the escapement and Canadian harvests to document annual sockeye salmon age and sex compositions. The ADF&G stock assessment program consists of monitoring the Alsek commercial and subsistence fisheries and sampling the catch to document annual age and sex composition of these sockeye salmon harvests. Since 2000, the CDFO and the ADF&G have collaborated in a tagging study of sockeye salmon. The Alsek fishery is managed by ADF&G predominantly based upon historic catch per effort statistics because of extensive travel time before sockeye salmon are counted past the Klukshu River weir in Canada. Canadian management has been concerned in recent years with the status of the early portion of the sockeye salmon run; ADF&G has responded by limiting fishing time during the early portion of the season.



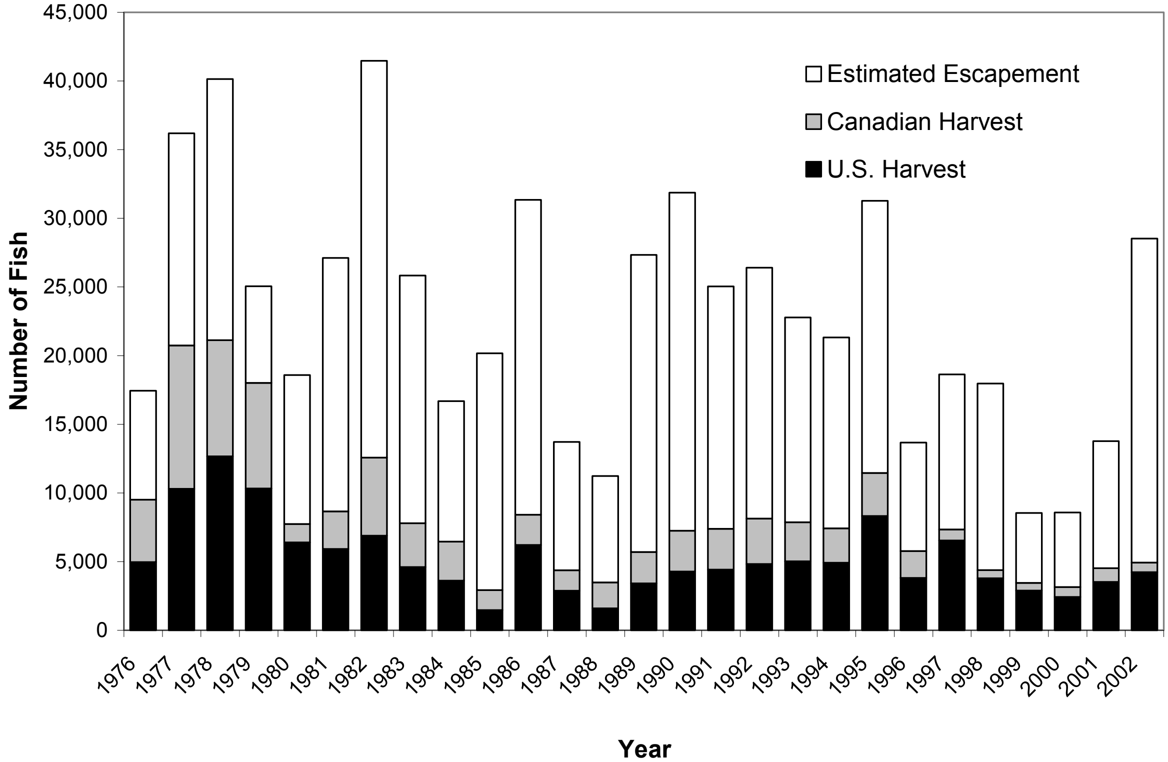
Appendix 2.5.1. Alsek River drainage, showing the tagging site and the approximate location of the adult weir on Klukshu River.

Appendix 2.5.2. Estimated escapements, harvests, run sizes and exploitation rates for Klukshu River system sockeye salmon, from 1976 to 2002. Escapement estimates are weir counts minus upstream removals. Tagging studies indicate that approximately 25% of the sockeye salmon in the U.S. portion of the Alsek River are Klukshu origin fish; hence 25% of the U.S. harvest is assigned to the Klukshu stock. U.S. subsistence catch estimates not available for 1976 to 1988; a proxy value of 100 is used and represents the approximate average catch from 1989 to 2001. Subsistence harvest estimate for 2002 was not available; this harvest is assumed to be 100 fish.

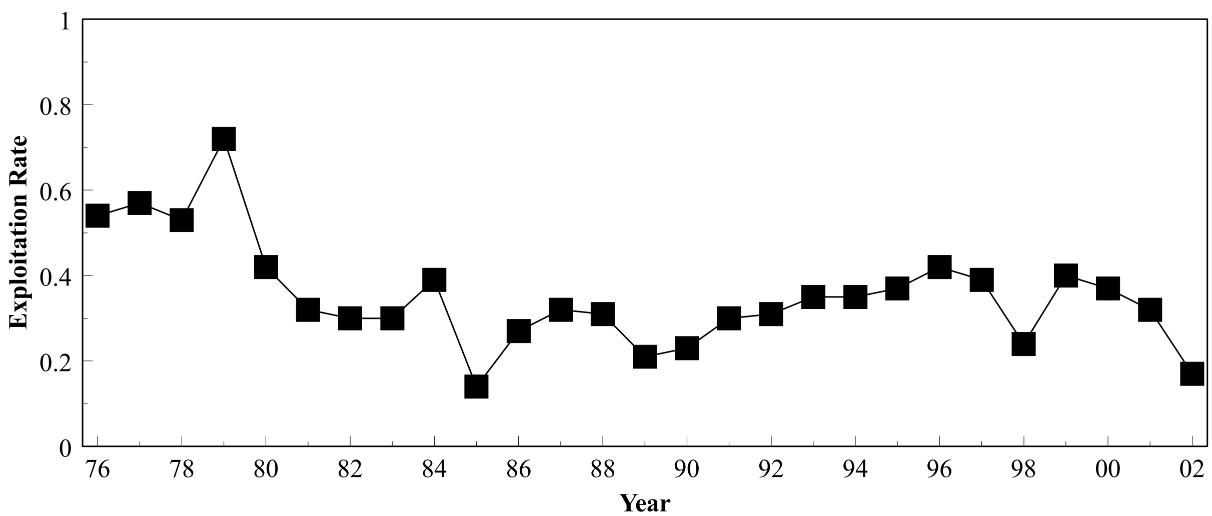
Year	Estimated Escapement	Canadian Harvest	U.S. Comm. Harvest	U.S. Subsist. Harvest	U. S. Total Harvest	25% of U.S. Harvest	Estimated Total Harvest	Estimated Total Run	Estimated Exploitation Rate
1976	7,941	4,540	19,775	*100*	19,875	4,969	9,509	17,450	54%
1977	15,441	10,450	41,075	*100*	41,175	10,294	20,744	36,185	57%
1978	19,017	8,450	50,580	*100*	50,680	12,670	21,120	40,137	53%
1979	7,051	7,675	41,230	*100*	41,330	10,333	18,008	25,059	72%
1980	10,850	1,340	25,522	*100*	25,622	6,406	7,746	18,596	42%
1981	18,448	2,727	23,641	*100*	23,741	5,935	8,662	27,110	32%
1982	28,899	5,680	27,443	*100*	27,543	6,886	12,566	41,465	30%
1983	18,017	3,209	18,293	*100*	18,393	4,598	7,807	25,824	30%
1984	10,227	2,860	14,326	*100*	14,426	3,607	6,467	16,694	39%
1985	17,259	1,451	5,792	*100*	5,892	1,473	2,924	20,183	14%
1986	22,936	2,190	24,791	*100*	24,891	6,223	8,413	31,349	27%
1987	9,346	1,503	11,393	*100*	11,493	2,873	4,376	13,722	32%
1988	7,737	1,894	6,286	*100*	6,386	1,597	3,491	11,228	31%
1989	21,636	2,288	13,513	131	13,644	3,411	5,699	27,335	21%
1990	24,607	2,969	17,013	144	17,157	4,289	7,258	31,865	23%
1991	17,645	2,986	17,542	104	17,646	4,412	7,398	25,043	30%
1992	18,269	3,299	19,298	37	19,335	4,834	8,133	26,402	31%
1993	14,921	2,825	20,043	96	20,139	5,035	7,860	22,781	35%
1994	13,892	2,506	19,639	47	19,686	4,922	7,428	21,320	35%
1995	19,817	3,139	33,112	167	33,279	8,320	11,459	31,276	37%
1996	7,891	1,959	15,182	67	15,249	3,812	5,771	13,662	42%
1997	11,303	800	25,879	273	26,152	6,538	7,338	18,641	39%
1998	13,580	585	15,042	158	15,200	3,800	4,385	17,965	24%
1999	5,101	554	11,441	152	11,593	2,898	3,452	8,553	40%
2000	5,422	745	9,522	146	9,668	2,417	3,162	8,584	37%
2001	9,248	1,010	13,995	72	14,067	3,517	4,527	13,775	33%
2002	23,587	700	16,862	*100*	16,962	4,241	4,941	28,528	17%

Appendix 2.5.3. Estimated total returns (recruits) of Klukshu River sockeye salmon, brood years 1976 to 2002. Brood table assumes 25% of the U.S. Alsek catch are Klukshu origin fish. Year specific age composition estimates taken from Clark and Etherton (2000) were used for annual 1976 to 1997 estimates. Average ages from that report were used for annual 1998 to 2002 estimates.

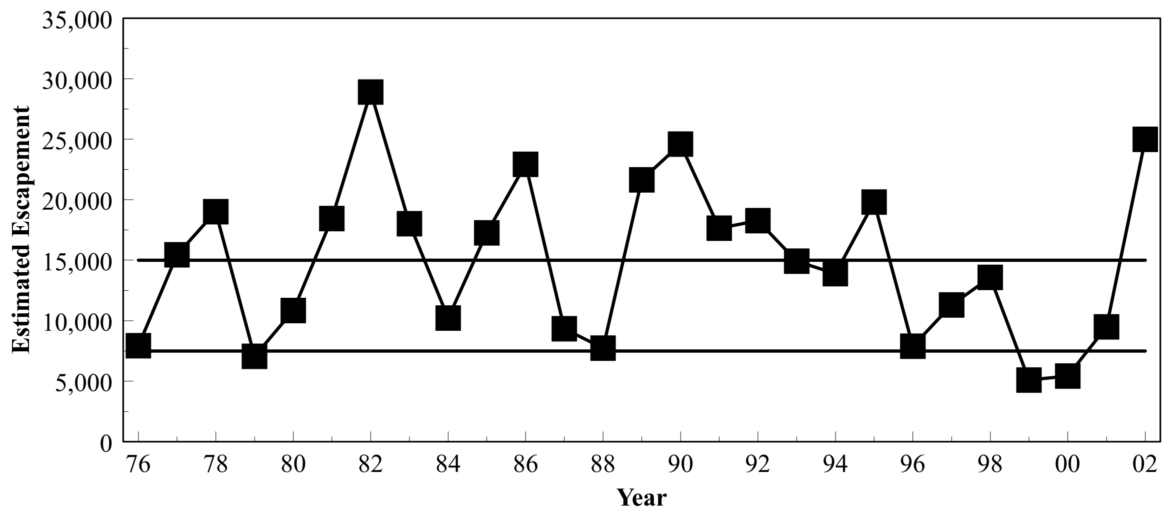
Brood Year	Estimated Total Escapement	Age 3 Returns (recruits)	Age 4 Returns (recruits)	Age 5 Returns (recruits)	Age 6 Returns (recruits)	Estimated Total Returns	Return Per Spawner
1976	7,941	103	4,322	16,369	828	21,622	2.72
1977	15,441	64	10,174	33,381	-	43,619	2.82
1978	19,017	271	7,187	24,211	334	32,003	1.68
1979	7,051	69	1,567	15,665	418	17,719	2.51
1980	10,850	46	658	16,659	687	18,050	1.66
1981	18,448	36	3,091	24,646	195	27,967	1.52
1982	28,899	15	5,892	10,956	722	17,584	0.61
1983	18,017	124	2,572	8,677	171	11,544	0.64
1984	10,227	-	1,812	19,305	257	21,375	2.09
1985	17,259	16	7,825	28,581	559	36,981	2.14
1986	22,936	34	2,984	20,050	457	23,525	1.03
1987	9,346	43	4,434	23,446	959	28,881	3.09
1988	7,737	-	2,451	17,999	410	20,860	2.70
1989	21,636	48	3,822	14,137	250	18,257	0.84
1990	24,607	-	6,773	29,026	410	36,209	1.47
1991	17,645	-	2,000	11,394	801	14,195	0.80
1992	18,269	-	1,662	16,113	473	18,248	1.00
1993	14,921	197	1,661	13,653	258	15,769	1.06
1994	13,892	65	3,800	6,500	244	10,610	0.76
1995	19,817	38	1,766	6,524	386	8,714	0.44
1996	7,891	29	1,792	10,657	726	13,203	1.67
1997	11,303	24	2,944	22,755		*incomplete*	
1998	13,580	35	6,417			*incomplete*	
1999	5,101	42				*incomplete*	
2000	5,422					*incomplete*	
2001	9,248					*incomplete*	
2002	23,587					*incomplete*	



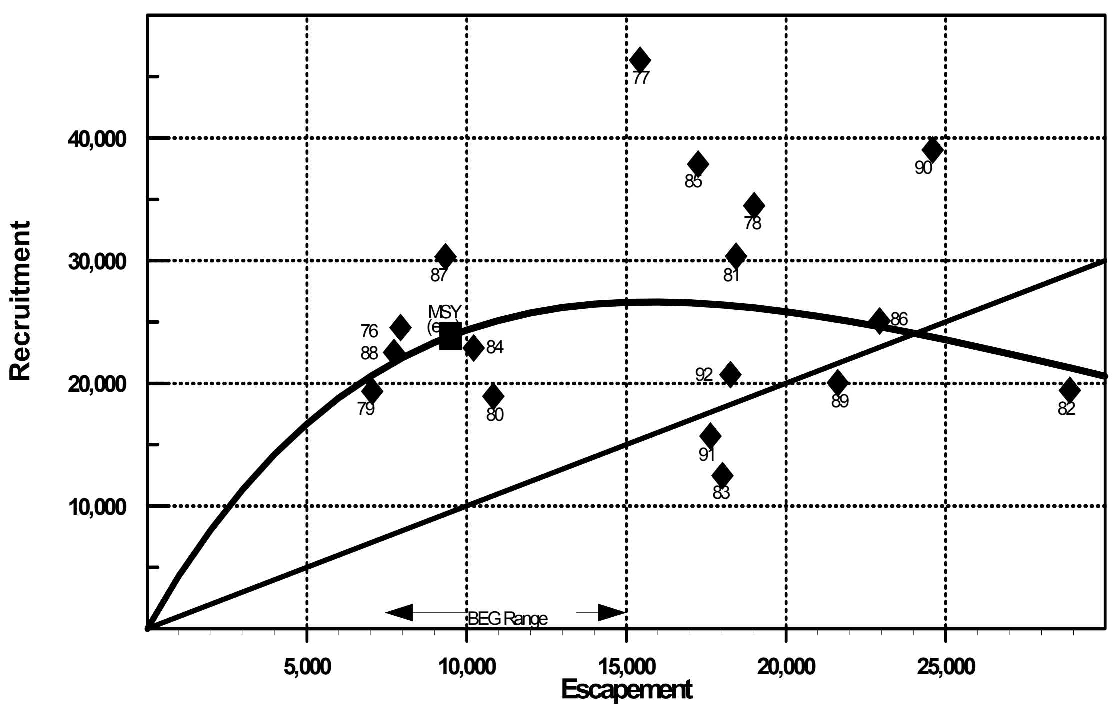
Appendix 2.5.4. Estimated annual runs of Klukshu River sockeye salmon, from 1976 to 2002.



Appendix 2.5.5. Estimated exploitation rates for Klukshu River sockeye salmon, from 1976 to 2002.



Appendix 2.5.6. Estimated total escapements of Klukshu River sockeye salmon, from 1976 to 2002. The region between the 2 solid horizontal lines, 7,500 to 15,000 total spawners, represents the *biological escapement goal* range adopted in 2000 by the Transboundary Technical Committee of the Pacific Salmon Commission, the Canadian Department of Fisheries and Oceans, and the ADF&G.



Appendix 2.5.7. Estimated stock-recruit relationship for Klukshu River sockeye salmon, based on brood years 1976 to 1992. The curve represents production predicted with Ricker's model; solid diamonds are brood year 1976 to 1992 data points. The square on the curve represents the point estimate of maximum-sustained-yield escapement (9,500). The *biological escapement goal* range is shown just above the *x* axis. The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to *x* axis).

Appendix 2.6. East Alsek-Doame River system sockeye salmon stock.

System: East Alsek-Doame River
Species: Sockeye salmon
Stock Unit: East Alsek-Doame River system sockeye salmon

Management Jurisdiction: Alaska Department of Fish and Game

Area Office: Yakutat

Primary Fisheries: Set gillnet commercial
Secondary Fisheries: Subsistence and sport
Escapement Goal Type: *Biological Escapement Goal*
Basis for Goal: Stock-recruit analysis for brood years 1972 to 1990; separate stock-recruit analysis for brood years 1991 to 1997.

Documentation:

Flushed Habitat: Clark, J. H., A. Burkholder, J. E. Clark. 1995. Biological escapement goals for 5 sockeye salmon stocks returning to streams in the Yakutat area of Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report Number 1J95-16. Douglas.

Clark, J. H., S. Fleischman, and G. Woods. *In press*. Revised *biological escapement goal* for the sockeye salmon stock returning to the East Alsek-Doame river system of Yakutat, Alaska. Special Publication. Sport Fish Division, Anchorage.

Inriver Goal: None
Action Points: None
Escapement Goal: Flushed Habitat, 26,000 to 57,000 index units
Unflushed Habitat, 13,000 to 26,000 index units
Escapement Measures: Sum of peak aerial counts in East Alsek & Doame (1972-present)

Stock-Recruit Analysis Summary

Model: Ricker[a] for brood years 1972 to 1990 (0.43 times estimate of replacement for brood years 1991 to 1997)

Number of years in model: 19 for brood years 1972 to 1990, 7 for 1991 to 1997

Ratio of highest escapement to lowest escapement: 6.6 for brood years 1972 to 1990, 1.7 for 1991 to 1997

Parameter estimates: α-parameter[b] = 5.72 (adjusted), 1/ $\beta \approx$ 85,500, (β-parameter[c] = $4.96 \cdot 10^{-5}$)

Basis of range of escapement goal:
For brood years 1972 to 1990, expected yield is at least 90% of *maximum sustainable catch*
For 1991–1997, escapement levels that range from 0.8 to 1.6 times escapement producing the *maximum sustainable catch*

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Summary

The East Alsek River was formed about a century ago when the Alsek River changed channels. The former main channel of the Alsek River forms the East Alsek River, and water from the glacially occluded Alsek River flows through a gravel berm and provides the East Alsek River with clear water. The East Alsek River flows about 20 miles before entering an estuary. Early in the 20th century, a chum salmon population used the East Alsek River for spawning and at some time thereafter, sockeye salmon started spawning in the system.

The Doame River is a small system just south of the East Alsek River. An earthquake in 1966 caused the Doame River mouth to be sealed off. The river formed a new channel to the west just inside the beach line, until it joined with and became a tributary of the East Alsek River. The Doame River is also a clear water system, and includes a lake. It is assumed that the Doame River system has supported sockeye salmon for several centuries.

The stock is unique in that the East Alsek River sockeye salmon are similar in life history patterns to chum salmon. Virtually all East Alsek sockeye salmon are "zero checks," migrating to sea the year they hatch. Sockeye salmon use the East River system for spawning, but only for short-term rearing. Adaptation of sockeye salmon with this life history characteristic and the exceptional spawning habitat in the East Alsek River allowed this stock to explode in magnitude since the middle of the 20th century. The river, with its crystal clear water, good substrate and flows, provided exceptional spawning habitat through the 1970s and 1980s, and the sockeye salmon stock exceeded 250,000 fish in some years. However, what facilitated and maintained this population growth was the periodic (about every 10 years) flushing of the gravel beds in the East Alsek River by flood events in the much bigger transboundary Alsek River. The last flood event of this type occurred in 1981. By the early 1990s, the spawning habitat of the East Alsek River had deteriorated considerably, due to emergent vegetation and the silt in the gravel beds. Thus, the history of the of sockeye salmon in the East Alsek River includes invasion in the early 1900s, adaptation to the unique environment, population explosion in the 1970s and 1980s followed by lesser abundance since the early 1990s due to deteriorating spawning habitat. The Doame River, on the other hand, supports a small but relatively stable population of sockeye salmon, with total runs likely never exceeding 10,000 sockeye salmon.

The East Alsek-Doame River system stock of sockeye salmon stock is harvested in a commercial set gillnet fishery sited in the lagoon where the river enters the ocean. The same commercial fishers use the same gear and harvest a few sockeye salmon for subsistence purposes. Lastly, a minor sport fishery occurs in the river and lagoon areas. The stock primarily returns at 4 years of age, although some return at age 2, age 3, age 5, and age 6.

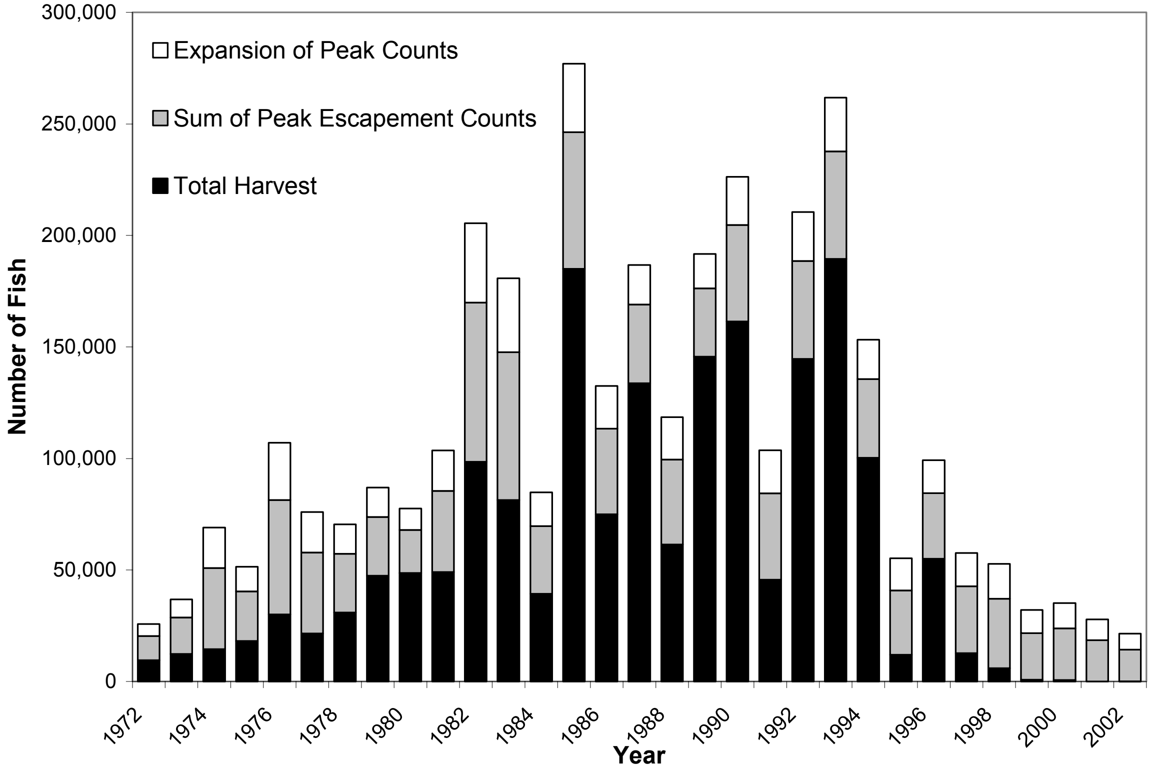
The stock assessment program consists of flying aerial surveys of both the East Alsek and Doame Rivers to count spawners, collection and tabulation of fish tickets and subsistence catch reports, and monitoring of the sport fishery through a postal questionnaire. Sampling of the commercial catch and the East Alsek River escapement for age, sex, and length information also takes place. Peak aerial survey counts are assumed to represent about two-thirds of the total escapement. Peak aerial counts of spawners since 1972 have ranged from 10,800 to 70,000, averaging about 52,000 over this 30-year period. In 1995, ADF&G adopted a *biological escapement goal* for this stock based upon the excellent spawning habitat quality years of the 1970s and 1980s. A recent analysis has identified an alternate interim *biological escapement goal* for this stock based upon the "unflushed" spawning habitat years since about 1990.

Appendix 2.6.1. Escapement index counts, total spawning escapement estimates, harvests, run sizes, and exploitation rates for East-Alsek-Doame River system sockeye salmon, from 1972 to 2002. Total escapement estimates were calculated by summing annual peak aerial survey counts of sockeye salmon in the East Alsek and Doame Rivers and multiplying that sum by a factor of 1.5, under the assumption that these peak counts represent two-thirds of the annual total escapement. Surveys of the Doame River were not conducted in 1973, 1974, and 1976 to 1987; the approximate average peak count of the other years in the data set of *1,333* (based on two-thirds of an assumed total escapement of 2000 spawners) was used for proxy estimates. The sport harvest estimate for 2002 was not available, the harvest is assumed to total about 100 sockeye salmon. Subsistence harvest estimate for 2002 was not available, this harvest is assumed to be zero.

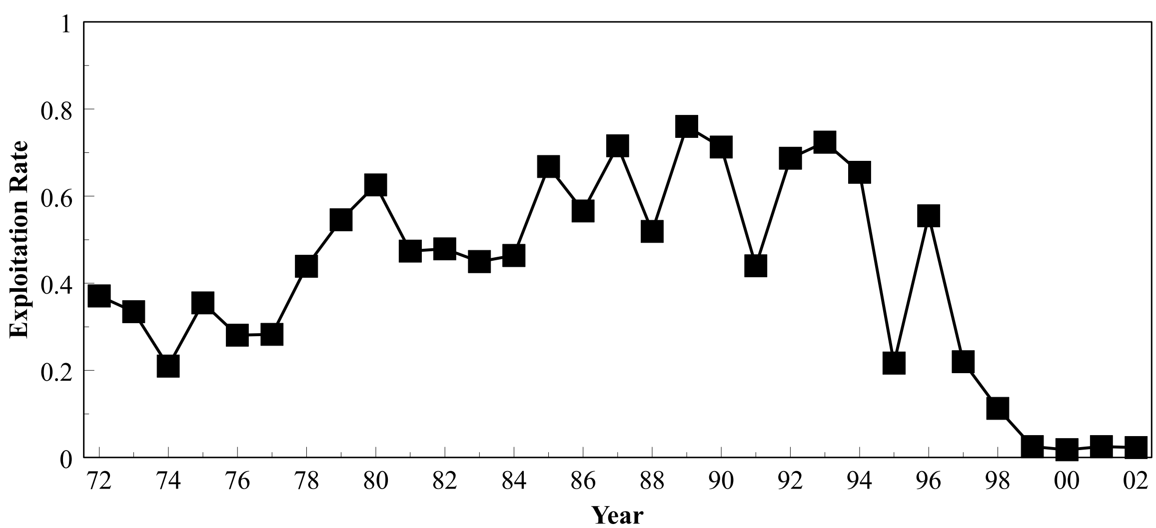
Year	East Alsek Peak Aerial Count	Doame River Peak Aerial Count	Estimated Total Escap.	Comm. Set Gillnet Harvest	Sport Harvest	Subsis. Harvest	Total Harvest	Estimated Total Runs	Estimated Exploit. Rate
1972	10,000	800	16,200	9,575			9,575	25,775	37.1%
1973	15,000	*1,333*	24,500	12,342			12,342	36,842	33.5%
1974	35,000	*1,333*	54,500	14,520			14,520	69,020	21.0%
1975	22,000	120	33,180	18,235			18,235	51,415	35.5%
1976	50,000	*1,333*	77,000	30,057			30,057	107,057	28.1%
1977	35,000	*1,333*	54,500	21,500			21,500	76,000	28.3%
1978	25,000	*1,333*	39,500	30,922			30,922	70,422	43.9%
1979	25,000	*1,333*	39,500	47,442			47,442	86,942	54.6%
1980	18,000	*1,333*	29,000	48,616			48,616	77,616	62.6%
1981	35,000	*1,333*	54,500	49,126			49,126	103,626	47.4%
1982	70,000	*1,333*	107,000	98,501			98,501	205,501	47.9%
1983	65,000	*1,333*	99,500	81,362			81,362	180,862	45.0%
1984	29,000	*1,333*	45,500	39,373			39,373	84,873	46.4%
1985	60,000	*1,333*	92,000	184,962			184,962	276,962	66.8%
1986	37,000	*1,333*	57,500	74,972	68		75,040	132,540	56.6%
1987	34,000	*1,333*	53,000	133,740			133,740	186,740	71.6%
1988	38,000	50	57,075	61,483			61,483	118,558	51.9%
1989	30,000	700	46,050	145,426	95	70	145,591	191,641	76.0%
1990	42,000	1,270	64,905	161,383		30	161,413	226,318	71.3%
1991	38,000	700	58,050	45,334	45	285	45,664	103,714	44.0%
1992	43,000	900	65,850	144,378	82	189	144,649	210,499	68.7%
1993	45,000	3,200	72,300	189,207	39	235	189,481	261,781	72.4%
1994	32,400	2,900	52,950	99,998	0	335	100,333	153,283	65.5%
1995	28,000	850	43,275	11,772	134	70	11,976	55,251	21.7%
1996	28,000	1,400	44,100	55,025	0	64	55,089	99,189	55.5%
1997	28,000	2,000	45,000	12,665	11	0	12,676	57,676	22.0%
1998	30,000	1,200	46,800	5,802	138	0	5,940	52,740	11.3%
1999	19,500	1,400	31,350	0	792	0	792	32,142	2.5%
2000	21,000	2,200	34,800	0	598	44	642	35,442	1.8%
2001	17,000	1,545	27,818	0	24	0	24	27,847	0.1%
2002	13,500	700	21,300	0	*100*	*0*	*100*	*21,400*	*0.4%*

Appendix 2.6.2. Estimated total returns (recruits) of East Alsek-Doame River system sockeye salmon, brood years 1972 to 2002. Sampling data for the age-5 return for brood year 1997 are not available, the recent 5-year average of *3,451* was used as a proxy estimate. Estimates for the 6-year old returns for brood years 1996 and 1997 are not available, proxy values of 0 were used.

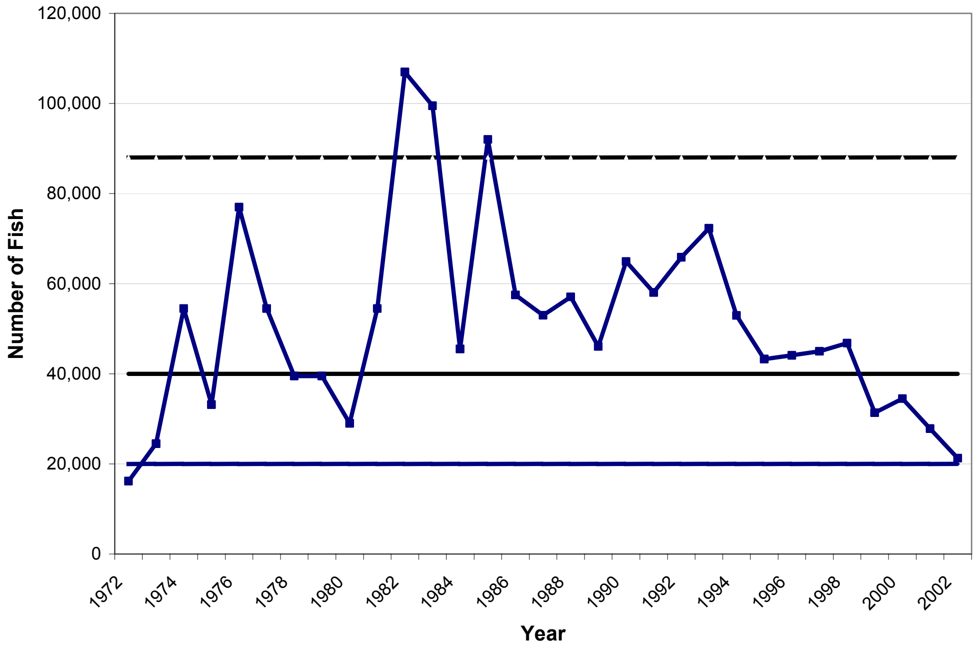
Brood Year	Parent Escapement	Age-2 Return	Age-3 Return	Age-4 Return	Age-5 Return	Age-6 Return	Estimated Total Return	Estimated Return per Spawner
1972	16,200	436	8,587	78,537	6,652	132	94,344	5.82
1973	24,500	265	18,370	55,762	6,340	182	80,919	3.30
1974	54,500	616	13,031	52,241	7,975	175	74,038	1.36
1975	33,180	436	11,393	64,978	7,220	202	84,229	2.54
1976	77,000	316	13,491	58,334	9,387	197	81,725	1.06
1977	54,500	316	11,655	77,062	16,462	163	105,658	1.94
1978	39,500	232	16,540	136,427	7,876	306	161,380	4.09
1979	39,500	436	52,201	161,229	26,654	370	240,890	6.10
1980	29,000	214	11,395	47,728	12,665	830	72,833	2.51
1981	54,500	199	10,094	213,872	11,219	1,605	236,989	4.35
1982	107,000	91	48,767	86,548	28,658	0	164,064	1.53
1983	99,500	1,288	33,713	146,910	4,185	674	186,770	1.88
1984	45,500	230	8,396	80,027	4,821	323	93,797	2.06
1985	92,000	1,171	33,889	142,678	21,141	0	198,879	2.16
1986	57,500	457	43,100	193,974	1,975	0	239,506	4.17
1987	53,000	368	10,361	72,369	6,735	0	89,833	1.69
1988	57,075	519	28,905	175,158	4,864	0	209,446	3.67
1989	46,050	464	28,080	232,222	2,979	108	263,853	5.73
1990	64,905	527	24,116	143,972	5,005	110	173,730	2.68
1991	58,050	578	5,326	33,605	8,321	0	47,829	0.82
1992	65,850	1,006	16,058	77,356	4,758	0	99,177	1.51
1993	72,300	476	13,050	46,854	2,310	34	62,724	0.87
1994	52,950	353	5,524	44,253	2,680	1	52,811	1.00
1995	43,275	540	5,802	23,151	4,901	1	34,396	0.79
1996	44,100	374	6,026	24,028	2,606	*0*	33,034	0.75
1997	45,000	251	6,512	21,482	*3,451*	*0*	*31,696*	*0.70*
1998	46,800	0	4,428				*Incomplete*	
1999	31,350	0					*Incomplete*	
2000	34,800						*Incomplete*	
2001	27,818						*Incomplete*	
2002	21,300						*Incomplete*	



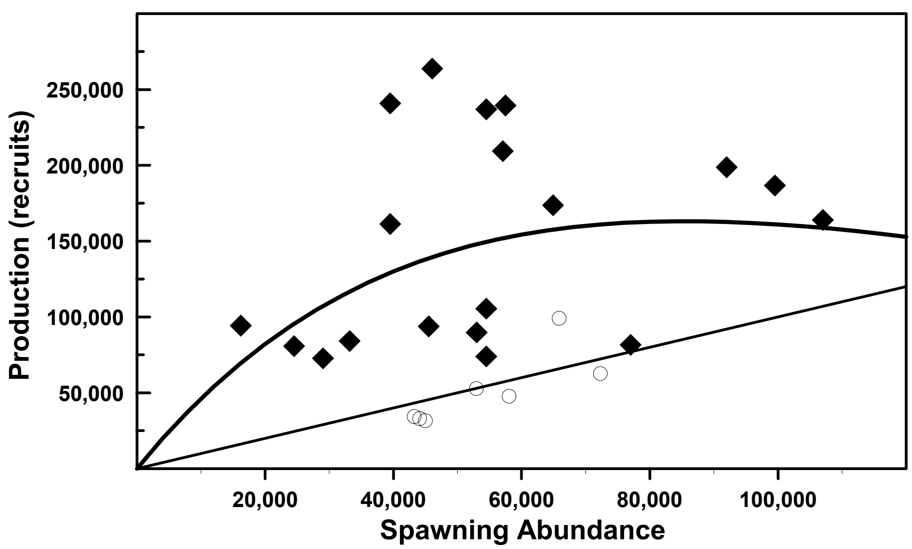
Appendix 2.6.3. Estimated total runs of East Alsek River and Doame River sockeye salmon, from 1972 to 2002.



Appendix 2.6.4. Estimated exploitation rates for East Alsek-Doame River system sockeye salmon, from 1972 to 2002.



Appendix 2.6.5. Estimated total escapements of East Alsek-Doame River system sockeye salmon, from 1972 to 2001. The region between the 2 solid horizontal lines (40,000 to 88,000 total spawners is believed to correspond to a peak count goal range of 26,000 to 57,000). This range represents the *biological escapement goal* adopted in 1995 and is appropriate for years with excellent spawning habitat (flushed spawning habitat). The area between the dashed horizontal line and the lower solid horizontal line represents the interim *biological escapement goal* for the stock when subjected to unflushed spawning habitat such as experienced by the spawning stock since 1991 (20,000 to 40,000 total spawners is thought to correspond to a peak count range of 13,000 to 26,000).



Appendix 2.6.6. Estimated stock-recruit relationship for East Alsek-Doame River system sockeye salmon, based on brood years 1972 to 1997. The curve represents production predicted with Ricker's model using all brood years (1972 to 1990); solid diamonds are the brood year 1972 to 1990 data points, open circles represent brood year 1991 to 1997 data points. The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to *x* axis).

Appendix 2.7. Chilkoot Lake Sockeye Salmon stocks.

System: Chilkoot Lake
Species: Sockeye salmon
Stock Unit: Early and late runs

Management Jurisdiction: Alaska Department of Fish and Game

Area Office: Haines

Primary Fisheries: Drift gillnet commercial, subsistence, and sport

Escapement Goal Type: *Biological Escapement Goal*

Basis for the Goal: Stock-recruit analysis using brood years 1976 to 1984

Documentation: McPherson, S. A. 1990. An inseason management system for sockeye salmon returns to Lynn Canal, Southeast Alaska. M. S. Thesis, University of Alaska Fairbanks.

Inriver Goal: None

Action Points: If the Chilkoot River weir count is less than 4,500 sockeye salmon through June 13, the eastern side of Section 15-C will be closed north of the latitude of Bridget Point and 6-inch mesh size gear restrictions will be in effect for Section 15-C. The eastern shoreline of Section 15-A will be closed if there are less than 4,500 sockeye salmon through the weir by June 13. This date was picked, so as to occur prior to the first news release announcing the general opening of the SE drift gillnet fishery.

Escapement Goal: Overall escapement goal is 50,500 to 91,500 sockeye salmon. For early stocks, escapement goal range is 16,500 to 31,500. For late run stocks, escapement goal range is 34,000 to 60,000.

Escapement Measures: Weir counts and mark–recapture estimates, 1976 to present

Stock-Recruit Analysis Summary

Model: Ricker[a]
Number of years in model: 9
Ratio of highest escapement to lowest escapement: 10.28 for early stock, 3.3 for late stock
Parameter estimates:

Early run, α-parameter[b] = 5.54, $1/\beta \approx 32{,}000$ (β-parameter[c] = $3.14\ 10^{-5}$)

Late run, α-parameter = 16.61, $1/\beta \approx 47{,}000$(β-parameter = $2.14\ 10^{-5}$)

Basis of range of escapement goal: Upper and lower bounds equal upper and lower 95% confidence intervals developed by bias-corrected procedure

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S\exp\{-\beta S+\varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Summary

Chilkoot Lake is a glacial lake located about 1 km from tide line, and drains into Lutak Inlet on Lynn Canal. The lake has a surface area of 7.02 km^2 and a mean depth of 89 meters. Chilkoot Lake and associated inlet rivers and streams drain approximately 332 km^2 of land. The lake is set in a transitional zone, with warmer and drier summers, and cooler winters than the rest of Southeast Alaska. The sockeye runs to Chilkoot and Chilkat Lakes are among the largest sockeye salmon runs in Southeast Alaska

The Chilkoot Lake sockeye salmon run consists of 2 stocks, which produce a bimodal entry curve: an early stock uses inlet streams for spawning, while a late stock uses beaches and the outlet stream for spawning

The primary fishery on Chilkoot Lake sockeye salmon is the Lynn Canal gillnet fishery. Sport fishing is an important secondary fishery on salmon runs into Chilkoot Lake, due to the lake's proximity to Haines and easy road access. Subsistence users also catch a portion of the salmon run. The subsistence harvest has been reduced recently because management biologists have encouraged people to target nearby Chilkat River fish to conserve Chilkoot sockeye salmon.

ADF&G has used an adult weir on the Chilkoot Lake outlet to monitor escapement since 1976. An extremely low weir count in 1995 prompted ADF&G to check the weir counts with mark–recapture estimates. Mark–recapture estimates have been considerably higher than the weir counts, by at least 27%. ADF&G is investigating the reasons for the discrepancy. The Northern Southeast Regional Aquaculture Association operates a smolt weir on Chilkoot Lake.

Chilkoot Lake appears to be recovering from an apparent downturn in productivity in the 1990s. The operating hypothesis is that an over escapement of sockeye salmon into the system, followed by an apparent increase of glacial silt into the lake, adversely impacted the food base for sockeye salmon fry. Weir counts fell below desired escapement goals between 1994 and 2000. Zooplankton levels have rebounded in the last several years, and escapement goals have been met in 2001 and 2002.

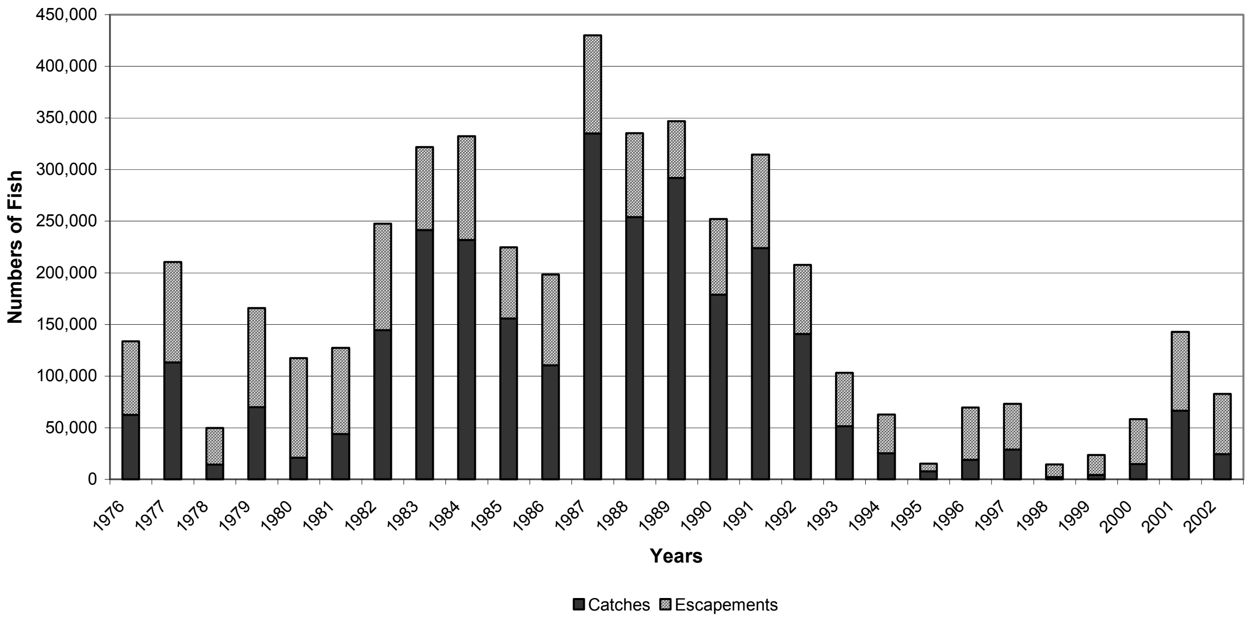
Appendix 2.7.1. Estimated spawning escapements, commercial harvest, total run size, and exploitation rates of Chilkoot Lake sockeye salmon, from 1976 to 2002.

Year	Weir Counts*	Mark–Recapture Estimates	Catch	Total Return	Estimated Exploitation Rate
1976	71,297		62,452	133,749	46.7%
1977	97,051		113,313	210,364	53.9%
1978	35,454		14,264	49,718	28.7%
1979	95,946		69,864	165,810	42.1%
1980	96,512		20,846	117,358	17.8%
1981	83,372		43,792	127,164	34.4%
1982	102,973		144,592	247,565	58.4%
1983	80,343		241,469	321,812	75.0%
1984	100,417		231,792	332,209	69.8%
1985	69,026		155,773	224,799	69.3%
1986	88,024		110,430	198,454	55.6%
1987	95,185		334,995	430,180	77.9%
1988	81,274		253,968	335,242	75.8%
1989	54,900		291,863	346,763	84.2%
1990	73,324		178,864	252,188	70.9%
1991	90,638		224,041	314,679	71.2%
1992	67,071		140,719	207,790	67.7%
1993	51,827		51,424	103,251	49.8%
1994	37,416		25,414	62,830	40.4%
1995	7,209		7,946	15,155	52.4%
1996	50,739	64,718	18,861	69,600	27.1%
1997	44,254	78,610	28,913	73,167	39.5%
1998	12,335	28,015	2,217	14,552	15.2%
1999	19,284	61,722	4,258	23,542	18.1%
2000	43,555	59,910	14,674	58,229	25.2%
2001	76,283	100,006	66,385	142,668	46.5%
2002	58,361	64,000	24,276	82,637	29.4%

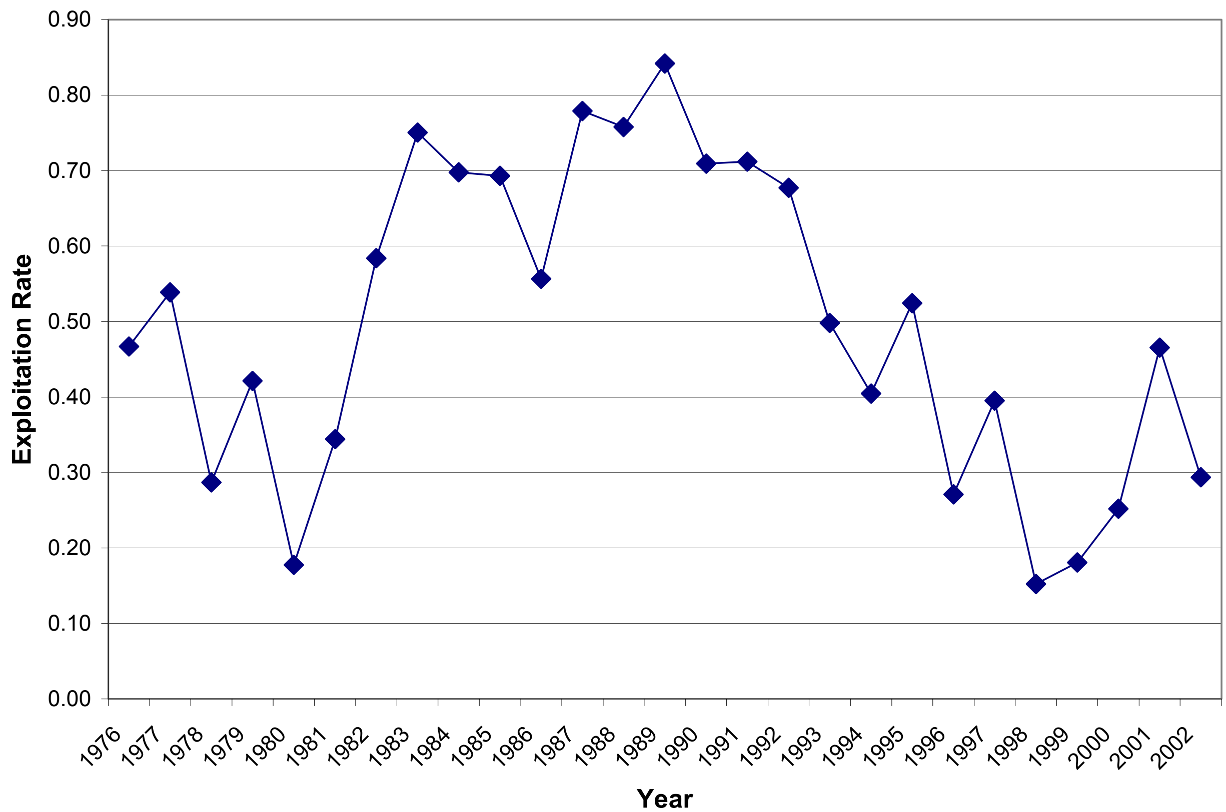
[a] Weir counts are used to represent escapement estimates.

Appendix 2.7.2. Estimated total return of Chilkoot Lake sockeye salmon, brood years 1976 to 2002.

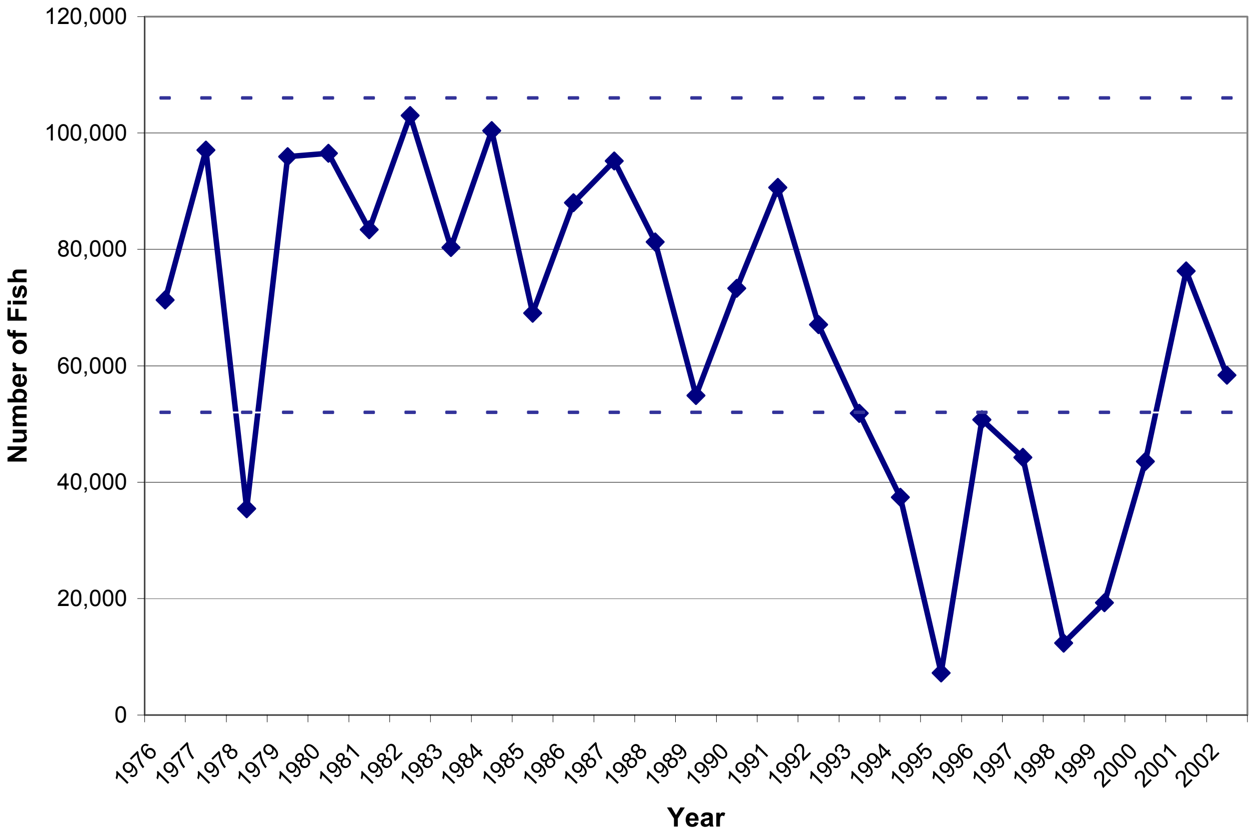
Year	Escapement	Age 3	Age 4	Age 5	Age 6	Age 7	Estimated Total Return	Estimated Return Per Spawner
1976	71,297		8,933	99,862	20,976		129,771	1.82
1977	97,051		9,556	198,529	79,724	139	287,948	2.97
1978	35,454	24	27,952	225,042	23,698	395	277,111	7.82
1979	95,946		16,911	298,328	34,788	501	350,528	3.65
1980	96,512	89	10,044	172,402	30,951	592	214,078	2.22
1981	83,372		17,018	148,666	112,139	719	278,542	3.34
1982	102,973	196	18,293	308,865	38,416	2,827	368,597	3.58
1983	80,343	43	28,298	273,785	123,075	1,752	426,953	5.31
1984	100,417	27	22,322	221,048	116,886	573	360,856	3.59
1985	69,026		13,813	131,511	81,299	869	227,492	3.30
1986	88,024	72	10,103	215,955	69,010	465	295,605	3.36
1987	95,185	85	25,426	145,439	55,417	138	226,505	2.38
1988	81,274	43	4,715	44,890	17,163	66	66,877	0.82
1989	54,900		2,376	44,057	3,272		49,704	0.91
1990	73,324	103	1,016	5,968	5,716	21	12,824	0.17
1991	90,638	457	5,674	58,796	5,670		70,598	0.78
1992	67,071	175	4,843	64,930	4,239	34	74,221	1.11
1993	51,827	245	2,025	9,562	4,106		15,938	0.31
1994	37,416	520	753	12,829	11,827		25,929	0.69
1995	7,209		6,584	36,962	6,408		49,954	*Incomplete return*
1996	50,739		8,902	132,106			141,008	*Incomplete return*
1997	44,254		5,272				5,272	*Incomplete return*
1998	12,335							
1999	19,284							
2000	43,555							
2001	76,283							
2002	58,361							



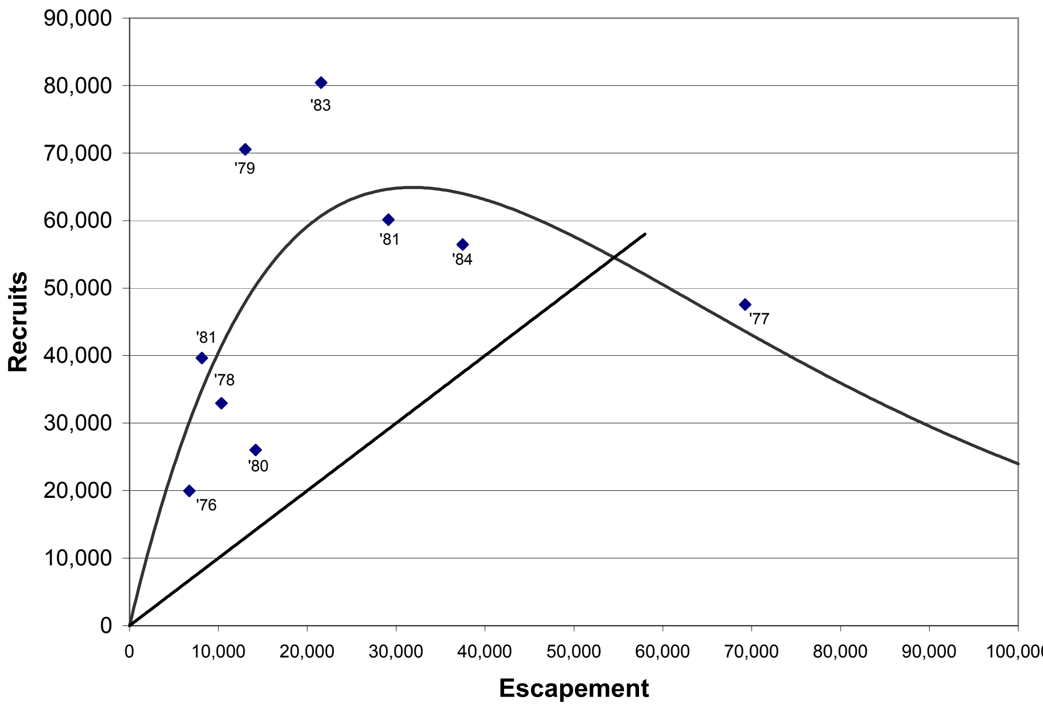
Appendix 2.7.3. Catches and escapements of Chilkoot Lake sockeye salmon, from 1976 to 2002.



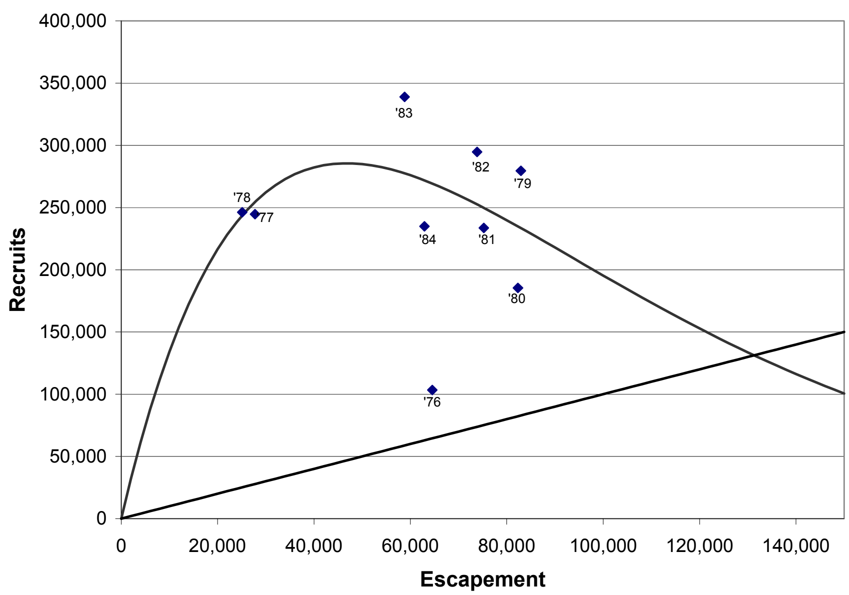
Appendix 2.7.4. Estimated exploitation rates for Chilkoot Lake sockeye salmon, from 1976 to 2002.



Appendix 2.7.5. Observed escapements of Chilkoot Lake sockeye salmon, 1976 to 2002, in comparison to upper and lower escapement goal bounds, delineated as dashed horizontal lines.



Appendix 2.7.6. Estimated stock-recruit relationship for early-run Chilkoot Lake sockeye salmon, based on brood years 1976 to 1984 (after McPherson 1990). The upper curve represents recruitment (total production) predicted by Ricker's model. The dotted curve represents yield predicted by Ricker's model. The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to *x* axis).



Appendix 2.7.7. Estimated stock-recruit relationship for late-run Chilkoot Lake sockeye salmon, based on brood years 1976 to 1984 (after McPherson 1990). The upper curve represents recruitment (total production) predicted by Ricker's model. The dotted curve represents yield predicted by Ricker's model. The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to x axis).

Appendix 2.8. Chilkat Lake sockeye salmon stocks.

System: Chilkat Lake
Species: Sockeye salmon
Stock Unit: Early and late runs

Management Jurisdiction: Alaska Department of Fish and Game

Area Office: Haines

Primary Fisheries: Drift gillnet commercial, subsistence, and sport

Escapement Goal Type: *Biological Escapement Goal*

Basis for the Goal: Stock-recruit analysis using brood years 1976 to 1984

Documentation: McPherson, S. A. 1990. An inseason management system for sockeye salmon returns to Lynn Canal, Southeast Alaska. M. S. Thesis, University of Alaska Fairbanks.

Inriver Goal: None

Action Points: None

Escapement Goal: Overall escapement goal is 52,000 to 106,000 sockeye salmon. For early stocks (age 1. fish), escapement goal range is 14,000 to 28,000. For late run stocks (age 2. fish), escapement goal range is 52,000 to 78,000

Escapement Measures: Weir counts and mark–recapture estimates, 1976 to present

Stock-Recruit Analysis Summary

Model: Ricker[a]
Number of years in model: 9
Ratio of highest escapement to lowest escapement: 5.07 for early stock, 2.74 for late stock
Parameter estimates:

Early run, α-parameter[b] = 4.30, $1/\beta \approx 35{,}000$ (β-parameter[c] = $2.83\ 10^{-5}$)

Late run, α-parameter = 8.05, $1/\beta \approx 47{,}000$ (β-parameter = $2.12\ 10^{-5}$)

Basis of range of escapement goal: Lower bound equals lower value of 95% confidence intervals developed by bias corrected procedure. Upper bound equals upper value of 95% confidence intervals developed by bias-corrected procedure, plus 10%.

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S\exp\{-\beta S+\varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Summary

Chilkat Lake is located about 37 km north of Lynn Canal, the northern terminus of the Inside Passage of Southeast Alaska. The lake and associated inlet rivers and streams drain approximately 105 km^2. Chilkat Lake is a large clear-water lake. The outlet of Chilkat Lake flows into the glacial Tsirku River, which in turn joins the Chilkat River, which empties into Chilkat Inlet in Lynn Canal. During the summer, glacial runoff in the Tsirku River sometimes increases to the point of causing a flow reversal, and glacial water flows into Chilkat Lake via its outlet stream, disrupting escapement estimation.

The Chilkat Lake sockeye run consists of a late run and an early run. The early stock consists primarily of age-1. fish, or fish that have spent 1 winter in freshwater prior to migrating out to sea. The late run consists of primarily age-2. fish, or fish having spent 2 winters in freshwater prior to becoming smolts.

The primary fishery on Chilkat Lake sockeye salmon is the Lynn Canal commercial gillnet fishery. Subsistence is an important secondary use of this stock, although the harvest is appreciably underreported. ADF&G personnel have been meeting with local residents to try and find a way to increase reporting accuracy of subsistence harvests. Some sport fishing takes place on Chilkat Lake, and estimates of sport harvest are generated by a statewide postal survey.

The methods used to estimate escapement into the Chilkat River system include mark–recapture and weir counts at Chilkat Lake. From 1976 to 1996, ADF&G operated the weir at Chilkat Lake. The weir was not operated between 1996 and 1998. ADF&G has operated fish wheels that serve as marking platforms for mark–recapture studies of salmon returning to the Chilkat River drainage since 1996. In 1999, at the request of ADF&G, the Northern Southeast Regional Aquaculture Association began operating the weir as a recovery platform for the fish wheel studies, and also counted the escapements into the lake.

Mark–recapture estimates, calculated with the aid of fish wheel marking platforms, were markedly higher than the weir counts. Flow reversals, opening the gates for boat passage, and fish maneuvering around the weir are some possible reasons for the discrepancy. A large-scale radio tagging study in the Chilkat River is planned in 2003, and this study should help to identify the reasons for differences between the mark–recapture estimates and the weir counts.

Northern Southeast Regional Aquaculture Association stocked sockeye salmon fry in Chilkat Lake from 1994 to 1997 and in 2001, on the premise that wild fish could not produce enough offspring to fully utilize the lake's rearing zones. Supplemental stocking has coincided with large escapements into Chilkat Lake. Zooplankton populations within the lake, the sockeye fry food base, have been substantially altered since the early 1990s, and are showing signs of being over-taxed. Supplemental stocking was suspended from 1998 to 2000 and again in 2002 pending recovery of the zooplankton populations.

In 2001, ADF&G and the Northern Southeast Regional Aquaculture Association agreed upon several trigger points for zooplankton densities, smolt size, and smolt biomass, which must be met prior to scheduling an egg take. Northern Southeast Regional Aquaculture Association is currently reviewing smolt, zooplankton, and hydroacoustic data to revamp the size of future proposed egg takes and fry stockings.

Appendix 2.8.1. Estimated spawning escapements, commercial harvest, total run size, and exploitation rates of Chilkat Lake sockeye salmon, from 1976 to 2002.

Year	Weir Counts	Mark–Recapture Estimates	Escapement Estimates	Catch	Total Return	Estimated Exploitation Rate
1976	69,729		69,729	59,328	129,057	46.0%
1977	41,044		41,044	41,389	82,433	50.2%
1978	67,528		67,528	89,558	157,086	57.0%
1979	80,589		80,589	115,994	196,583	59.0%
1980	95,347		95,347	30,681	126,028	24.3%
1981	84,089		84,089	48,460	132,549	36.6%
1982	80,221		80,221	127,036	207,257	61.3%
1983	134,207		134,207	123,888	258,095	48.0%
1984	115,269		115,269	98,231	213,500	46.0%
1985	57,724		57,724	135,503	193,227	70.1%
1986	23,947		23,947	168,361	192,308	87.5%
1987	48,593		48,593	70,069	118,662	59.0%
1988	27,593		27,593	76,473	104,066	73.5%
1989	140,475		140,475	159,446	299,921	53.2%
1990	60,231		60,231	147,056	207,287	70.9%
1991	52,889		52,889	59,806	112,695	53.1%
1992	97,740		97,740	111,887	209,627	53.4%
1993	209,730		209,730	100,717	310,447	32.4%
1994	80,764	153,540	153,540	122,212	275,752	44.3%
1995	59,558	184,541[a]	184,541	63,396	247,937	25.6%
1996	*no weir*	262,852	262,852	96,380	359,232	26.8%
1997	*no weir*	238,803	238,803	70,056	308,859	22.7%
1998	*no weir*	211,114	211,114	120,644	331,758	36.4%
1999	129,533	236,374	236,374	149,715	386,089	38.8%
2000	47,077	131,322	131,322	78,868	210,190	37.5%
2001	76,283	131,687	131,687	58,947	190,634	30.9%
2002	65,085	137,566	137,566	47,286	184,852	25.6%

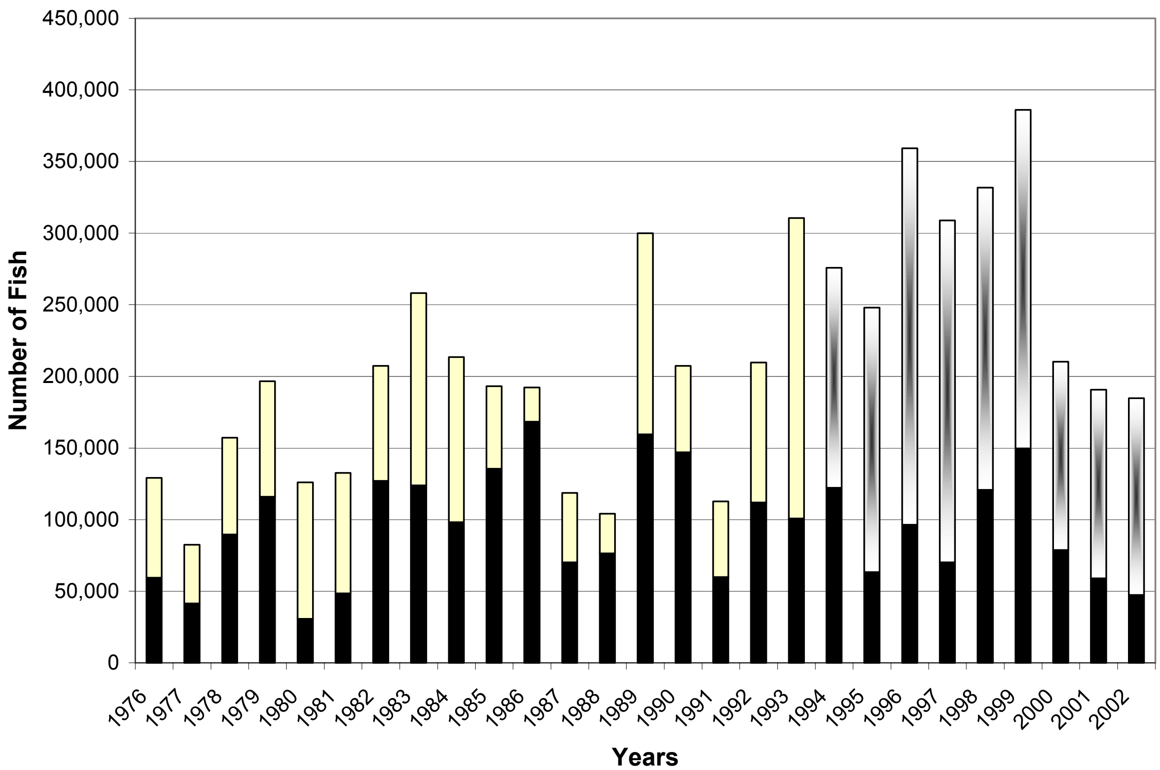
[a] Estimate was derived from marking experiment at the weir.

Appendix 2.8.2. Estimated total return of Chilkat Lake sockeye salmon, brood years 1976 to 2002.

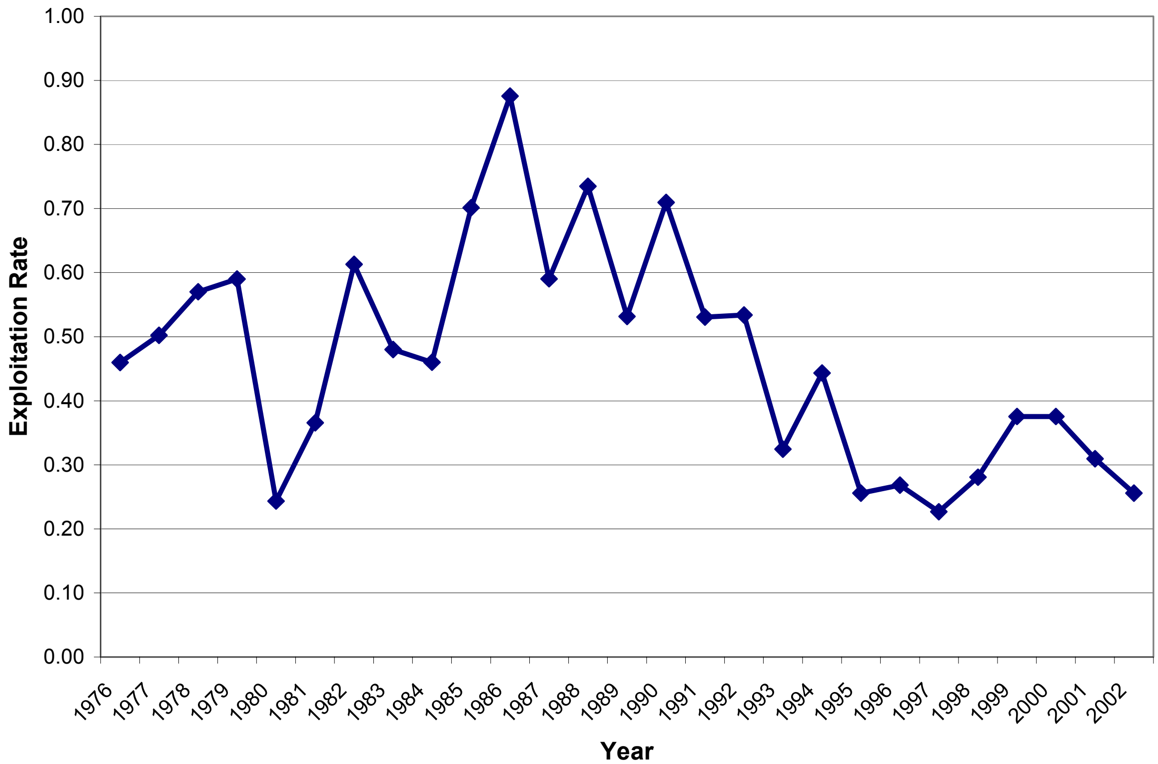
Year	Escapement	3-Year Old	4-Year Old	5-Year Old	6-Year Old	7-Year Old	8-Year Old	Estimated Total Return	Estimated Return Per Spawner
1976	69,729		3,053	72,275	98,928	203		174,459	2.50
1977	41,044		1,800	102,160	103,535	224		207,719	5.06
1978	67,528		5,053	142,192	52,042	80		199,367	2.95
1979	80,589	220	11,198	156,867	120,783	469		289,537	3.59
1980	95,347	967	4,235	81,654	117,182	400		204,438	2.14
1981	84,089	134	3,353	70,411	42,467	280	70	116,645	1.39
1982	80,221	444	4,246	71,838	55,085	184		131,797	1.64
1983	134,207		3,246	46,392	89,635	242		139,515	1.04
1984	115,269	711	2,292	208,091	114,693	502	50	326,289	2.83
1985	57,724		1,534	90,427	56,691	341		148,993	2.58
1986	23,947	171	2,896	52,990	99,548	0		155,605	6.50
1987	48,593		2,220	107,802	142,200	0		252,222	5.19
1988	27,593	16	2,003	142,431	100,425	0	0	244,875	8.87
1989	140,475	133	15,236	196,489	121,447	63		333,368	2.37
1990	60,231		6,458	112,478	123,961	364	0	243,261	4.04
1991	52,889		13,512	219,553	147,719	585	0	381,369	7.21
1992	97,740		15,655	130,071	97,412	532	0	243,670	2.49
1993	209,730		27,182	216,629	174,338	729	0	418,878	2.00
1994	153,540	3,524	14,342	189,077	163,952	4,975	0	375,870	2.45
1995	184,541	2,790	10,875	30,123	40,664			84,452	*Incomplete return*
1996	262,852	3,540	12,664	125,043				141,247	*Incomplete return*
1997	238,803	2,703	17,374					20,077	*Incomplete return*
1998	211,114	2,580							
1999	236,674								
2000	131,322								
2001	131,687								
2002	137,566								

Appendix 2.8.3. Stocking history of sockeye salmon into Chilkat Lake, estimated number of smolts produced from stocked fry, and estimated survivals, from 1994 to 2002.

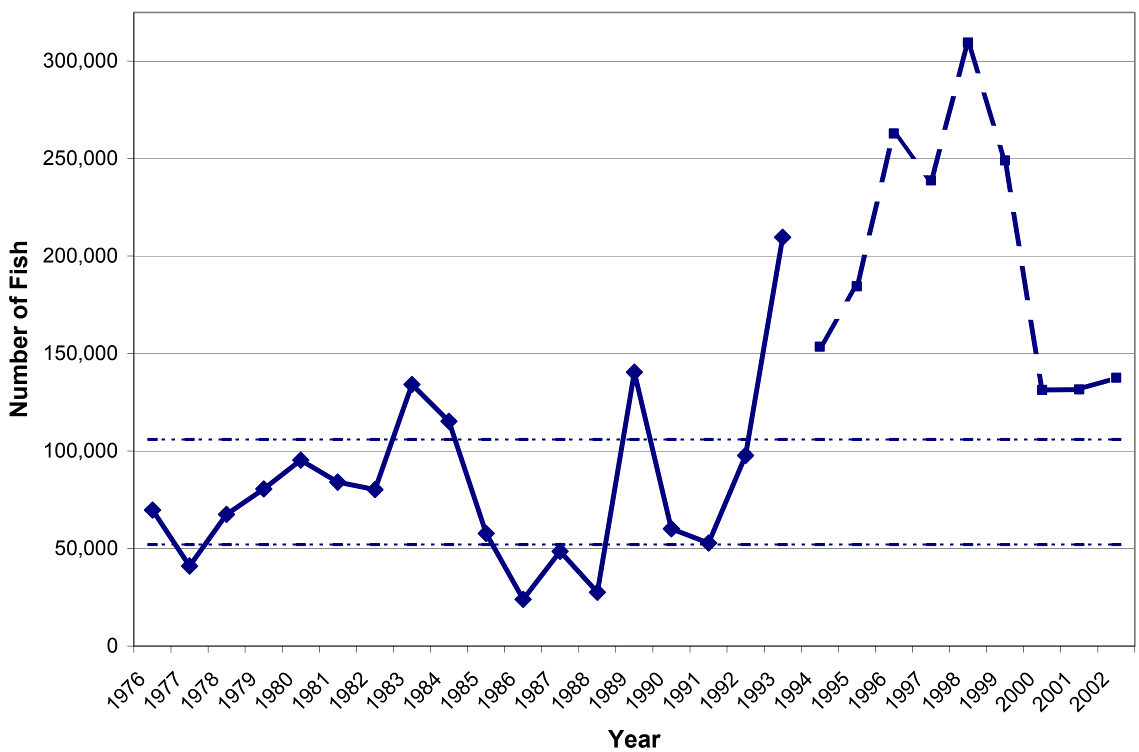
Year Stocked	Number of Fry Stocked	Smolts Produced			Total Smolts Produced	Percent Fry-to-Smolt Survival
		Age 1.	Age 2.	Age 3.		
1994	4,400,000	686,000	330,000	0	1,016,000	23.1%
1995	2,394,000	269,000	377,000	16,000	662,000	27.7%
1996	2,691,000	99,000	34,000	25,000	158,000	5.9%
1997	2,807,000	221,000	447,000	0	668,000	23.8%
1998	0					
1999	0					
2000	0					
2001	2,699,000	2,000				



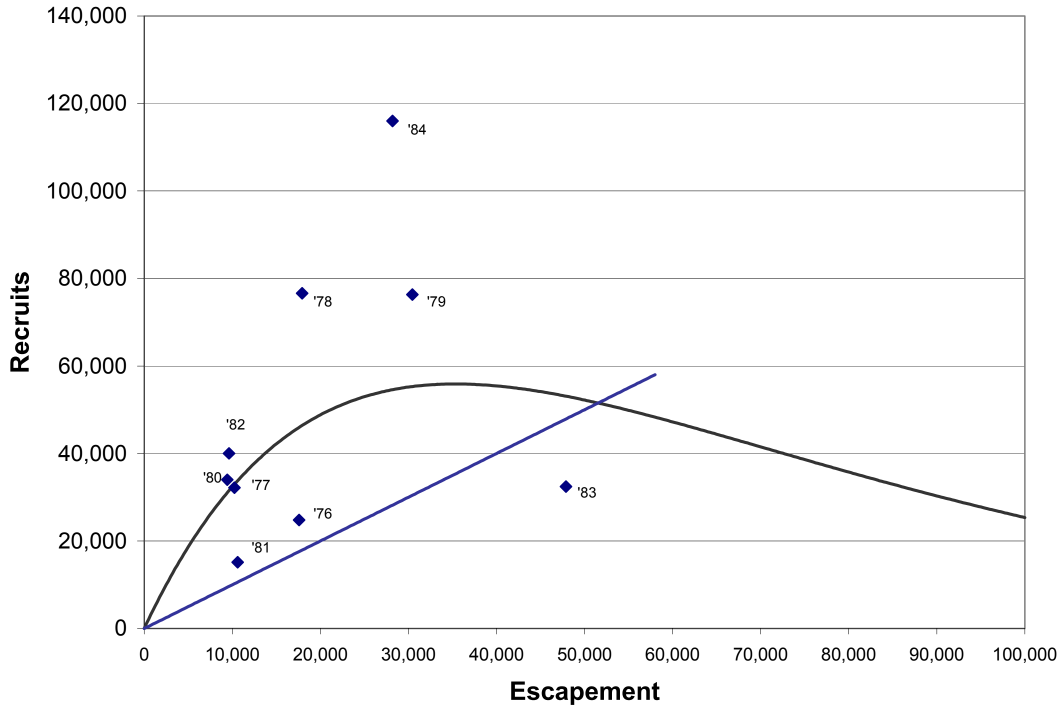
Appendix 2.8.4. Catches and escapements of Chilkat Lake sockeye salmon, from 1976 to 2002. Catches delineated by black bars, weir counts by lighter bars (1976 to 1993), mark–recapture escapement estimates denoted by center shading (1994 to 2002).



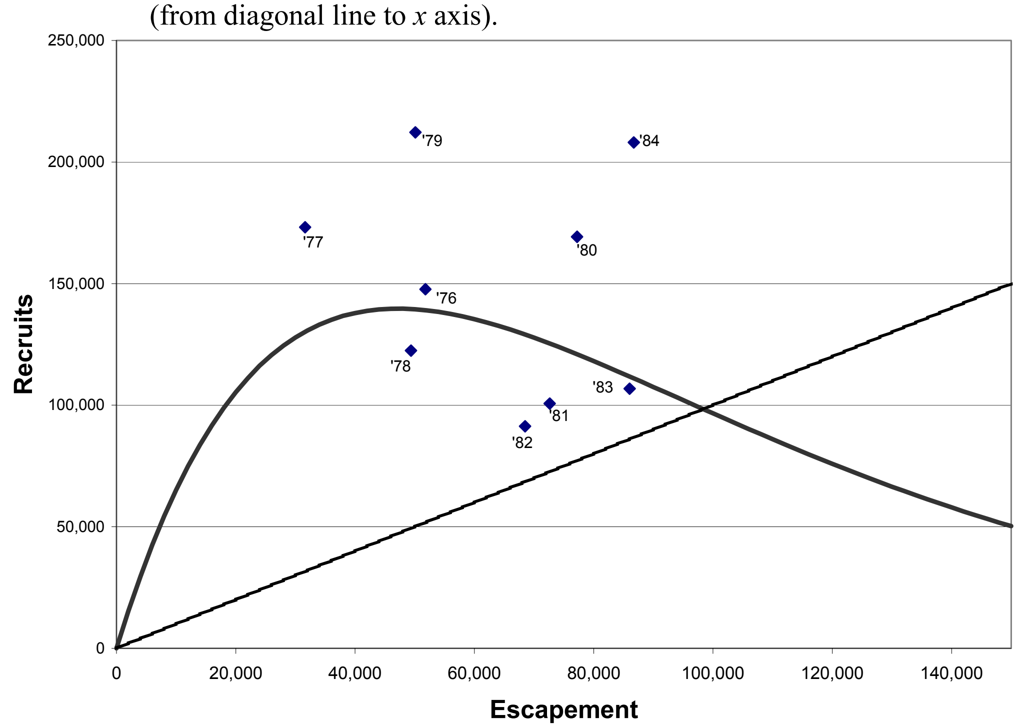
Appendix 2.8.5. Estimated exploitation rates for Chilkat Lake sockeye salmon, from 1976 to 2002.



Appendix 2.8.6. Escapement estimates for Chilkat Lake sockeye salmon, 1976 to 2002. The solid line delineates weir counts, the heavy dotted line represents mark–recapture estimates, and the light dotted lines denote the upper and lower bounds of the escapement range.



Appendix 2.8.7. Estimated stock-recruit relationship for early-run Chilkat Lake sockeye salmon, based on brood years 1976 to 1984 (after McPherson 1990). The curve represents production predicted by Ricker's model. The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to *x* axis).



Appendix 2.8.8. Estimated stock-recruit relationship for late-run Chilkat Lake sockeye salmon, based on brood years 1976 to 1984 (after McPherson 1990). The curve represents production predicted by Ricker's model. The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to *x* axis).

Appendix 2.9. Redoubt Lake sockeye salmon.

System: Redoubt Lake
Species: Sockeye salmon
Stock Unit: Redoubt Lake

Management Jurisdiction: Alaska Department of Fish and Game, U.S. Forest Service

Area Office: Sitka

Primary Fishery: Subsistence and sport

Escapement Goal Type: *Biological Escapement Goal, Optimal Escapement Goal*

Basis for Goal: Stock-recruit model using brood years 1982 to 1996

Documentation: Geiger, H. J. 2003. Sockeye salmon stock status and escapement goals for Redoubt Lake in Southeast Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 1J03-01. Juneau, Alaska.

Inriver Goal: None

Action Points: Numerous (described in new Redoubt Lake Management Plan passed by the Board of Fisheries in January 2003)

Escapement Goal: 10,000 to 25,000 fish (*Biological Escapement Goal*)
7,000 to 25,000 fish (*Optimal Escapement Goal*)

Escapement Measures: Weir counts, 1982 to 1997, 1999 to present

Stock-Recruit Analysis Summary

Model: Ricker[a]
Number of years in model: 15
Ratio of highest escapement to lowest escapement: 160
Parameter estimates: α-parameter[b] = 4.30 ("bias adjusted" value is 8.55), $1/\beta \approx 23{,}000$ (β-parameter[c] = 4.30 10^{-5}), σ^2-parameter = 1.294
Basis of range of escapement goal: Range of sustained escapements expected to produce at least 90% of *maximum sustained catch*, rounded to the nearest whole 2,500 spawners

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[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Summary

Redoubt Lake is a large sockeye-producing system located about 11 km south of Sitka, Alaska, just inside the southwest entrance to Sitka Sound on the west coast of Baranof Island. The lake has a drainage area of about 113 km^2, a volume of 2,311 hm^3, a surface area of about 16.6 km^2 and a maximum depth of approximately 266 meters. The lake is meromictic, with an approximately 100 m deep freshwater lens that overlays a bottom layer of dense, anoxic saltwater.

After 2 years of pre-fertilization monitoring, fertilization of Redoubt Lake began in 1984 and continued through 1987. Fertilization was stopped in 1988 and 1989, but continued again from 1990 to 1995. Throughout this time, slightly different delivery modes were used, although the fertilizer was broadcast throughout the lake, at intervals throughout the summer, in a liquid form. When fertilization restarted, beginning in 1998, the U.S. Forest Service used dry pellets fertilizer (i.e., starting in 1998, a completely different delivery mode and fertilizer level was used).

Weirs have been used to estimate escapement in most years from 1982 to the present. Run timing of the Redoubt Lake sockeye salmon run is fairly early and extended, with the first fish usually entering the lake in June, counts peaking at the end of July, and fish continuing to enter the lake well into September. Harvests in the marine waters of Redoubt Bay and fresh waters of the Redoubt Lake drainage are assumed to be entirely of Redoubt Lake origin—although those harvest levels have been estimated in a variety of ways over the entire time series.

The escapement was measured at fewer than 500 fish in 1982, but escapement level rose to over 70,000 in 1990, and subsequently fluctuated between very high, moderate sizes, and even low stock sizes. Production in this system has been highly variable, with fishing effort appearing to cause very little of the variability in recruitment. Overall, there is no substantial trend, up or down, in escapement level.

ADF&G set an escapement goal for this system in 2003 using a Ricker analysis. Virtually the entire data set used to generate the Ricker model was collected while the lake was undergoing the intensive fertilization. There is very little, if any, evidence that the fertilization affected sockeye salmon productivity in Redoubt Lake, and the escapement goal that was recommended is based on the assumption the fertilization *did not* increase productivity. If the fertilization did have an effect on the lake's productivity, then the recommended escapement goal may not lead to escapements that will maximize yield—even though the recommended goal of 10,000 to 25,000 spawners still may be preferred for other reasons.

Appendix 2.9.1. Stock status statistics for Redoubt Lake sockeye salmon. Weir counts, harvest, and total return estimates are for return year.

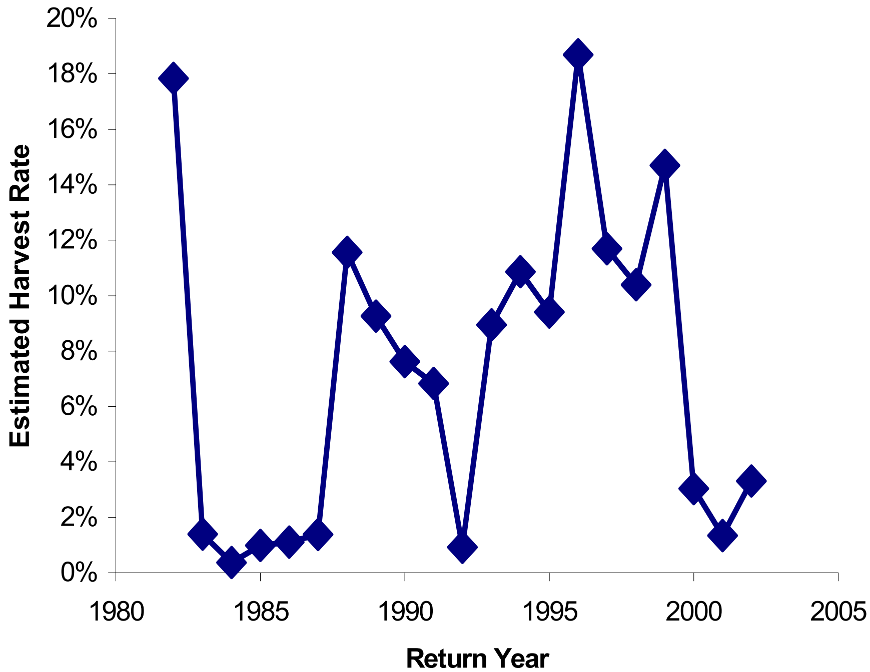
Year	Full limnology Survey[a]	Adult Weir Count	Adult Escapement Estimate[b]	Estimated Subsistence Harvest[c]	Sportfish Mail Survey[d]	Onsite Creel Survey[e]	Total Harvest Estimate[f]	Total Adult Return	Fry Stocking Activity[g]		Fertilization Activity		Other Enhancement Activities		
									Species	Number	Fert (tons)	Total P (kg)	Activity	Species	Number
1953	no	22,988													
1954	no	21,148													
1955	no	23,648													
-															
1980	yes														
1981	yes														
1982	yes	430	456				99	555							
1983	yes	2,525	2,540				36	2,576							
1984	yes	11,558	11,579		n.e.	.	42	11,62			61	1,682			
1985	yes	10,669	10,991	97	n.e.		109	11,10			65	1,763			
1986	yes	9,414	9,798	86	n.e.		109	9,907	sockeye	28,220	78	2,163	fry stocking	chinook	900,00
1987	yes	12,990	14,251	199	n.e.		199	14,45	sockeye	28,711	75	3,045			
1988	yes	1,889	3,252	334	n.e.		425	3,677							
1989	no	28,669	31,570	2,685	n.e.		3,220	34,79	sockeye	38,800					
1990	yes	72,517	73,181	5,326	703		6,029	79,21	sockeye	59,520	107	3,045			
1991	yes	45,039	45,510	3,105	n.e.		3,337	48,84	sockeye	236,436[f]	97	2,844			
1992	yes	10,231	10,326	96	n.e.		96	10,42			95	2,003			
1993	yes	24,422	25,018	2,326	130		2,456	27,47			109	3,205			
1994	yes	39,216	39,710	4,120	721		4,841	44,55			80	1,682			
1995	yes	34,280	34,798	2,968	646		3,614	38,41			94	2,740			
1996	yes	18,076	19,209	3,337	n.e.		4,415	23,62							
1997	no	28,898	28,898	2,253	n.e.		3,822	32,72							
1998	no	na	52,039	4,296	1,734		6,030	58,06							
1999	yes	57,754	57,754	6,761	3,192		9,953	67,70			9				
2000	yes	2,948	3,032	35	n.e.	95	95	3,127			10				
2001	yes	3,499	3,665	16	n.a.	50	50	3,715			10				
2002	n.a	23,943	23,943	952	n.a.	820	820	24,76			n.a.				

[a] Full limnology survey includes water chemistry, zooplankton, and physical characteristics including light, temp and DO profiles by depth.
[b] Provided by Ben Van Alen of the U.S. Forest Service, Juneau, AK.
[c] Harvest includes sockeye salmon harvested in subsistence and sport fisheries from returned permits and questionnaires; no terminal commercial harvest; indirect commercial harvest unknown.
[d] Estimates are estimated annual sport fish harvest based on a mail survey. Estimates are reported only when the number of responses exceeds 12; “n.e.” denotes less than 12 responses.
[e] On-site creel survey of subsistence and sport harvest conducted in 2000 to 2002.
[f] Sum of what was considered the best estimate of subsistence and sport harvests.
[g] Fry stocking involved incubation boxes for sockeye salmon, with survival estimates to hatching only; chinook salmon fry were stocked also in 1986.
[h] Liquid fertilizer applied by boat from 1984 to 1995; granular fertilizer suspended in bags and applied to beaches from 1999 to 2001.
The weir count for 2002 is preliminary.

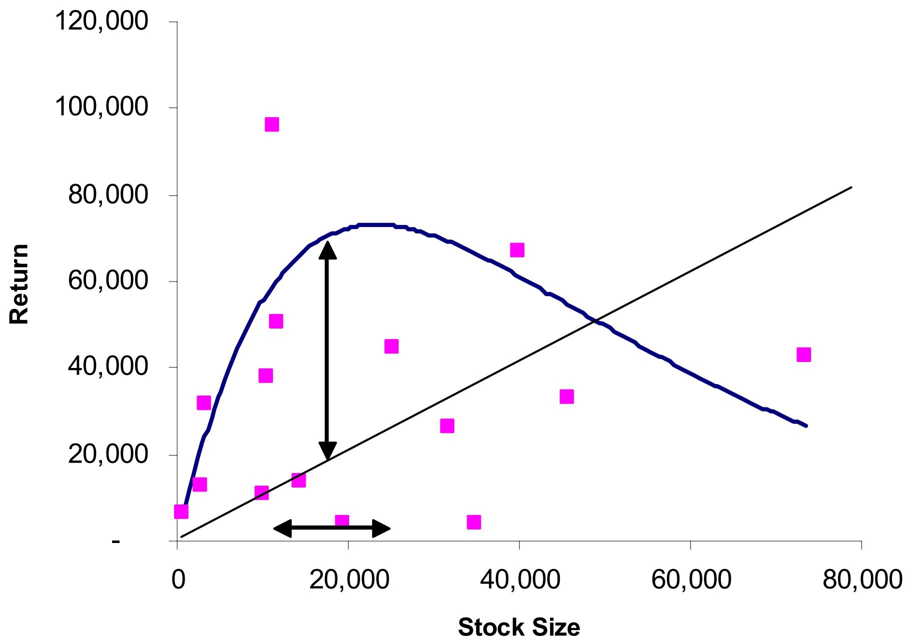
Appendix 2.9.2. Estimated brood-year specific return of Redoubt Lake sockeye salmon. Columns denote brood years, and rows denote return year. Column totals denote estimated return for the brood year, based on the estimated age classes.

Return Year	Estimated Escapement	Estimated Harvest	Total Run	Brood Year																	
				1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995[a]	1996[a]
1982	456	99	555	2																	
1983	2,540	36	2,576	640	8																
1984	11,579	42	11,621	7,716	732																
1985	10,991	109	11,100	7,226	3,408	133	78														
1986	9,798	109	9,907	85	4,750	3,190	1,813	69													
1987	14,251	199	14,450		43	3,771	4,596	5,939	101												
1988	3252	425	3,677			0	349	2,850	478	0											
1989	31,570	3,220	34,790				35	4,070	27,589	2,922	174										
1990	73,181	6,029	79,210					0	21,070	53,467	4,198	475									
1991	45,510	3,337	48,847						1,270	39,956	3,273	4,250	98								
1992	10,326	96	10,422							198	3,043	4,691	1,740	750							
1993	25,018	2,456	27,474								247	4,039	13,737	9,149	302						
1994	39,710	4,841	44,551									713	16,172	14,968	12,252	446					
1995	34,798	3,614	38,412										115	1,959	27,504	5,339	3,495				
1996	19,209	4,415	23,624											24	2,929	13,962	5,977	732			
1997	28,898	3,822	32,720												0	12,990	14,789	4,025	916		
1998	52,039	6,030	58,069													514	14,536	31,870	10,085	1,064	
1999	57,754	9,953	67,707														0	10,156	56,400	1,016	135
2000	3,032	95	3,127															0	191	2,010	844
2001	3,665	50	3,715																0	74	2,544
2002	23,943	820	24,763																		
			Estimated Return:	15,669	8,940	7,095	6,870	12,928	50,507	96,544	10,935	14,167	31,862	26,851	42,987	33,250	38,798	46,784	67,592	*4,242*	*4,362*

Age composition of total adult return extrapolated from scale sampling of escapement.
[a] Total return for 1995 and 1996 brood years was based on statistically expanding the return up to 2001. The expansion was based on the average rage class at return for the 1982 to 1994 brood years. Note the 1982 to 1985, and the 2000 and 2001 return year's total return do not sum to row totals because these include brood years not in this table.



Appendix 2.9.3. Estimated harvest rate on Redoubt Lake sockeye stock, 1982 to 2002.



Appendix 2.9.4. Estimated stock-recruit relationship for Redoubt Lake sockeye salmon, based on brood years 1982 to 1996. The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to *x* axis). The horizontal arrow shows the region of escapement levels expected to produce at least 90% of the *maximum sustainable yields*.

Appendix 2.10. Taku River sockeye salmon stock

System: Taku River
Species: Sockeye Salmon
Stock Units: Kuthai Lake, Little Trapper Lake, Tatsamenie Lake, Mainstem Taku River

Management Jurisdiction: ADF&G, CDFO: Joint management through the Pacific Salmon Commission

Area Office: Douglas (ADF&G), Whitehorse Y. T. (CDFO)

Primary Fisheries: Drift Gillnet, U.S. Commercial, Canadian Commercial

Secondary Fisheries: Personal Use, Canadian Aboriginal, Recreational

Escapement Goal Type: *Sustainable Escapement Goal*

Basis for Goal: Best professional judgment. Goal set by Transboundary Technical Committee in 1985.

Documentation: Transboundary Technical Committee. 1986. Report of the Canada/United States Transboundary Technical Committee. Transboundary Technical Committee Report (86). Final Report. February 5, 1986.

Inriver Goal: None

Action Points: None

Escapement Goal: System-wide escapement goal of 71,000 to 80,000 fish

Escapement Measures: Darroch Mark–Recapture Estimate,1984–2002, Canyon Island Fish Wheel project, ADF&G; Canadian Dept. Fisheries and Oceans weir sites on Kuthai, Little Trapper, and Tatsamenie Lakes.

Stock-Recruit Analysis Summary

Not applicable

Summary

The transboundary Taku River originates in the Stikine Plateau of northwestern British Columbia and drains an area of approximately 17,000 square km. The Taku is formed by the merging of 2 principal tributaries, the Inklin and Nakina Rivers, approximately 50 km upstream from the international border. The river flows southwest from this point through the Coast Mountain Range and empties into Taku Inlet about 30 km east of Juneau, Alaska. Approximately 95% of the watershed lies within Canada. The mainstem Taku River is highly turbid because much of its discharge originates from glaciers. This turbidity makes visual estimation of salmon escapements impossible in many areas, although some headwater lakes and rivers are clear.

Taku River sockeye salmon support directed commercial gillnet fisheries in Alaska's District 111 and, since 1979, in a Canadian inriver fishery located near the U.S./Canada border. A sockeye salmon-directed personal use fishery is allowed in the Taku River during the month of July. Canadian aboriginal food fisheries harvest sockeye salmon in the lower river, and some are taken in a Canadian test fishery that is operated for stock assessment purposes. Although there is some recreational harvest of Taku River sockeye salmon, numbers are considered to be very small and are not included in run reconstructions. Management of salmon returning to the Taku River has been under the auspices of the Pacific Salmon Commission since the signing of the U.S./Canada Pacific Salmon Treaty in 1985. The Treaty specifies harvest sharing of the Total Allowable Catch of sockeye migrating originating in Canada; total allowable catch is the harvest in excess of the escapement goal. The 2 countries publish an annual joint management plan for fisheries on these stocks, through the bilateral Transboundary Technical Committee of the Pacific Salmon Commission (Transboundary Technical Committee 2001a and b). Fishery managers from ADF&G and CDFO have inseason communications on a weekly basis to discuss various aspects of stock assessment and management of the run in order to coordinate their actions.

The river supports a diverse assemblage of sockeye salmon stocks returning to lakes and streams in the headwaters, as well as substantial numbers that spawn in the mainstem river and side sloughs, and not associated with lakes. There is a small, largely unmonitored amount of spawning that occurs in several small tributary streams on the U.S. side of the border. A joint U.S./Canada mark–recapture program is operated inriver (Kelley and Milligan 1997). The agencies operate fish wheels at Canyon Island, located approximately 4 km downstream from the border. Fish are sampled for length and scales and are tagged and released at that location. The Canadian fishery located just upstream serves as the principal tag recovery site. Weekly in-season estimates of the escapement past the Canyon Island field site have been generated by the program since 1984. In addition to the mark–recapture project, a number of counting weirs are operated by Canada in headwater lake systems. Long-term weir count datasets are available for the Tatsamenie Lake system (1985 to the present), the Trapper Lake system (1983 to the present), Kuthai Lake (1980–1981 and 1992 to the present). Weirs have been operated intermittently on several other headwater systems, including the Nahlin River and Hackett River.

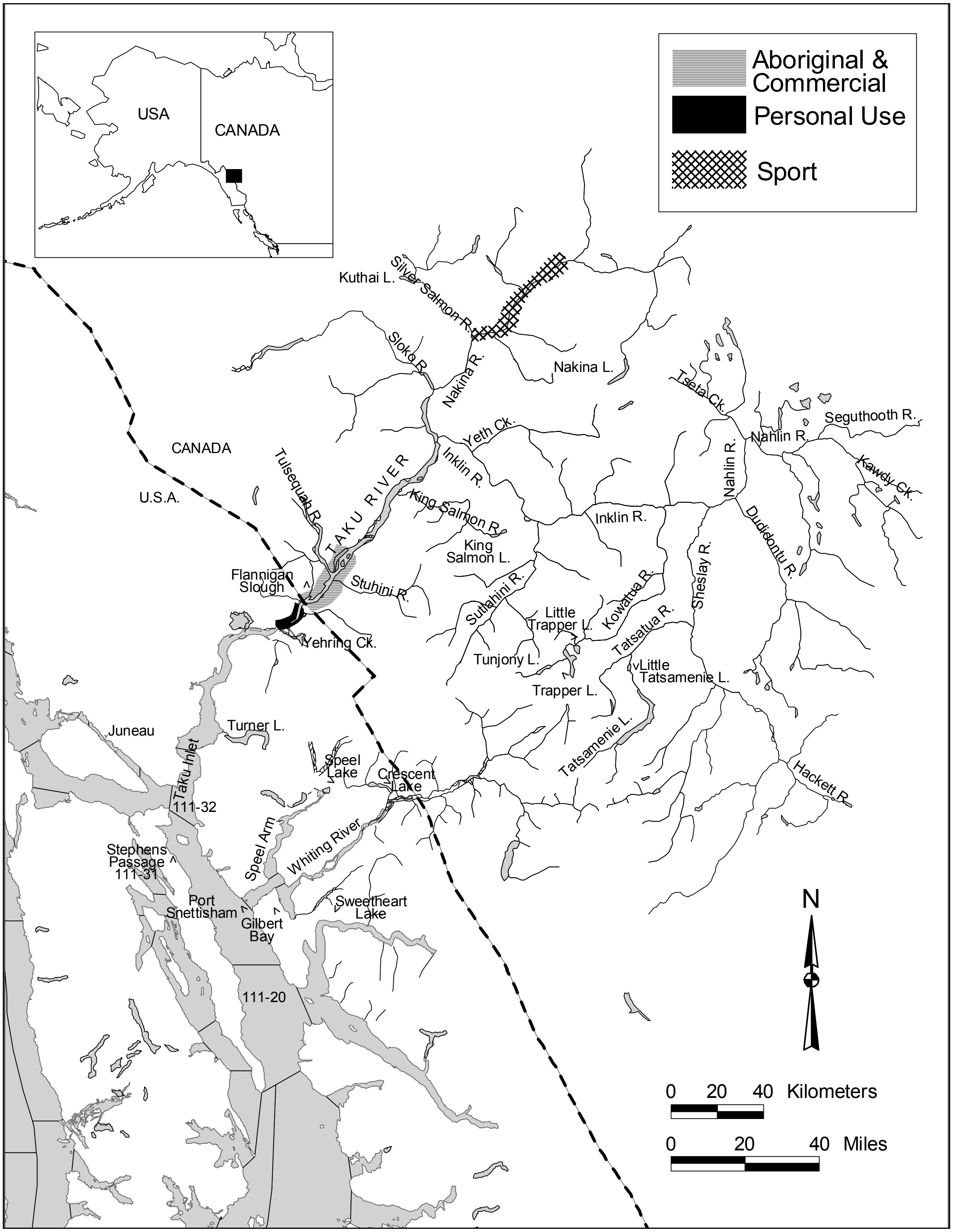
Harvests of Taku River sockeye salmon have been estimated from stock identification studies of the District 111 commercial gillnet fishery since 1983. Beginning in 1986, the process was refined to provide contribution estimates for 4 Taku River stock groups (Kuthai Lake, Little Trapper Lake, Tatsamenie Lake and Mainstem) and 2 domestic Port Snettisham stock groups (Crescent and Speel Lakes) (McGregor and Walls 1987). Since that time, analysis of brain parasites (Moles et al. 1990) has been combined with scale pattern analysis and thermal otolith

mark sampling (to estimate hatchery origin fish) to provide postseason estimates of stock contribution of marine harvests (Jensen 2000). Scale pattern analysis is also used to assign Canadian inriver commercial catches to Taku stock group of origin. The mark–recapture and stock identification datasets are combined to reconstruct the Taku River sockeye salmon runs.

The countries have operated a bilateral sockeye salmon enhancement program, as specified in the Annexes to the Pacific Salmon Treaty, since 1990 (Transboundary Technical Committee 2001b). Brood stock have been collected at the Trapper and Tatsamenie Lake systems, and gametes have been flown to the Snettisham Hatchery in Alaska where they are incubated and treated to mark their otoliths—allowing the fish to be distinguished throughout their lives. Resultant fry are returned to the lake systems they originated from. Survivals of hatchery-incubated fish stocked into Canadian lakes have been poor. Fry stocking into the Trapper Lake system was suspended in 1995 as a result of low production and biological concerns with the program, and the countries are evaluating the Tatsamenie program to determine the cause of the poor survivals of fry plants in that system.

Taku River sockeye salmon runs have been experiencing record high abundances since 1990, including record harvests in the District 111 and Canadian inriver fisheries. Escapements have been within or exceeded the interim escapement goal range of 71,000 to 80,000 fish every year since the escapement monitoring program began in 1984. Fishery managers of both countries target the overall escapement goal for the drainage. However they also take management actions to increase escapements or allow increased harvests from particular segments of the run that are assessed to be either strong or weak. This is possible because of differences in run timing among the major stocks returning to the drainage (McGregor et al. 1991).

The Transboundary Technical Committee adopted an "interim" escapement goal range of 71,000 to 80,000 for sockeye salmon spawning in Canadian portions of the drainage in 1985 (Transboundary Technical Committee 1986). The goal was based largely on professional judgment and is considered to be an interim goal until a formal scientifically-based goal is developed. The Transboundary Technical Committee is currently compiling detailed age-specific run reconstruction data to allow stock-recruitment analyses to be conducted. Escapement goals for individual stocks within the river system have not been developed.

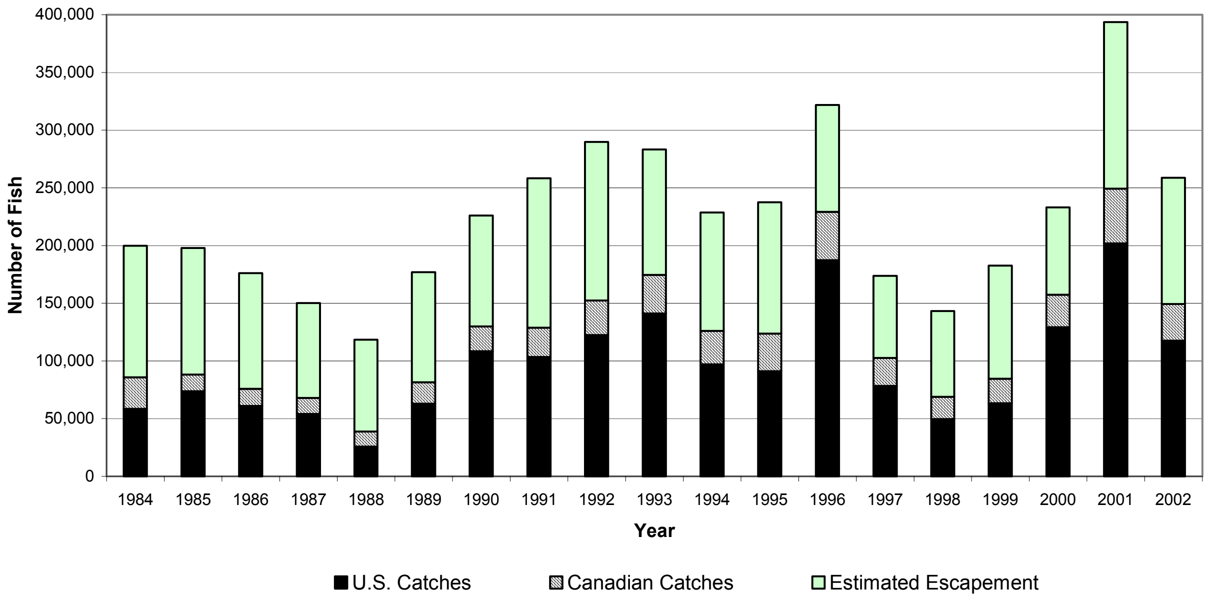


Appendix 2.10.1. Taku River drainage and surroundings, showing location of commercial, sport, and recreational fisheries.

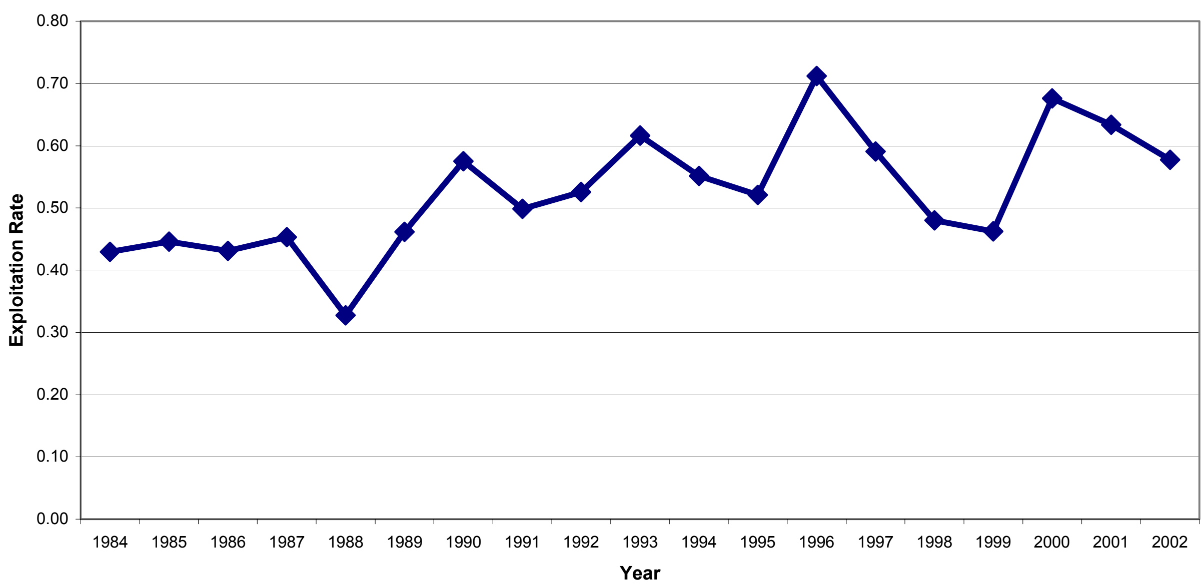
Appendix 2.10.2. Estimated catches of Taku River sockeye salmon in the U.S. and in Canada, estimated escapements into Canadian waters, and estimated harvest rates in the combined fisheries, from 1984 to 2002.

Year	U.S. Catch	Canadian Catch	Estimated Escapement	Total Run	Estimated Harvest Rate
1984	58,543	27,292	113,962	199,796	43.0%
1985	74,729	14,411	109,563	198,703	44.9%
1986	60,934	14,939	100,106	175,980	43.1%
1987	55,154	13,887	82,136	151,178	45.7%
1988	25,811	12,967	79,674	118,452	32.7%
1989	63,367	18,805	95,263	177,435	46.3%
1990	109,292	21,474	96,099	226,865	57.6%
1991	104,931	25,380	129,493	259,804	50.2%
1992	123,655	29,862	137,514	291,031	52.7%
1993	142,239	33,523	108,625	284,387	61.8%
1994	98,157	29,001	102,579	229,737	55.3%
1995	91,998	32,711	113,739	238,448	52.3%
1996	188,396	42,025	92,626	323,047	71.3%
1997	79,341	24,352	71,086	174,779	59.3%
1998	50,646	19,277	74,451	144,374	48.4%
1999	64,580	21,151	98,241	183,972	46.6%
2000	129,258	28,237	75,498	232,993	67.6%
2001	201,960	47,502	144,286	393,748	63.4%
2002	117,610	31,726	109,337	258,673	57.7%

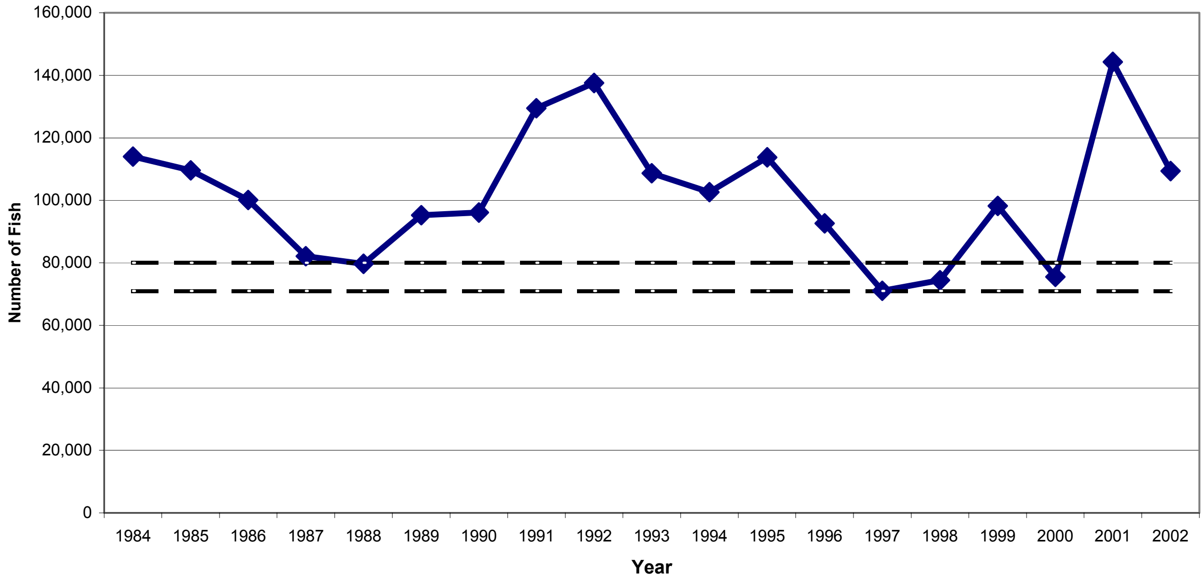
Catches and escapements for 2002 are preliminary.



Appendix 2.10.3 Estimated catches of Taku River sockeye salmon in the U.S. and in Canada, as well as escapement into Canadian waters, from 1984 to 2002. Escapement estimates do not include escapements below the U.S./Canada border. Catch and escapement estimates for 2002 are preliminary.



Appendix 2.10.4. Estimated exploitation rate of Taku River sockeye salmon in U.S. plus Canadian fisheries, from 1984 to 2002. The estimated rate for 2002 is preliminary.



Appendix 2.10.5. Estimated escapement of Taku River sockeye salmon into Canadian waters, from 1984 to 2002. Heavy line is estimated escapement, dotted lines are escapement bounds. Escapement estimates does not include escapements below the U.S./Canada border. The 2002 escapement estimate is preliminary.

Appendix 2.10.6. References cited for Taku River sockeye salmon.

Jensen, K. A. 2000. Research programs and stock status for salmon in three transboundary rivers. Pages 273–294 *in* E. E. Knudsen, C.R. Steward, D. D. MacDonald, J. E. Williams, and D. W. Reiser (*editors*). Sustainable Fisheries Management: Pacific salmon. Lewis Publishers, Boca Raton, Florida.

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Moles, A., P. Rounds, and C. Kondzela. 1990. Use of the brain parasite *Myxobolus neurobius* in separating mixed stocks of sockeye salmon. Pages 224–231 *in* R. C. Parker, and five coauthors. Fish Marking Techniques. American Fisheries Society, Symposium 7, Bethesda, Maryland.

TTC (Transboundary Technical Committee). 1986. TCTR (86). Report of the Canada/United States Transboundary Technical Committee. Final Report. February 5, 1986.

TTC (Transboundary Technical Committee). 2001a. TCTR (01)-01. Salmon management and enhancement plans for the Stikine, Taku and Alsek Rivers, 2001.

TTC (Transboundary Technical Committee). 2001b. TCTR (01)-02. Transboundary river sockeye salmon enhancement activities final report for summer, 1995 to fall, 1999.

Appendix 2.11. Speel Lake sockeye salmon stocks

System:	Speel River
Species:	Sockeye salmon
Stock Unit:	Speel Lake
Management Jurisdiction:	Alaska Department of Fish and Game (ADF&G)
Area Office:	Douglas
Primary Fisheries:	Commercial drift gillnet
Escapement Goal Type:	*Biological Escapement Goal*
Basis for the Goal:	Stock-recruit analysis using brood years 1983 to 1996
Documentation:	Riffe, R. R. and J. H. Clark. 2003. Biological escapement goal for Speel Lake sockeye salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report, 03-34. Juneau, Alaska.
Inriver Goal:	None
Action Points:	None
Escapement Goal:	4,000 to 13,000 fish
Escapement Measures:	Weir counts, 1983 to 1992 and 1995 to present

Stock-Recruit Analysis Summary

Model: Ricker[a]
Number of years in model: 13
Ratio of highest escapement to lowest escapement:
Parameter values: α-parameter[b] = 17.22 (adjusted), $1/\beta \approx 9{,}100$, (β-parameter[c] = .00011)
Basis of range of escapement goal: Escapement range predicted to provide for 80% or more of estimated *maximum sustainable yield*

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S\exp\{-\beta S+\varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Summary

Speel Lake is a clear water system located south of the Taku River in Speel Arm of Port Snettisham. The lake has a surface area of 167.5 hectares (413.9 acres), maximum depth of 8.5 meters (28 feet), and a mean depth of 3 meters (10 feet). The Snettisham hatchery is located downstream from Speel Lake, about 10 km (6 miles) south and west.

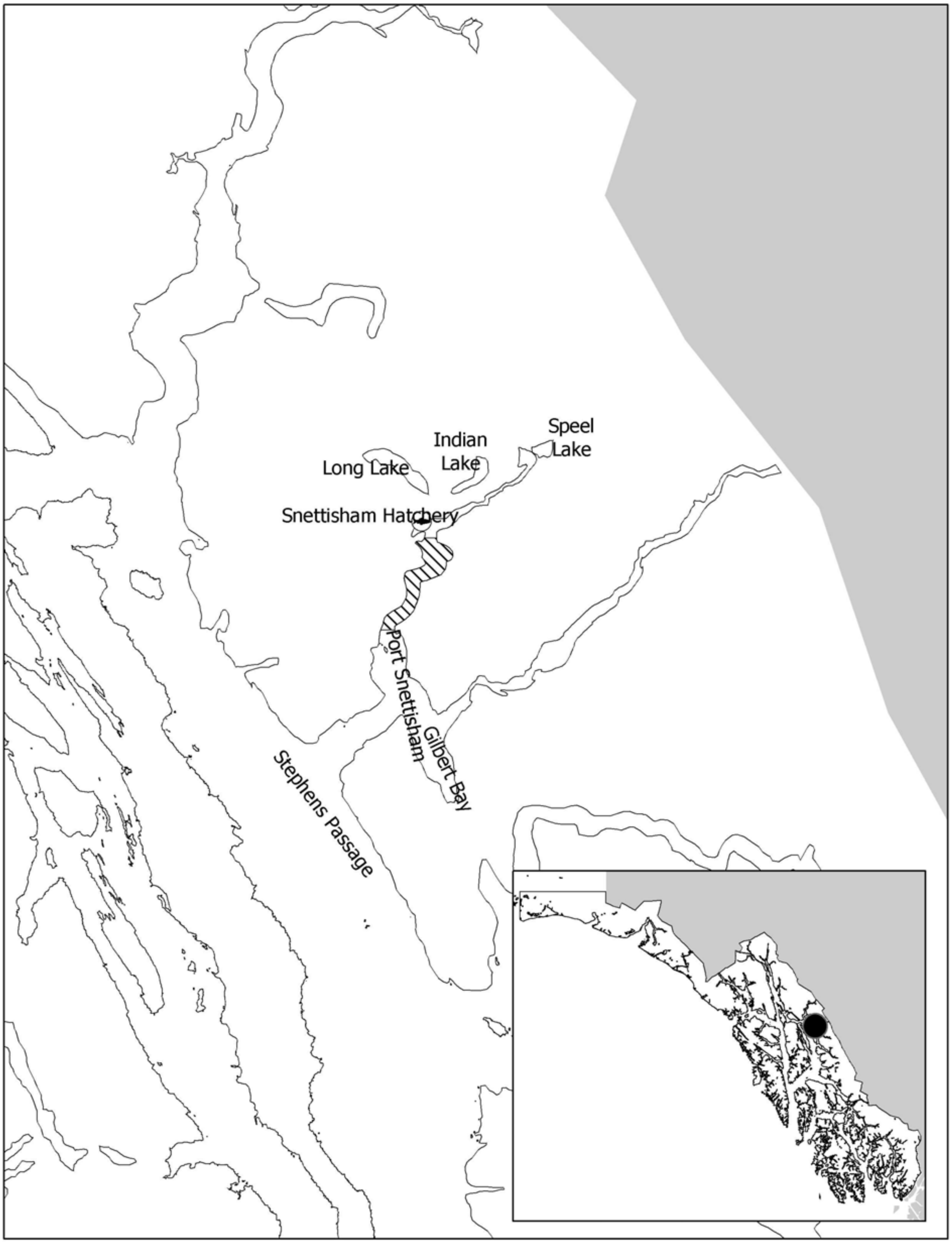
Speel Lake sockeye salmon exhibit a life cycle typical for many sockeye stocks in Alaska: most fish spend 1 year in freshwater before becoming smolts, and return after 2 or 3 years spent in the ocean. The date at which the adults migrate into Speel Lake is quite variable, and is dependent upon amount of rainfall in August. The Speel River is a cold, glacially influenced river. If August rainfall has been low, and Speel Lake outlet water flows shallow and warm, the fish will school up in the Speel River. When a heavy rainfall produces freshets, the fish will migrate en masse into the lake, and greater than 30% of the annual escapement may move past the weir in one day. The timing of these freshets varies from early August to early September, depending on annual rainfall patterns.

The Speel Lake sockeye stock is a minor contributor to the District 111 commercial gillnet fishery, which also targets Taku River sockeye salmon. Historically, annual harvest rates of Speel Lake fish have been changeable. With the establishment of a Snettisham hatchery run of sockeye salmon that migrates in concert with the Speel Lake sockeye stock, use patterns by commercial fishers are now changing, and more intense harvest pressure will likely be exerted on the Speel Lake stock.

Since Speel Lake sockeye salmon are being harvested in conjunction with Taku River sockeye salmon, the stock assessment projects for adult returns of Speel Lake sockeye salmon are comprehensive. The proportion of Speel Lake sockeye salmon in the District 111 sockeye harvest is estimated via analysis of paired samples: a tissue sample for detection of brain parasites, and fish scales for stock age structure and linear discriminant function analysis.

An adult weir located at the outlet of Speel Lake counts the fish that will spawn in the lake. Unfortunately, for 17 of the last 20 years, the weir ceased operation on about August 31, prematurely truncating the escapement count. Since salmon were moving past the weir in response to rainfall patterns, the degree of truncation varied annually. This was not recognized until ADF&G biologists began a stock-recruit analysis. Thus, an average expansion would not effectively estimate escapements for all years of escapement counts. Inclusion of rainfall in an expansion produced more credible escapement estimates, but the estimates still have a great degree of uncertainty.

In order to mitigate for the uncertainty of the escapement estimates, ADF&G recommends a wide escapement range, that the escapement weir remain in operation through the third week in September, and that the escapement goal be revisited in about 3 years. Given the uncertainty in previous escapement counts, management biologists need flexibility in the escapement to gain a better understanding of the system. Operating the weir through the third week in September will give ADF&G more reliable escapement counts, and should allow more insight into the effects of rainfall on escapement counts. If escapements are variable enough in their entry pattern between now and 2006, ADF&G may be able to develop an improved method of expanding earlier escapement counts.



Appendix 2.11.1. Speel Lake and surrounding area. Striped area denotes the hatchery Special Harvest Area (SHA).

Appendix 2.11.2. Estimated spawning escapements, commercial harvests, total return size, and exploitation rates for Speel Lake sockeye salmon, from return years 1983 to 2002.

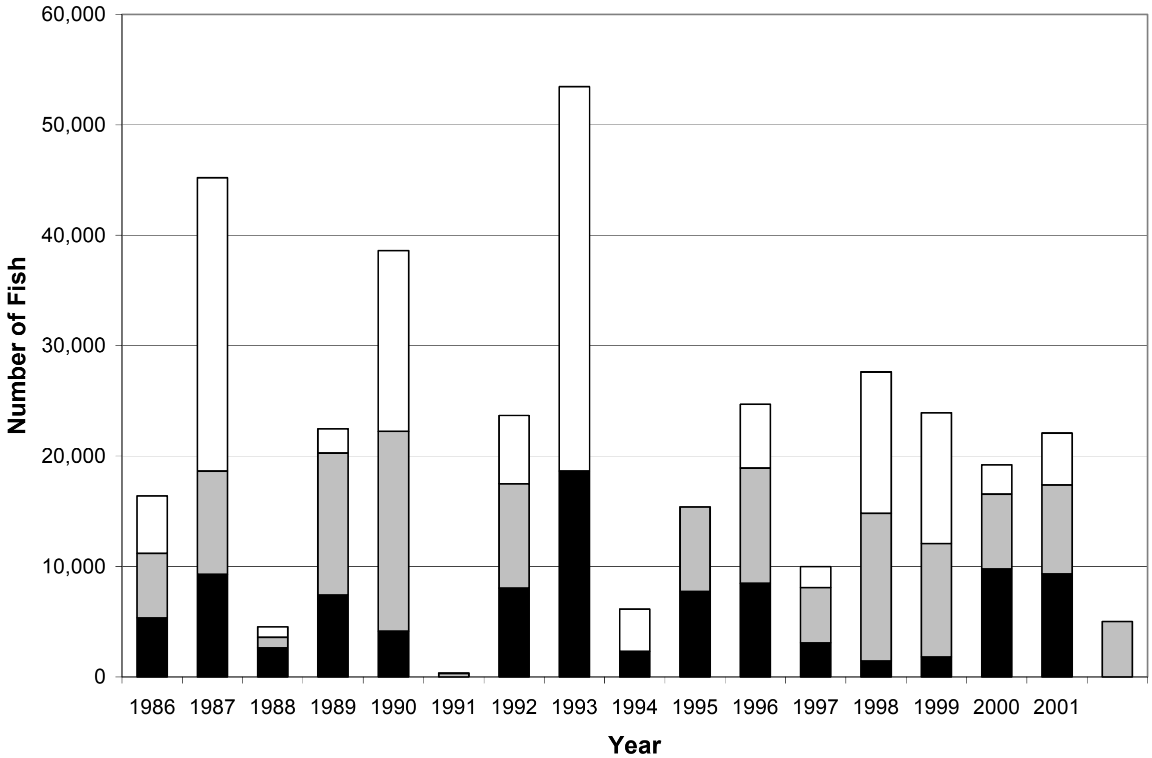
Year	Weir Counts	Escapement Estimates	Catch	Total Return	Estimated Exploitation Rate
1983	10,484	10,484		10,484	0.0%
1984	9,764	11,424		11,424	0.0%
1985	7,073	14,483		14,483	0.0%
1986	5,857	11,062	5,346	16,408	32.6%
1987	9,353	35,927	9,284	45,211	20.5%
1988	969	1,903	2,637	4,540	58.1%
1989	12,854	15,039	7,425	22,464	33.1%
1990	18,095	34,463	4,143	38,606	10.7%
1991	299	359	0	359	0.0%
1992	9,439	15,623	8,053	23,676	34.0%
1993[a]		34,823	18,641	53,464	34.9%
1994[a]		3,834	2,319	6,153	37.7%
1995	7,668	7,668	7,741	15,409	50.2%
1996	10,442	16,215	8,475	24,690	34.3%
1997	4,999	6,906	3,086	9,992	30.9%
1998	13,358	26,155	1,456	27,611	5.3%
1999	10,277	22,115	1,812	23,927	7.6%
2000	6,763	9,426	9,786	19,212	50.9%
2001	8,060	12,735	9,331	22,066	42.3%
2002	5,016	5,016	—[b]	n/a	n/a

[a] Weir was not operated during 1993 and 1994.
[b] Catch figures not yet available.

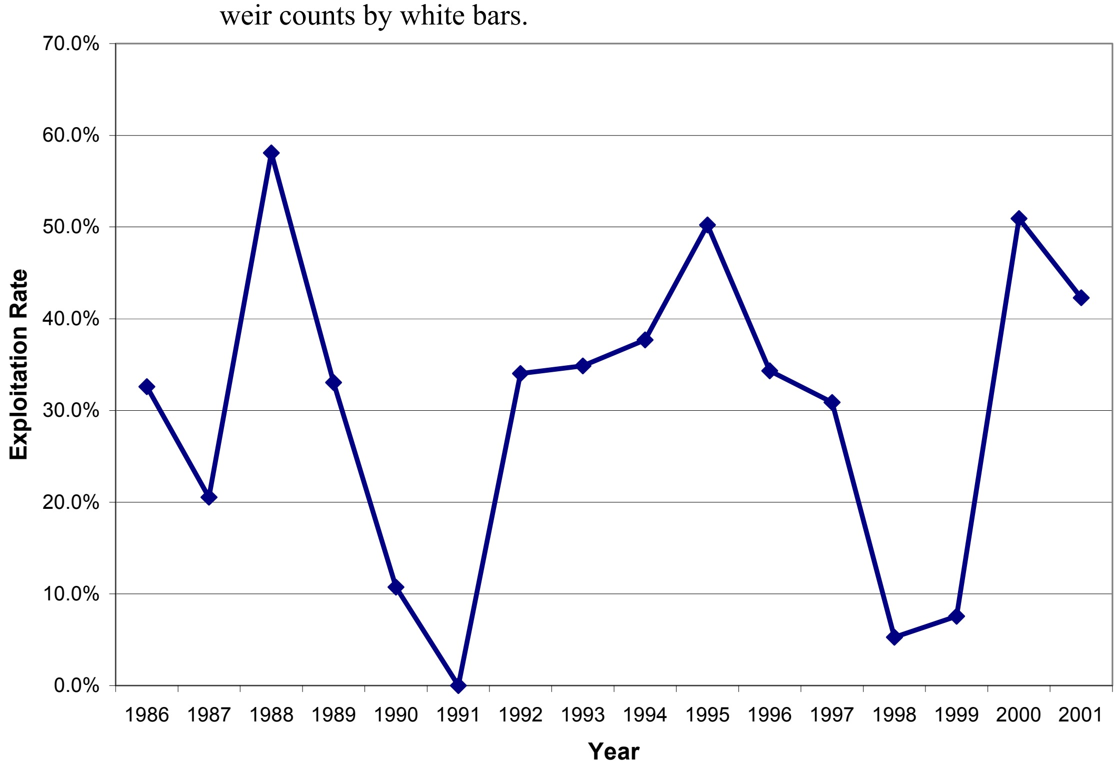
Appendix 2.11.3. Estimated total return of Speel Lake sockeye salmon from brood years 1983 to 2001.

Year	Escapement [a]	3-Year Old	4-Year Old	5-Year Old	6-Year Old	Estimated Total Return	Estimated Return Per Spawner
1983	10,484	28	1,929	2,605	1,701	6,263	0.60
1984	11,424	0	1,858	15,687	1,180	18,725	1.64
1985	14,483	2	5,073	20,407	21	25,503	1.76
1986	11,062	4	16,849	396	496	17,745	1.60
1987	35,927	170	126	11,990	2,152	14,438	0.40
1988	1,644	2	11,190	37,633	580	49,405	30.05
1989	12,924	0	14,720	4,622	1,738	21,080	1.63
1990	33,266	0	1,410	7,131	5	8,546	0.26
1991	359	169	6,523	22,020	64	28,776	80.16
1992	14,106	16	2,494	4,848	136	7,494	0.53
1993	34,823	171	4,960	11,073	147	16,351	0.47
1994	3,834	121	15,618	15,367	24	31,130	8.12
1995	5,965	783	7,973	11,336	75	20,167	3.38
1996	14,288	442	7,336	16,443		24,221	1.70
1997	6,906	368	7,706				*Incomplete return*
1998	26,155	1,121					*Incomplete return*
1999	22,115						*Incomplete return*
2000	9,426						*Incomplete return*
2001	12,735						*Incomplete return*
2002	5,016						*Incomplete return*

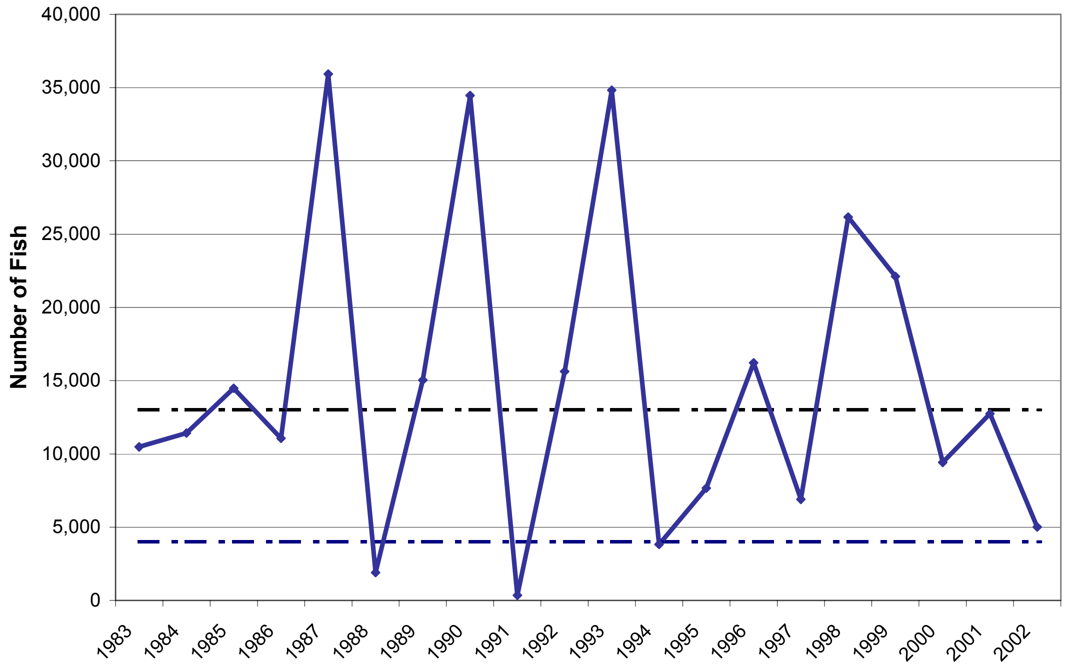
[a] Escapement estimates for 1988 to 1990, 1992, 1995, and 1996 reduced by number of fish used in hatchery egg take.



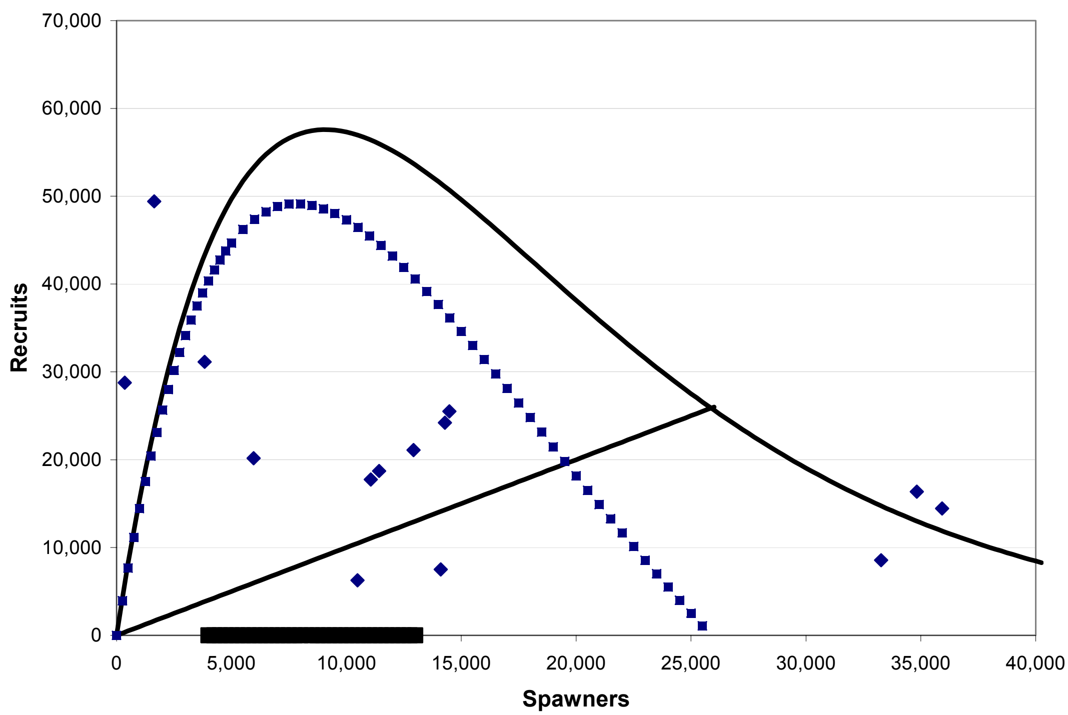
Appendix 2.11.4. Catches and escapements of Speel Lake sockeye salmon, from 1983 to 2001. Catches delineated by black bars, weir counts by gray bars, expansion of weir counts by white bars.



Appendix 2.11.5. Estimated exploitation rates for Speel Lake sockeye salmon, from 1983 to 2001.



Appendix 2.11.6. Escapement estimates for Speel Lake sockeye salmon, 1983–2002. Solid line delineates weir counts and dotted lines denote upper and lower bounds of the recommended escapement range



Appendix 2.11.7. Estimated stock-recruit relationship for Speel Lake sockeye salmon, based on brood years 1983 to 1995. The upper curve represents production predicted by Ricker's model. The dotted line represents yield predicted by Ricker's model. The straight diagonal line partitions recruitment into yield (between Ricker curve and diagonal line) and escapement (from diagonal line to *x* axis). Black line on x-axis denotes escapement range.

Appendix 2.12. Tahltan Lake sockeye salmon stocks

System:	Stikine River
Species:	Sockeye salmon
Stock Unit:	Tahltan Lake sockeye salmon
Management Jurisdictions:	Alaska Department of Fish and Game, Department of Fisheries and Oceans, Canada (CDFO): joint management through the Pacific Salmon Commission
Area Office:	Petersburg/Wrangell (ADF&G), Whitehorse, Y. T. (CDFO)
Primary Fisheries:	District 106 and 108 commercial gillnet, Canadian inriver commercial and aboriginal gillnet
Secondary Fisheries:	U.S. and Canadian sport and subsistence fisheries
Escapement Goal Type:	*Biological Escapement Goal*
Basis for Goal:	Stock-recruit analysis, using data from brood years 1975 to 1987
Documentation:	Humphreys, R. D., S. M. McKinnel, D. Welch, M. Stocker, B. Turris, F. Dickson, and D. Ware (*editors*). 1994. Pacific Stock Assessment Review Committee (PSARC) Annual Report for 1993. Canadian. Manuscript. Report of Fisheries and Aquatic Sciences, Number 2227.
Inriver Goal:	None
Action Points:	Based on inseason assessment and agreement between managers if the run size projection has a very small allowable catch District 108 may be closed and the Canadian commercial fishery in the lower river may be limited. This is not a formal set action but rather a negotiation.
Escapement Goal:	18,000 to 30,000 fish (of which 4,000 are for hatchery supplementation broodstock)
Escapement Measures:	Weir counts since 1959; brood stock removal documented since inception in 1989 and apportionment between natural wild fish and hatchery plants available since 1993 (return in 1992 likely had a small number of planted fish).

Stock-Recruit Analysis Summary

Model: Ricker[a]
Number of years in model: 12
Ratio of highest escapement to lowest escapement: 8.2
Parameter estimates: α-parameter[b] = 1.44, $1/\beta \approx 33,300$ (β-parameter[c] = $3.0 \cdot 10^{-5}$)
Basis of range of escapement goal: Best professional judgment

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[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.
[b] α is defined as Rickers productivity parameter.
[c] β is defined as Ricker's carrying capacity parameter.

Summary

Tahltan Lake, one of the major sockeye salmon producers in northern British Columbia and Southeast Alaska, is located in the Stikine River drainage. The mouth of Stikine River is less than 30 km north and east of Wrangell, Alaska (Appendix 2.12.1).

The river drains an area of over 52,000 km^2, of which over 90% is inaccessible to salmon due to velocity and other natural barriers. Useable freshwater habitat for salmon exists below Telegraph Creek, British Columbia. The river itself is glacially occluded, but accesses a variety of habitats in lakes, side channels, and tributaries.

The Stikine River is 1 of 3 transboundary rivers in Southeast Alaska that are subject to the U.S./Canada Pacific Salmon Treaty, the Taku and Alsek Rivers being the others. The U.S./Canada Pacific Salmon Treaty of 1985 shapes management of salmon in transboundary rivers. Salmon are managed jointly by Alaska Department of Fish and Game, and Department of Fisheries and Oceans Canada (CDFO), and are in turn monitored by the Pacific Salmon Commission.

For management purposes, Stikine River sockeye salmon have been grouped into 3 stocks: Tahltan Lake, Tuya Lake, and mainstem Stikine. The first 2 stocks are associated with specific lakes, while the mainstem Stikine stock is a conglomerate of all other Stikine River sockeye salmon stocks. Pre-season forecasts are generated for each general stock. An in-season management model is jointly maintained by ADF&G and CDFO members of the Transboundary Technical Committee of the Pacific Salmon Commission to forecast run size and monitor harvest sharing. U.S. and Canadian fishery managers communicate weekly on management of their respective fisheries. Accuracy of the management model was poor in recent years, which contributed to escapement goals not being reached between 1997 and 2000. Several major changes to the model were made prior to the 2001 season to improve its performance, and model parameters are routinely updated on an annual basis by the Transboundary Technical Committee. As a result of low pre-season forecasts for Tahltan sockeye, ADF&G and CDFO fishery managers agreed to manage their respective fisheries very conservatively in 2001 and 2002.

Stikine River salmon pass through several fishing districts and types of fisheries before reaching their respective spawning areas. Directed harvest of Tahltan Lake sockeye occurs near the mouth of the Stikine River in the terminal District 108 drift gillnet fishery, during the first 6 weeks of the fishery. Tahltan sockeye are also harvested primarily on an incidental basis in the more distant District 106 (Sumner and Clarence Strait) drift gillnet fishery, where they represent a much lower percentage (average of <10%) of the catch. Management actions to protect Tahltan sockeye salmon in U.S. fisheries concentrate in the District 108 gillnet fishery early in the season. Sport harvests of sockeye salmon in the Stikine River are minimal, as estimated from the Statewide Harvest Survey, and the proportion of Tahltan fish in the catch is unavailable. A personal use fishery has been allowed in recent years but there has been no reported catch and the fishery was closed in 2002 in anticipation of low stock abundance.

Canadian commercial fisheries operate in the lower river. The main fishery occurs just upstream of the international border, with a smaller fishery in the upper river near Telegraph Creek. A Canadian food fishery also operates at Telegraph Creek. In coordination with ADF&G, CDFO managers implemented a series of restrictions in 2001 and 2002, including delayed opening of the season, reduced fishing time, gear reduction, and restricted fishery boundaries.

ADF&G and CDFO have a variety of projects in place to estimate the number of fish in each component of the Stikine River sockeye salmon run. Harvests are estimated using a variety of

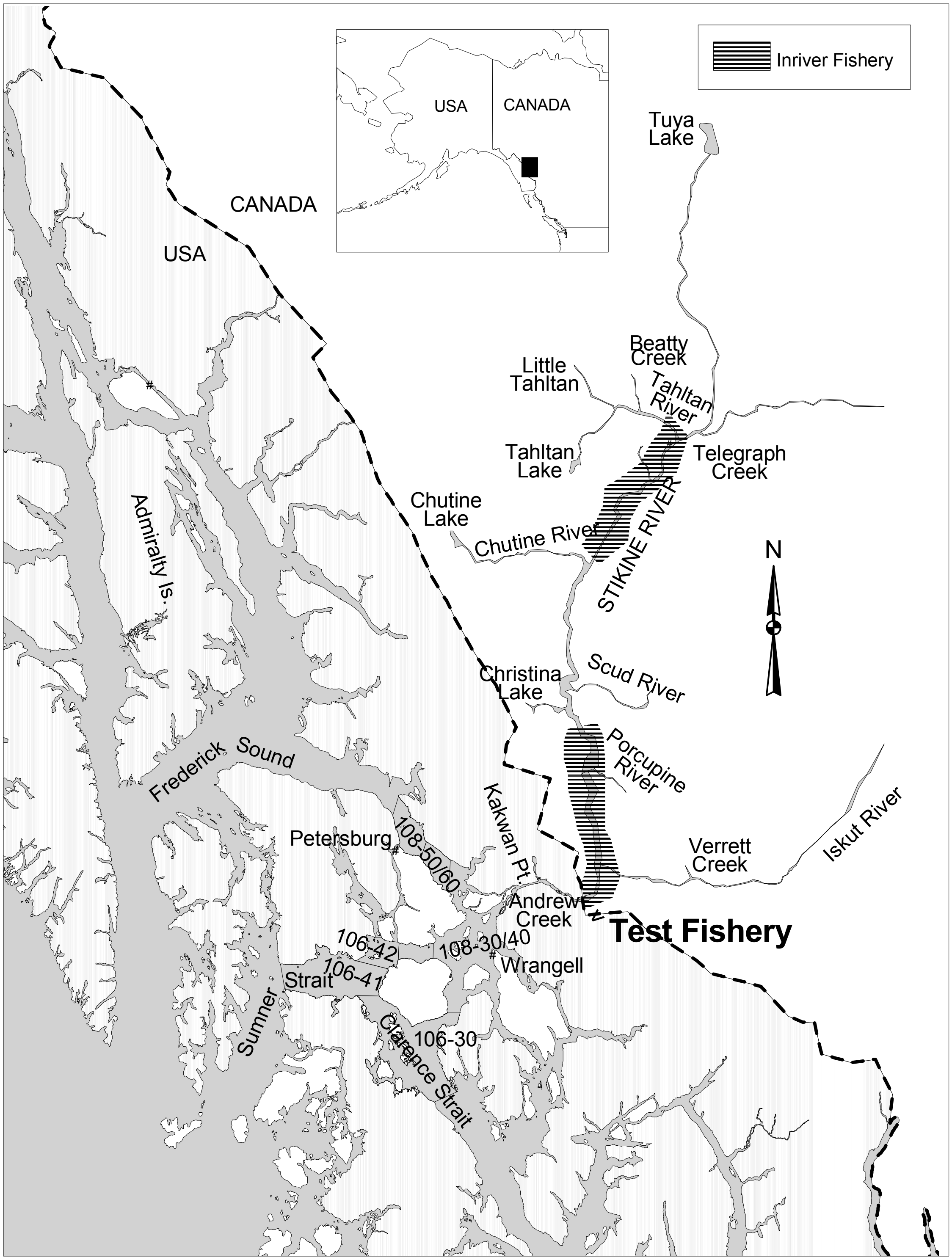
stock identification data, including scale patterns, otolith marks, and egg diameters. Since 2000, a mark–recapture program at Rock Island eddy, near the U.S./Canada border, provides an estimate of the size of the inriver migration. The Rock Island eddy project is currently being evaluated for accuracy of the estimate. Escapement into Tahltan Lake has been monitored annually at a weir since 1959. The weir also serves as a platform to estimate emigrating smolt in late spring.

Tahltan Lake has been enhanced since 1989 under a bilateral program specified in Annex IV of the Pacific Salmon Treaty. Eggs are taken at the lake, incubated and thermally marked at Snettisham Hatchery, and returned as unfed fry to Tahltan or Tuya Lake, located further upstream.

The Transboundary Technical Committee established the current escapement goal of 24,000 (range 18,000 to 30,000) for Tahltan Lake in 1993, based on an analysis conducted by CDFO staff and reviewed by the Pacific Stock Assessment Review Committee. The escapement goal represents 20,000 naturally spawning fish and a maximum of approximately 4,000 fish needed for broodstock to achieve Pacific Salmon Treaty enhancement directives (Transboundary Technical Committee Report 96-1). The analysis indicated *maximum sustainable catch* of naturally spawning fish is achieved at escapements of 15,000 to 19,000 spawners. Pacific Stock Assessment Review Committee recommendations specified that the 20,000 spawning target for naturally spawning sockeye reflected a conservative (high end of the range) interpretation of the stock-recruitment analysis. Further review of this goal is scheduled to occur this winter within the Transboundary Technical Committee.

Sockeye salmon production from Tahltan Lake has varied dramatically. Escapements have ranged from a low of 1,500 to a high of 67,300 fish. Total run sizes have been estimated since 1979, and have varied from 9,400 to 243,100. Escapements have annually been below the escapement goal range since 1997, averaging 11,400 fish from 1997 through 2001. The escapement in 2002 was 17,500, very close to the lower end of the goal. Smolt counts in 2001 and 2002 averaged 1.7 million fish, well above the 1991 to 2000 average of 1.2 million and the 1997 to 2000 average of 610,000 smolts.

The Tahltan sockeye salmon escapement goal range has not been reached for 6 consecutive years, and could therefore be considered as a candidate for *stock of concern* status, as specified in the Policy for the Management of Sustainable Salmon Fisheries (5 AAC. 39.222). However, the stock spawns in Canada and is managed under stipulations of the Pacific Salmon Treaty, as well as the Sustainable Salmon Fisheries Policy. The department believes the following factors make it highly likely the stock will reach escapement goals in the immediate future under the current management regime: 1) The trend in escapements over the last 3 years is positive, and the escapement was within several hundred fish of the lower end of the goal range in 2002, 2) escapements in the range achieved in recent years have produced large returns in the past, 3) estimates of smolt outmigration from Tahltan Lake in 2001 and 2002 were well above average and are expected to produce increased returns beginning in 2003, 4) assessment and management of U.S. and Canadian fisheries, conducted under the auspices of the Transboundary Technical Committee, has been coordinated and highly responsive to reduced abundance of Tahltan sockeye salmon, and 5) new and improved inseason stock assessment programs have been instituted, including improvements to the joint management model, as well as development of a new joint U.S./Canada inriver mark–recapture program. ADF&G therefore does not recommend Tahltan Lake sockeye for consideration as a *stock of concern*.



Appendix 2.12.1. Stikine River drainage and surroundings, showing location of commercial, subsistence, and recreational fisheries.

Appendix 2.12.2. Estimated marine catches, inriver returns, inriver catches, escapement, total returns, and harvest rates for Tahltan Lake sockeye salmon from 1979 to 2002.

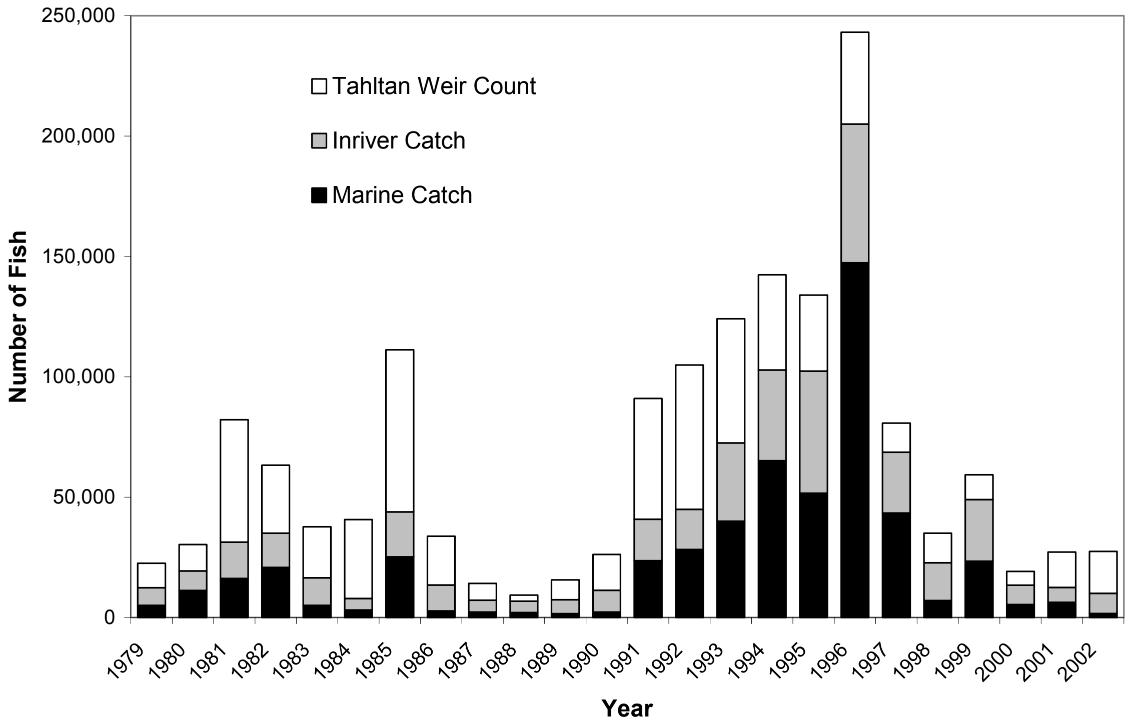
Year	Estimated Marine Catch	Est. Inriver Return	Est. Inriver Catch	Estimated Escapement	Estimated Total Return	Estimated Harv. Rate
1979	5,076	17,472	7,261	10,211	22,548	54.7%
1980	11,239	19,137	8,119	11,018	30,376	63.7%
1981	16,189	65,968	15,178	50,790	82,157	38.2%
1982	20,819	42,493	14,236	28,257	63,312	55.4%
1983	5,071	32,684	11,428	21,256	37,755	43.7%
1984	3,083	37,571	4,794	32,777	40,655	19.4%
1985	25,197	86,008	18,682	67,326	111,205	39.5%
1986	2,757	31,015	10,735	20,280	33,771	39.9%
1987	2,259	11,923	4,965	6,958	14,182	50.9%
1988	2,129	7,222	4,686	2,536	9,351	72.9%
1989	1,561	14,110	5,794	8,316	15,671	46.9%
1990	2,307	23,923	8,996	14,927	26,230	43.1%
1991	23,612	67,394	17,259	50,135	91,006	44.9%
1992	28,218	76,681	16,774	59,907	104,899	42.9%
1993	40,036	84,068	32,458	51,610	124,104	58.4%
1994	65,101	77,239	37,728	39,511	142,340	72.2%
1995	51,665	82,290	50,713	31,577	133,955	76.4%
1996	147,435	95,706	57,545	38,161	243,141	84.3%
1997	43,408	37,319	25,214	12,105	80,727	85.0%
1998	7,086	27,941	15,673	12,268	35,027	65.0%
1999	23,431	35,918	25,599	10,319	59,349	82.6%
2000	5,340	13,803	8,133	5,670	19,143	70.4%
2001	6,339	20,847	6,171	14,676	27,186	46.0%
2002[a]	1,660	25,806	8,466	17,340	27,466	36.9%

[a] Marine harvest estimates for 2002 are preliminary.

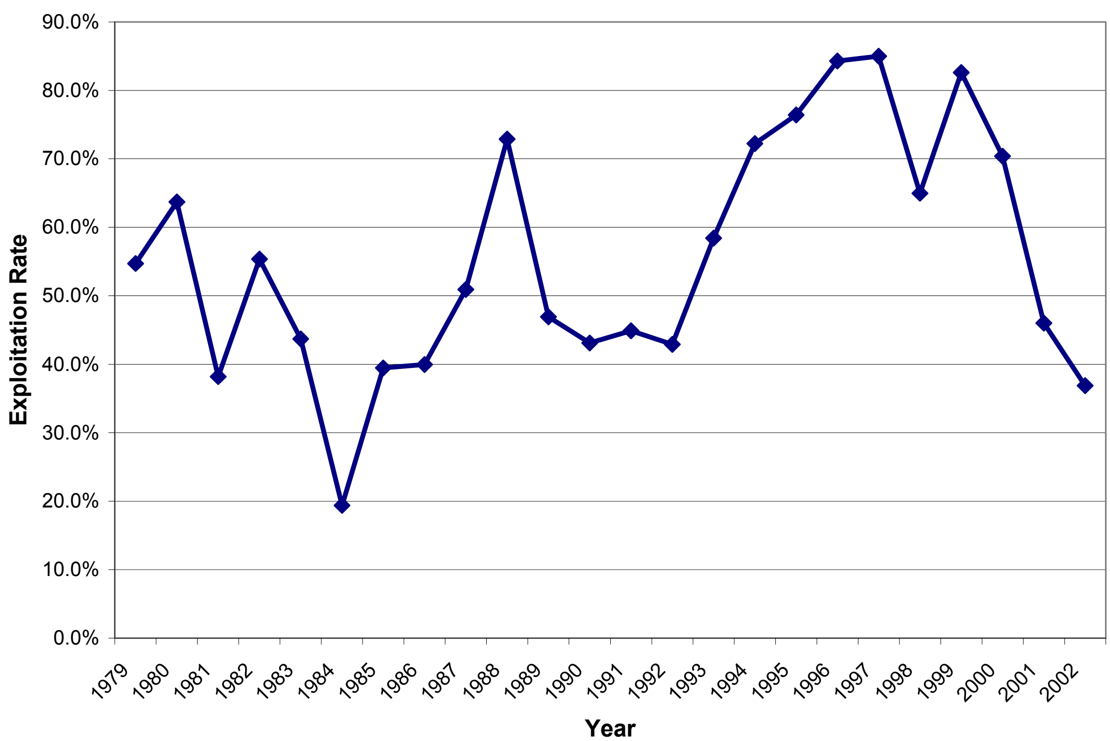
Appendix 2.12.3. Estimated number of emigrating smolts counted at Tahltan Lake weir from 1984 to 2002.

Year	Date Count Initiated	Total Estimate	Enhanced	Wild
1984	5/10	218,702		218,702
1985	4/25	613,531		613,531
1986	5/8	244,330		244,330
1987	5/7	810,432		810,432
1988	5/1	1,170,136		1,170,136
1989	5/5	580,574		580,574
1990	5/5	610,407		610,407
1991	5/5	1,487,265	266,868	1,220,397
1992	5/7	1,555,026	804,324	750,702
1993	5/7	3,255,045	399,483	2,855,562
1994	5/8	915,119	294,310	620,809
1995	5/5	822,284	55,257	767,027
1996	5/11	1,559,236	151,216	1,408,020
1997	5/7	518,202	169,517	348,685
1998	5/7	540,866	214,446	326,420
1999	5/6	762,033	293,545	468,488
2000	5/7	619,274	263,656	355,618
2001	5/6	1,495,642	654,374	841,268
2002	5/6	1,873,598	--	--

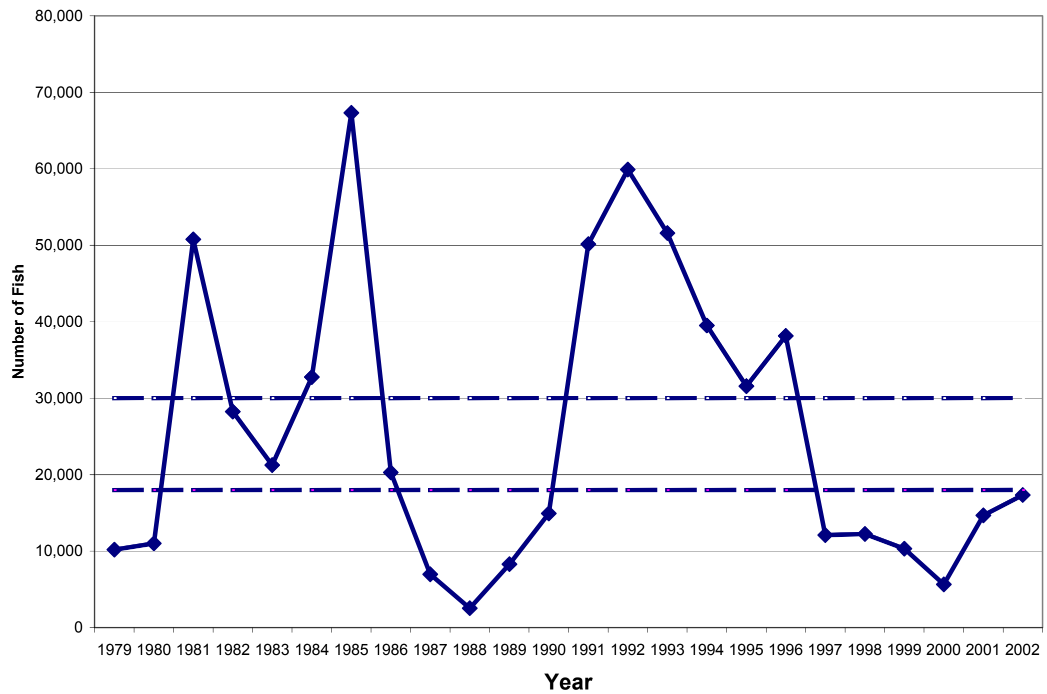
[a] Wild and enhanced proportions for smolts not yet available.



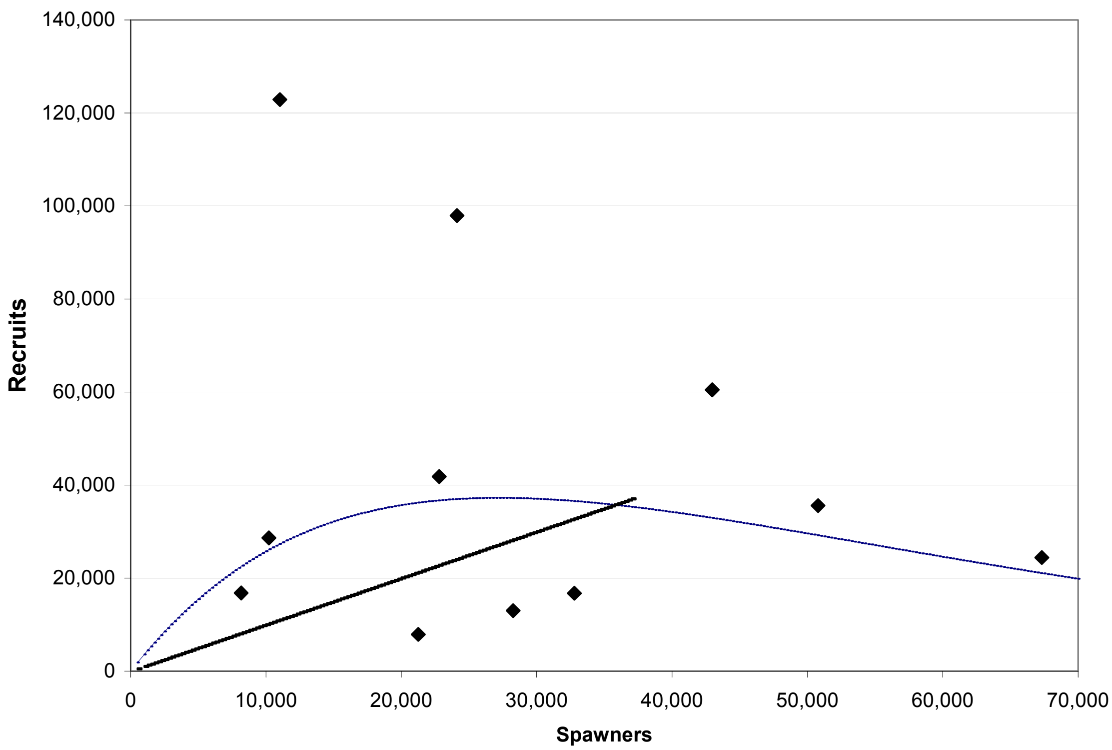
Appendix 2.12.4. Estimated marine catches, inriver catches, and escapement of Tahltan Lake sockeye salmon from 1979 to 2002.



Appendix 2.12.5. Estimated exploitation rates of Tahltan Lake sockeye salmon in U.S. and Canadian fisheries from 1979 to 2002.



Appendix 2.12.6. Estimated escapement of Tahltan Lake sockeye salmon, compared with the escapement goal range from 1979 to 2002. Solid line is escapement estimate; dotted lines are the upper and lower bounds of escapement goal range.



Appendix 2.12.7. Estimated stock-recruit relationship for Tahltan Lake sockeye salmon, based on brood years 1975 to 1985. The curve represents production predicted by Ricker's mode, the diamonds represent 1975 to 1985 data points, and the straight diagonal line represents replacement.

Appendix 2.13. Mainstem Stikine sockeye salmon stock

System:	Stikine River
Species:	Sockeye Salmon
Stock Unit:	Mainstem Stikine River
Management Jurisdiction:	Alaska Department of Fish and Game, (ADF&G), Department. of Fisheries and Oceans Canada (CDFO)): joint management through the Pacific Salmon Commission
Area Office:	Petersburg/Wrangell (ADF&G), Whitehorse, Yukon Territory (CDFO)
Primary Fisheries:	District 106 and 108 commercial gillnet fisheries, Canadian commercial gillnet fisheries in the lower and upper Stikine River
Secondary Fisheries:	Canadian aboriginal, recreational, mixed stock seine fisheries in Southeast Alaska
Escapement Goal Type:	*Sustainable Escapement Goal*
Basis for Goal:	Best professional judgment. Set in 1987 by the Transboundary Technical Committee.
Documentation:	Transboundary Technical Committee. 1987. Report of the U.S./Canada Transboundary Technical Committee to the Pacific Salmon Commission, February 8, 1987, Vancouver, British Columbia.
Inriver Goal:	None
Action Points:	None
Escapement Goal:	20,000 to 40,000 estimated mainstem spawners
Escapement Measures:	Estimated harvest rates, based on returns of Tahltan Lake stocks. Tahltan adult weir operated from 1959 to present. Scale pattern analysis in use since 1984.

Stock-Recruit Analysis Summary

Not applicable

Summary

As indicated by its name, the mainstem Stikine sockeye salmon stock originates from the Stikine River system. The mouth of Stikine River is located less than 30 km. north and east of Wrangell, Alaska (Appendix 2.11.1). The river drains an area of over 52,000 km^2, of which over 90% is inaccessible to salmon due to velocity and other natural barriers. Useable freshwater habitat for salmon exists below Telegraph Creek, British Columbia. The river itself is glacially occluded, but accesses a variety of habitats in lakes, side channels, and tributaries.

The Stikine River is 1 of 3 transboundary rivers in Southeast Alaska that are subject to the U.S./Canada Pacific Salmon Treaty; the Taku and Alsek Rivers are the others. Management of salmon in transboundary rivers is bound by the U.S./Canada Pacific salmon treaty of 1985, and salmon management involves state, provincial, tribal, and federal input. Research and management plans were developed jointly under the purview of the Transboundary Technical Committee, and in turn, the Pacific Salmon Commission. CDFO and ADF&G monitor catches and escapements in the Stikine River system. The Tahltan First Nation is heavily involved in monitoring escapements and smolt migrations at Tahltan and Tuya Lakes.

For management purposes, Stikine River sockeye salmon have been grouped into 3 general stocks: Tahltan Lake, Tuya Lake, and mainstem Stikine. The first 2 stocks are associated with specific lakes, while the mainstem Stikine stock is a conglomerate of all other Stikine River sockeye salmon stocks. The mainstem Stikine stocks make use of a wide variety of habitats, including small lakes, side channels, and sloughs that connect with the main channel of the Stikine River.

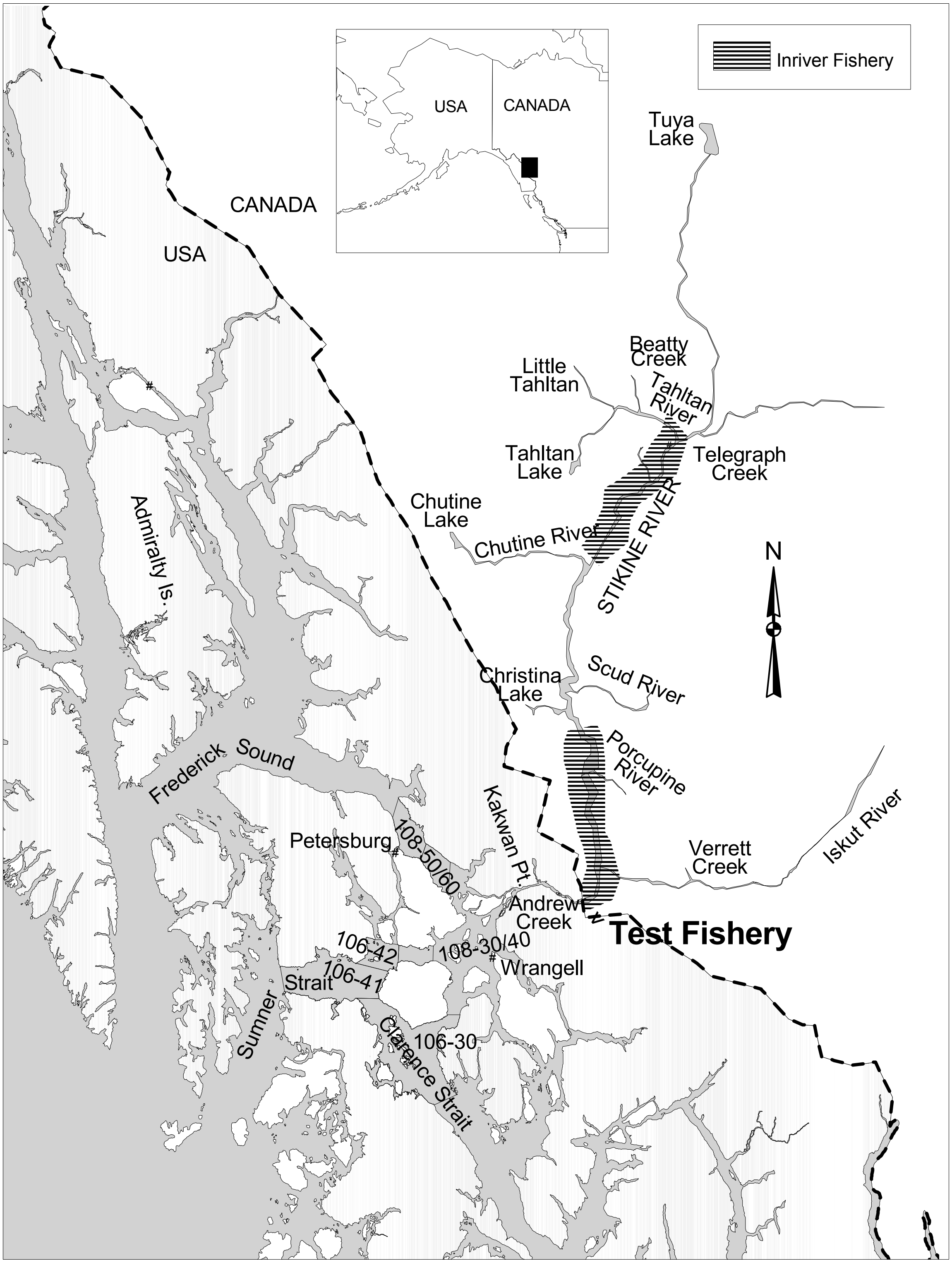
The Stikine River sockeye salmon run is managed for component stocks, one of which is mainstem Stikine. Pre-season forecasts are generated for component stocks. An inseason management model is jointly maintained by ADF&G and CDFO members of the Transboundary Technical Committee to forecast run size and monitor harvest sharing. U.S. and Canadian fishery managers communicate weekly on management of their respective fisheries. Accuracy of the management model was poor in recent years, which contributed to escapement goals not being reached between 1997 and 2000. Several major changes to the model were made prior to the 2001 season to improve its performance, and model parameters are routinely updated on an annual basis by the Transboundary Technical Committee.

Stikine River salmon pass through several fishing districts and types of fisheries before reaching their respective spawning areas. District 106 and 108 gillnet fisheries harvest the most Stikine River sockeye salmon stocks. At Rock Island eddy, just below the U.S./Canada border, the fish are caught by gillnet, marked and released. The fish then pass through the first Canadian inriver gillnet fishery, sited just above the U.S./Canada border. This fishery also serves as a recovery point for salmon marked at Rock Island eddy, and the data provides a timely estimate of run strength for fish migrating into Canada. Sockeye salmon encounter the second commercial fishery and the aboriginal subsistence fishery between the Chutine River and Telegraph Creek, British Columbia.

The number of Stikine River mainstem sockeye salmon is the remainder of the Stikine sockeye salmon run, after subtracting the Tahltan Lake and Tuya Lake stocks—at least for inseason analysis. An estimate of in-river run size is developed, as well as a ratio of Tahltan fish: to mainstem Stikine fish. The total inriver run estimate multiplied by the proportion of mainstem Stikine sockeye salmon in the run equals the total return of mainstem Stikine fish. Escapement of

mainstem Stikine sockeye salmon equals estimated inriver return of mainstem Stikine sockeye salmon minus estimated inriver catch of mainstem Stikine fish.

Monitoring of Stikine River sockeye salmon stocks involves scale pattern analysis to separate Alaska stocks from Canadian stocks. The presence of thermal otolith marks (seen in fish stocked into Tahltan or Tuya Lake), size of eggs (egg diameter), and scale pattern analysis distinguishes Tahltan Lake and Tuya Lake fish from mainstem Stikine fish. Scale pattern analysis must be done post-season, with scales from the escapement from the same year as the catch. The mark–recapture project at Rock Island eddy is being evaluated for the accuracy of its estimates.

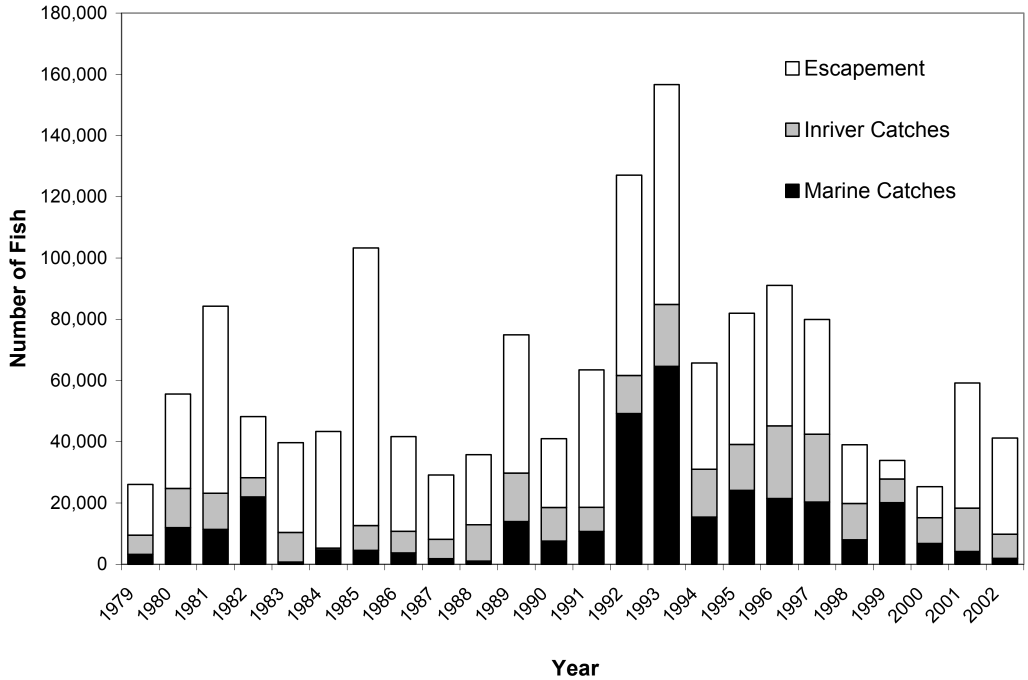


Appendix 2.13.1. Stikine River drainage and surroundings, showing location of commercial, subsistence, and recreational fisheries.

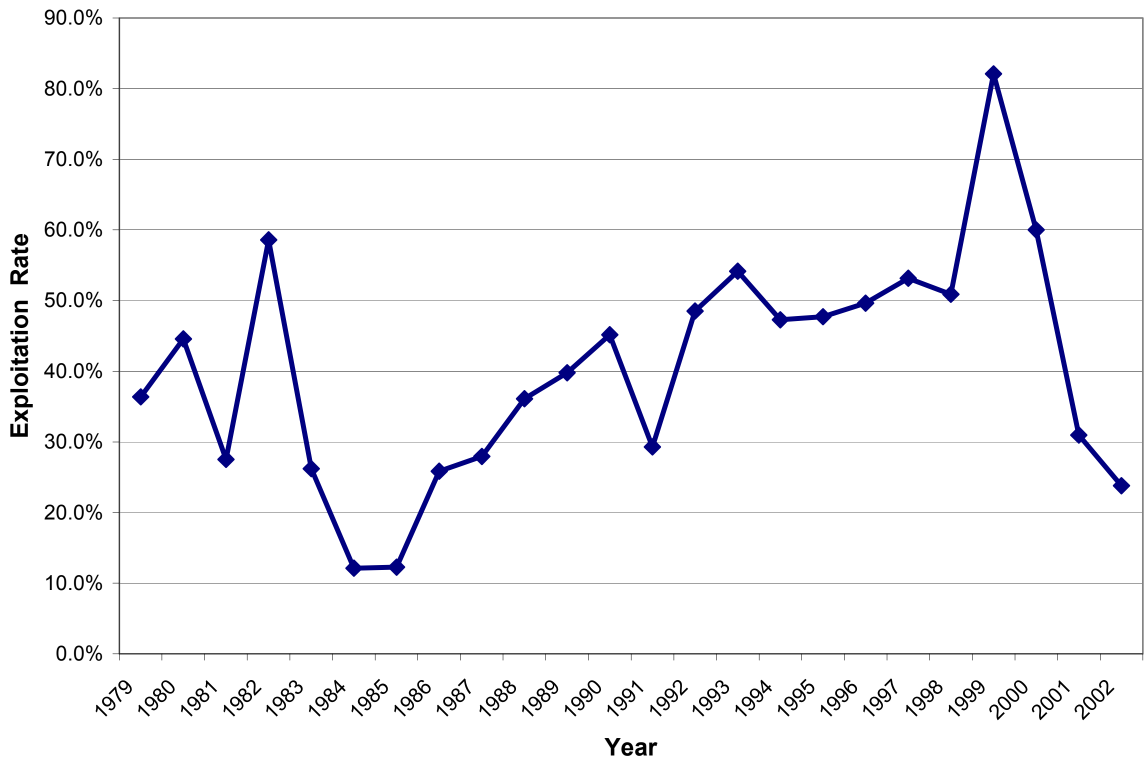
Appendix 2.13.2. Estimated marine catches, inriver returns, inriver catches, escapement, and total returns for Stikine River mainstem sockeye salmon from 1979 to 2002.

Year	Estimated Marine Catch	Est. Inriver Return	Est. Inriver Catch	Estimated Escapement	Estimated Total Return	Estimated Harv. Rate
1979	3,223	22,880	6,273	16,608	26,103	36.4%
1980	11,967	43,606	12,800	30,806	55,573	44.6%
1981	11,349	72,911	11,839	61,072	84,260	27.5%
1982	21,953	26,267	6,304	19,964	48,221	58.6%
1983	711	38,999	9,692	29,307	39,710	26.2%
1984	4,721	38,640	533	38,107	43,361	12.1%
1985	4,550	98,739	8,122	90,617	103,289	12.3%
1986	3,663	38,022	7,111	30,910	41,685	25.8%
1987	1,826	27,342	6,318	21,023	29,168	27.9%
1988	1,052	34,693	11,852	22,841	35,745	36.1%
1989	13,931	60,944	15,845	45,099	74,875	39.8%
1990	7,549	33,464	10,968	22,495	41,013	45.2%
1991	10,712	52,758	7,879	44,879	63,470	29.3%
1992	49,176	77,861	12,468	65,393	127,037	48.5%
1993	64,594	92,033	20,240	71,792	156,627	54.2%
1994	15,408	50,288	15,652	34,636	65,696	47.3%
1995	24,169	57,802	14,953	42,850	81,971	47.7%
1996	21,508	69,536	23,684	45,852	91,044	49.6%
1997	20,330	59,600	22,164	37,436	79,930	53.2%
1998	7,962	31,077	11,902	19,175	39,039	50.9%
1999	20,087	13,797	7,726	6,071	33,884	82.1%
2000	6,764	18,563	8,431	10,132	25,327	60.0%
2001	4,193	54,987	14,132	40,855	59,180	31.0%
2002	1,906	39,278	7,892	31,387	41,187	23.8%

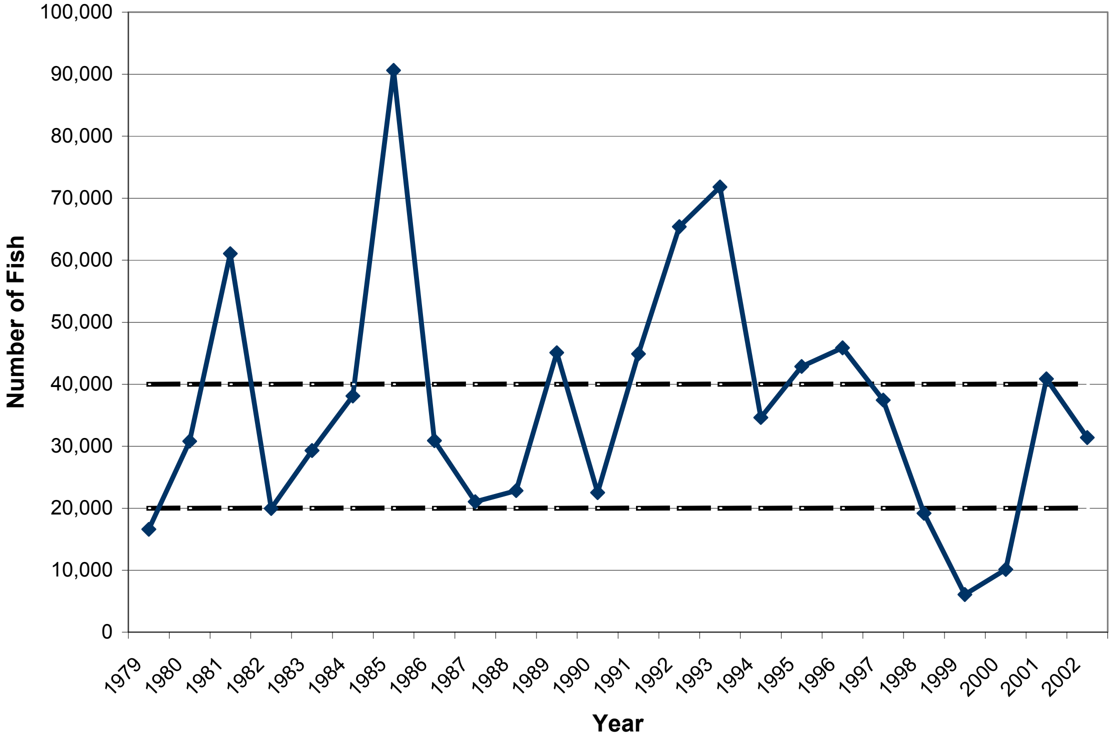
[a] 2002 data is preliminary.



Appendix 2.13.2. Estimated catch in U.S. fisheries, in Canadian fisheries, and estimated escapement into Canadian waters, of mainstem Stikine sockeye salmon from 1979 to 2002. Escapement estimates do not include escapements below the U.S./Canada border.



Appendix 2.13.3. Estimated exploitation rate of mainstem Stikine River sockeye salmon, in U.S. and Canadian fisheries from 1979 to 2002.



Appendix 2.13.4. Estimated escapement of mainstem Stikine River sockeye salmon into Canadian waters, from 1979 to 2002. Solid line is estimated escapement; dotted lines are upper and lower bounds of escapement range. Escapement estimates do not include escapements below the U.S./Canada border.

Appendix 2.14. Hugh Smith sockeye salmon stock

System: Hugh Smith
Species: Sockeye Salmon
Stock Unit: Hugh Smith Lake

Management Jurisdiction: Alaska Department of Fish and Game

Area Office: Ketchikan

Primary Fisheries: Gillnet and seine commercial fisheries

Escapement Goal Type: *Biological Escapement Goal*

Basis for Goal: Three unconventional analyses

Documentation: Geiger, H. J., T. P. Zadina, and S C. Heinl. 2003. Sockeye salmon stock status and escapement goal for Hugh Smith Lake in Southeast Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report Number 1J03-05. Douglas.

Inriver Goal: None

Action Points: None

Escapement Goal: 8,000 to 18,000 fish

Escapement Measures: Weir counts minus hatchery removals

Stock-Recruit Analysis Summary

Not applicable

Summary

Hugh Smith Lake is a meromictic sockeye salmon-producing system about 97 km southeast of Ketchikan, Alaska. This system has a history of commercial exploitation of sockeye salmon going back to the late 19th century. From 1895 to 1912, catches in the vicinity of Hugh Smith Lake varied between 42,000 and 210,000 sockeye salmon—although it is unknown what fraction of these were actually bound for Hugh Smith Lake.

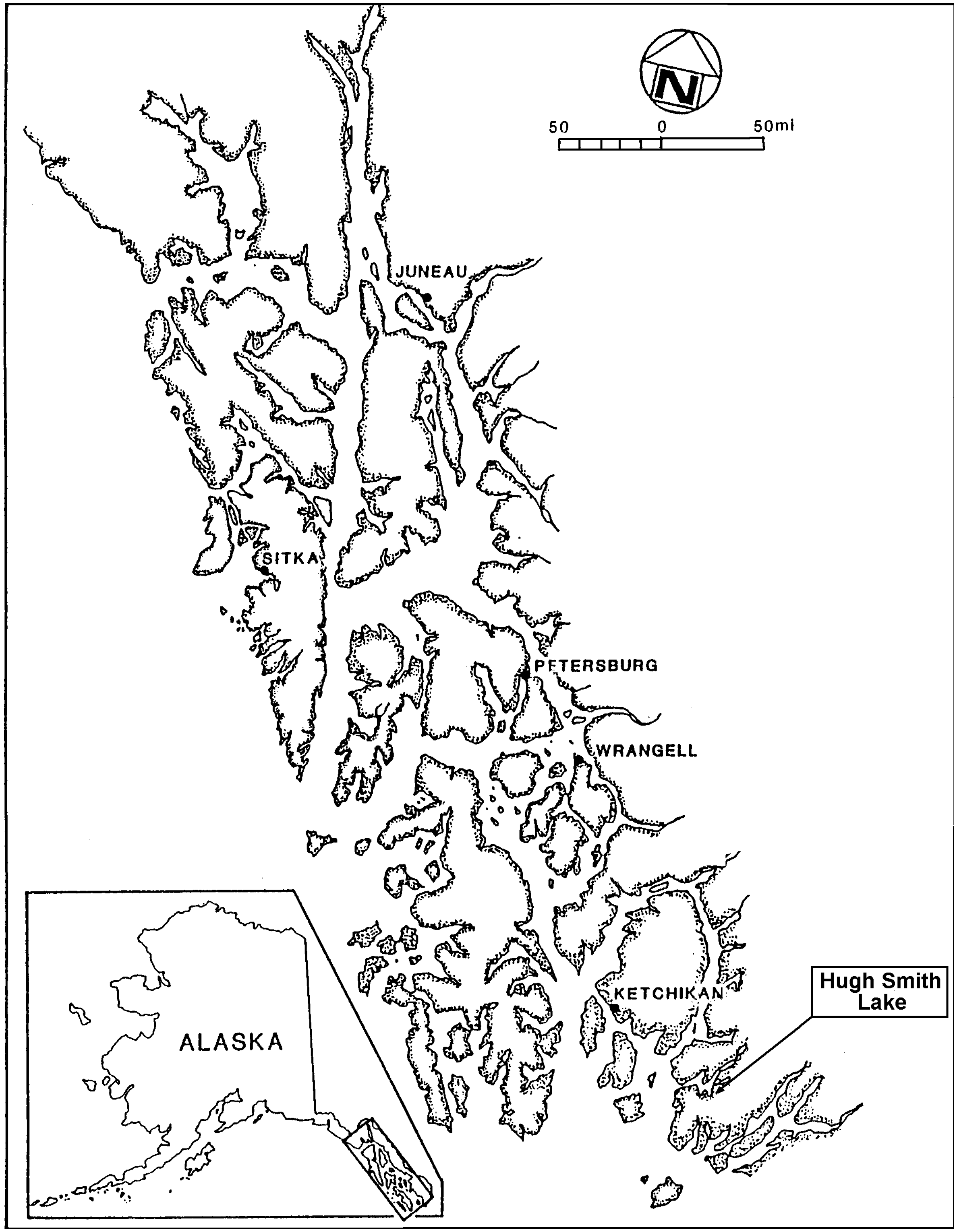
In recent times, the harvest of Hugh Smith bound sockeye salmon has been mostly incidental in other fisheries, with the coded wire tags originating from this system principally recovered in Districts 101 and 104 in Alaska, but there has been no sampling for these tags in Canadian fisheries. From smolt years 1980 to 1996, the estimated harvest rate of coded wire tagged groups of this stock in Alaskan waters ranged from 40% to 96% (the latter number based on very few tag recoveries), with a median value of 61%.

Since 1980, and in a few years before that, the escapements into this system have been estimated by means of a weir, with confirmation of these estimates by mark–recapture studies since 1992. The most recent escapement goal—15,000 to 35,000 spawners—is mentioned in the most recent purse seine management plan. This goal was apparently based on "professional judgment," and put into practice in the mid-1990s.

Because of the difficulty of reconstructing the total number of adults originating from this system, a traditional Ricker analysis could not be used to set the escapement goal. Three alternate analyses, each with its own limitations, were combined to develop a revised *biological escapement goal* of 8,000 to 18,000 spawners for Hugh Smith Lake sockeye salmon.

Escapements over the past 5 years were 897 spawners in 1998, 2,878 spawners in 1999, 3,989 spawners in 2000, 3,551 spawners in 2001, and 5,880 spawners in 2002. Considering the length of time escapements have been below the escapement goals, the department has identified Hugh Smith Lake sockeye salmon as a candidate *stock of concern*. The 5-year average escapement is 3,439 fish, or 42% of the lower end of the revised escapement goal. Thus to fully address the concern, future escapements will need to be more than double the recent 5-year average. A reduction in harvest rates on this stock will be necessary, particularly during years of poor returns.

The department is reviewing available harvest distribution and timing information to develop options for reducing harvest rates on this stock, particularly during years when poor returns are apparent, while limiting disruption of important commercial fisheries to the extent possible. The department will also conduct a review of the Hugh Smith Lake sockeye salmon enhancement program and the stock assessment program for the system, in conjunction with the Southern Southeast Regional Aquaculture Association, before the summer of 2003.



Appendix 2.14.1. The location of Hugh Smith Lake in Southeast Alaska.

Appendix 2.14.2. Hugh Smith Lake sockeye salmon escapement estimates and run timing from 1967 to 2002.

Year	1967	1968	1969	1970	1971	1980	1981	1982	1983	1984	1985
Weir Count	6,754	1,617	10,357	8,755	22,096	12,714	15,545	57,219	10,429	16,106	12,245
Total Escapement[a]								57,219	10,429	16,106	12,245
Weir Mortalities	NA	NA	NA	NA	NA	NA	NA	81	45	134	201
Adults Used for Egg Takes	0	0	0	0	0	0	0	0	0	439	798
Spawning Escapement[b]	NA	NA	NA	NA	NA	NA	NA	57,138	10,384	15,533	11,246
Weir Starting Date	1-Jun	13-Jun	11-Jun	9-Jun	20-Jun	5-Jun	7-Jun	4-Jun	30-May	1-Jun	1-Jun
Weir Ending Date	3-Sep	21-Aug	14-Aug	1-Sep	22-Aug	4-Oct	8-Sep	27-Nov	30-Nov	26-Nov	11-Nov
Total Days Elapsed	94	69	64	84	63	121	93	176	184	178	163
Date of First Sockeye	13-Jun	14-Jun	11-Jun	11-Jun	20-Jun	6-Jun	8-Jun	7-Jun	1-Jun	6-Jun	5-Jun
Date of Last Sockeye	3-Sep	21-Aug	14-Aug	1-Sep	22-Aug	4-Oct	8-Sep	25-Oct	25-Oct	19-Nov	29-Oct
No. of Days Elapsed Between First and Last Sockeye	82	68	64	82	63	120	92	140	146	166	146
10th Percentile Run Date	22-Jun	2-Jul	26-Jun	26-Jun	1-Jul	4-Jul	28-Jun	20-Jun	11-Jul	14-Jul	12-Jul
25th Percentile Run Date	28-Jun	11-Jul	9-Jul	6-Jul	9-Jul	20-Jul	7-Jul	29-Jun	17-Jul	26-Jul	25-Jul
50th Percentile Run Date	7-Jul	15-Aug	20-Jul	27-Jul	20-Jul	6-Aug	27-Jul	9-Jul	11-Aug	8-Aug	23-Aug
75th Percentile Run Date	18-Jul	19-Aug	7-Aug	6-Aug	19-Aug	26-Aug	24-Aug	18-Jul	4-Sep	26-Aug	2-Sep
90th Percentile Run Date	28-Jul	21-Aug	9-Aug	13-Aug	20-Aug	9-Sep	3-Sep	7-Aug	24-Sep	10-Sep	13-Sep

[a] The total escapement equals weir count from 1967 to 1985.
[b] The spawning escapement equals the total estimated escapement minus the weir mortalities (coded wire tagged fish) and fish killed for egg takes.

-continued-

Appendix 2.14.2. (page 2 of 3)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Weir Count	2,312	33,097	5,056	6,513	1,285	5,885	65,586	11,312	8,386	3,422	7,123
Total Escapement[a]	6,968	33,097	5,056	6,513	1,285	5,885	65,737	13,532	8,992	3,452	7,123
Weir Mortalities	12	0	28	32	28	33	151	278	42	11	57
Adults Used for Egg Takes	619	1,902	424	1,547	0	357	178	1,460	763	312	513
Spawning Escapement[b]	6,337	31,195	4,604	4,934	1,257	5,495	65,408	11,794	8,187	3,129	6,553
Weir Starting Date	17-Jun	3-Jun	5-Jun	3-Jun	8-Jun	17-Jun	16-Jun	17-Jun	20-Jun	17-Jun	17-Jun
Weir Ending Date	29-Oct	21-Oct	22-Oct	25-Oct	31-Oct	9-Oct	25-Oct	4-Nov	1-Nov	3-Nov	4-Nov
Total Days Elapsed	134	140	139	144	145	114	131	140	134	139	140
Date of First Sockeye	18-Jun	8-Jun	12-Jun	11-Jun	13-Jun	19-Jun	16-Jun	20-Jun	20-Jun	19-Jun	20-Jun
Date of Last Sockeye	3-Oct	4-Oct	16-Oct	18-Oct	21-Oct	11-Oct	18-Oct	3-Nov	26-Oct	1-Nov	20-Oct
No. of Days Elapsed Between First and Last Sockeye	107	118	126	129	130	114	124	136	128	135	122
10th Percentile Run Date	11-Jul	18-Jul	19-Jul	30-Jul	8-Jul	22-Jul	12-Jul	2-Jul	20-Jul	7-Jul	25-Jul
25th Percentile Run Date	15-Jul	20-Jul	24-Jul	5-Aug	23-Jul	29-Jul	19-Jul	16-Jul	1-Aug	17-Jul	11-Aug
50th Percentile Run Date	20-Jul	4-Aug	9-Aug	10-Aug	27-Aug	21-Aug	27-Jul	30-Jul	23-Aug	29-Jul	19-Aug
75th Percentile Run Date	28-Jul	30-Aug	25-Aug	14-Aug	7-Sep	12-Sep	29-Jul	14-Aug	26-Aug	9-Aug	3-Sep
90th Percentile Run Date	8-Aug	31-Aug	1-Sep	22-Aug	16-Sep	22-Sep	11-Aug	31-Aug	3-Sep	21-Aug	13-Sep

[a] The total escapement equals the mark–recapture estimate (1986, 1993, 1994, 1995) plus weir mortalities, or the weir count. (Data used to calculate a Petersen estimate in 1986 are not available.)

[b] The spawning escapement equals the total estimated escapement minus the weir mortalities (coded wire tagged fish) and fish killed for egg takes.

-continued-

Appendix 2.14.2. (page 3 of 3)

Year	1997	1998	1999	2000	2001	2002
Weir Count	12,182	1,138	3,174	4,281	3,665	6,166
Total Escapement[a]	12,182	1,138	3,174	4,281	3,825	6,166
Weir Mortalities	28	23	20	12	6	0
Adults Used for Egg Takes	0	218	276	280	268	286
Spawning Escapement[b]	12,154	897	2,878	3,989	3,551	5,880
Weir Starting Date	18-Jun	17-Jun	16-Jun	17-Jun	16-Jun	17-Jun
Weir Ending Date	5-Nov	11-Nov	8-Nov	11-Nov	11-Nov	4-Nov
Total Days Elapsed	140	147	145	147	148	140
Date of First Sockeye	18-Jun	19-Jun	22-Jun	19-Jun	19-Jun	19-Jun
Date of Last Sockeye	1-Nov	12-Oct	4-Oct	27-Oct	6-Oct	17-Oct
No. of Days Elapsed Between First and Last Sockeye	136	115	104	130	109	120
10th Percentile Run Date	3-Jul	8-Jul	7-Jul	29-Jun	2-Jul	10-Jul
25th Percentile Run Date	16-Jul	21-Jul	15-Jul	7-Jul	18-Jul	4-Aug
50th Percentile Run Date	25-Jul	30-Jul	31-Jul	20-Jul	16-Aug	7-Aug
75th Percentile Run Date	2-Aug	10-Aug	15-Aug	30-Jul	22-Aug	9-Aug
90th Percentile Run Date	15-Aug	18-Aug	22-Aug	6-Aug	23-Aug	12-Aug

[a] The total escapement equals the mark–recapture estimate (2001) plus weir mortalities, or the weir count.
[b] The spawning escapement equals the total estimated escapement minus the weir mortalities (coded wire tagged fish) and fish killed for egg takes.

Appendix 2.14.3. Mark–recapture escapement estimates for Hugh Smith Lake sockeye salmon from 1992 to 2002.

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Live Weir Count[a]	65,435	11,034	8,344	3,413	7,066	12,154	1,115	3,154	4,269	3,629	5,999
Proportion Marked	36%	99%	97%	100%	99%	67%	67%	67%	67%	50%	50%
Number Released With											
Period 1 (16 Jun–18 Jul)	8,817	4,199	1,132	1,430	637	3,663	117	598	1,151	543	491
Period 2 (19 Jul–15 Aug)	11,173	4,383	1,655	1,465	1,622	3,657	496	975	1,539	317	2318
Period 3 (16 Aug–Nov)	3,800	2,391	5,339	501	4,736	780	132	530	156	947	190
Number Sampled for Marks	1,974	2,377	1,152	1,028	374	934	226	323	443	484	908
Number of Marks Recovered	814	2,029	1,041	1,006	369	638	157	221	299	230	449
Mark–Recapture Estimate[b,c,e]	57,652	**13,254**	**8,925**	**3,441**	7,090	11,853	1,071	3,070	4,213	**3,789**	6,059
Se	1,520	134	77	70	41	253	42	109	131	168	187
± 95% CI	2,979	263	151	137	80	496	82	214	257	329	367
CV	3%	1%	1%	2%	1%	2%	4%	4%	3%	4%	3%
Total Escapement[e]	65,737	13,532	8,992	3,452	7,123	12,182	1,138	3,174	4,281	3,825	6,166

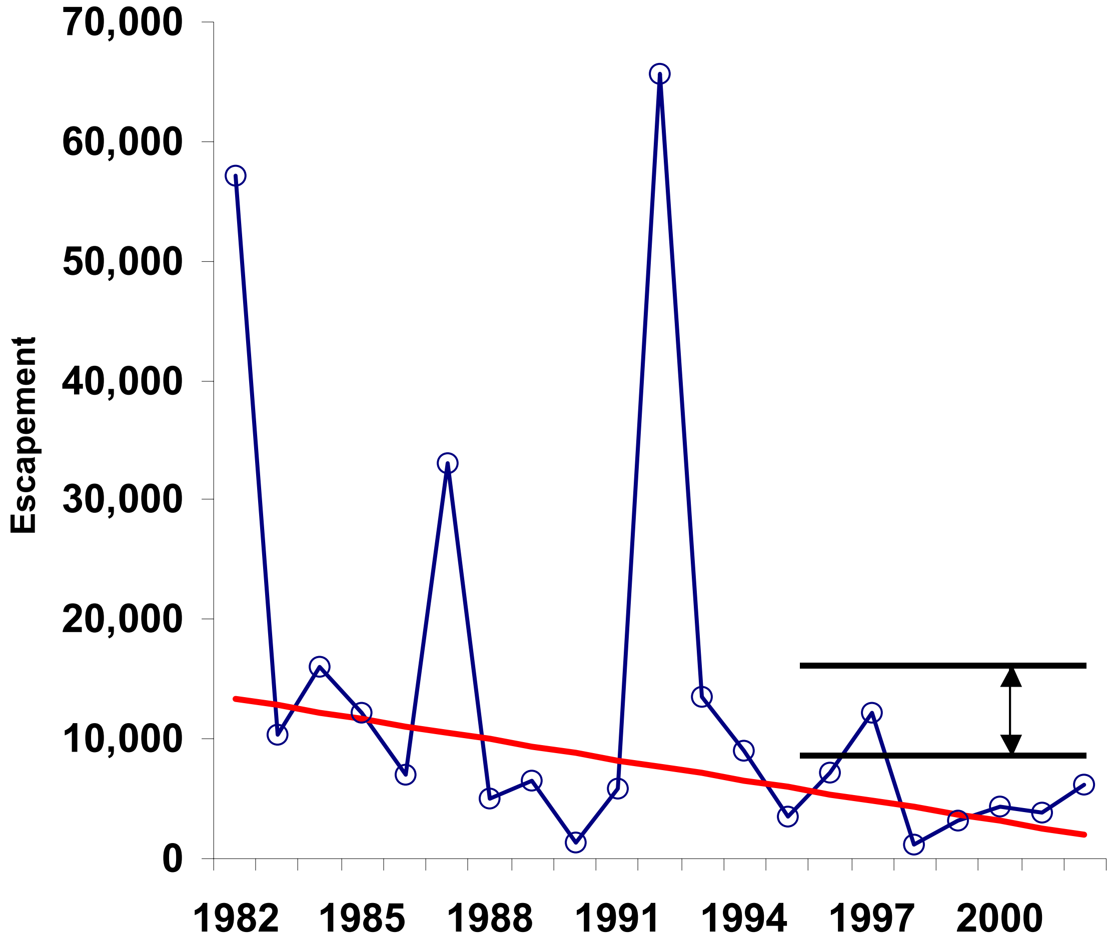
[a] The weir count used for mark–recapture calculations was the number of live fish (weir count minus weir mortalities) passed through the weir.

[b] Pooled Petersen, and ML Darroch estimates and their standard errors were calculated using Stratified Population Analysis Software. Release data were stratified into 3 release periods, and recovery data were stratified by recovery days.

[c] Mark–recapture estimates for 1992, 1996, 1997, 1998, 1999, 2000, 2001, and 2002 are Pooled Petersen estimates. Chi-square tests for goodness of fit and complete mixing in 1993, 1994, and 1995 were significant ($P<0.05$), and suggested that ML Darroch estimates be used rather than a Pooled Petersen estimate for those years.

[d] The bold mark–recapture estimates in 1993, 1994, 1995, and 2001 were used to estimate total escapement, rather than the weir count. A small hole was detected in the weir in 2001, so it is known that fish escaped unsampled into the lake. In other years, the weir count fell within the confidence interval of the mark–recapture estimate, and therefore, the weir count was judged to be acceptable.

[e.] The total escapement equals the mark–recapture estimate plus weir mortalities (1993, 1994, 1995, and 2001), or the live weir count plus weir mortalities (1992, 1996, 1997, 1998, 1999, 2000, and 2002).



Appendix 2.14.4. Escapement estimates for Hugh Smith sockeye salmon from 1982 to 2002. The diagonal line is the robust trend in escapement over time, and the 2 horizontal lines show the new escapement goal range.

Appendix 2.14.5. Estimated survival of sockeye salmon smolt from Hugh Smith Lake that were coded wire tagged from 1980 to 1996. The column labeled "Number Recovered in Escapement" represents the estimated number of coded wire tagged fish in the escapement. The column labeled "Estimated Number of Tags in Alaskan Fisheries" represents the sum of the estimated harvest of coded wire tagged fish in all Alaskan fisheries (excludes all harvest in Canadian fisheries). Each tag recovery was expanded, by dividing by the fishery-sampling rate (obtained from the ADF&G coded wire tag database, summing the "fishery expansion factor"). The column labeled "Estimated Harvest Rate" represents our estimate of the Alaskan harvest rate on Hugh Smith sockeye salmon. The "Estimated Alaskan Survival" represents the survival rate of the coded wire tagged fish to Alaskan fisheries and the escapement. The inverse, natural mortality, in this case will include any mortality induced through handling stress and tagging, the effects of a variable marine environment, and an unknown level of fishing mortality in Canada.

Smolt Year	Life Stage When Tagged	Number Tagged (A)	Number Recovered in Escapement (B)	Estimated Number of Tags in Alaskan Fisheries (C)	Estimated Adult Tagged Fish in Return (B+C)	Estimated Harvest Rate [C/(B+C)]	Estimated Alaskan Survival [(B+C)/A]
1980	smolt	4,048	24	32	56	57%	1.4%
1981	smolt	28,376	181	328	509	64%	1.8%
1982	smolt	30,000	487	535	1,022	52%	3.4%
1983	smolt	17,035	28	50	78	64%	0.5%
1986	smolt	32,577	183	712	895	80%	2.7%
1987	smolt	33,032	26	515	541	95%	1.6%
1988	smolt	39,434	103	183	286	64%	0.7%
1991	smolt	60,888	1,869	2,959	4,828	61%	7.9%
1992	smolt	14,146	778	572	1,350	42%	9.5%
1993	smolt	34,504	1,174	1,534	2,708	57%	7.8%
1994	smolt	35,687	1,111	1,719	2,830	61%	7.9%
1995	smolt	17,503	379	975	1,354	72%	7.7%
1996	smolt	13,480	565	372	937	40%	7.0%

Appendix 2.14.6. Minimum estimated numbers of hatchery-propagated sockeye salmon smolt emigrating from Hugh Smith Lake, by year of smolting. The estimates are based on the classification of the sampled smolts into hatchery or natural categories based on an analysis of otolith patterns. The 1999 hatchery smolt were age 2.0 fish that remained in the lake from stocking in 1997. The 2000 otolith samples were lost in transit. For each smolt year, the number of hatchery smolt is a minimum estimate because not all smolt are enumerated at the weir. Most hatchery smolt are age 1.0.

Smolt Year	Number of Smolt Sampled	Proportion of Sampled Smolt with Otolith Bands	Number of Smolt Counted at Weir Site	Minimum Number of Hatchery Origin Smolt Produced
1998	417	47%	64,667	30,257
1999	455	4%	42,397	1,611
2000			71,849	
2001	475	71%	189,323	134,975
2002	453	55%	296,203	163,752

Appendix 2.15. McDonald Lake sockeye salmon stock

System:	McDonald Lake
Species:	Sockeye salmon
Stock Unit:	McDonald Lake sockeye salmon
Management Jurisdiction:	Alaska Department of Fish and Game, (ADF&G)
Area Office:	Ketchikan (ADF&G)
Primary Fisheries:	Mixed stock commercial fisheries in Southeast Alaska
Secondary Fisheries:	Mixed stock commercial fisheries in Southeast Alaska
Escapement Goal Type:	*Biological Escapement Goal*
Basis for Goal:	Ricker analysis
Documentation:	This goal has not been adequately documented
Inriver Goal:	None
Action Points:	None
Escapement Goal:	65,000 to 85,000 fish
Escapement Measures:	A series of standard foot surveys, expanded to an estimate of total escapement by historic ratio of weir to foot-survey estimate

Stock-Recruit Analysis Summary

Not applicable

Summary

McDonald Lake is located approximately 70 km north of Ketchikan. The lake is organically stained with a surface area of 420 ha, and a mean depth of 45.6 m. The lake empties into Yes Bay, West Behm Canal via Wolverine Creek (2 km). A lake fertilization program was initiated in 1982. Nutrient additions have continued annually since then. This system is the major sockeye producing systems in southern Southeast Alaska.

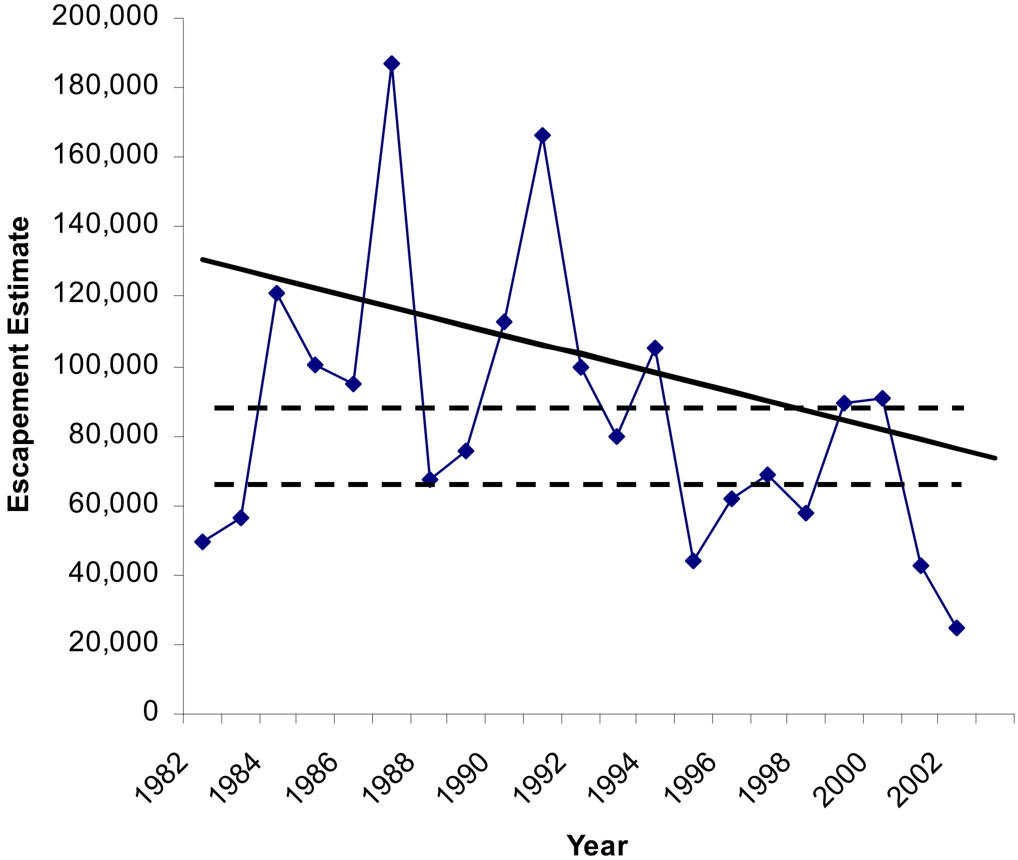
Historically, McDonald Lake sockeye salmon were harvested primarily in the District 106 drift gillnet fishery. Today these fish are caught in a variety of Canadian and Alaskan fisheries. Both coded wire tag and U.S./Canada migration tagging studies indicated that McDonald Lake sockeye salmon have been harvested in all the Alaskan fisheries and gear groups from Districts 101 through 107, including Annette Island and in British Columbia Areas 1 and 3, from early July through late August. The McDonald Lake stock migrates along both the north and south routes around Prince of Wales Island. The District 101 West Behm Canal fisheries became the predominant harvest area in the past 10 years, due to development of a directed near-terminal seine fishery. In addition, McDonald Lake has provided the largest personal use/subsistence harvest in southern Southeast, and sometimes the highest annual personal use/subsistence harvest within the region.

Prior to the start of the lake fertilization program, McDonald Lake did not have an escapement goal for any species. The system was known to have sockeye salmon from historical records, but most escapement surveys since statehood were sporadic and directed in late July to early August at pink salmon, well before this sockeye salmon stock spawns. This early survey timing did not reveal the true magnitude of sockeye salmon abundance in the system. The first escapement goal of any type was identified in 1989, based on habitat considerations (the euphotic volume model). This first escapement goal was set at 85,000 sockeye salmon, based on fry loading of the system, which translated into 2,500 spawning adults per EV unit. The escapement goal was lowered in 1993 from a point goal to the current range of 65,000 to 85,000 sockeye salmon, based on an early Ricker analysis, which was not formally documented. The 1993 goal can be considered a *biological escapement goal*, although this goal needs to be updated and documented at the earliest possible opportunity.

Appendix 2.15.1. Estimated total return of McDonald Lake sockeye salmon from 1982 to 2001. Commercial Catch estimated by run reconstruction (Gazey and English 2000). Escapement estimated by expanded foot surveys (Zadina and Heinl 1999).

Return Year	Commercial Harvest	Personal Use Harvest	Assumed Sport Harvest	Test Fish	Brood Stock	Escapement	Total Return	Total Catch	Harvest Rate
1982	84,291	182	0	0	0	49,716	134,189	84,473	63%
1983	100,749	10	0	0	0	56,142	156,901	100,759	64%
1984	163,956	0	0	0	0	121,224	285,180	163,956	57%
1985	175,978	1,185	200	0	0	100,655	278,018	177,363	64%
1986	144,956	1,808	200	0	0	94,581	241,545	146,964	61%
1987	195,034	3,989	200	0	0	187,173	386,396	199,223	52%
1988	94,748	2,344	200	4	2,946	67,486	167,728	100,242	60%
1989	110,851	3,415	200	663	4,032	75,704	194,865	119,161	61%
1990	144,581	5,738	200	436	600	112,974	264,529	151,555	57%
1991	219,536	8,203	200	1,751	1,268	166,267	397,225	230,958	58%
1992	209,620	9,937	200	1,933	2,001	99,828	323,519	223,691	69%
1993	442,852	9,862	200	677	1,922	79,729	535,242	455,513	85%
1994	146,260	10,245	200	97	1,422	104,960	263,184	158,224	60%
1995	116,280	6,691	200	365	840	44,052	168,428	124,376	74%
1996	539,671	4,448	200	0	0	61,932	606,251	544,319	90%
1997	234,003	7,338	200	2,270	0	68,462	312,273	243,811	78%
1998	112,313	6,123	200	642	0	57,501	176,779	119,278	67%
1999	174,995	6,525	200	2,426	0	89,609	273,755	184,146	67%
2000	175,957	7,578	200	2,659	300	90,627	277,321	186,694	67%
2001	Incomplete	6,348	200	917	294	42,768			
2002						25,000[a]			
1982 to 2000 average	188,770	5,033	168	733	807	90,980	286,491	195,511	66%

[a] The 2002 escapement estimate is preliminary.



Appendix 2.15.1. Annual estimated escapement of sockeye salmon to McDonald Lake from 1982 to 2002. The solid line shows the trend in escapement over the last 21 years of data. The dashed lines denote the current escapement goal range of 65,000 to 85,000 spawners. The preliminary 2002 estimate is approximately 25,000, which is below the lower end of the goal range. Although the escapement shows a decline, much of this decline represents a lowered escapement goal in 1993, active management, and an intentional reduction of the escapement size to a level intended to maximize yield while meeting escapement goals.

Appendix 2.15.3 Literature Cited

Gazey, W. J., and K. K. English. 2000. Assessment of sockeye and pink salmon stocks in the northern boundary area using run reconstruction techniques, 1982–1995. Can. Tech. Rep. Fish. and Aquatic Sciences. 2320:132p.

Zadina, T. P., and S. C. Heinl. 1999. Limnological and fisheries investigations at McDonald Lake, Southeast Alaska, 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries Regional Information Report 1J99-15. Juneau, Alaska.

Appendix 2.16. Information on the 12 subsistence projects.

Appendix 2.16.1. Klawock Lake

Klawock Lake is located on the west coast of Prince of Wales Island, approximately 1 mile upstream from the mouth of Klawock River and the community of Klawock. Cannery records from before the turn of the last century provide a history of the commercial fisheries in Klawock Lake and in marine areas adjacent to Klawock River. Sockeye enhancement dates back to the late 1890s.

The current hatchery program was initiated in 1979. A total of 11.9 million sockeye fry were stocked between 1979 and 2001, with a range of 18 thousand to 2.7 million stocked each year. Large-scale logging began in the 1950s. By the 1990s, 75% to 80% of the Klawock watershed was clear cut.

Limnology data, sockeye fry population estimates, and smolt population characteristics were sporadically collected in the last 20 years. Coded wire tags from the Klawock sockeye stock have been recovered in the District 104 seine fisheries in the 1980s. However, the number of sockeye salmon sampled for tags in U.S. and Canadian ports was small, and only 66 tags were collected between 1988 and 1998.

Between 1985 and 1989, the average number of subsistence fishery permits was 125, and the average number of sockeye salmon harvested annually was 2,400 fish. In the 1990s, 2000, and 2001, the average effort remained about the same, 125 permits, but the catch nearly doubled to an annual average catch of 4,100 sockeye salmon adults.

Weir counts from the 1930s are available, and these show escapements averaging about 30,000 sockeye spawners. Unfortunately, the weir counts in the 1970s and 1980s are incomplete and unreliable. In 2001, ADF&G, the Klawock Cooperative Association, and the US Forest Service initiated a 3-year study on Klawock Lake. In 2001, approximately 14,000 sockeye salmon adults were in the escapement. Several additional assessment activities are ongoing, including a paleolimnology study to look at long-term changes in lake production, a predation study on stocked sockeye salmon fry, and an assessment of the wild-hatchery ratio of fry, smolts, and adult sockeye salmon in this system.

Appendix 2.16.2. Hetta Lake

Hetta Lake is located on the southwestern side of Prince of Wales Island, approximately 18 miles southeast of Hydaburg. The system has a long history of commercial and subsistence harvest, and an early hatchery operation. Overfishing of Hetta Lake salmon stocks was documented late in the 1800s; by 1914 less than 10,000 sockeye adults returned to Hetta Lake. A hatchery, under various owners, operated at Hetta Lake for 19 years around the turn of the century—without success. The Hetta Lake watershed was extensively logged in the 1950s.

Biologists have operated various stock-assessment projects at Hetta Lake intermittently for the last 34 years. A weir operated from 1968 to 1971 and in 1982 to count the number of adult sockeye salmon returning to the lake. In 1980, ADF&G collected smolt length and age data to describe the size and ages of the juvenile sockeye population in the lake. An evaluation of lake productivity was conducted from 1979 to 1982, which led to the conclusion that Hetta Lake was a good candidate for lake fertilization. The lake was dropped as a potential enhancement project in the early 1980s due to lack of support in the Hydaburg community.

Although we do not have a means to distinguish Hetta Lake sockeye salmon from other stocks harvested in the commercial fishery, it appears that majority of the sockeye salmon enter Hetta

Inlet earlier than the first commercial purse seine fishery in mid to late August. The mean annual reported subsistence harvest over the last 15 years has remained fairly constant, at about 1,500 fish per year. However, the catch numbers reported on permits considerably underestimates the actual harvest. In 2001, Hydaburg technicians interviewed all subsistence fishery participants either on the fishery grounds, at the dock, or else contacted them at home. The interviews indicated 4,400 sockeye salmon were taken from the Hetta system. In comparison, only 1,089 sockeye adults were reported on the mail-in permits returned to ADF&G in 2001.

In 2001, ADF&G, the Hydaburg Cooperative Association, and the U.S. Forest Service initiated a 3-year sockeye salmon stock assessment project. Approximately 6,000 sockeye salmon spawned in Hetta Lake that year.

Appendix 2.16.3. Sitkoh Lake

Sitkoh Lake is located approximately 10 miles west of Angoon, on the southeast corner of Chichagof Island. Commercial fishing activities in the early 1900s most likely contributed to the decline in returns to this area. In 1926, commercial fishery closures were initiated to protect the Sitkoh sockeye salmon population. Stock assessment activities included a weir in the 1930s, 1982, and early 1990s.

A commercial purse seine fishery is prosecuted in Chatham and Peril Strait Subdistricts adjacent to Sitkoh Bay (Subdistricts 112-11, 112-12, 113-51, and 113-55). We do not know the stock composition of sockeye harvested in these purse seine fisheries. Nevertheless, all of Sitkoh Bay and the outer Peril Strait area (Subdistrict 113-51) are closed to purse seining to ensure escapement and subsistence opportunities.

Between 25% and 60% of the Angoon residents reported using Sitkoh Bay for subsistence fish each year between 1957 and 1984. The average annual reported subsistence catch was 396 sockeye salmon from 1985 to 1990, based on an average of 31 permits. The highest reported catch was 680 sockeye salmon in 1986. Between 1991 and 2000, an average of only 35 sockeye salmon were reported as annual harvest, on an average of just 3 permits—about one-tenth the former harvest levels. There were 2 years, 1991 and 1993, with no recorded effort or harvest at Sitkoh Bay. The reported catch was 240 sockeye salmon in 2001 on 14 permits—nearly double the amount of effort in 2000 (8 permits). A possible explanation for the increase in effort in Sitkoh Bay may be the depressed sockeye salmon run in Kanalku Bay, which is closer to Angoon and easily accessible with small boats.

A weir count in 1982 and mark–recapture estimates of escapement obtained in 1996 through 2000 show a range of 6,000 to 17,000 adult sockeye salmon in the escapement to Sitkoh Lake. An estimated 12,200 sockeye salmon spawners escaped into the system in 2001.

Appendix 2.16.4. Kanalku Lake

Kanalku Lake is located approximately 12 miles southeast of Angoon. Kanalku Lake empties into Kanalku Bay, which is one of many bays within Mitchell Bay. Kanalku Lake and Bay were heavily fished by clans in the Angoon area for sockeye and coho salmon returning to the area. There have been no directed commercial fisheries in Mitchell Bay (Kanalku and Salt Lake). Currently, a commercial purse seine fishery operates in Chatham Strait outside of Mitchell Bay. The majority of the sockeye salmon enter Mitchell Bay earlier than the first commercial purse seine fishery opening in northern Chatham Strait.

The subsistence permits returned from Kanalku Bay recorded an average of 35 permit holders annually fishing, from 1985 to 2000, and an average annual harvest of 969 sockeye salmon during this period. These numbers are considered to be only a fraction of the actual harvest. At a public meeting in Sitka, Alaska in March of 2002, ADF&G biologists voiced their concern that the escapement into Kanalku Lake had reached a very low level and suggested that Kanalku Bay be closed to subsistence fishing to rebuild the stocks. Several people from Angoon requested that the Angoon Community Association be allowed to educate the community on the need to restrict fishing in the area and request that subsistence users stay out of Kanalku Bay. ADF&G agreed to allow the community to internally police the fishing in Kanalku Bay in 2002. Reports from Angoon Community Association suggest that this effort was successful in the 2002 season. Preliminary data from 2002 shows a 5-fold increase in the escapement estimate between 2002 (1,600 spawners) and 2001 (300 spawners).

Appendix 2.16.5. Falls Lake

Falls Lake is located on the east coast of Baranof Island between Red Bluff Bay and Cape Ommaney and is approximately 35 miles southwest of Kake. The sockeye salmon returning to Falls Lake continue to be an important resource for the community of Kake. Commercial exploitation was closed in the terminal area at Falls Lake in 1926. The lake was fertilized from 1983 to 1985, and the U.S. Forest Service constructed a fish pass in 1986. Sockeye and coho salmon escapements into Falls Lake were monitored through a weir in the lower part of the outlet stream from 1981 to 1989.

The commercial purse seine fisheries operating in the nearby waters of Chatham Strait are not specifically directed at sockeye salmon. The average annual sockeye salmon harvest in the Falls and Gut Bay areas (Subdistricts 109-20, 112-11, 112-21, and 112-22) increased from 1,113 sockeye salmon in the 1970s to 2,508 in the 1980s to 11,146 in the 1990s. However, in 2000, 2001, and 2002, 8,600, 11,300, and 3,300 sockeye salmon were harvested in these subdistricts, respectively. Headland to headland regulatory markers are used in Subdistrict 109-20 to provide for escapement of Falls Lake sockeye salmon. Very often, local area closures exceed area restrictions provided in regulation, and are subject to reconsideration during inseason management.

The subsistence harvest of Falls Lake sockeye salmon has increased substantially in the last decade. From 1993 to 2000 the average annual reported harvest was 1,003 sockeye salmon on 62 permits, compared with the average reported harvest of 203 sockeye salmon on 15 permits between 1985 and 1992.

In 2001, ADF&G developed a creel survey to estimate subsistence harvest in this system. A total of 56 boats fished in the marine waters near Falls Lake. Of those, 21 boats conveyed sport fishermen and 35 boats conveyed subsistence users. The total reported harvest of sockeye salmon was 2,000 fish. Subsistence users caught 98.9% and sport fishers caught 2.1% of the sockeye salmon, based on the survey. By way of contrast, the total subsistence harvest reported on subsistence permits was 1,200 sockeye salmon.

In 2001, ADF&G, the Organized Village of Kake, and the U.S. Forest Service initiated a sockeye salmon stock assessment project. In 2001, the sockeye salmon escapement was estimated to be 2,500 fish, nearly the same as the estimated escapement counted into Falls Lake in previous years. No fish entered the lake until the subsistence fishery ended July 20, 2001.

Appendix 2.16.6. Gut Bay Lake

Gut Bay Lake is located on the east side of Baranof Island, approximately 40 miles southwest of Kake. In recent times, over 50% of Kake households have reported using Gut Bay for subsistence hunting and fishing. Between 1892 and 1927, commercial fisheries targeted sockeye salmon in Gut Bay. Gut Bay was closed to commercial fishing in 1926, along with most other sockeye salmon systems in Chatham Strait.

The purse seine fishery operating in Chatham Strait outside of Gut Bay is not specifically directed at sockeye salmon. Similar to Falls Lake, the average annual sockeye salmon harvest in the Gut Bay area commercial fisheries (Subdistricts 109-20, 112-11, 112-21, and 112-22) increased from 1,113 sockeye salmon in the 1970s to 2,508 in the 1980s to 11,146 in the 1990s. As noted in the Falls Lake section, the most recent catch records from 2000 and 2001 show a 4-fold decline in the sockeye salmon catches in this area. The majority of the sockeye salmon are taken in hatchery terminal fisheries in Chatham Strait. Gut Bay is generally closed to commercial fisheries to ensure sockeye salmon escapement into Gut Bay Lake. Very often local area closures exceed area restrictions provided in regulation, and are subject to reconsideration during inseason management.

The reported subsistence fishery catch has been between 400 and 500 sockeye salmon for the last 15 years. The subsistence fishery in Gut Bay is one of the earliest in Chatham Strait, and it continues over a protracted time compared to other systems.

Appendix 2.16.7. Luck Lake

Luck Lake is located on the northeast side of Prince of Wales Island and is accessible by road. Very little historical data is available for this system. Between 1928 and 1931 the U.S. Bureau of Fisheries operated a weir and recorded escapements ranging from 2,000 to 15,700 with an annual mean of 6,700. In the 1970s Luck Lake drainage was logged to the stream bank.

Commercial fisheries in subdistricts adjacent to Luck Lake (106-10, 106-20, 106-22, 106-30) averaged harvests of 40,000 sockeye salmon between 1998 and 2002, and the 20-year average commercial harvest between 1977 and 1997 was 62,000 sockeye salmon. However, the number of Luck Lake salmon harvested in these fisheries is unknown. To ensure adequate escapement, commercial gillnet fishing is not allowed within a little over a mile of the stream. Purse seining in District 106, the waters adjacent to the outlet of Luck Lake, does not usually start until the first or second week in August. This period is after the Luck Lake sockeye salmon have entered the stream. The reported subsistence catches of sockeye salmon in the Luck Lake area are very low; only 22 sockeye salmon (caught in 1990) were reported between 1985 and 2001. The residents of Prince of Wales Island are interested in Luck Lake as an alternative to Klawock Lake for subsistence sockeye salmon if the stock assessment study shows an adequate run in this system.

In 2001, ADF&G, Wrangell Cooperative Association, and the U.S. Forest Service initiated a sockeye salmon stock assessment project on Luck Lake. In 2001, the sockeye salmon escapement was estimated to be 7,900 fish using mark–recapture methods on the spawning grounds.

Appendix 2.16.8. Thoms Lake

Thoms Lake is located approximately 10 miles south of the Wrangell road system on Wrangell Island. There is very little historical information about the sockeye salmon population in Thoms Lake. There are 2 commercial fisheries in the area adjacent to Thoms: the purse seine fishery in Subdistrict 107-20, and the drift gillnet fishery in Subdistrict 108-40. The most recent 5-year average seine harvest in these subdistricts (6,300) is nearly twice the latest 20-year average (3,100 fish). In the gillnet fishery, the most recent 5-year (4,100) and 20-year (5,500) average were about the same.

Purse seining is prohibited north of Thoms Point, which is about 4.5 miles from Thoms Creek. Gillnet fishing is prohibited south of Nemo Point, which is about 10 miles from Thoms Creek. Although these area closures are designed to ensure adequate escapement and subsistence opportunities, the number of Thoms Lake sockeye salmon caught in the commercial fisheries is unknown. An average of 300 sockeye salmon were harvested annually in the subsistence fisheries between 1985 and 2000, with a range from 100 (1988) to 600 (1993) fish. In 2001, 20 permit holders reported harvesting 163 sockeye salmon in Thoms Lake.

In 2001, ADF&G, Wrangell Cooperative Association and the U.S. Forest Service initiated a sockeye salmon stock assessment project on Thoms Lake. In 2001, the sockeye salmon escapement was estimated to be 3,000 fish using mark–recapture methods on the spawning grounds.

Appendix 2.16.9. Salmon Bay

Salmon Bay Lake is located on the northeast tip of Prince of Wales Island, approximately 35 miles southwest of Wrangell. The majority of the commercial sockeye salmon caught in the vicinity of Salmon Bay Lake (Subdistricts 106-30 and 106-41) are caught in the drift gillnet fisheries (98%), with about 2% caught in purse seine fisheries. Between 1998 and 2002, the commercial harvest in Subdistrict 106-30 averaged 37,500 sockeye salmon, down from the average in previous years. Although the number of Salmon Bay Lake salmon harvested in these fisheries is unknown, Salmon Bay is closed within a mile of the stream prior to the time period when sockeye salmon start schooling in Salmon Bay. The closure is enlarged significantly in mid-July to prevent the harvest of schooling fish that occasionally back out of Salmon Bay. The reported sockeye salmon catch in the subsistence fishery between 1985 and 2000 averaged 400 sockeye salmon per year, and varied from 83 fish (in 1988) to 724 fish (in 1998). In 2001, 52 permits reported 900 sockeye salmon taken from the terminal area of the Salmon Bay Lake system. Although this system is open to subsistence fishing June 1 through July 31, 98% of the reported subsistence catch of sockeye salmon is landed in July. A weir operated between 1965 and 1968 and then again between 1982 and 1988; weir counts ranged from 6,000 to 34,000 sockeye salmon.

In 2001, ADF&G, Wrangell Cooperative Association, and the U.S. Forest Service initiated a sockeye salmon stock assessment project on Salmon Bay Lake. In 2001, the sockeye salmon escapement was estimated to be 20,800 fish using mark–recapture methods.

Appendix 2.16.10. Kook Lake

Kook Lake is located approximately 35 miles northwest of Angoon on Chichagof Island. The earliest record of commercial fishing in the area was from Sitkoh Bay in 1890. Because of the interest in sockeye salmon at that time, nearby Basket Bay must have also been fished commercially during this period. The first cannery in the area was built in 1889 at Pavlof Harbor. However, this cannery was moved south to the Bay of Pillars in the following year. Beginning in 1924, conservation closures were implemented in Basket Bay and other bays along Chatham Strait.

Currently, a commercial purse seine fishery operates in upper Chatham Strait (Subdistricts 112-11, 112-12, 112-21, and 112-22). Most of sockeye salmon caught in the seine fishery are incidental, as most of this effort is directed at the Hidden Falls Hatchery chum salmon return in Subdistrict 112-22. Although the stock origins of these sockeye salmon are unknown, managers typically take actions to provide for escapement and an opportunity for subsistence. The Chichagof shoreline, immediately adjacent to Basket Bay, has been closed to commercial fishing in recent years to minimize sockeye salmon catch in the purse seine fisheries. Very often local area closures exceed area restrictions provided by regulation, and are subject to reconsideration during inseason management.

Since 1985, the reported sockeye salmon subsistence catch has been between 200 and 450 fish for most years. Two notable exceptions are 1986 and 1987; 1,400 sockeye salmon were harvested in 1986 and 1,200 in 1987. A total of 260 sockeye salmon were reported on subsistence permits in 2001, compared to 234 in 2000 and 308 in 1999. An adult weir was operated in 1994 and 1995 with weir counts of 1,800 and 5,800 sockeye salmon, respectively.

In 2001, ADF&G, the Organized Village of Kake, and the U.S. Forest Service initiated a sockeye salmon stock assessment project on Kook Lake. In 2001, a mark–recapture estimate of beach spawners was 720 sockeye salmon; the preliminary estimate of beach spawners in 2002 was about 3,000 sockeye salmon.

Appendix 2.16.11. Hoktaheen Lake

Hoktaheen Lake is located approximately 50 miles west Hoonah in the northwest quadrant of Yakobi Island. There are no directed sockeye salmon fisheries in the vicinity of Hoktaheen Cove (Subdistricts 113-91, 113-94, 114-21), and there has been very little commercial harvest of sockeye salmon in this area, in recent time. The total subsistence sockeye salmon harvest and the number of permits issued for Hoktaheen rose steeply from 1 in 1988 to a peak of 59 in 1997, and declined in recent years to 28 in 2001. The reported sockeye salmon harvest peaked at 1,720 in 1997, and then declined to 623 and 610 in 2000 and 2001, respectively. The subsistence fishery occurs during June and July.

In 2001, most spawners were observed in the outlet stream and a peak of 480 live sockeye salmon were counted in the stream on September 3. Approximately 700 sockeye salmon spawners were observed in the stream in 2001.

Appendix 2.16.12. Klag Lake

Klag Lake is located approximately 35 miles northwest of Sitka on Chichagof Island. Klag Bay ranks third in importance, after Redoubt and Necker Bays, for subsistence users in Sitka. Its importance has increased in recent years as a consequence of conservation closures at Redoubt Lake. Historical commercial fishing at Klag Bay coincided mostly with the operation of a cannery at Ford Arm, from 1911 to 1924. The commercial catch has dwindled to very low numbers along the west coast of Chichagof Island in recent years. There is no directed fishery on sockeye salmon in this area. Subsistence harvests of sockeye salmon at Klag Bay have increased dramatically in the past decade. The season was reduced starting in 1999 in an attempt to increase escapement, until such time as the run timing and escapement could be more accurately assessed. Currently the subsistence fishing season runs from June 25 to July 25, and sockeye salmon are harvested continuously throughout this period. In 2001, the reported catch on the subsistence permits was 1,300, compared to 1,600 fish estimated in a creel survey in Klag Bay.

In 2001, ADF&G, Sitka Tribe of Alaska, and the U.S. Forest Service initiated a stock assessment project on Klag Lake. In 2001, the sockeye salmon escapement was estimated using mark–recapture methods in combination with the weir counts to be 12,000.

Chapter 3: Coho Salmon
Stock Status and Escapement Goals in Southeast Alaska

by
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ABSTRACT

The status of coho salmon stocks in Southeast Alaska was assessed from information on escapement, smolt abundance, marine survival and total adult abundance from coded wire tagged indicator stocks and streams that were surveyed for escapement. The escapement trend since the early to mid-1980s has been relatively level for most stocks, with a peak in the early to mid-1990s and generally high escapements in 2001 and 2002. Escapements have generally tracked the pattern of total abundance and marine survival, with smolt production estimates in most systems showing no trend.

We assessed escapements relative to established objectives for stocks that have goals. With very few exceptions, observed escapements were within or above goal since 1990. The only substantial exception, Jordan Creek near Juneau, had peak survey counts that were within or above goal in all but one year during 1981 to 1994 but declined to below goal every year from 1996 to 2000 and were proportionately far below other Juneau roadside systems during that period. However, the Jordan Creek escapement was within goal in 2001 and increased dramatically in 2002 to nearly double the record for the previous 21 years. Although smolt production from Auke Creek declined by 35% over a 24-year period, spawning escapements have been above goal in 20 of 23 years, including the last 7 years. Effects of extensive urbanization may be a possible explanation for the apparent decline in Auke Creek production and recent highly variable production from Jordan Creek. We identified no coho salmon *stocks of concern* in Southeast Alaska.

Marine survival has been the primary factor influencing coho salmon returns, accounting for an average of 61% (range 57% to 70%) of variability in run size of all wild indicator stocks in all years, compared with 39% (range 30% to 43%) for freshwater factors, including spawning escapement. Synchrony in run strength among systems, in marine survival and to a lesser extent in smolt production, facilitates management of mixed-stock fisheries based on information on fishery performance and indicator stock abundance.

A recent reduction in exploitation caused by reduced fishing effort associated with low salmon prices has resulted in exceptionally large escapements in 2002 that were far in excess of breeding needs. While substantial surplus escapements may continue under current salmon market trends, we do not expect them to adversely affect future returns. Under 2002 exploitation rates, future runs would have to be substantially lower than the smallest runs in the past 2 decades for escapements to indicator systems to fall below goal. Until the fisheries return to their historical levels of effort and exploitation, the primary concern for managers in most years will be to assist harvesters in accessing and utilizing the stocks in a cost effective manner.

Key words: coho salmon, *Oncorhynchus kisutch*, escapement, escapement goals, smolts, marine survival, exploitation rates, Auke Creek, Berners River, Taku River, Ford Arm Lake, Hugh Smith Lake, Chuck Creek, Unuk River, Slippery Creek

INTRODUCTION

Coho salmon (*Oncorhynchus kisutch*) are important to a variety of commercial, sport, and subsistence users. Trollers have accounted for over 60% of the commercial catch, on average, but coho salmon are also important to seine, drift gillnet and set gillnet fisheries. Recreational fisheries occur in both fresh and saltwater areas and have constituted an increasing component of the catch in recent years. Directed subsistence fisheries have been very limited, but regulations allowing directed subsistence fishing for coho salmon have been recently expanded under federal rules in many freshwater areas.

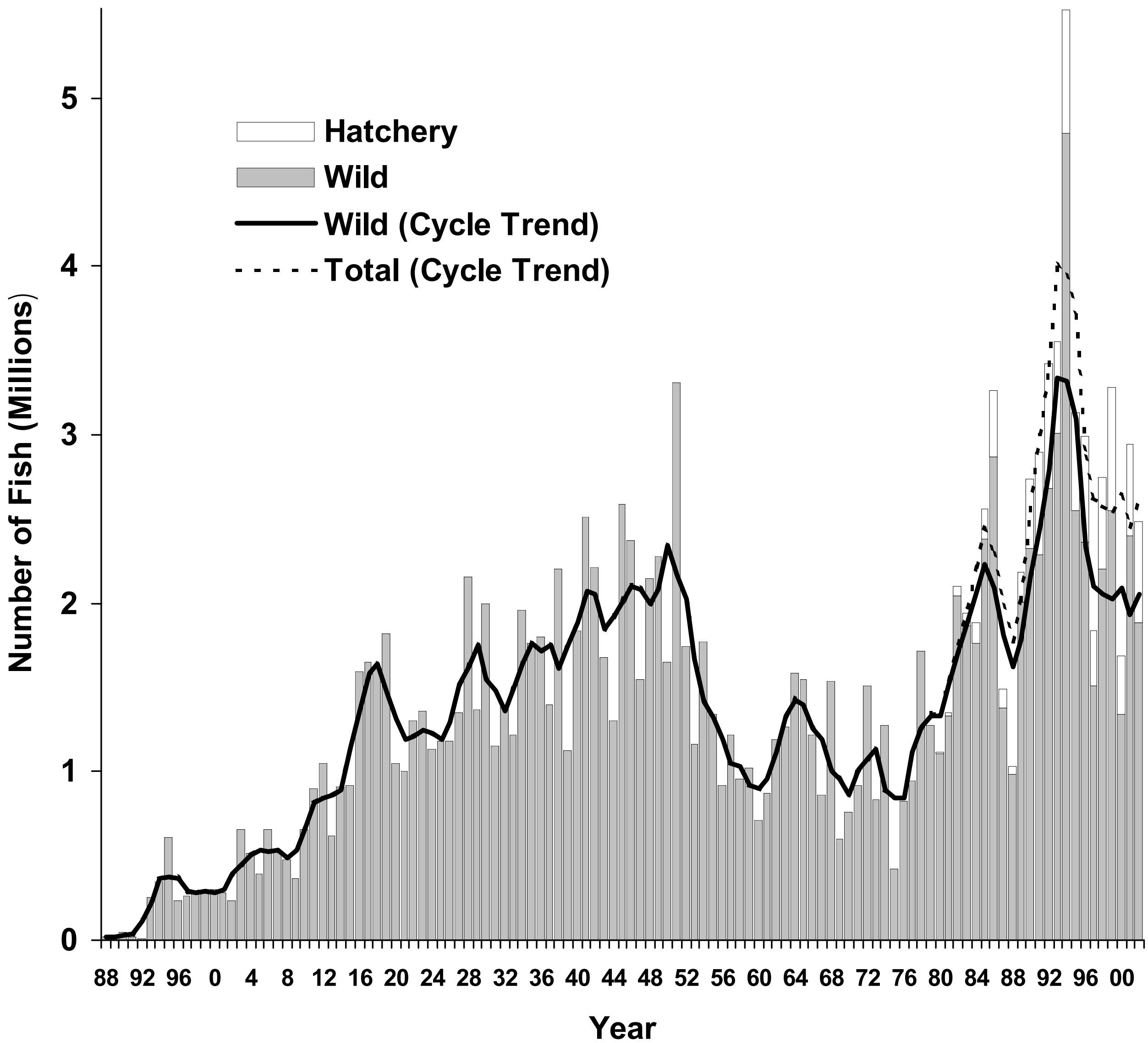

Figure 3.1. Commercial harvest of wild and hatchery coho salmon in Southeast Alaska from 1888 to 2002. Also shown is a 3½-year "cycle trend" that approximates the average age of returning adult coho salmon in Southeast Alaska.

The commercial catch of wild stocks has probably tracked overall regional stock abundance since the 1940s when the troll fishery for coho salmon became widely established (Figure 3.1). However, the 2002 catch of 1.89 million fish clearly does not track wild stock abundance, because exploitation rates declined sharply with deteriorating market conditions. Stocks recovered in the early 1980s from a prolonged period of low abundance extending for 26 years. Whereas poor marine survival was likely a major factor driving poor catches from 1956 to 1981, improved marine survival has been an important factor influencing larger wild-stock catches during 1982 to 2002.

Excellent coho salmon habitat occurs throughout Southeast Alaska (Figure 3.2). In addition to wild stocks within Southeast, important contributions to the region's total harvest are made by local hatchery stocks, the transboundary rivers, and by natural systems and hatcheries on the northern British Columbia coast. Coho salmon are produced by thousands of streams and by 13 hatcheries in Southeast Alaska. Many of the streams are small producers about which little is known. During 1998 to 2002, hatcheries contributed an average of 22% (range 13% to 28%) of the Southeast Alaska commercial catch, of which over 97% was produced by Alaskan facilities.

The Alaska Department of Fish and Game implemented an improved stock assessment program in the early 1980s to better understand and manage coho salmon stocks. New assessment projects were implemented to monitor population and fishery parameters for indicator stocks (Shaul 1994; Shaul and Crabtree 1998). In addition, a systematic escapement survey program was developed. These programs have improved understanding among fishery researchers and managers of the status of Southeast Alaska coho salmon stocks and have formed the basis for improved management.

The principal management objective for Southeast Alaska fisheries for coho salmon is to achieve *maximum sustained yield* from wild stocks. Hatchery contributions and natural production are identified inseason in key fisheries using coded wire tags. Fisheries directed primarily at coho salmon are managed based on wild stock fishery performance to achieve adequate escapement while harvesting the surplus. *Biological escapement goal* ranges have been established for a number of wild indicator stocks and surveyed systems.

A secondary management objective is to achieve long-term commercial gear-type allocations that were established by the Alaska Board of Fisheries in 1989. These allocations preserve a 1969 to 1988 historical base distribution of 61% for troll gear, 19% for purse seine gear, 13% for drift gillnet gear, and 7% for set gillnet gear.

The wide distribution of coho salmon production across thousands of small stream systems necessitates that much of the harvest occur in highly mixed-stock fisheries where the stocks intermingle. Except for years of strong deviations from average abundance, trollers fish a relatively stable season and harvest a relatively stable proportion of the total run. This results in a more even distribution of the troll harvest across all stocks in the region, thereby realizing some harvest from all stocks, while insuring that more heavily exploited inside stocks are able to support some harvest in inside fisheries and still achieve escapement. Most active management to harvest surpluses and achieve escapements is conducted in gillnet fisheries, based on returns to single major systems or local concentrations of productive systems. Nearly all of the harvest of many small to medium stocks on the outer coast and along inside passages occurs in the troll fishery, with a small incidental harvest by purse seine fisheries for pink salmon.

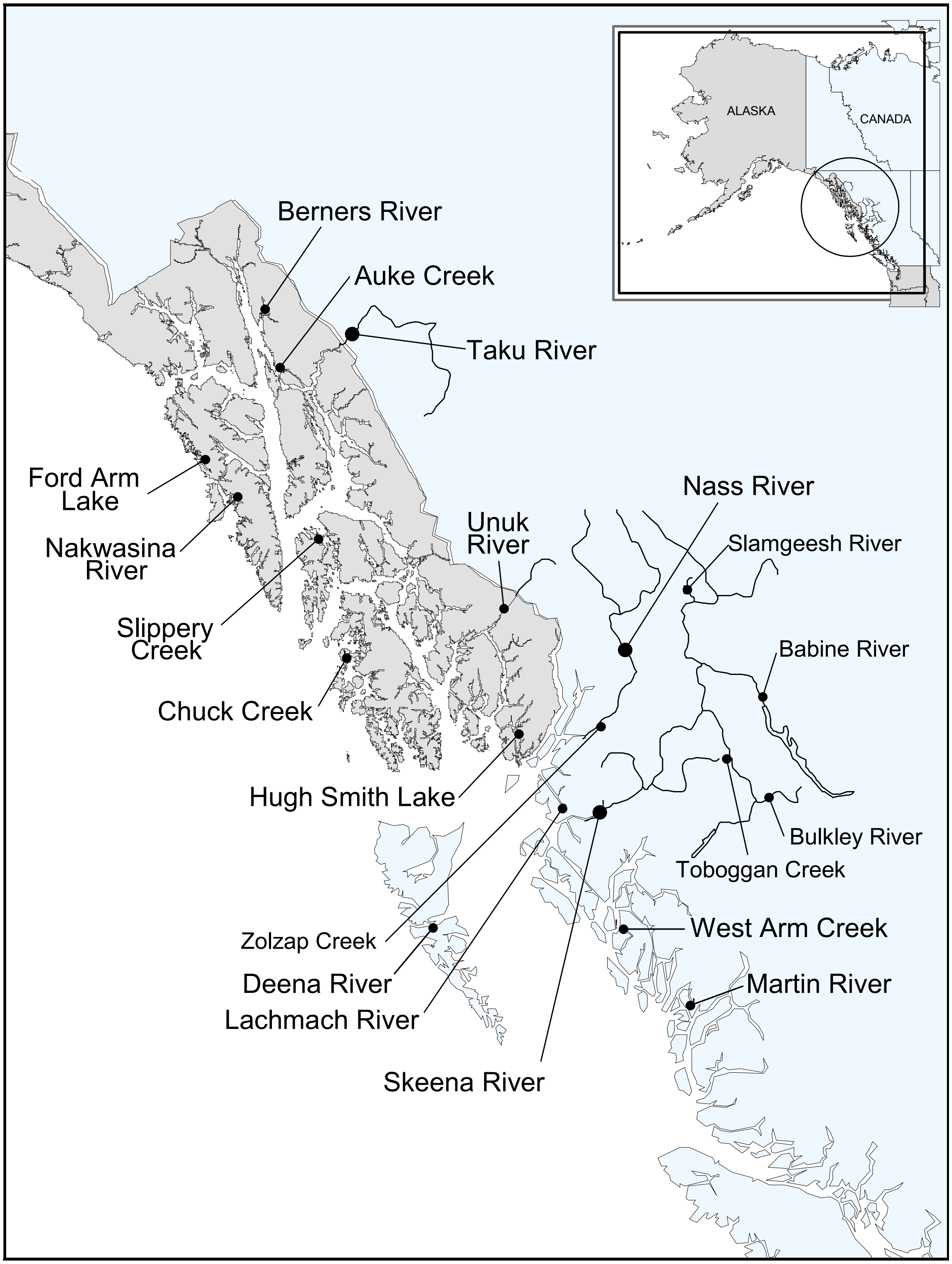

Figure 3.2. Map of Southeast Alaska and northern British Columbia, showing the locations of coho salmon full indicator stock assessment projects.

The commercial fisheries are managed under specific management plans for each fishery. The troll management plan for coho salmon contains several decision points that potentially trigger early or midseason closures for conservation and allocation, and an extension of the troll coho season for up to 10 days after the regulatory closing date of September 20. Most provisions of the plan were written in the late 1970s and 1980s when direct information on coho stocks was very limited, aside from fishery catch and effort. In recent years, fishery managers have tried to balance the specific provisions of the management plan with increasing capability to assess stocks and their escapement needs. Inseason management has increasingly focused on escapement goals that produce *maximum sustained yield* as a specific priority objective. Managers have also accommodated recent changes in the fisheries, including a price-driven reduction in participation by commercial users that has reduced the overall capability of the fisheries to exploit the stocks.

In addition to provisions specified in the management plans, the Pacific Salmon Treaty contains provisions for the conservation of northern British Columbia coho stocks. The Pacific Salmon Treaty provisions are essentially the same as Board of Fisheries management plan provisions for potential early and midseason troll fishery closures. However, the Pacific Salmon Treaty also contains provisions that trigger a closure of the troll fishery in boundary areas of Southern Southeast and in northern British Columbia when abundance of northern British Columbia stocks is indicated to be low based on fishery performance.

Marine sport fisheries are managed primarily under a 6-fish bag limit. The same bag limit applies in most freshwater systems, except for some more accessible streams where the bag limit is 2 fish. The sport fishery has accounted for a small but increasing component of the catch, reaching 10% of the all-user region harvest in 2000. Although emergency inseason management actions have been less frequent in the recreational fisheries, seasons have been closed or bag limits reduced in both marine and freshwater fisheries in response to inseason indicators of low abundance. Bag limits were increased in some locations to harvest the very large 1994 return.

Small subsistence coho salmon fisheries occur in Southeast Alaska, primarily in terminal areas near Yakutat and Angoon. These fisheries have not been actively managed, but harvest levels are monitored through permit returns. The reported harvest during 1992 to 2001 averaged only 2,700 fish.

STOCK STATUS

Status of coho salmon stocks in the Southeast region was judged by trends in abundance and escapement of indicator stocks relative to established goals. Coho salmon stocks are very widely distributed and are believed to be present in over 2,500 primary anadromous streams. Stock assessment projects can only be carried out on a small fraction of those streams. Most direct assessment of the stocks occurs at 2 levels: full indicator stock and escapement indicator.

Full Indicator Stocks

Full indicator stocks are marked as smolts or presmolts with coded wire tags, which makes it possible to estimate their smolt production (from the marked rate at return) and contribution to the fisheries by systematically sampling fishery harvests and escapements.

Full indicator stock programs have been expanded in recent years and are now well established in 9 systems in the region (Figure 3.2). The data series extends from the early 1980s for 4 systems (Auke Creek, Berners River, Ford Arm Lake, and Hugh Smith Lake). Programs have been expanded in the 1990s to include the Taku River, Unuk River, Nakwasina River, and Slippery Creek. In addition, Chuck Creek, which was added as an indicator stock in 2001, has total run estimates for 3 earlier years (1982, 1983, and 1985).

Full indicator stock programs provide detailed population information needed to establish and manage for *biological escapement goals*. Specific parameters that are estimated for these stocks include: total adult abundance, spawning escapement (including age, size, and sex), smolt production (abundance, age, size), marine survival, fishery contributions by area, gear type and time, and exploitation rates. Over time, these parameters are used to evaluate the relationship between spawning escapement and production and to establish biological escapement goals that maximize sustained yield. One major advantage of the smolt estimation programs associated with coho indicator stocks is that they make it possible to filter out variation in return abundance caused by variation in marine survival and to improve resolution of the relationship between escapement and brood-year production.

In 1994, *biological escapement goals* were established for the 4 long-term indicator stocks based on Ricker spawner-recruit relationships (Clark et al. 1994). Also, for the Taku River a minimum inriver abundance goal of 38,000 spawners is specified in the 1999 Pacific Salmon Treaty. In practical terms, the abundance goal upriver of the US/Canada border translates into an escapement goal of about 35,000 fish after inriver harvests by commercial, food and test fisheries.

Escapement Indicators

Foot or helicopter surveys have been systematically carried out on sets of streams in the Juneau, Sitka, and Ketchikan areas. These projects provide greater coverage but a much lower level of resolution about stock status compared with full indicator stocks. High and variable rainfall in the fall months makes it difficult to obtain consistent surveys. In the Juneau area, repetitive foot surveys are conducted on 5 streams of which all have individual goals. In the Sitka area, 5 local streams have been surveyed on foot most years since 1985, and the Black River north of Sitka has been surveyed by helicopter since 1984. In the Ketchikan area, surveys have been conducted by helicopter on 14 streams since 1987.

Only peak survey counts that met standards for timing, survey conditions, and completeness were included in the indexes. Interpolations were made for missing counts under the assumption that the expected value is determined for a given stream and year in a multiplicative way (i.e., counts across streams for a given year are multiples of counts for other years, and counts across years for a stream are multiples of counts for other streams). The estimated expected count for a given stream, in a given year, is then equal to the sum of all counts for the year, times the sum of all counts for the stream, divided by the sum of counts over all streams and years. If there is more than one missing value, an iterative procedure, as described by Brown (1974), must be used since the sums change as missing counts are filled in at each step. Most of the consistent indicators of coho salmon escapement were established in the early to mid-1980s (Table 3.1).

Table 3.1. Southeast Alaska coho salmon escapement estimates and index counts from 1980 to 2002.

Year	Auke Creek	Juneau Roadside Index[a]	Berners River	Taku River	Ford Arm Lake	Black River	Sitka Survey Index[b]	Hugh Smith Lake	Unuk River	Ketchikan Survey Index[c]	Chuck Creek	Slippery Creek
1980	698											
1981	646	1,552										
1982	447	1,545	7,505		2,662		1,533	2,144			1,017	
1983	694	1,287	9,840		1,938		456	1,490			1,238	
1984	651	1,312	2,825			425	2,061	1,408				
1985	942	1,466	6,169		2,324	1,628	1,245	903			956	
1986	454	887	1,752		1,546	312	590	1,783				
1987	668	945	3,260	55,457	1,694	262	275	1,118		4,833		
1988	756	1,127	2,724	39,450	3,028	280	402	513		5,007		
1989	502	1,241	7,509	56,808	2,177	181	576	433		6,761		
1990	697	2,518	11,050	72,196	2,190	842	566	870		3,471		
1991	808	2,641	11,530	127,484	2,761	690	1,510	1,826		5,721		
1992	1,020	4,405	15,300	84,853	3,847	866	1,899	1,426		7,017		
1993	859	2,351	15,670	109,457	4,202	764	1,718	830		7,270		
1994	1,437	2,916	15,920	96,343	3,228	758	1,965	1,753		8,690		
1995	460	1,405	4,945	55,710	2,445	1,265	1,487	1,781		8,627		
1996	515	1,291	6,050	44,635	2,500	500	1,451	958		8,831		
1997	609	1,471	10,050	32,345	4,965	686	809	732		5,052		
1998	862	1,516	6,802	61,382	7,049	1,520	1,242	983	12,615	7,068		632
1999	845	1,762	9,920	60,844	3,598	1,590	777	1,246	26,132	8,038		
2000	683	1,355	10,650	64,700	2,287	880	803	600	16,919	8,634		411
2001	865	1,760	19,290	104,460	2,178	1,080	1,465	1,580	35,527	11,705	1,350	2,674
2002	1,176	4,543	27,700	219,789	7,109	1,194	1,868	3,291	55,730	12,223	2,189	5,341
Goal Range												
Lower	200	500 [d]	4,000	35,000 [e]	1,300			500				
Upper	500	1,425 [d]	9,200		2,100			1,100				

[a] The Juneau roadside index is the sum of peak survey counts on five streams.
[b] The Sitka survey index is the sum of peak survey counts on five streams.
[c] The Ketchikan survey index is the sum of peak survey counts on 14 streams.
[d] Goal bounds shown for Juneau roadside streams are the sum of upper bounds and the sum of lower bounds for individual streams.
[e] The listed Taku River lower bound is the inriver run threshold of 38,000 specified in the Pacific Salmon Treaty minus an allowance of 3,000 fish caught in inriver fisheries.

Juneau Area Stocks

Escapement to Auke Creek and the aggregate count for 5 roadside streams have been consistently within or above escapement goal ranges since the early 1980s (Figure 3.3, Table 3.2).

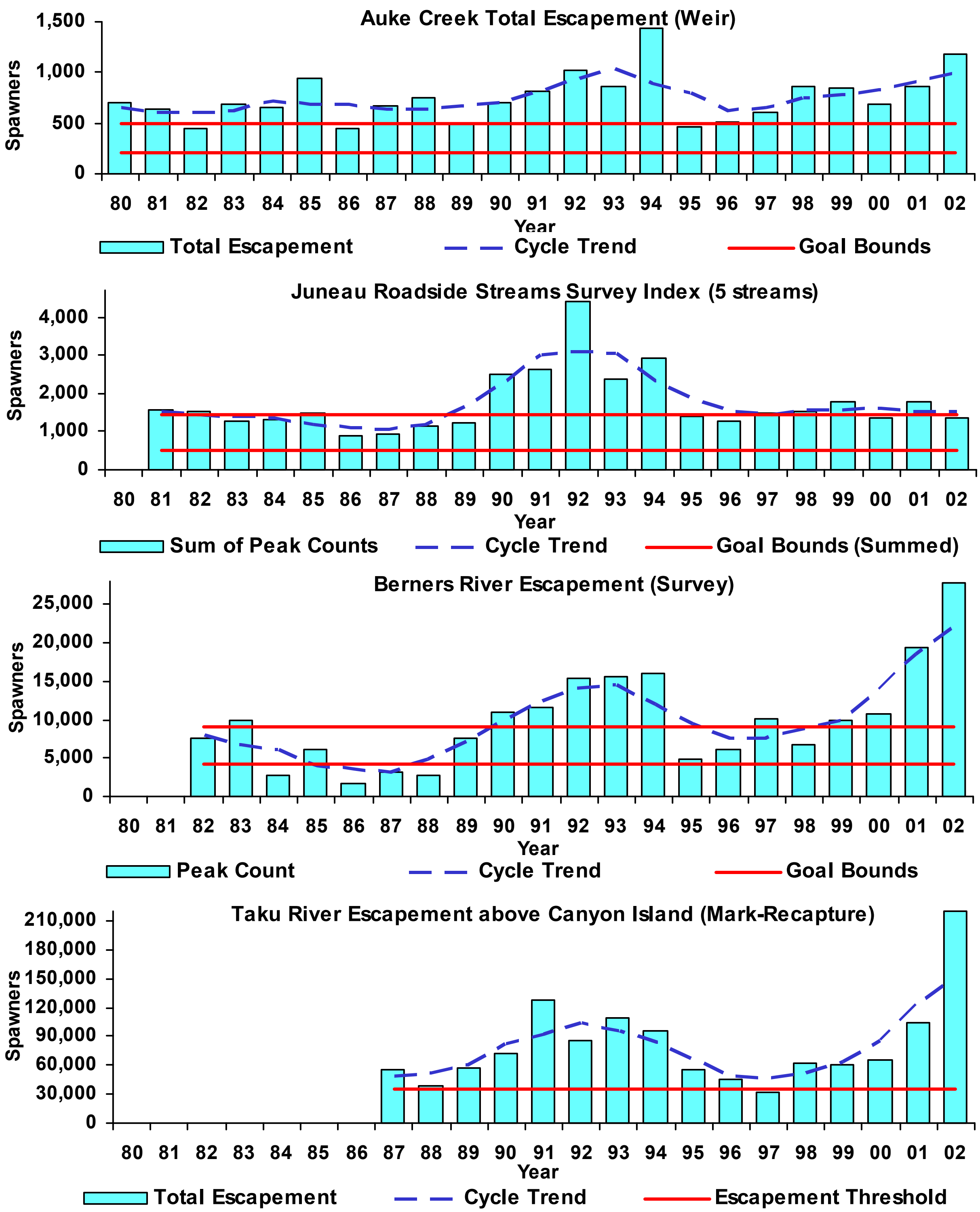

Figure 3.3. Coho salmon escapement estimates and indexes for streams in the Juneau area (Districts 111 and 115). Also shown are 3½-year moving average "cycle" trends and escapement goal ranges. The threshold of 35,000 shown for the Taku includes the inriver run threshold of 38,000 under the Pacific Salmon Treaty minus an allowance for a catch of 3,000 fish in inriver commercial, food, personal use and test fisheries.

However, counts for individual surveyed streams have been below goal in 9 out of 133 cases during 1981 to 2002. This was probably related in some cases to variable weather conditions that made surveys very difficult in some years. For example, very difficult conditions with sequential freshets in 1986 likely contributed to the very low peak count of only 60 fish in Montana Creek, the largest stream in the Juneau index. On the other hand, the abrupt decline in Jordan Creek escapements to levels below goal (and proportionately far below other local streams) for 5 consecutive years (1996 to 2000) probably reflected reduced smolt production. Jordan Creek flows through an area of heavy residential and commercial development. Peak escapement counts in the creek showed a sharp drop after 1994 and remained consistently below 100 spawners until 2001 (Table 3.2). The 2001 count of 119 spawners was within the goal range of 75 to 200.

Table 3.2. Peak coho salmon escapement survey counts for Juneau roadside streams and total count of wild adult coho salmon at the Auke Creek weir from 1981 to 2002.

Year	Montana Creek	Steep Creek	Jordan Creek	Switzer Creek	Peterson Creek	Total for Surveyed Streams	Auke Creek (Weir)
1980							698
1981	227	515	482	109	219	1,552	646
1982	545	232	368	80	320	1,545	447
1983	636	171	184	77	219	1,287	694
1984	581	168	251	123	189	1,312	651
1985	810	186	72	122	276	1,466	942
1986	60	247	163	54	363	887	454
1987	314	128	251	48	204	945	668
1988	164	155	215	51	542	1,127	756
1989	566	222	133	78	242	1,241	502
1990	1,711	185	216	82	324	2,518	697
1991	1,415	267	322	227	410	2,641	808
1992	2,512	612	785	93	403	4,405	1,020
1993	1,352	471	322	94	112	2,351	859
1994	1,829	200	371	198	318	2,916	1,437
1995	600	409	77	42	277	1,405	460
1996	798	134	54	42	263	1,291	515
1997	1,018	182	18	67	186	1,471	609
1998	1,160	149	63	42	102	1,516	862
1999	1,000	392	47	51	272	1,762	845
2000	961	88	30	74	202	1,355	683
2001	1,119	366	119	50	106	1,760	865
2002	2,448	380	1,396	124	195	4,543	1,176
Average	992	266	270	88	261	1,877	752
Goals:							
Point	450	150	150	50	200	1,000	340
Lower	200	100	75	25	100	500	200
Upper	500	300	200	75	350	1,425	500

In 2002, a record 1,396 spawners were counted in Jordan Creek which was nearly 7 times the upper end of the goal range and far higher than the prior record of 785 fish in 1992. Surprisingly, the 2002 count was proportionately higher in Jordan Creek than other Juneau roadside streams, even when compared with pre-1995 average escapements prior to the decline in Jordan Creek.

The reason for the tremendous resurgence in the run in Jordan Creek in 2002 is unknown but was consistent with a weir count of 25,909 smolts (>70 mm) from the system in 2001 (B. Glynn, Alaska Department of Fish and Game, Douglas, personal communication). If marine survival for the 2002 return was similar to the Auke Creek stock (26.6%), the Jordan Creek smolt count would have equated to an adult return of about 6,900 fish and an escapement of about 5,060 spawners which is not inconsistent with a peak survey count of nearly 1,400 spawners. Fewer than one-third as many smolts (8,312) were counted from the system in Spring 2002, suggesting that the 2001 smolt migration was an unusual occurrence.

The large 2002 return does not appear to have been related to an increase in spawning escapement because peak brood year spawner counts were only 63 in 1998 and 47 in 1999. The sudden surge in smolt production suggests that the stock may be particularly sensitive to variable environmental conditions affecting freshwater survival. There is also a possibility that juveniles move intermittently into Jordan Creek from other systems prior to final sea-migration. In spring 2002, a coded wire tagged smolt was recovered in Jordan Creek that had been marked in May 2001 in the Chilkat River in upper Lynn Canal (B. Glynn, Alaska Department of Fish and Game, Douglas, personal communication).

Strong escapements relative to goals for most streams in most years reflect high marine survival rates and moderate exploitation rates for roadside stocks since the early 1980s. Estimated marine survival of Auke Creek smolts to adulthood has averaged 20.1% while the exploitation rate on the stock has averaged only 40.5%. Auke Creek and surveyed stocks on the Juneau roadside are harvested primarily in highly mixed-stock troll, seine, and sport fisheries, with only light exploitation in inside gillnet fisheries.

The Berners River in lower Lynn Canal, north of Juneau, has been an indicator system since 1982. This stock is atypical of Southeast Alaska coho runs in that the escapement is compressed in time within a highly visible area, making it possible to routinely count most of the escapement in a single foot and helicopter survey in mid to late October. The stock fell short of the existing escapement goal during 4 years in the mid-1980s (Figure 3.3; Table 3.1) due primarily to intensive exploitation in the Lynn Canal gillnet fishery, which targeted Chilkat River chum salmon with record effort ranging from 2,725 to 4,923 fall boat-days from 1982 to 1988 (Shaul 1998).

An abrupt and persistent decline in fall chum abundance after 1988 resulted in greatly reduced fishing effort, while Berners River coho runs increased in the early 1990s. This combination has resulted in escapements ranging from well within to substantially above the goal of 4,000 to 9,200 spawners since 1989. Sequential record high escapements occurred in 2001 and 2002. The 2002 estimate of 27,700 spawners was 3 times the upper end of the goal range.

The Taku River south of Juneau may be the single largest coho salmon producing system in the region. Escapement estimates were first made in 1987 and run reconstruction estimates are available since 1992 (Elliott and Bernard 1994; McPherson et al. 1994, 1997, 1998; McPherson and Bernard 1995, 1996; Yanusz et al. 1999, 2000). The escapement past Canyon

Island near the US/Canada boundary is estimated using a mark–recapture technique. Marking is done at research fishwheel sites in the Canyon while recovery sampling is done in commercial and test fisheries in Canada. Results of a 1991 radiotelemetry study indicated that the fishwheel estimate represented about 78% of the total system escapement with about 22% spawning in Alaskan waters below Canyon Island (Eiler *in press*). In the 1999 Pacific Salmon Treaty agreement, the U.S. agreed to manage for a minimum run above Canyon Island of 38,000 fish. Allowing for a probable harvest of up to 3,000 fish above Canyon Island from an inriver run of 38,000 fish results in a de facto current threshold goal of about 35,000 spawners.

The escapement estimate past Canyon Island has exceeded 35,000 spawners in all years except 1997 when the estimate was only 32,345 spawners (Figure 3.3, Table 3.1), despite timely implementation of extensive inseason restrictions in troll, gillnet, and sport fisheries. In the early 1990s, the Taku River coho run increased sharply and greatly exceeded the current threshold goal despite increased fishing effort in the District 111 gillnet fishery, which targets the stock in late August and September.

Since 1998, Taku River escapements have ranged above the goal by an increasing margin because of increasing run sizes and low exploitation rates due to low gillnet effort levels. Recent fall openings in District 111 have been limited to 3 days per week to protect the Taku River chum stock, which has declined sharply from historical levels. Limited fishing time, combined with a lower number of participating vessels in recent years, has substantially reduced the exploitation rate of the gillnet fishery on the coho stock. At the same time, the ability of the Canadian fishery to harvest Taku coho salmon within the river has been limited by fall weather and other logistical and economic limitations associated with a remote fishing area.

Sitka Area Stocks

Ford Arm Lake is the only indicator stock in the Sitka area that has a long-term escapement database and an established biological escapement goal (Figure 3.4, Table 3.3). This stock is available along the coast from early July through early September and is harvested intensively by local directed commercial troll and marine sport fisheries, and incidentally to pink salmon in the Khaz Bay seine fishery. In 20 years, the goal of 1,300 to 2,900 spawners has been met in 12 years and exceeded in 8 (Figure 3.3). The goal has been exceeded more often since 1992.

The escapement to Black River, located north of Ford Arm Lake, has been surveyed once annually by helicopter since 1984. Escapement to this system was relatively low during 1986 to 1989 with counts ranging from 181 to 312, but trended upward since the late 1980s.

The sum of peak escapement surveys for 5 small streams near Sitka trended downward in the late 1980s but increased sharply in the early 1990s (Tables 3.1 and 3.3; Figure 3.4). The counts declined again from 1997 to 2000 before increasing in 2001 and 2002.

Southern Southeast Stocks

Hugh Smith Lake is the only full indicator stock in southern Southeast that has a long-term data series and an established escapement goal (Tables 3.1 and 3.4; Figure 3.5). However, additional indicator stocks have recently been added, including the Unuk River on the mainland northeast of Ketchikan (Jones et al. 1999, 2001a, 2001b), Chuck Creek on the southern outside coast, and Slippery Creek, west of Petersburg (Beers 1999, 2001). Three total escapement counts for Chuck Creek from the 1980s (Shaul et al. 1991) are available for comparison with recent counts in 2001 and 2002.

Over the past 21 years, the escapement goal range of 500 to 1,100 spawners in Hugh Smith Lake (Clark et al. 1994) has been achieved 8 times (Figure 3.5). Escapements have been below the range only once (1989) and above it twelve times.

Escapement to the Unuk River is estimated using a mark–recapture technique and total run reconstruction and smolt estimates have been made based on coded wire tags since 1998. Escapement estimates have trended upward from 12,422 spawners in 1998 to 54,409 spawners in 2001 (Table 3.1 and Figure 3.5).

The Ketchikan area survey index of peak helicopter counts for 14 streams has followed a generally upward trend since 1987 to a record count of 12,223 spawners in 2002 (Tables 3.1 and 3.4; Figure 3.5).

Weir counts in Chuck Creek, on the outer coast of southern Southeast, totaled 1,350 spawners in 2001 and 2,189 spawners in 2002, compared with counts from 1982 to 1985 that ranged from 956 to 1,238 spawners (Shaul et al. 1991).

Yakutat Stocks

Yakutat stocks are harvested primarily in set gillnet and sport fisheries that target runs to discrete systems, but trollers fishing on mixed stocks off the coast account for some of the catch. *Biological escapement goals* exist for 7 stocks in this area (Clark and Clark 1994), but comparable peak escapement surveys have been conducted relatively consistently in recent years on only 3 systems, the Lost, Situk, and Tsiu rivers.

Although the data series starts in 1972, the quality and comparability of peak survey counts in the Yakutat area are somewhat lower than other areas. Most aerial and foot surveys on these systems have been conducted early in the run to support inseason management of the set gillnet fisheries.

Utility of the peak survey counts in assessing historical escapement is limited by decreasing survey effort near the peak of spawner abundance at the end of the fishery, and by frequently deteriorating weather conditions after mid-September. Survey effort on these systems declined from 1995 to 2000, but has improved in 2001 and 2002. Escapement goals have been attained in most years (Table 3.5, Figure 3.6).

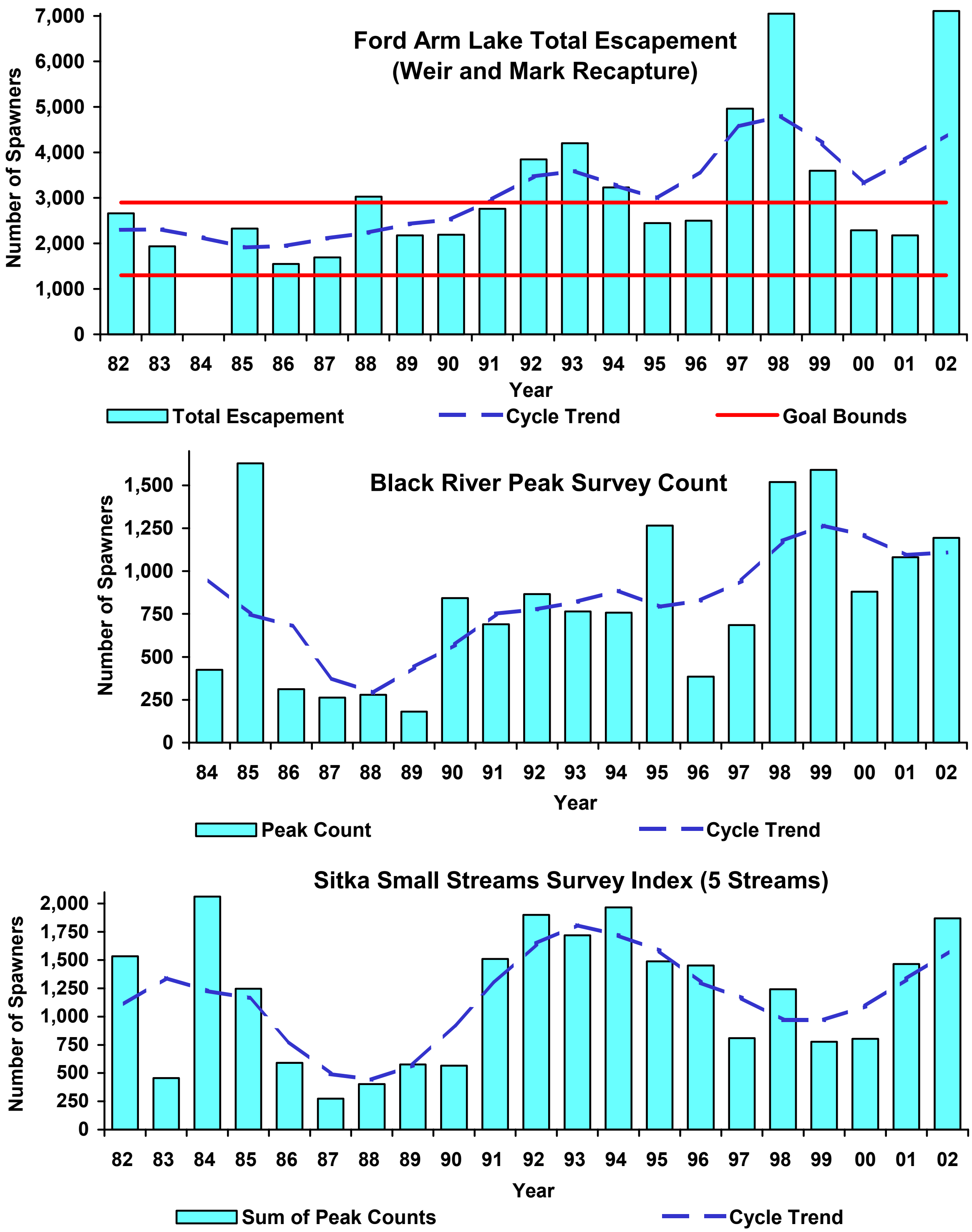

Figure 3.4. Coho salmon escapement estimates and indexes for streams in the Sitka area (District 113) and 3½-year moving average "cycle" trends.

Table 3.3. Peak coho salmon survey counts for 5 streams near Sitka and the Black River, and the total adult coho salmon escapement to Ford Arm Lake from 1982 to 2002. Interpolated values are shown in shaded bold italic print.

Year	Starrigavan Creek	Sinitsin Creek	St. John's Creek	Nakwasina River	Eagle River	Sitka Survey Total	Black R. Survey Count	Ford Arm Lake (Weir- M/R)
1982								2,662
1983								1,938
1984							425	
1985	317	46	79	359	***316***	1,117	1,628	2,324
1986	45	***31***	***12***	217	205	510	312	1,546
1987	385	160	***154***	715	420	1,834	262	1,694
1988	193	144	109	408	***366***	1,220	280	3,028
1989	57	61	45	275	245	683	181	2,177
1990	36	21	40	47	167	311	842	2,190
1991	45	56	71	104	273	549	690	2,761
1992	101	76	89	129	131	526	866	3,847
1993	39	80	38	195	214	566	764	4,202
1994	142	186	107	621	454	1,510	758	3,228
1995	241	265	110	654	629	1,899	1,265	2,445
1996	256	213	90	404	511	1,474	500	2,500
1997	304	313	227	400	717	1,961	686	4,965
1998	274	152	99	626	336	1,487	1,520	7,049
1999	59	150	201	***553***	***488***	1,451	1,590	3,598
2000	55	90	68	300	296	809	880	2,287
2001	123	109	57	653	300	1,242	1,080	2,178
2002	227	169	100	713	659	1,868	1,194	7,109
Average	157	127	94	392	357	1,126	830	3,060

Smolt Production

Smolt production estimates are available for 4 years or more for 5 systems while pre-smolt estimates in the summer prior to smolt emigration are available for Ford Arm Lake (Table 3.6). Estimates are listed by adult return year for the smolt emigration in the previous year.

Despite relatively level escapements to Auke Creek that have trended above the *biological escapement goal* (Figure 3.3, Table 3.2), smolt production from the system has trended gradually lower since the early 1980s (Table 3.6, Figure 3.7). Decade averages were 7,323 smolts for 1980 to 1989 adult returns, 6,292 smolts for 1990 to 1999 and 4,832 smolts for 2000 to 2003. An analysis of the trend in Auke Creek smolt production over 24 years using the method presented in Geiger and Zhang (2002) indicates a decline of 35% (1.45% of the year-zero reference value per year), or a loss of about 2,662 smolts (111/year) from a beginning population of about 7,660 smolts.

Table 3.4. Peak coho salmon survey counts for 14 streams in the Ketchikan area and total adult coho salmon escapement to Hugh Smith Lake from 1987 to 2002. Total index is the sum of counts and interpolated values. Interpolated values are shown in shaded bold italic print.

Year	Herman Creek	Grant Creek	Eulachon River	Klahini River	Indian River	Barrier Creek	King Creek	Choca Creek
1987	92	***79***	154	***55***	***348***	***88***	***278***	***137***
1988	72	150	205	20	300	50	175	150
1989	75	101	290	15	925	450	510	200
1990	150	30	235	150	***250***	***63***	35	***98***
1991	245	50	285	50	550	100	300	220
1992	115	270	860	90	675	100	250	150
1993	90	175	460	50	475	325	110	300
1994	265	220	755	200	560	175	325	225
1995	250	94	435	165	600	220	415	180
1996	94	92	383	40	570	230	457	220
1997	75	***82***	420	60	***364***	***92***	***291***	175
1998	94	130	460	120	304	50	411	190
1999	75	127	657	150	356	25	627	225
2000	135	94	600	110	380	72	620	180
2001	80	110	929	151	1,140	***213***	891	450
2002	88	138	1,105	20	940	70	700	220
Average	125	121	515	90	546	145	400	207

Year	Carroll River	Blossum River	Keta River	Marten River	Humpback Creek	Tombstone River	Combined Survey Count	Hugh Smith Lake (Weir)
1987	180	700	800	740	650	532	4,833	1,118
1988	193	790	850	600	52	1,400	5,007	513
1989	70	1,000	650	1,175	350	950	6,761	433
1990	***124***	800	550	575	135	275	3,471	870
1991	375	725	800	575	671	775	5,721	1,826
1992	360	650	627	1,285	550	1,035	7,017	1,426
1993	310	850	725	1,525	600	1,275	7,270	830
1994	475	775	1,100	2,205	560	850	8,690	1,753
1995	400	800	1,155	1,385	82	2,446	8,627	1,781
1996	240	829	1,506	1,924	440	1,806	8,831	958
1997	140	1,143	571	759	32	847	5,052	732
1998	***253***	1,004	1,169	1,961	256	666	7,068	983
1999	425	598	1,895	1,518	520	840	8,038	1,246
2000	275	1,354	1,619	1,421	102	1,672	8,634	600
2001	173	1,561	***1,702***	1,956	506	***1,843***	11,705	1,580
2002	270	1,359	1,368	2,302	2,004	1,639	12,223	3,291
Average	266	934	1,068	1,369	469	1,178	7,434	1,246

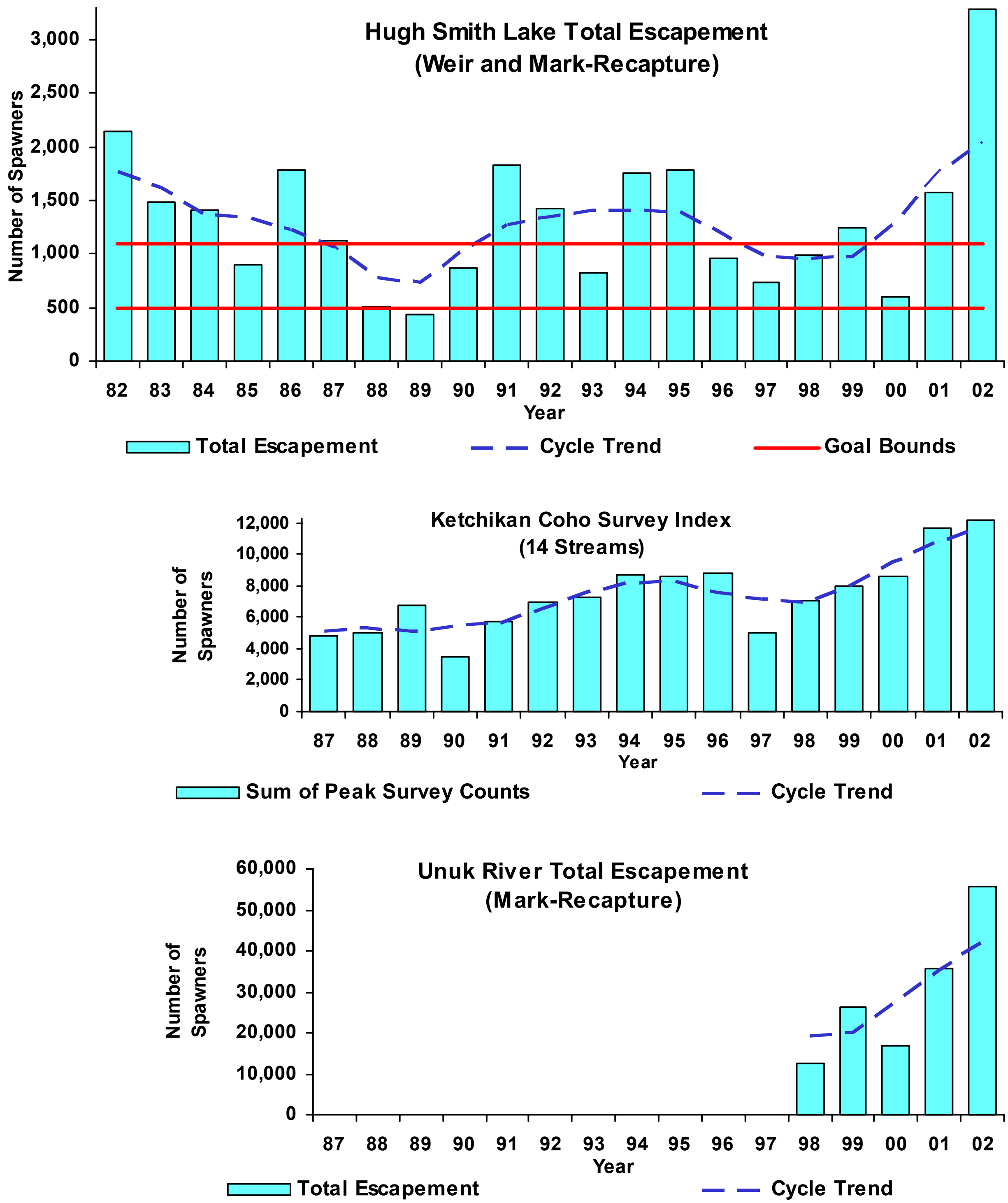

Figure 3.5. Coho salmon escapement estimates and indexes for streams in the Ketchikan area (District 101). Also shown are 3½-year moving average "cycle" trends.

Table 3.5. Yakutat area coho salmon peak escapement survey counts from 1972 to 2002.

Year	Lost River	Situk River	Tsiu River	Total Count[a]
1972	3,800	5,100		26,361
1973	1,978	1,719	30,000	33,697
1974	2,500	4,260	15,000	21,760
1975	1,300	4,500	8,150	13,950
1976	1,200	3,280	30,000	34,480
1977	4,050	3,750	25,000	32,800
1978	3,450	3,850	40,000	47,300
1979	8,450	7,000	25,000	40,450
1980	5,700	8,100	18,000	31,800
1981	7,363	8,430	20,000	35,793
1982	10,400	9,180	40,000	59,580
1983	8,110	5,300	16,500	29,910
1984	6,780	14,000	30,000	50,780
1985	3,300	6,490	52,350	62,140
1986	3,610	3,162	14,100	20,872
1987	5,482	2,000	8,500	15,982
1988	2,600	11,000	16,000	29,600
1989	2,190	3,900	38,000	44,090
1990	9,460	1,630	16,800	27,890
1991	1,786	NA	16,600	23,441
1992	4,235	13,820	30,800	48,855
1993	5,436	10,703	18,500	34,639
1994	6,000	21,960	55,000	82,960
1995	2,642	NA	30,000	41,616
1996	4,030	NA	19,000	29,361
1997	2,550	9,780	22,000	34,330
1998	NA	NA	12,000	18,116
1999	NA	NA	NA	NA
2000	1,572	NA	12,000	17,303
2001	3,190	5,030	17,000	25,220
2002	8,093	40,000	31,000	79,093
Average	4,526	8,318	24,390	36,472
Lower Bound	2,200	3,300	10,000	
Upper Bound	6,500	9,800	29,000	

[a] Total includes interpolations for systems without counts (see Escapement Indicators section for a description of the method used).

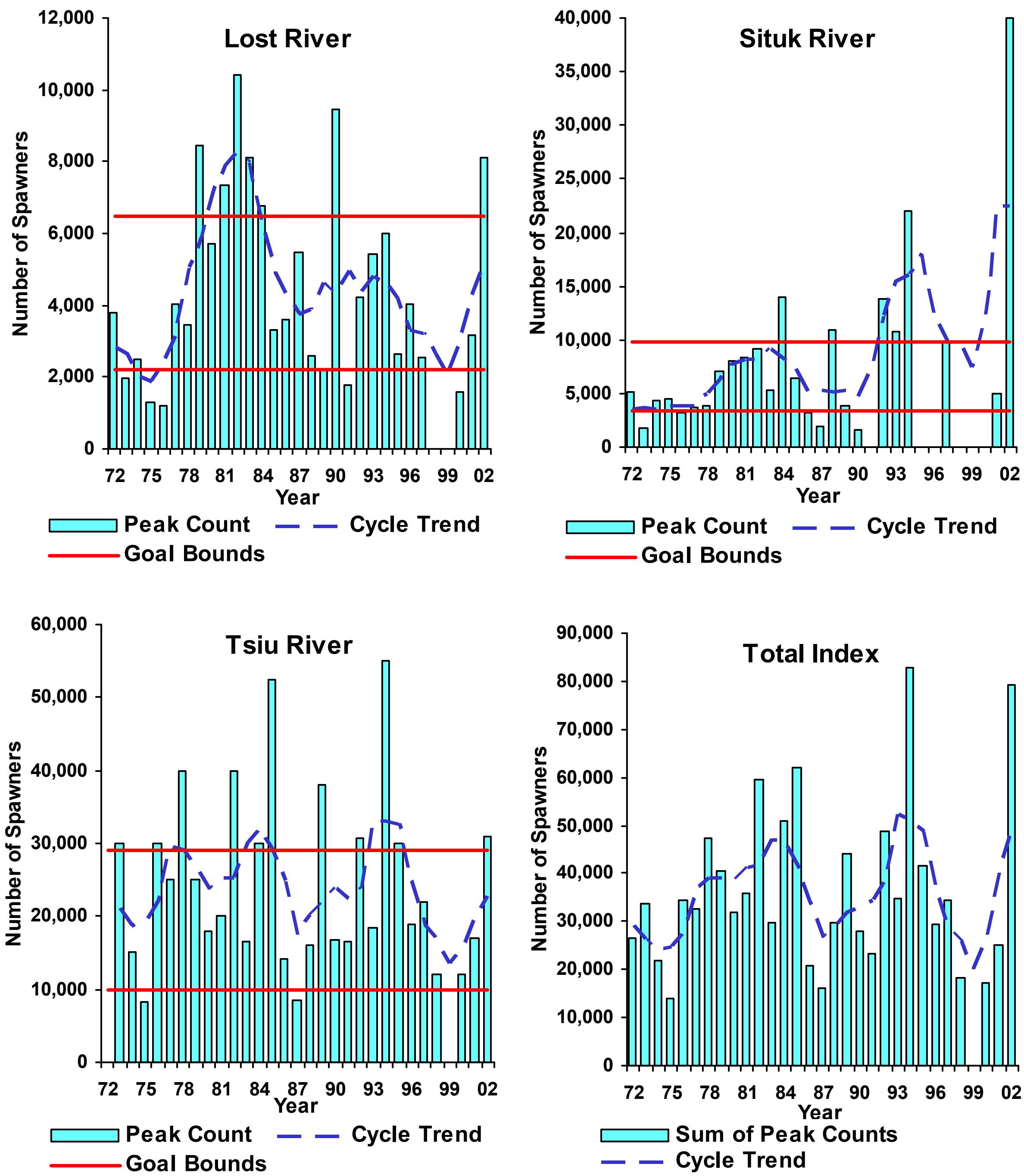

Figure 3.6. Peak coho salmon escapement survey counts for 3 systems in the Yakutat area and the combined count for all 3 systems from 1972 to 2002, with 3½-year moving average "cycle" trends. The total index includes interpolations for systems without counts in all years except 1999 (see Escapement Indicators section for a description of the method used).

Table 3.6. Total coho smolt and pre-smolt production estimates for 6 wild coho salmon-producing systems in Southeast Alaska by age .1 return year from 1980 to 2002. Smolts migrated from the stream in the year prior to the return year.

Return Year	Auke Creek Smolts	Berners River Smolts	Taku River Smolts	Ford Arm Lake Pre-smolts	Hugh Smith Lake Smolts	Unuk River Smolts
1980	8,789					
1981	10,714					
1982	6,967			78,682		
1983	6,849			65,186		
1984	6,901				51,789	
1985	6,838			38,509	32,104	
1986	5,852			46,422	23,499	
1987	5,617			73,272	21,878	
1988	7,014			88,649	36,218	
1989	7,685			43,354	23,336	
1990	7,011	164,356		55,803	26,620	
1991	5,137	141,154		56,284	32,925	
1992	5,690	187,715	0	61,724	23,326	
1993	6,596	326,126	1,510,032	57,401	32,853	
1994	8,647	255,431	1,475,874	83,686	48,433	
1995	7,495	181,503	1,525,330	134,640	49,288	
1996	4,884	194,019	986,489	91,843	22,413	
1997	3,934	133,629	759,763	66,528	32,294	
1998	6,111	139,959	853,662	80,567	37,898	809,677
1999	7,420	252,199	1,184,195	132,607	29,830	562,217
2000	5,233	183,023	1,387,399	62,444	19,902	802,554
2001	4,969	268,468	1,720,387	106,531	23,343	599,960
2002	5,980	264,772	2,292,949	102,010	36,502	757,080
2003	3,644	[a]	[a]	[a]	[a]	[a]
Average	6,499	207,104	1,245,098	76,307	31,813	706,298

[a] Estimates for these systems are unavailable pending mark–recovery sampling of 2003 returning adults.

Smolt estimates for the Taku and Berners Rivers have followed short-term cycles with common peaks for 1993 to 1994 and 2001 to 2002 and low smolt production from both systems for 1997 and 1998 returns (Table 3.6). Smolt production from the 2 systems was positively correlated over 11 years ($R^2 = 0.45$, $P = 0.024$). The 2002 return to the transboundary Taku system was produced by a record seaward migration estimated at 2.29 million smolts.

Smolt production has followed no evident trend for either the Hugh Smith Lake stock since 1984, or for the Unuk River stock since 1998. Estimated midsummer pre-smolt abundance in the Ford Arm Lake system has trended upward from an average of 62,000 pre-smolts for returns in the 1980s to 82,100 in the 1990s, and 90,300 from 2000 to 2002.

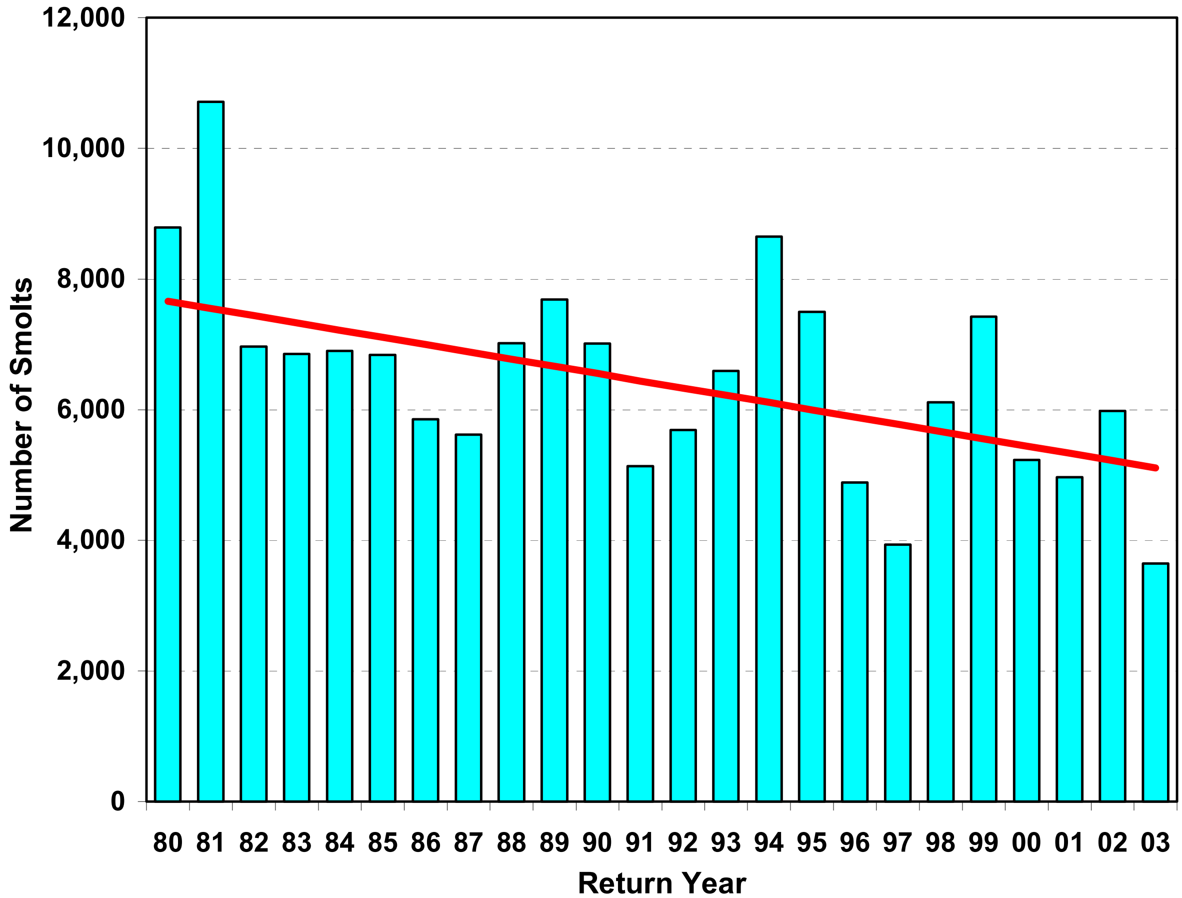

Figure 3.7. Total number of wild coho salmon smolts migrating from Auke Creek from 1979 to 2002 (corresponding to 1980 to 2003 adult returns). Also shown is the trend computed using the methodology of Geiger and Zhang (2002).

No physical habitat changes have been noted that might explain this increase but escapements of all salmon species in the system, particularly pink and sockeye salmon, have shown an increasing trend in recent years. Increased carcass inputs may have enhanced habitat productivity through nutrient enrichment.

Marine Survival

Marine survival rates increased in the early 1980s and reached a peak in the early to mid-1990s before declining to more moderate levels from 1995 to 2002 (Figure 3.8; Table 3.7).

While smolt production from Auke Creek declined after 1981, marine survival increased in the early to mid-1980s and reached a peak of 35.3% in 1994. Overall, Auke Creek marine survival averaged 20.1% from 1980 to 2002.

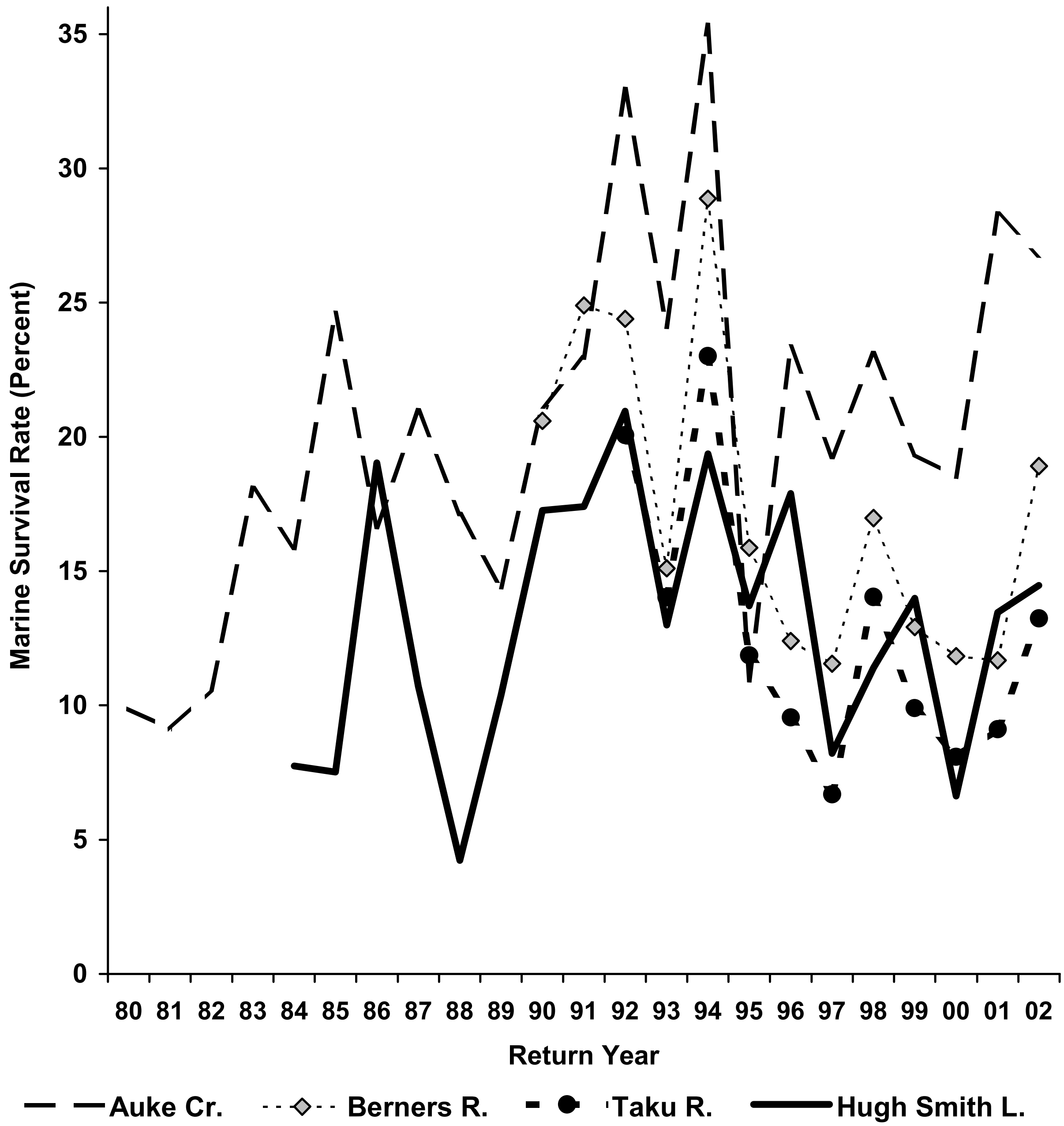

Figure 3.8. Estimated marine survival rate for coho salmon smolts from 4 indicator stocks in Southeast Alaska from 1980 to 2002.

Table 3.7. Estimated survival rate (percent) of coho salmon smolts and pre-smolts from 6 wild Southeast Alaska indicator stocks from the time of tagging until return to the fisheries.

Return Year	Auke Creek Smolts	Berners River Smolts	Taku River Smolts	Ford Arm Lake Pre-smolts	Hugh Smith Lake Smolts	Unuk River Smolts
1980	9.9					
1981	9.1					
1982	10.6			6.0		
1983	18.1			9.5		
1984	15.9				7.7	
1985	24.6			12.3	7.5	
1986	16.6			8.8	19.0	
1987	21.0			4.4	10.7	
1988	17.1			6.7	4.2	
1989	14.4			13.3	10.4	
1990	21.1	20.6		9.4	17.3	
1991	23.0	24.9		10.8	17.4	
1992	33.0	24.4	20.1	15.0	21.0	
1993	24.1	15.1	14.0	22.0	13.0	
1994	35.3	28.9	23.0	13.8	19.4	
1995	10.9	15.9	11.9	5.5	13.7	
1996	23.4	12.4	9.6	6.5	17.9	
1997	19.2	11.6	6.7	15.3	8.2	
1998	23.1	17.0	14.0	19.9	11.4	6.5
1999	19.3	12.9	9.9	7.4	14.0	10.0
2000	18.5	11.8	8.1	12.8	6.6	3.8
2001	28.3	11.7	9.1	8.2	13.5	11.0
2002	26.8	18.9	13.2	14.7	14.5	9.4
Average	20.1	17.4	12.7	11.1	13.0	8.2

Hugh Smith Lake had lower average marine survival than Auke Creek, but shows a similar trend with high survival rates in 1992 and 1994. Fishery performance indicators and direct survival indicators both point to a regionwide peak in marine survival in the early to mid-1990s (Shaul 1998). Marine survival has remained higher for the Auke Creek stock compared with the other inside indicator stocks (Berners and Taku Rivers, and Hugh Smith Lake) since 1996 (Figure 3.8).

Among the 3 stocks in the northern inside area, survival was inversely related to average stock size, with marine survival rates for 1992 to 2002 returns averaging 23.8% for Auke Creek (small producer), 16.4% for the Berners River (medium producer) and 12.7% for the Taku River (large producer). A similar pattern was noted among 3 closely situated stocks (Nass River, Lachmach River, Hugh Smith lake) in the northern boundary area (Joint Northern Boundary Technical Committee 2002).

Marine survival of smolts from the 2 northern inside river systems, Berners and Taku, was closely correlated over a period of 11 years (R^2 = 0.94, P < 0.001), but Taku River smolts consistently had lower survival, averaging only 76% of Berners River smolt survival.

Hugh Smith Lake smolts survived at an average rate of 13.0% during 1984 to 2002 and have been positively correlated in survival with Berners smolts over 13 years (R^2 = 0.53, P = 0.005) and with Taku smolts over 11 years (R^2 = 0.54, P = 0.010). The positive correlation with Auke Creek smolts over 19 years is weaker (R^2 = 0.25, P = 0.030).

Survival of Ford Arm pre-smolts has averaged a relatively high 11.1% (range 4.4% to 22.0%) over 20 years.

Total Stock Abundance

Total return abundance of the stocks, including catch and escapement, is the product of smolt production and marine survival. For the full indicator stocks, estimates of total escapement and harvest are shown in Tables 3.8–3.13 and Figures 3.9–3.11.

The 3 long-term indicator stocks in inside areas of Southeast show similar patterns in abundance since the early 1980s. The Auke Creek, Berners River, and Hugh Smith Lake stocks all show relatively level long-term trends, with a period of high abundance in the early 1990s and a spectacular peak in 1994 (Figure 3.9). The Hugh Smith stock experienced a record low return of 1,314 fish in 2000, resulting from a combination of record low smolt production (19,900 smolts) and a marine survival rate that was the second lowest on record (6.6%). However, despite the exceptionally low return, the escapement of 600 spawners was within the goal range. The 2002 return of 5,285 adults was the fifth highest in 21 years.

The Ford Arm Lake stock on the outer coast was also abundant from 1992 to 1994, but returned in proportionately greater abundance than inside stocks during 1997 to 2001 and reached a peak in 1998.

The estimated Taku River total return (Figure 3.10; Table 3.12) has been closely correlated with the Berners River stock over the past 11 years (R^2 = 0.88, P < 0.001). Following a peak in abundance estimated at 339,600 fish in 1994, the stock declined to a very low return of only 50,900 fish in 1997. The Taku run has increased since 1997, reaching 303,600 fish in 2002. The Hugh Smith run has been strongly correlated with runs to the Taku River (R^2 = 0.59, P = 0.006) and Berner River (R^2 = 0.59, P = 0.005).

Return estimates for other indicator stocks, including Unuk River, Chuck Creek, and Slippery Creek, are too limited to infer trends (Figure 3.11, Table 3.13).

Variation in marine survival has been a greater influence on adult returns than the combined influence of freshwater factors (including spawning escapement) expressed as variation in smolt production. We computed the coefficient of variation squared (CV^2) for marine survival and smolt production for all available years for Auke Creek (23 years), Berners River (13 years), Taku River (11 years), and Hugh Smith Lake (19 years). Because CV^2 is approximately additive for independent factors (Goodman 1960), we were then able to apportion variation in return abundance to marine survival versus freshwater factors, including spawning escapement (Table 3.14). The mean-average proportion of variation accounted for by marine survival for all stocks in all years was 61% compared with 39% for smolt production. The marine components of variation in run size by stock were as follows: Auke Creek 70%, Berners River 57%, Taku River 60%, and Hugh Smith Lake 59%.

Table 3.8. Estimated harvest by gear type, escapement, and total run of coho salmon returning to Auke Creek from 1980 to 2002.

Year	Fishery Sample Size	Number of Fish: Troll	Seine	Drift Gillnet	Sport	Total Catch	Escapement	Total Return
1980	15	117	0	29	24	170	698	868
1981	70	280	0	31	19	330	646	976
1982	45	149	117	24	2	292	447	739
1983	129	385	10	28	122	545	694	1,239
1984	124	372	8	13	51	444	651	1,095
1985	177	594	3	71	73	741	942	1,683
1986	110	421	2	60	37	520	454	974
1987	145	438	2	48	23	511	668	1,179
1988	145	306	12	72	55	445	756	1,201
1989	182	533	7	15	49	604	502	1,106
1990	168	635	15	57	78	785	697	1,482
1991	47	200	8	152	11	371	808	1,179
1992	53	603	10	196	46	855	1020	1,875
1993	169	611	8	92	19	730	859	1,589
1994	330	1064	224	218	112	1618	1437	3,055
1995	82	264	5	65	26	360	460	820
1996	160	446	11	133	36	626	515	1,141
1997	43	94	4	0	50	148	609	757
1998	157	437	17	43	54	551	862	1,413
1999	160	485	5	58	42	590	845	1,435
2000	103	228	6	23	29	286	683	969
2001	149	435	10	41	55	541	865	1,406
2002	125	288	8	77	51	424	1176	1,600
Average		408	21	67	46	543	752	1,295

Table 3.9. Estimated harvest by gear type, escapement and total run of coho salmon returning to the Berners River from 1982 to 2002.

		Number of Fish								
Year	Fishery Sample Size	Troll	Seine	Drift Gillnet	Sport	B.C. Net	Cost Recovery	Total Catch	Escapement	Total Run
1982	48	12,887	0	10,568	0	0	0	23,455	7,505	30,960
1983	125	17,153	0	6,978	65	0	0	24,196	9,840	34,036
1984									2,825	
1985	93	10,865	198	7,015	0	0	0	18,078	6,169	24,247
1986	157	13,560	0	8,928	395	0	0	22,883	1,752	24,635
1987	53	7,448	0	3,301	48	0	0	10,797	3,260	14,057
1988	102	5,926	181	6,141	0	0	0	12,248	2,724	14,972
1989	58	10,515	0	1,664	0	0	0	12,179	7,509	19,688
1990	470	14,751	149	7,339	525	0	0	22,764	11,050	33,814
1991	1,025	6,417	579	16,519	117	0	0	23,632	11,530	35,162
1992	701	15,337	344	14,677	192	0	0	30,550	15,300	45,850
1993	1,496	19,353	192	14,239	140	0	0	33,924	15,670	49,594
1994	2,647	27,319	1,686	27,907	891	5	0	57,808	15,920	73,728
1995	1,384	8,847	22	14,869	117	0	0	23,855	4,945	28,800
1996	601	10,524	380	6,434	412	0	0	17,750	6,050	23,800
1997	312	2,454	282	2,477	179	0	0	5,392	10,050	15,442
1998	613	10,427	435	5,716	380	0	0	16,958	6,802	23,760
1999	948	12,877	208	9,317	261	0	0	22,663	9,920	32,583
2000	693	5,362	145	5,296	196	0	6	11,005	10,650	21,655
2001	745	8,840	195	3,499	123	0	0	12,657	19,290	31,947
2002	788	8,671	228	13,014	471	0	0	22,384	27,700	50,084
Average		11,477	261	9,295	226	0	0	21,259	9,831	31,441

Table 3.10. Estimated harvest by gear type, escapement, and total run of coho salmon returning to Ford Lake from 1982 to 2002.

		Number of Fish							
Year	Fishery Sample Size	Alaska Troll	Seine	Drift Gillnet	Sport	Canadian Troll	Total Catch	Escapement	Total Run
1982	38	1,948	106	0	0	0	2,054	2,662	4,716
1983	93	3,344	912	0	0	0	4,256	1,938	6,194
1984									
1985	49	2,438	0	0	0	0	2,438	2,324	4,762
1986	87	2,500	62	0	0	0	2,562	1,546	4,108
1987	71	1,456	79	0	0	0	1,535	1,694	3,229
1988	151	2,857	46	0	0	30	2,933	3,028	5,961
1989	221	3,777	185	0	0	0	3,962	2,177	6,139
1990	174	2,979	108	0	0	0	3,087	2,190	5,277
1991	193	3,208	44	10	0	0	3,262	2,761	6,023
1992	199	5,252	208	0	0	0	5,460	3,847	9,307
1993	349	7,847	443	0	201	0	8,491	4,202	12,693
1994	236	6,918	1,234	0	112	0	8,264	3,228	11,492
1995	91	3,577	1,468	0	0	0	5,045	2,445	7,490
1996	64	3,148	0	0	332	0	3,480	2,500	5,980
1997	241	4,883	0	0	373	0	5,256	4,965	10,221
1998	315	7,835	435	20	679	0	8,969	7,049	16,018
1999	145	5,872	66	0	441	0	6,379	3,598	9,977
2000	193	4,603	926	13	221	0	5,763	2,287	8,050
2001	131	6,023	97	0	479	0	6,599	2,178	8,777
2002	246	5,756	1,260	0	998	0	8,014	7,109	15,123
Average		4,311	384	2	192	2	4,890	3,186	8,077

Table 3.11. Estimated harvest by gear type, escapement, and total run of coho salmon returning to Hugh Smith Lake from 1982 to 2002.

		Number of Fish										
Year	Fishery Sample Size	Alaska Troll	Alaska Seine	Alaska Gillnet	Alaska Trap	Alaska Sport	B.C. Troll	B.C. Net	B.C. Sport	Total Catch	Escapement	Total Return
1982	91	2,780	627	203	0	0	264	78	0	3,952	2,144	6,096
1983	189	1,373	424	277	49	0	211	51	0	2,385	1,490	3,875
1984	151	1,260	501	470	18	0	325	28	0	2,602	1,408	4,010
1985	212	868	287	137	5	0	199	13	0	1,509	903	2,412
1986	257	1,585	515	315	2	14	234	26	0	2,691	1,783	4,474
1987	100	656	95	249	0	23	153	50	0	1,226	1,118	2,344
1988	42	408	230	122	0	0	234	23	0	1,017	513	1,530
1989	91	1,213	375	237	0	41	105	20	0	1,991	433	2,424
1990	263	1,810	538	504	24	0	794	53	0	3,723	870	4,593
1991	408	2,102	195	881	0	54	630	43	0	3,905	1,826	5,731
1992	497	1,852	674	601	0	42	286	9	0	3,464	1,426	4,890
1993	162	2,259	262	677	0	0	197	43	0	3,438	830	4,268
1994	846	4,339	1,125	1,424	0	59	684	53	13	7,697	1,753	9,450
1995	433	2,030	908	1,651	0	101	241	28	13	4,972	1,781	6,753
1996	496	1,581	640	478	0	104	126	36	0	2,965	950	3,915
1997	481	1,286	121	397	0	27	89	0	0	1,920	732	2,652
1998	666	1,772	471	980	0	113	0	0	0	3,336	983	4,319
1999	493	1,761	291	727	0	153	0	0	0	2,932	1,246	4,178
2000	141	487	44	116	0	67	0	0	0	714	600	1,314
2001	312	684	489	324	0	58	7	0	0	1,562	1,580	3,142
2002	432	892	451	555	0	91	5	0	0	1,994	3,291	5,285
Average		1,571	441	539	5	45	228	26	1	2,857	1,317	4,174

Table 3.12. Estimated catch and escapement of coho salmon bound for the Taku River above Canyon Island from 1987 to 2002.

		Number of Fish							
Year	Fishery Sample Size	Troll	Seine	Gillnet	Marine Sport	Canadian Inriver	Total Catch	Escapement	Total Return
1987						6,519		55,457	
1988						3,643		39,450	
1989						4,033		56,808	
1990						3,685		72,196	
1991						5,439		127,484	
1992	129	41,733	5,062	76,325	3,337	5,541	131,998	84,853	216,851
1993	121	61,129	2,675	31,440	2,513	4,634	102,392	109,457	211,849
1994	178	97,040	26,352	86,198	19,018	14,693	243,301	96,343	339,644
1995	201	45,042	1,853	56,820	7,857	13,738	125,310	55,710	181,020
1996	136	24,780	220	17,067	2,461	5,052	49,580	44,635	94,215
1997	66	8,823	550	1,490	4,963	2,690	18,516	32,345	50,861
1998	231	28,827	742	19,371	4,428	5,090	58,458	61,382	119,840
1999	252	36,229	2,881	7,507	4,170	5,575	56,361	60,844	117,205
2000	229	21,018	1,577	9,935	9,552	5,447	47,529	64,700	112,229
2001	351	32,454	2,096	11,542	3,325	3,033	52,450	104,460	156,910
2002	396	39,025	3,457	30,894	7,076	3,802	84,254	219,360	303,614
1992-2002 Average		39,645	4,315	31,690	6,245	6,300	88,195	84,917	173,113
1987-2002 Average		-	-	-	-	5,788	-	80,343	-

Table 3.13. Estimated harvest by gear type, escapement and total run of coho salmon returning to Chuck Creek, Unuk River and Slippery Creek from 1982 to 2002.

Year	Fishery Sample Size	Troll	Seine	Gillnet	Sport	Total Catch	Escapement	Total Return
		Number of Fish						
Chuck Creek								
1982	28	1,320	418			1,738	1,017	2,755
1983	11	551	618			1,169	1,238	2,407
1985	29	1,906	975			2,881	956	3,837
2001							1,350	
2002							2,189	
Average		1,259	670			1,929	1,350	3,000
Unuk River								
1998	119	24,141	3,530	7,914	4,643	40,228	12,615	52,843
1999	222	16,605	4,072	5,241	4,345	30,263	26,132	56,395
2000	65	8,488	1,985	2,296	1,038	13,807	16,919	30,726
2001	232	13,616	11,400	3,143	2,486	30,646	35,527	66,173
2002	141	7,214	3,445	3,402	1,271	15,332	55,730	71,062
Average		14,013	4,886	4,399	2,757	26,055	29,385	55,440
Slippery Creek								
1998	528	2,196	672	4	60	2,932	632	3,564
1999								
2000	226	1,659	495	7	32	2,193	411	2,604
2001	247	2,507	636	35	90	3,268	2,674	5,942
2002	236	1,257	640	0	93	1,990	5,341	7,331
Average		1,905	611	12	69	2,596	2,265	4,860

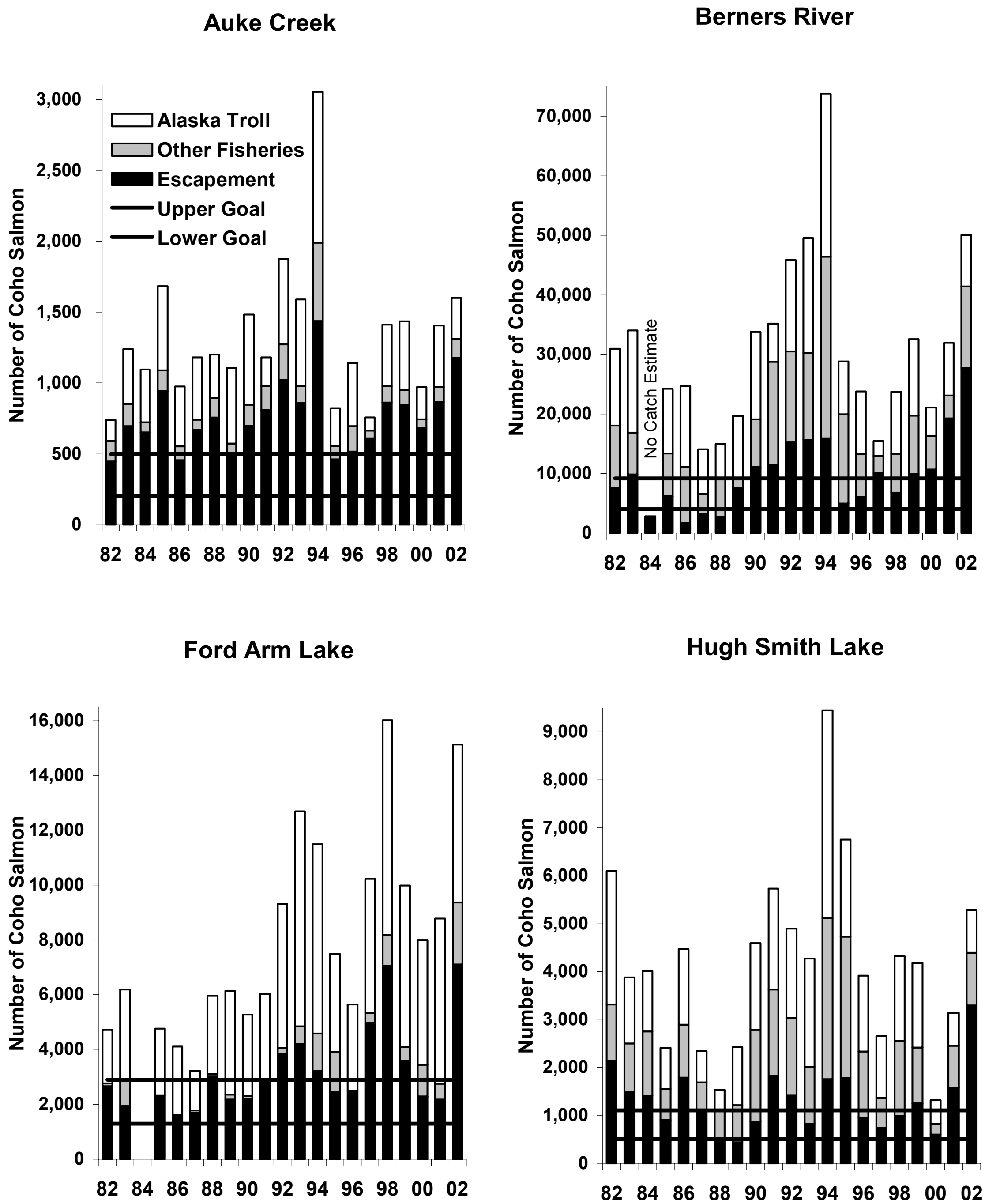

Figure 3.9. Total run size, catch, escapement and *biological escapement goal* range for 4 wild Southeast Alaska coho salmon indicator stocks from 1982 to 2002.

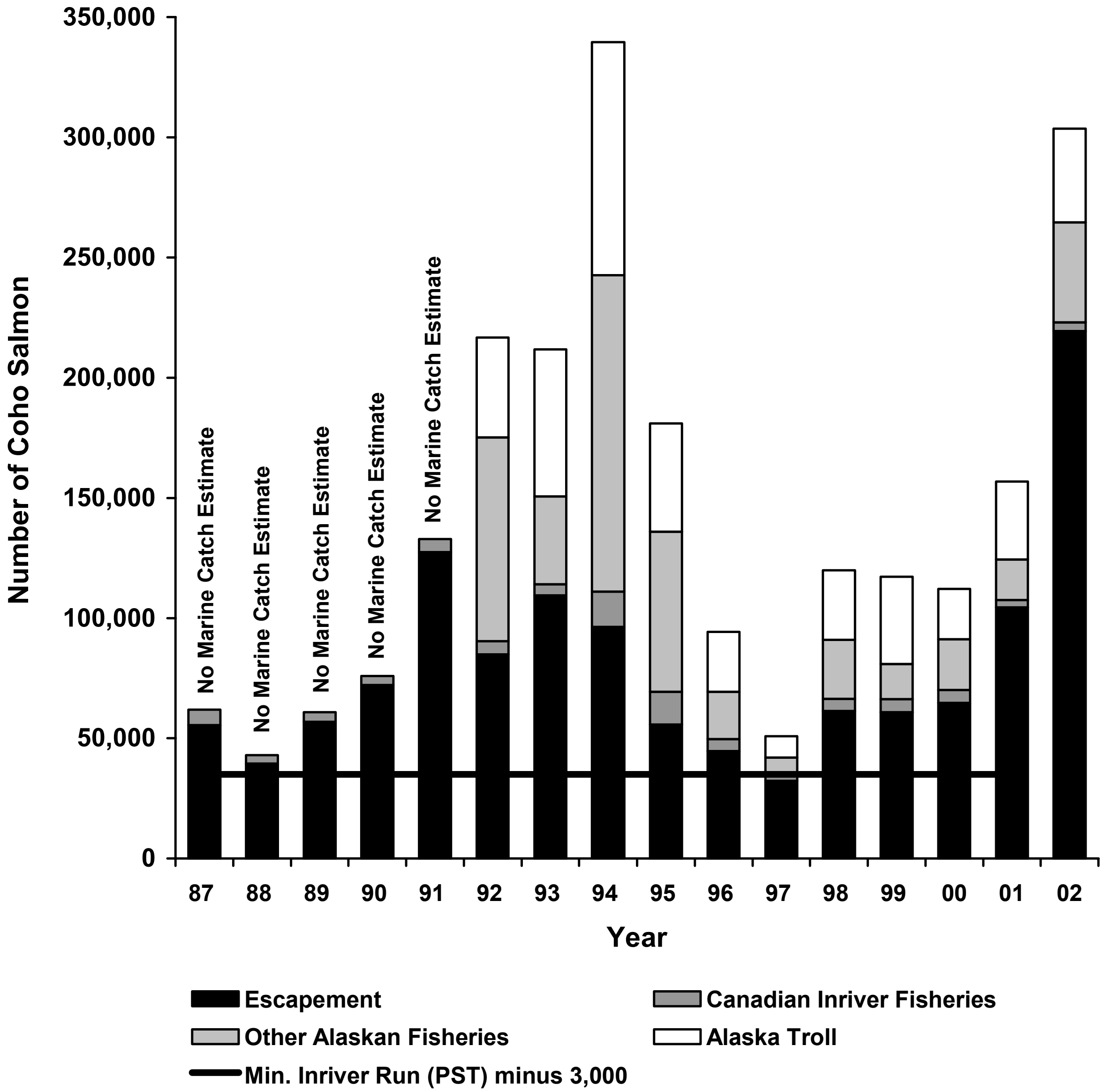

Figure 3.10. Total estimated run size, catch, and escapement of coho salmon bound for the Taku River above Canyon Island from 1987 to 2002. There are no catch estimates for 1987 to 1991.

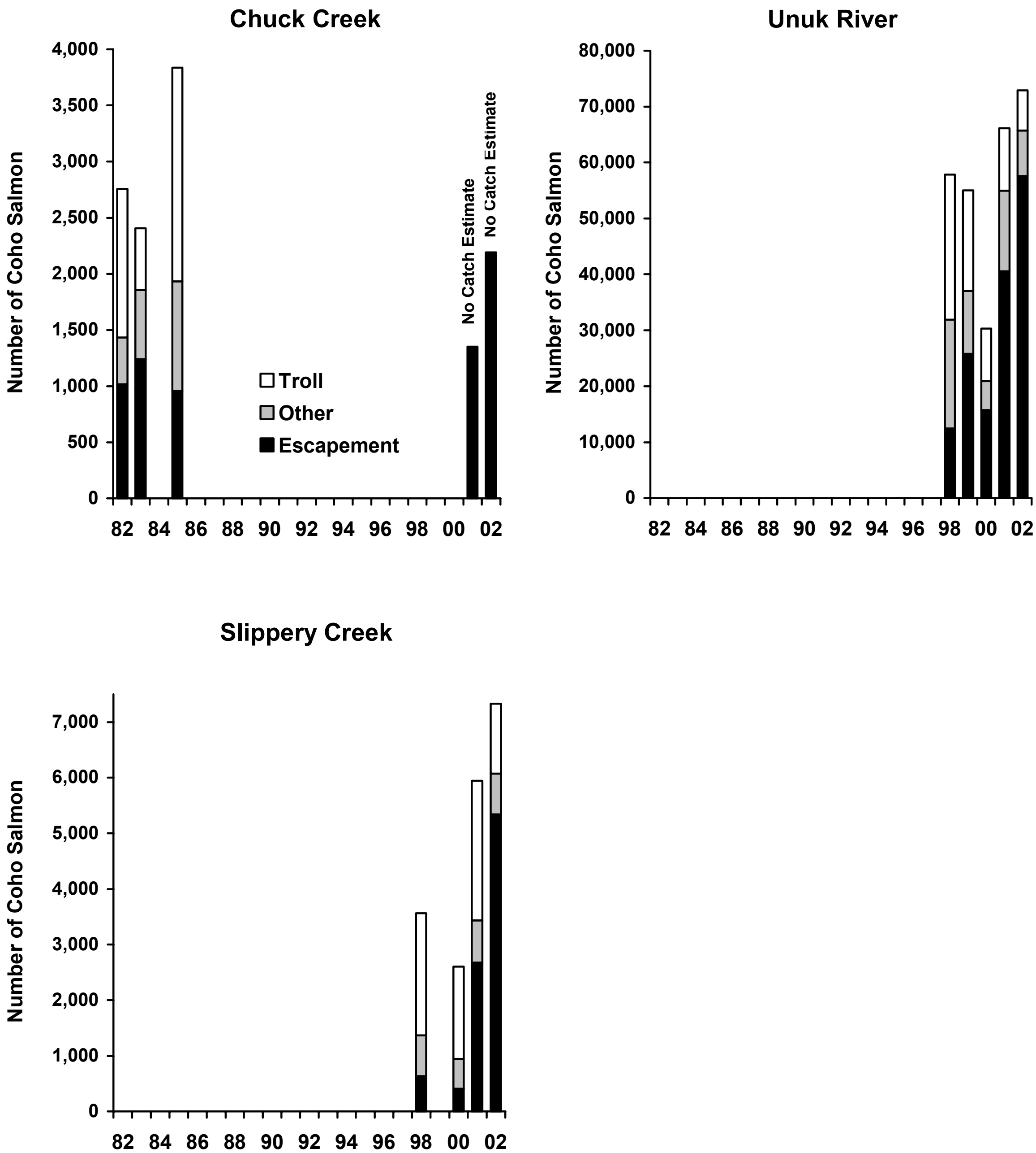

Figure 3.11. Total run size, catch, and escapement for 3 wild coho salmon stocks in southern Southeast Alaska from 1982 to 2002.

Table 3.14. Smolt migration and marine survival rate estimates for 3 wild coho salmon stocks, showing the coefficient of variation (*CV*), CV^2 and the percent of variation in total run size attributed to smolt abundance and marine survival.

Return Year	Auke Creek		Berners River		Taku River		Hugh Smith Lake	
	Smolts	Survival (%)	Smolts	Survival (%)	Smolts	Survival (%)	Smolts	Survival (%)
1980	8,789	9.9						
1981	10,714	9.1						
1982	6,967	10.6						
1983	6,849	18.1						
1984	6,901	15.9					51,789	7.7
1985	6,838	24.6					32,104	7.5
1986	5,852	16.6					23,499	19.0
1987	5,617	21.0					21,878	10.7
1988	7,014	17.1					36,218	4.2
1989	7,685	14.4					23,336	10.4
1990	7,011	21.1	164,356	20.6			26,620	17.3
1991	5,137	23.0	141,154	24.9			32,925	17.4
1992	5,690	33.0	187,715	24.4	1,080,551	20.1	23,326	21.0
1993	6,596	24.1	326,126	15.1	1,510,032	14.0	32,853	13.0
1994	8,647	35.3	255,431	28.9	1,475,874	23.0	48,433	19.4
1995	7,495	10.9	181,503	15.9	1,525,330	11.9	49,288	13.7
1996	4,884	23.4	194,019	12.4	986,489	9.6	22,413	17.9
1997	3,934	19.2	133,629	11.6	759,763	6.7	32,294	8.2
1998	6,111	23.1	139,959	17.0	853,662	14.0	37,898	11.4
1999	7,420	19.3	252,199	12.9	1,184,195	9.9	29,830	14.0
2000	5,233	18.5	183,023	11.8	1,387,399	8.1	19,902	6.6
2001	4,969	28.3	268,468	11.7	1,720,387	9.1	23,343	13.5
2002	5,980	26.8	264,772	18.9	2,292,949	13.2	36,531	14.5
CV	0.225	0.343	0.291	0.332	0.327	0.396	0.306	0.370
CV^2	0.051	0.118	0.085	0.110	0.107	0.157	0.094	0.137
Percent of Variation	30.1	69.9	43.4	56.6	40.5	59.5	40.6	59.4

Mean-Average Percent of Variation in Adult Abundance Attributed to Smolt Abundance = 38.6%
Mean-Average Percent of Variation in Adult Abundance Attributed to Marine Survival = 61.4%

For Ford Arm Lake, the variation in adult production attributed to survival after tagging as pre-smolts (with about 10 months of remaining freshwater residence) was 60%, which was comparable with the influence of pure marine survival on the other stocks. This observation and the observed high average survival rate (11.1%) of Ford Arm pre-smolts (Table 3.7) both suggest that the strong compensatory processes that affect coho salmon survival in fresh water were largely complete when the pre-smolts were tagged in July. In fact, spawning escapement at Ford Arm Lake has been more variable (CV^2 = 0.247) than freshwater and marine survival after marking (CV^2 = 0.185), while pre-smolt abundance estimates have varied substantially less than either of these factors (CV^2 = 0.125).

Exploitation Rates

Most Southeast Alaska coho salmon stocks accumulate substantial exploitation rates in mixed-stock fisheries. Some inside stocks run a gauntlet of fisheries, from troll and marine sport fisheries along the outer coast, through net, sport and troll fisheries in corridor areas, and through intensive inside gillnet fisheries concentrated near some estuaries. In some cases, there are significant freshwater sport harvests as well. The overall intensity of the gauntlets has lessened substantially in the past 2 or 3 years because of market and price pressures on the fisheries.

The Auke Creek stock has been exploited at a relatively low average rate of 41% (range 20% to 55%) during 1980 to 2002, owing mainly to lack of intensive net fishing in its migratory pathway during the fall (Figures 3.12 and 3.13; Table 3.15). The troll fishery has accounted for the majority of the harvest, exploiting the stock at an average rate of 31% (range 12% to 48%) with less than 5% each attributed to seine, gillnet, and sport fisheries.

The Berners River stock was exploited intensively in the Lynn Canal drift gillnet fishery during the 1980s (Figures 3.12 and 3.13; Table 3.16). During that period, coho salmon were taken in the gillnet fishery primarily as incidental harvest to fall Chilkat River chum salmon. The decline in fall chum abundance, described earlier, coincided with a peak in marine survival of coho salmon in the 1990s, resulting in dispersal of fall gillnet effort to other districts and a reduction in exploitation of Berners River coho salmon.

Exploitation rate estimates declined from an average of 76% in the 1980s to 68% in the 1990s and averaged only 45% (range 40% to 51%) from 2000 to 2002.

Like other stocks, a market-driven reduction in fishing effort was largely responsible for the recent drop in exploitation of the Berners River stock. The exploitation rate by the troll fishery, which has accounted for about half of the harvest of the stock, fell to only 17% in 2002 from a 1990s average of 41% despite a total run that was the second largest on record (Figure 3.9, Table 3.9). The decline in the troll exploitation rate and small number of participating gillnetters was mitigated to some extent by special gillnet openings in Berners Bay, resulting in a gillnet exploitation rate of 26% that was only moderately lower than the 1990s average of 31%. Despite these measures, the total exploitation rate in 2002 was only 45%, and the escapement of 27,700 spawners was the largest on record.

The Ford Arm Lake stock has been harvested at moderate to high exploitation rates, primarily in the region troll fishery, which is most intensive in waters near this system. The stock is available in nearby waters over most of the summer, making it highly available to hook-and-line fisheries. The exploitation rate by the troll fishery has averaged 53% (Figure 3.12; Table 3.17) while intermittent seine harvests and increasing marine sport fishing have brought the long-term average exploitation rate by all fisheries up to 60%. During the most recent 5-year period (1998 to 2002), the marine sport fishery based primarily out of Sitka has accounted for an average of 564 Ford Arm Lake fish, or about 5% of the total run.

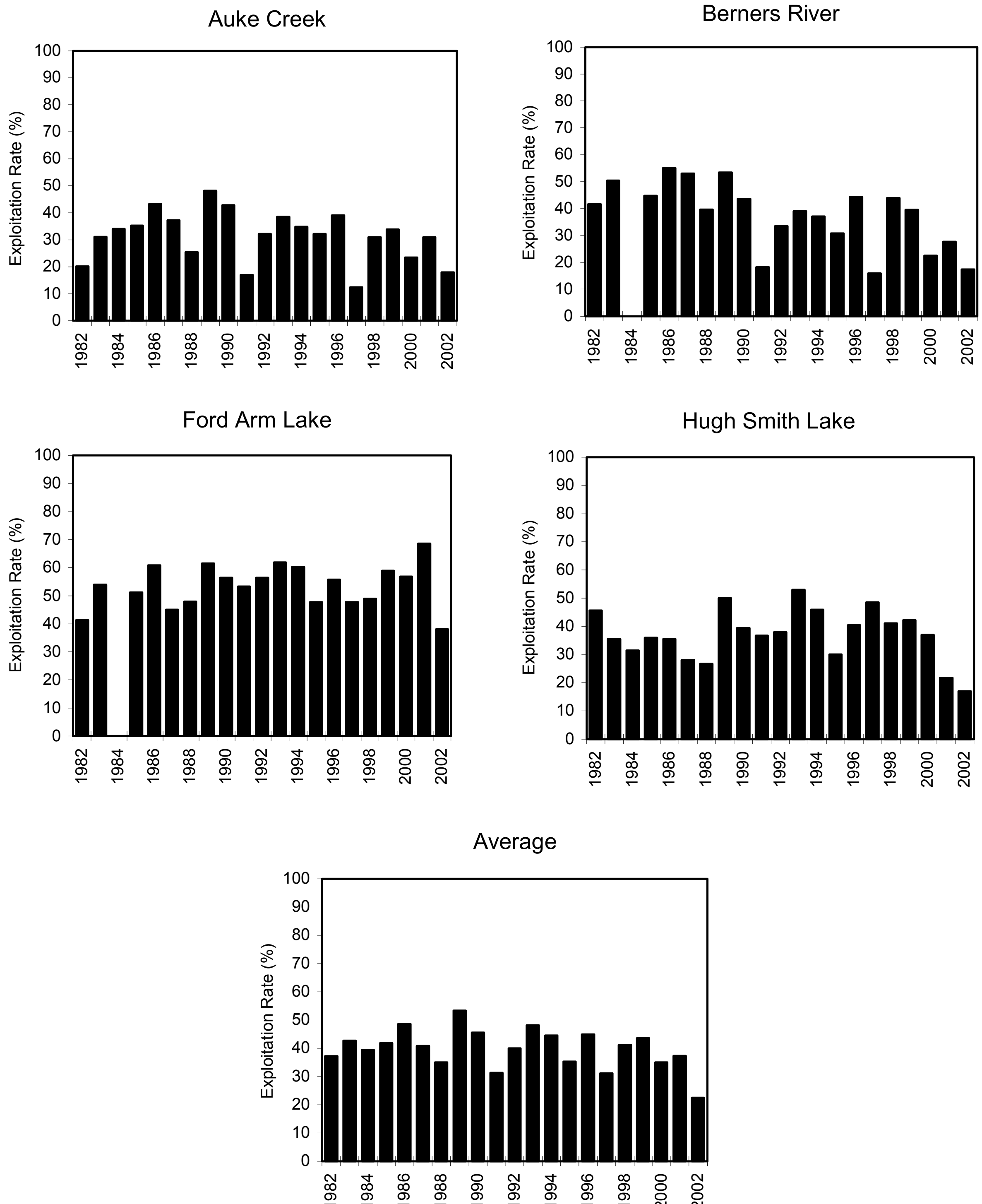

Figure 3.12. Estimated exploitation rates by the Alaskan troll fishery for 4 coded wire tagged Southeast Alaska coho stocks from 1982 to 2002.

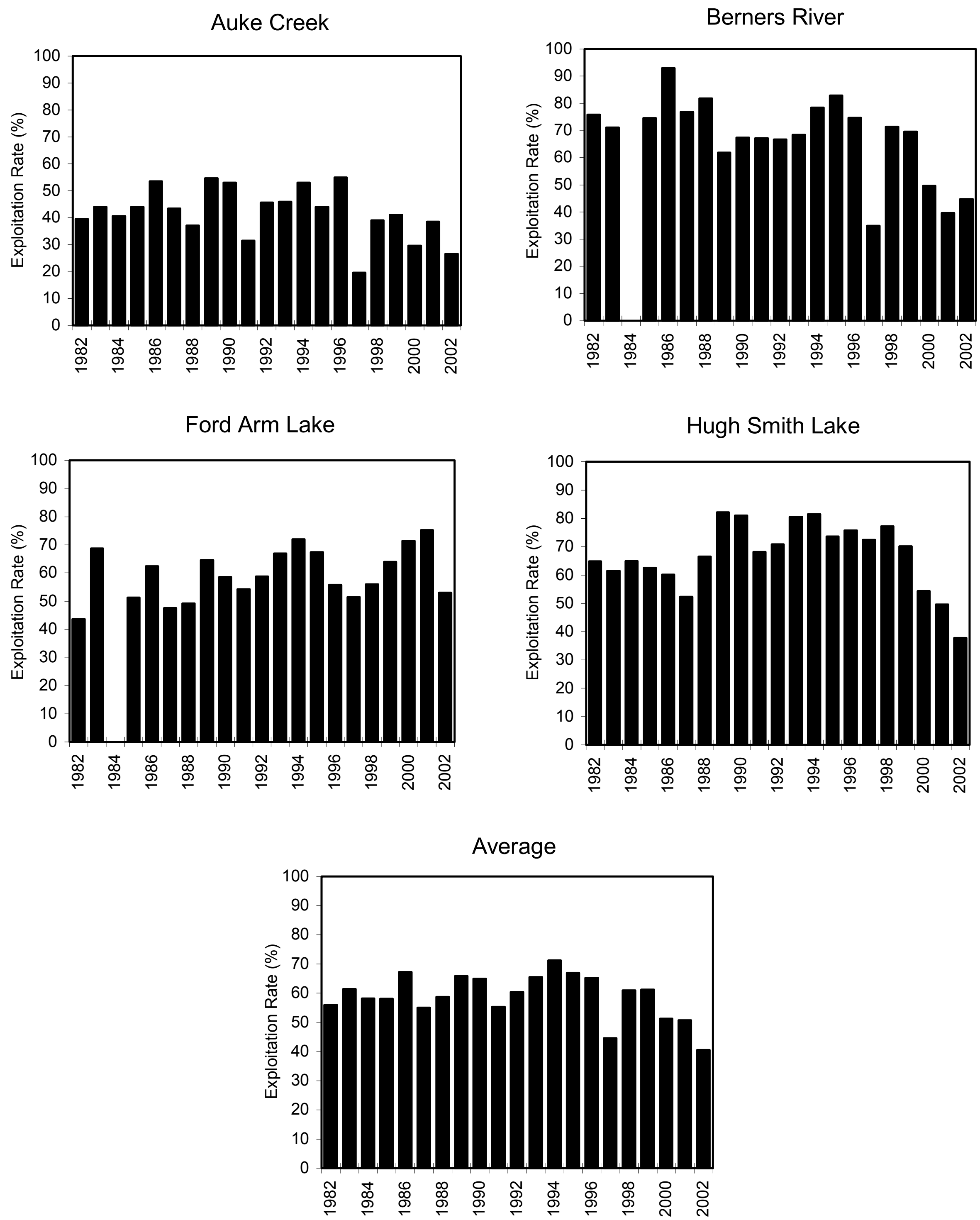

Figure 3.13. Estimated total exploitation rates by all fisheries for 4 coded wire tagged Southeast Alaska coho stocks from 1982 to 2002.

Table 3.15. Estimated percent harvest by gear type, escapement, and total run of coho salmon returning to Auke Creek from 1980 to 2002.

		Percent of Total Run						
Year	Fishery Sample Size	Troll	Seine	Drift Gillnet	Sport	Total Catch	Escapement	Total Return
1980	15	13.5	0.0	3.3	2.8	19.6	80.4	100.0
1981	70	28.7	0.0	3.2	1.9	33.8	66.2	100.0
1982	45	20.2	15.8	3.2	0.3	39.5	60.5	100.0
1983	129	31.1	0.8	2.3	9.8	44.0	56.0	100.0
1984	124	34.0	0.7	1.2	4.7	40.5	59.5	100.0
1985	177	35.3	0.2	4.2	4.3	44.0	56.0	100.0
1986	110	43.2	0.2	6.2	3.8	53.4	46.6	100.0
1987	145	37.2	0.2	4.1	2.0	43.3	56.7	100.0
1988	145	25.5	1.0	6.0	4.6	37.1	62.9	100.0
1989	182	48.2	0.6	1.4	4.4	54.6	45.4	100.0
1990	168	42.8	1.0	3.8	5.3	53.0	47.0	100.0
1991	47	17.0	0.7	12.9	0.9	31.5	68.5	100.0
1992	53	32.2	0.5	10.5	2.5	45.6	54.4	100.0
1993	169	38.5	0.5	5.8	1.2	45.9	54.1	100.0
1994	330	34.8	7.3	7.1	3.7	53.0	47.0	100.0
1995	82	32.2	0.6	7.9	3.2	43.9	56.1	100.0
1996	160	39.1	1.0	11.7	3.2	54.9	45.1	100.0
1997	43	12.4	0.5	0.0	6.6	19.6	80.4	100.0
1998	157	30.9	1.2	3.0	3.8	39.0	61.0	100.0
1999	160	33.8	0.3	4.0	2.9	41.1	58.9	100.0
2000	103	23.5	0.6	2.4	3.0	29.5	70.5	100.0
2001	149	30.9	0.7	2.9	3.9	38.5	61.5	100.0
2002	125	18.0	0.5	4.8	3.2	26.5	73.5	100.0
Average		30.6	1.5	4.9	3.6	40.5	59.5	100.0

The overall exploitation rate on the Ford Arm Lake stock has remained higher compared with other stocks during the recent decline in regional fishing effort. In 2001, the Ford Arm Lake stock was exploited at a record 75% while the 2002 exploitation rate of 53% was down only moderately from the historical average of 60% (Figure 3.13 and Table 3.17).

The Hugh Smith Lake stock is an example of a stock that traverses an extended gauntlet of mixed stock fisheries along the coast and is exposed to fisheries outside of state jurisdiction in Canada and around Annette Island. From 1982 to 1988, the Hugh Smith Lake stock was exploited at moderate rates for coho salmon, averaging 62% (Figures 3.12 and 3.13; Table 3.18).

However, exploitation became markedly more intense during 1989 to 1999 at an average rate of 76% (range 68% to 82%). The increase was split between the troll fishery in northern Southeast and gillnet fisheries in southern Southeast.

Table 3.16. Estimated percent harvest by gear type, escapement and total run of coho salmon returning to the Berners River from 1982 to 2002.

		Percent of Total Run								
Year	Fishery Sample Size	Troll	Seine	Drift Gillnet	Sport	B.C. Net	Cost Recovery	Total Catch	Escapement	Total Run
1982	48	41.6	0.0	34.1	0.0	0.0	0.0	75.8	24.2	100.0
1983	125	50.4	0.0	20.5	0.2	0.0	0.0	71.1	28.9	100.0
1984										
1985	93	44.8	0.8	28.9	0.0	0.0	0.0	74.6	25.4	100.0
1986	157	55.0	0.0	36.2	1.6	0.0	0.0	92.9	7.1	100.0
1987	53	53.0	0.0	23.5	0.3	0.0	0.0	76.8	23.2	100.0
1988	102	39.6	1.2	41.0	0.0	0.0	0.0	81.8	18.2	100.0
1989	58	53.4	0.0	8.5	0.0	0.0	0.0	61.9	38.1	100.0
1990	470	43.6	0.4	21.7	1.6	0.0	0.0	67.3	32.7	100.0
1991	1,025	18.2	1.6	47.0	0.3	0.0	0.0	67.2	32.8	100.0
1992	701	33.5	0.8	32.0	0.4	0.0	0.0	66.6	33.4	100.0
1993	1,496	39.0	0.4	28.7	0.3	0.0	0.0	68.4	31.6	100.0
1994	2,647	37.1	2.3	37.9	1.2	0.0	0.0	78.4	21.6	100.0
1995	1,384	30.7	0.1	51.6	0.4	0.0	0.0	82.8	17.2	100.0
1996	601	44.2	1.6	27.0	1.7	0.0	0.0	74.6	25.4	100.0
1997	312	15.9	1.8	16.0	1.2	0.0	0.0	34.9	65.1	100.0
1998	613	43.9	1.8	24.1	1.6	0.0	0.0	71.4	28.6	100.0
1999	948	39.5	0.6	28.6	0.8	0.0	0.0	69.6	30.4	100.0
2000	693	24.8	0.7	24.5	0.9	0.0	0.0	50.8	49.2	100.0
2001	745	27.7	0.6	11.0	0.4	0.0	0.0	39.6	60.4	100.0
2002	787	17.3	0.5	26.0	0.9	0.0	0.0	44.7	55.3	100.0
Average		37.7	0.8	28.4	0.7	0.0	0.0	67.6	32.4	100.0

Although the increase in exploitation in gillnet fisheries could be attributed to more liberal management, it appears that the increase in the troll fishery exploitation rate was due, at least in part, to a shift in the migratory pattern of the stock into northern waters where the fishery was more intense.

Exploitation rates on Hugh Smith Lake coho salmon have subsequently plunged to only 54% in 2000, 50% in 2001 and 38% in 2002. The Alaska troll exploitation rate on the Hugh Smith stock dropped from an average of 39% from 1982 to 1999, to 37% in 2000, 22% in 2001, and 17% in 2002 (Figure 3.12; Table 3.18).

Exploitation rate estimates for the Taku River stock were relatively low considering the fact that the stock has been exposed to a gauntlet of fisheries extending from offshore waters into the system. Total exploitation rate estimates for the stock averaged 51% from 1992 to 2002 (Table 3.19). The troll exploitation rate during that period averaged only 24% compared with averages of 30% and 32%, respectively, for nearby Auke Creek and Berners River stocks that migrate through the same waters with somewhat later timing. Exploitation of the Taku River run by all fisheries has declined markedly since 1999, and in 2002 was only about half of the 1992 to 1999 average. In 2002, the total exploitation rate on the Taku River run was estimated at only 28% compared with the 1992 to 1999 average of 57%. Decreases by fishery from the period 1992 to 1999 to 2002 were as follows: troll 26% to 13%, seine 2% to 1%, marine gillnet 21% to 10%, marine sport 3% to 2%, and inriver gillnet 5% to 1%.

Table 3.17. Estimated percent harvest by gear type, escapement, and total run of coho salmon returning to Ford Arm Lake from 1982 to 2002.

		Percent of Total Run							
Year	Fishery Sample Size	Alaska Troll	Seine	Drift Gillnet	Sport	Canadian Troll	Total Catch	Escapement	Total Run
1982	38	41.3	2.2	0.0	0.0	0.0	43.6	56.4	100.0
1983	93	54.0	14.7	0.0	0.0	0.0	68.7	31.3	100.0
1984									
1985	49	51.2	0.0	0.0	0.0	0.0	51.2	48.8	100.0
1986	87	60.9	1.5	0.0	0.0	0.0	62.4	37.6	100.0
1987	71	45.1	2.4	0.0	0.0	0.0	47.5	52.5	100.0
1988	151	47.9	0.8	0.0	0.0	0.5	49.2	50.8	100.0
1989	221	61.5	3.0	0.0	0.0	0.0	64.5	35.5	100.0
1990	174	56.5	2.0	0.0	0.0	0.0	58.5	41.5	100.0
1991	193	53.3	0.7	0.2	0.0	0.0	54.2	45.8	100.0
1992	199	56.4	2.2	0.0	0.0	0.0	58.7	41.3	100.0
1993	349	61.8	3.5	0.0	1.6	0.0	66.9	33.1	100.0
1994	236	60.2	10.7	0.0	1.0	0.0	71.9	28.1	100.0
1995	91	47.8	19.6	0.0	0.0	0.0	67.4	32.6	100.0
1996	64	52.6	0.0	0.0	5.6	0.0	58.2	41.8	100.0
1997	241	47.8	0.0	0.0	3.6	0.0	51.4	48.6	100.0
1998	315	48.9	2.7	0.1	4.2	0.0	56.0	44.0	100.0
1999	145	58.9	0.7	0.0	4.4	0.0	63.9	36.1	100.0
2000	193	57.2	11.5	0.2	2.7	0.0	71.6	28.4	100.0
2001	131	68.6	1.1	0.0	5.5	0.0	75.2	24.8	100.0
2002	246	38.1	8.3	0.0	6.6	0.0	53.0	47.0	100.0
Average		53.5	4.4	0.0	1.8	0.0	59.7	40.3	100.0

In 2002, mean-average exploitation rates for the 4 long-term indicator stocks were the lowest recorded, having declined from 62% in 1990 to 1999, to 40% in 2002 (Figure 3.13), while the Alaska troll component declined from 41% in the 1990s to 23% in 2002 (Figure 3.12).

ESCAPEMENT GOALS

Biological escapement goals were established for the 4 long-term indicator stocks in 1994 using Ricker[a] analysis (Clark et al. 1994). Subsequently, Clark (1995) developed goals for the 5 surveyed roadside streams in the Juneau area. These *biological escapement goal* ranges are designed to maintain wild stocks at high levels of productivity, and to maintain yields near maximum. The goals represent a range of escapements that were estimated to produce 90% or more of *maximum sustainable yield.*

The Taku River has a minimum goal for the number of coho salmon passing above Canyon Island specified in the 1999 Pacific Salmon Treaty. The Transboundary Technical Committee of the Pacific Salmon Commission is expected to develop a *biological escapement goal* for this stock for 2003 to 2004. The current above-border goal of 38,000 effectively translates to an escapement goal of about 35,000 spawners after harvests in commercial, food, and test fisheries.

Goals have not yet been formally developed for newer indicator stocks and surveyed streams that lack adequate data series for spawner-recruit analysis.

[a] for R (run size) and S (stock size) the Ricker model is parameterized as $R = \alpha S \exp\{-\beta S + \varepsilon\}$, for ε a random variable.

Table 3.18. Estimated harvest by gear type, escapement and total run of coho salmon returning to Hugh Smith Lake from 1982 to 2002.

Year	Fishery Sample Size	Alaska Troll	Alaska Seine	Alaska Gillnet	Alaska Trap	Alaska Sport	B.C. Troll	B.C. Net	B.C. Sport	Total Catch	Escapement	Total Return
		Percent of Total Run										
1982	91	45.6	10.3	3.3	0.0	0.0	4.3	1.3	0.0	64.8	35.2	100.0
1983	189	35.4	10.9	7.1	1.3	0.0	5.4	1.3	0.0	61.5	38.5	100.0
1984	151	31.4	12.5	11.7	0.4	0.0	8.1	0.7	0.0	64.9	35.1	100.0
1985	212	36.0	11.9	5.7	0.2	0.0	8.3	0.5	0.0	62.6	37.4	100.0
1986	257	35.4	11.5	7.0	0.0	0.3	5.2	0.6	0.0	60.1	39.9	100.0
1987	100	28.0	4.1	10.6	0.0	1.0	6.5	2.1	0.0	52.3	47.7	100.0
1988	42	26.7	15.0	8.0	0.0	0.0	15.3	1.5	0.0	66.5	33.5	100.0
1989	91	50.0	15.5	9.8	0.0	1.7	4.3	0.8	0.0	82.1	17.9	100.0
1990	263	39.4	11.7	11.0	0.5	0.0	17.3	1.2	0.0	81.1	18.9	100.0
1991	408	36.7	3.4	15.4	0.0	0.9	11.0	0.8	0.0	68.1	31.9	100.0
1992	497	37.9	13.8	12.3	0.0	0.9	5.8	0.2	0.0	70.8	29.2	100.0
1993	162	52.9	6.1	15.9	0.0	0.0	4.6	1.0	0.0	80.6	19.4	100.0
1994	846	45.9	11.9	15.1	0.0	0.6	7.2	0.6	0.1	81.4	18.6	100.0
1995	433	30.1	13.4	24.4	0.0	1.5	3.6	0.4	0.2	73.6	26.4	100.0
1996	496	40.4	16.3	12.2	0.0	2.7	3.2	0.9	0.0	75.7	24.3	100.0
1997	481	48.5	4.6	15.0	0.0	1.0	3.4	0.0	0.0	72.4	27.6	100.0
1998	666	41.0	10.9	22.7	0.0	2.6	0.0	0.0	0.0	77.2	22.8	100.0
1999	493	42.1	7.0	17.4	0.0	3.7	0.0	0.0	0.0	70.2	29.8	100.0
2000	141	37.0	3.4	8.8	0.0	5.1	0.0	0.0	0.0	54.3	45.7	100.0
2001	312	21.8	15.6	10.3	0.0	1.8	0.2	0.0	0.0	49.7	50.3	100.0
2002	432	16.9	8.5	10.5	0.0	1.7	0.1	0.0	0.0	37.7	62.3	100.0
Average		37.1	10.4	12.1	0.1	1.2	5.4	0.7	0.0	67.0	33.0	100.0

Table 3.19. Estimated percent of harvest by gear type, escapement, and total run of coho salmon returning to the Taku River above Canyon Island from 1992 to 2002.

Year	Fishery Sample Size	Troll	Seine	Gillnet	Marine Sport	Canadian Inriver	Total Catch	Escapement	Total Return
		Percent of Total Run							
1992	129	19.2	2.3	35.2	1.5	2.6	60.9	39.1	100.0
1993	121	28.9	1.3	14.8	1.2	2.2	48.3	51.7	100.0
1994	178	28.6	7.8	25.4	5.6	4.3	71.6	28.4	100.0
1995	201	24.9	1.0	31.4	4.3	7.6	69.2	30.8	100.0
1996	136	26.3	0.2	18.1	2.6	5.4	52.6	47.4	100.0
1997	66	26.3	0.2	18.1	2.6	5.4	52.6	47.4	100.0
1998	231	24.1	0.6	16.2	3.7	4.2	48.8	51.2	100.0
1999	252	30.9	2.5	6.4	3.6	4.8	48.1	51.9	100.0
2000	229	18.7	1.4	8.9	8.5	4.9	42.4	57.7	100.0
2001	351	20.7	1.3	7.4	2.1	1.9	33.4	66.6	100.0
2002	396	12.9	1.1	10.2	2.4	1.3	27.8	72.2	100.0
Average		23.8	1.8	17.5	3.5	4.0	50.5	49.5	100.0

One major problem with spawner-recruit analysis of northern coho salmon stocks has been difficulty in accurately determining freshwater age. C. W. Farrington (ADF&G) and S. G. Taylor (National Marine Fisheries Service, unpublished data, personal communication, 1994) found most Auke Creek smolts to be over-aged by 1 or 2 years. Whereas most smolts from that system had been believed to be age 3, with age 1 smolts almost nonexistent, Farrington and Taylor found most to be age 1, based on marked known-age samples.

Their findings have spurred age-verification studies on other systems including Hugh Smith Lake and the Berners River. The findings at Hugh Smith Lake are similar to Auke Creek and may be applicable to other systems that are dominated by lake habitat. Somewhat different and less severe aging error rates have been found in Berners River samples. The primary problem in accurate freshwater aging appears to be formation in scale patterns of false checks that are mistaken for annuli.

A project is underway to further develop and analyze the data series of known-age samples to develop aging criteria and protocols that increase the accuracy of age composition estimates. The historical scale collection for the indicator stocks will then be re-aged and *biological escapement goals* updated, with completion planned for 2005.

A major advantage of coho salmon indicator stocks for spawner-recruit analysis is the ability to account for varying marine survival, thereby avoiding spurious results from shifts in ocean survival (Geiger 2001). Most indicator stock programs provide estimates of total population size after the freshwater phase (smolts) and after the ocean phase (returning adults). Because of the territorial nature of coho salmon, average smolt size varies relatively little with brood year abundance, so there is probably very little effect of brood year abundance on marine survival. The ability to account for approximately 60% of the variability in adult production (see Total Stock Abundance section) is a major advantage in determining the underlying relationship between brood year escapement and resulting stock abundance.

An analysis of spawner-recruit data from coho salmon stocks from Oregon through central British Columbia by Bradford et al. (1999) indicates that smolt production is typically unrelated to spawner abundance above a minimum threshold level that represents full seeding. The authors found that the most consistent best fit was provided by a simple “hockey stick” model with return proportionate to brood-year escapement up to a threshold escapement level above which returns are stable at all escapement levels. Above the threshold escapement, juvenile coho salmon are limited in their ability to survive and grow by territorial effects that result in unequal access to food and promote uneven growth and mortality rates within the population. This system of population regulation tends to produce a relatively constant number of smolts of a consistent size from highly variable levels of seeding of fry by spawners. We have found no indication that spawner-recruit relationships for Southeast Alaska coho stocks are substantially different from the southern stocks investigated by Bradford et al. (1999). Recent escapements that were 2 or 3 times the *biological escapement goals* reflect foregone harvest opportunity but are unlikely to significantly reduce future returns.

In some regions, habitat measurements have been used to estimate production capability in order to develop escapement goals. For example, Holtby et al. (1999) generated an estimate of *maximum sustainable yeild* escapement for the Babine system in interior northern British Columbia based on spawner densities of 13 females per kilometer and 41 spawners per mile that were determined to approximate *maximum sustainable yield* escapement, based on studies of coastal streams in southern British Columbia and Oregon, respectively.

We find a habitat-based approach to estimating carrying capacity to be of doubtful utility in Southeast Alaska. Habitat capability of northern coho salmon systems appears to be highly variable relative to system size. For example, Shaul and Van Alen (2001) reported average smolt production density estimates varying nearly 3-fold for the 4 long-term coastal indicator systems in Southeast Alaska, ranging from 1,148 smolts/km in the Auke Creek system to 4,140 smolts/km in the Ford Arm Lake system. Comparable estimates for 2 tributaries in the interior Taku River drainage were only 213 smolts/km and 420 smolts/km respectively. We believe that applying spawner density factors to measures of habitat will result in escapement goals that are unrealistic relative to actual sustained yield needs.

As an alternative, we suggest using average observed smolt production (excluding production from brood years when escapement was particularly low) as the best estimate of system capability. Given that escapement in most systems is at or near historic highs, smolt production in succeeding years should provide further evidence of the productive capacity of these systems. If an adequate data series is unavailable for direct spawner-recruit analysis, productivity estimates from longer-term full indicator stocks can be scaled to habitat capability estimates for other stocks to generate an initial escapement goal. Based on information from Southeast Alaska indicator stocks and estimates presented in Bradford et al. (1999), *maximum sustainable yield* for most stocks appears to fall in the range of about 30 to 60 smolts per spawner. For Hugh Smith Lake where production has averaged about 31,800 smolts (Table 3.5), the current escapement goal range of 500 to 1,100 spawners (with predicted returns of 90% or more of *maximum sustainable yield*) corresponds with 29 to 64 smolts per spawner.

In cases where the available data series consists only of escapement survey counts, smolt production associated with those counts can be estimated using marine survival and exploitation rate estimates for full indicator stocks in the same area. When aging validation work is completed, an updated analysis of spawner-recruit relationships will be done for the full indicator stocks. This in turn will aid in establishing goals for more of the surveyed systems.

DISCUSSION

Southeast Alaska coho salmon stocks are currently in excellent overall condition. We found no *stocks of concern* from a fishery management perspective. Stocks that have *biological escape-ment goals* have been within or above target ranges in the vast majority of cases. For most stocks, escapements peaked in the early to mid-1990s when runs were exceptionally strong and have reached relatively high levels again from 2000 to 2002 because of strong runs combined with declining exploitation.

Fishing effort in troll and net fisheries has declined substantially because of downward pressure on markets for salmon. Until effort increases again, fisheries will rarely require inseason restrictions to achieve escapement goals, and escapements will greatly exceed goals when runs are strong. For example, spawning escapement in 2002 was triple the upper end of the biological goal range for 2 key inside indicator stocks (Berners River and Hugh Smith Lake). These exceptionally large escapements represent substantial foregone harvest, but we do not expect them to adversely affect future returns.

Until the late 1990s, the Berners River and Hugh Smith Lake stocks were intensively exploited by a gauntlet of fisheries at rates that were commonly in the 70% to 80% range. If 2002 exploitation rates of 45% and 38% persist, the Berners River and Hugh Smith Lake stocks will not fall under escapement objectives unless their returns are less than 51% and 61%, respectively, of the lowest run sizes in the past 21 years. Until the capacity for the fisheries to exploit the stocks increases again, the primary concern of fishery managers and industry participants will be to create opportunities to economically exploit and extract value from available surplus production. Sport fishing in marine waters has increased substantially in the past decade but still exploits most indicator stocks at rates of only 3% to 5%.

Fishery performance indicators like the troll catch of wild coho salmon indicate that Southeast Alaska coho stocks have been at historically high abundance since 1982, after a protracted period of low production from 1956 to 1981 (Shaul and Van Alen 2001). The primary long-term indicator stock projects were initiated at about the time that abundance improved. Within the period of stronger runs since the early 1980s, total return estimates for specific stocks indicate a generally level overall trend, except for a peak in the early to mid-1990s. The primary factor that has driven both short and long-term fluctuations in abundance is marine survival, which has accounted for about 61% (range 57% to 70%) of the observed variability in abundance of wild indicator stocks since 1980, while only about 39% (range 30% to 43%) was attributed to freshwater factors including spawning escapement. The relative influence of survival might appear even greater if it were possible to estimate its effect over a broader period that transited poor as well as favorable trends in ocean conditions.

Strong positive correlations in returns to systems over broad geographic areas facilitate use of indicator stocks as a tool to manage highly mixed-stock fisheries (Shaul 1998, Shaul et al. 1998, Shaul and Van Alen 2001). Smolt production as well as marine survival can be strongly correlated for systems of the same habitat type over substantial geographic areas, as evidenced by strong positive relationships in smolt production and survival between the Taku River and Berners River stocks that are separated by 90 km. Marine survival of stocks in systems entering inside marine waters can be strongly correlated over longer distances up to at least 490 km (the distance between Berners River and Hugh Smith Lake).

Although we identified no *stocks of concern* from a fishery management perspective, the Joint Northern Boundary Technical Committee (2002) described land-use practices in the region that have likely reduced habitat capability for coho salmon. Most habitat loss is a long-term ongoing process resulting from historical forestry practices that have resulted in loss and reduced recruitment of woody debris in stream channels. Problems have also been identified with improperly installed culverts that block fish passage under logging roads. These effects apply primarily to smaller streams in areas where timber has been harvested. Most wetland habitat that is essential to coho salmon production in larger mainland river systems is in nearly pristine condition.Urbanization impacts are minor over most of the region, but we noted decreases in 2 Juneau roadside stocks that may have been related to the ongoing process of urban development. The declines appear unrelated to fishery effects on spawning escapement, but natural habitat changes and ecological shifts cannot be ruled out.

The Auke Creek stock has undergone a gradual decline in smolt production of about 1.45% of the year-zero reference point per year over the 24-year history of the indicator stock, for a total decline of 35%. The reason for the decline is unclear but does not appear related to a limitation in the number of spawners, as average escapement has increased from 650 fish in 1980 to 1990, to 840 fish in 1991 to 2002. Spawner-recruit analysis may shed more light on the influence of escapement on smolt production.

However, the trend may be related to habitat change in the system. The surrounding area has undergone substantial development and noticeable changes have included increased residential development and large bed-load shifts in Lake Creek, the main inlet stream that serves as the primary spawning area and provides some rearing habitat (Jerry Taylor, National Marine Fisheries Service, personal communication). D. M. Bishop (Environaid Inc., unpublished data, personal communication) noted an absence of large woody debris in lower sections of Lake Creek, which may have reduced pool rearing habitat and subjected spawning habitat to increased bed-load movement. He also noted low and intermittent winter flows in Lake Creek. Its possible that the system has undergone an ecological shift that has favored species other than coho salmon. Such a shift might also have increased predation on rearing coho salmon. Dolly Varden and cutthroat trout have both increased substantially in abundance since the early 1980s (S. G. Taylor and J. L. Lum, unpublished data, personal communication).

Jordan Creek, located in a heavily developed section of the Mendenhall Valley, experienced a sharp drop in escapement beginning in 1995, with escapements falling under the goal for 5 consecutive years. The decline was disproportionate with changes in escapement in other Juneau roadside streams. However, there was a surprisingly strong record escapement in Jordan Creek in 2002 that was nearly double the previous record and proportionately higher than escapements in nearby systems. The recent history of highly variable escapements in Jordan Creek, combined with widely disparate smolt counts in 2001 and 2002, suggests that survival and smolt production from the system has recently been particularly sensitive to environmental conditions.

One stock that has experienced a substantial increase in freshwater production since the early 1980s is Ford Arm Lake, a virtually pristine watershed in a wilderness area on the outer coast. There have been no obvious changes in the physical features of the habitat that would indicate increased production, but it's possible that the coho salmon stock has benefited from increasing nutrient inputs from recent large pink, sockeye and coho salmon escapements in that system.

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Chapter 4: Pink Salmon
Stock Status and Escapement Goals in Southeast Alaska and Yakutat

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ABSTRACT

Pink salmon stocks in Southeast Alaska appear to be at their highest abundance level since record keeping began in the late 1800s. At statehood the commercial harvest of pink salmon was near 3 million fish, but the commercial harvest has since risen to levels sometimes exceeding twenty times that amount. Five of the top 10 harvest levels in the 109-year harvest history have occurred in the last 10 years, including the highest harvest of 78 million fish in 1999, and the second highest harvest of 67 million fish in 2001. Escapements have similarly increased and escapement measures have all tended upwards over the entire history of the series, from 1960 to the present, although the sharpest increase began in the late 1970s.

The escapement goals for pink salmon in Southeast Alaska were previously presented on the basis of 12 management districts. We considered these previous goals to be *sustainable escapement goals*, under the definition of the Alaska Board of Fisheries' Escapement Goal Policy. We recommend new escapement goals, which we consider to be *biological escapement goals*. These new goals are established at the level of 3 sub-regions of Southeast Alaska, as the commercial harvest of these fish cannot be differentiated in the mixed-stock fisheries of Southeast Alaska to a scale finer than sub-region. We used a "tabular approach" to summarize 42 years of escapement and harvest information, and we examined yield as a function of escapement level, using a range of hypothesized expansions of escapement index to total escapement. This approach then provided a range of highest potential yields, which the revised *biological escapement goals* are based on. We also divided these goals into management targets for 12 fishing districts and 45 stock groups as an aid to management in reaching the new escapement goals, and also as an aid to the Board of Fisheries and the public in evaluating escapement distribution. Escapement goals for 2 streams in the Yakutat area have previously been established and we consider these to be *biological escapement goals.*

We did not identify any stock groups with biologically meaningful declines in escapement over the last 21 years. Of the 45 stock groups we examined, 42 showed clear increases in escapement over the last 21 years, and 3 stocks measured very small declines. The largest decline was less than 0.3% of the escapement level at the beginning of the series, which we interpreted as functionally stable. Similarly, though pink salmon production in the Yakutat area is much lower than in Southeast Alaska and there are few directed pink salmon fisheries in the area, escapement trends in 2 monitored Yakutat area systems indicate sustainable harvests and returns. There are no stocks of pink salmon in Southeast Alaska or the Yakutat area that can be considered *stocks of concern*, under the definition of the Board of Fisheries' Sustainable Salmon Fisheries Policy.

Key words: Pink salmon, Oncorhynchus gorbuscha, escapement, escapement goals, escapement goal ranges, stock status, bias adjusting, harvest estimation, Situk River, Humpy Creek, Cross Sound-Icy Strait, Yakutat, Petersburg management area, Ketchikan management area, Sitka management area.

INTRODUCTION

Pink salmon (*Oncorhynchus gorbuscha)* spawn in approximately 2,500 short, coastal streams throughout the Southeast Alaska and Yakutat area (Figure 4.1). Pink salmon are harvested in the region primarily in commercial purse seine fisheries, and to a lesser extent by commercial drift gillnet, troll, and set gillnet (Yakutat area only) fisheries, as well as sport, personal use, and subsistence fisheries. The total annual exvessel value of the commercial pink salmon harvest in recent years has been near $20 to $30 million ($27 million in 2001). Almost all (>97%) of the pink salmon harvest in Southeast Alaska and Yakutat is of wild-stock origin.

Commercial Fishery History

Commercial utilization of salmon in Southeast Alaska began in 1878 (Moser 1899). The first recorded commercial harvests of pink salmon were made in the early 1890s (Byerly et al 1999). Annual commercial harvests remained below 10 million pink salmon through 1906 (Appendix 4.1). Harvests reached a peak of 60 million in 1941, gradually declined to a low of 3 million in 1960, and then increased to between 10 and 20 million fish through the mid-1960s. Annual harvests declined again to 3 million fish in 1967 and remained at low levels until the late 1970s.

Harvests have risen tremendously since then, reaching nearly 60 million in 1989, and fluctuating between 20 million and a historical high of 78 million fish (1999) since 1990.

Fish traps were the dominant gear used to harvest pink salmon from the early 1900s through statehood in 1959. Use of fish traps was prohibited at statehood, with the exception of several that were operated annually on the Annette Island Fishery Reserve until 1993. Net fisheries had grown in importance by the mid-1900s and became the dominant harvester of pink salmon after statehood.

Federal regulation of commercial fisheries was lax in the early 1900s. Crutchfield and Pontecorvo (1969) describe early regulation as “indicative of congressional intent rather than operational programs.” They note that in 1896 “funds were provided for one inspector and an assistant” to monitor fisheries in the region. Alexandersdottir (1987) notes that concern with falling harvests in the late 1910s and early 1920s led to implementation of the White Act in 1924. The regulation mandated that half of the run be allowed to escape the fishery, and was in force until the state assumed management from the federal government. Under the Act, between 1924 and 1945, fisheries operated prior to around mid-July and then were closed to allow for escapement (Thorsteinson 1950). Alexandersdottir (1987) concludes that this resulted in over-exploitation of early runs, a shift in the temporal run timing pattern, and depressed pink salmon production throughout the region.

Low returns of pink salmon in the early to mid-1970s caused ADF&G to severely curtail the purse seine fishery for several years to rebuild runs. As a result of chronic weakness of early run stocks to several inside areas of northern Southeast Alaska, the department modified its management strategy in the Icy Strait/northern Chatham Strait area. When improved returns developed in the late 1970s, harvest opportunities were moved from the Cross Sound area to more inside waters of eastern Icy Strait and northern Chatham Strait and fishing opportunities were limited early in the season until managers could assess returns of early run stocks (Ingledue 1989).

Present-day management of pink salmon stocks in Southeast Alaska is accomplished through extensive monitoring of fishing effort, harvests, and developing escapements. Preseason and inseason forecasts of abundance are developed and catch, effort, and sex ratios of commercial and test fishery harvest data are tracked, and aerial surveys are flown extensively throughout the region to monitor escapements (ADF&G 2002).

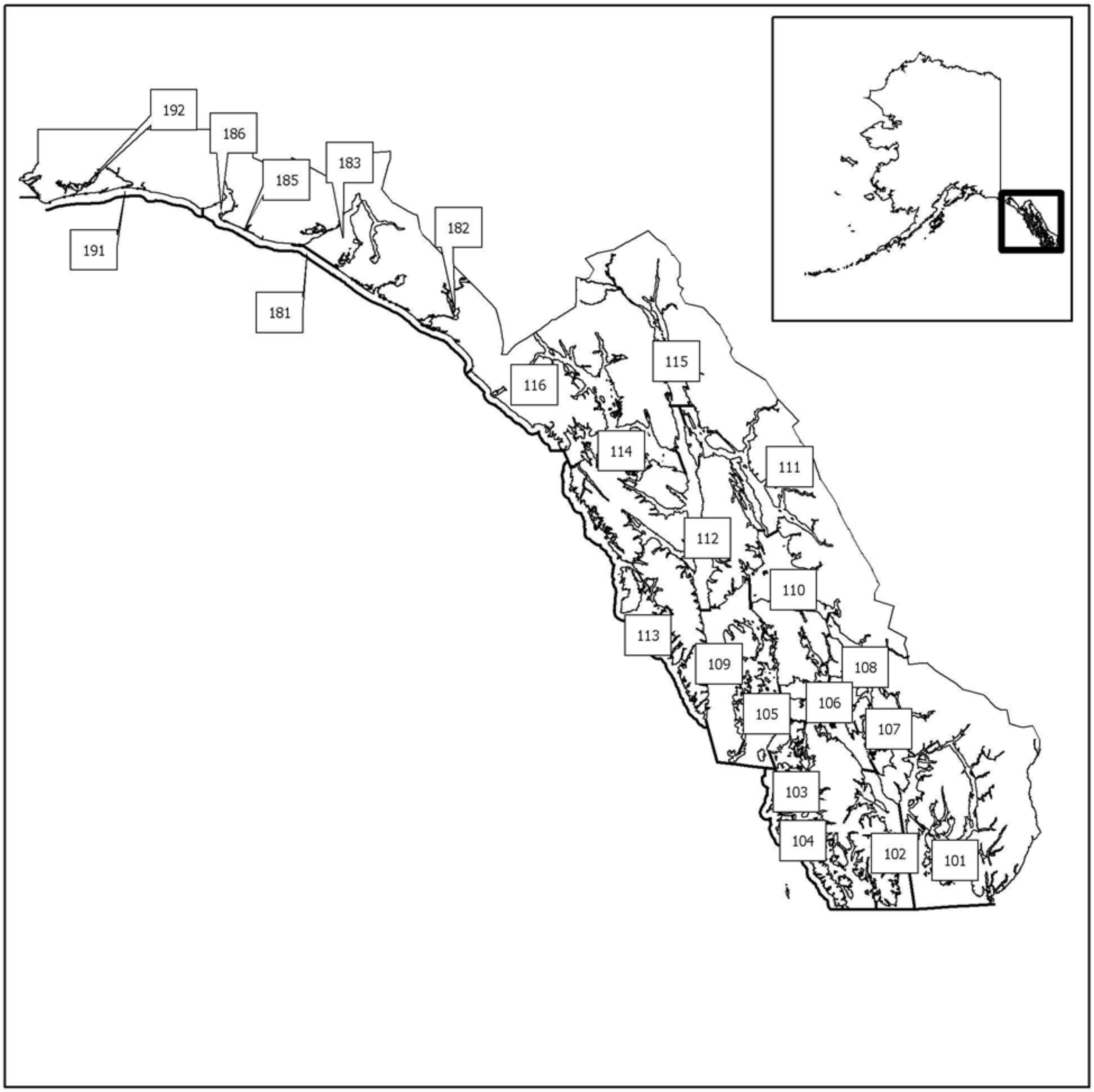

Figure 4.1. Map of Southeast Alaska and the Yakutat area, showing the management districts.

Escapement Monitoring Program

In Southeast Alaska, ADF&G maintains an annual index of escapement (or size of the spawning populations) that covers the period from 1960 to present. The index is based on a standardized set of 718 streams that are observed at intervals during the salmon migration and spawning period (Van Alen 2000). Observers fly a series of surveys over the course of a season, and their observations are statistically adjusted so the estimates of the number of fish are comparable among observers and comparable with historical observations. The observations, collected throughout the season, are visual counts of fish adjusted to the level of the senior manager in the 1995 base year, and we refer to these as the *adjusted counts*. The largest count for the year is then retained for each stream in the survey and termed the *peak-adjusted count* for each stream. The index for each stock group is made up of the peak-adjusted counts summed over this standard set of index streams for a particular area.

The methods of calculating the escapement index have changed over the years, and, the term "index escapement" has been applied to several different statistical series. Recently ADF&G has applied the term "index escapement," to 2 different series that differ by a factor of 2.5. The 2.5 multiplier was originally intended to convert peak escapement counts to an estimate of what was actually present at the time of the survey (Hofmeister 1990). Dangle and Jones (1988) showed that aerial observers usually see an average of about 40% to 50% of the actual fish present—although this relationship is highly dependent on the run size (Jones et al. 1998). Jones et al. (1998) state that "Peak aerial counts ... are summed as the total escapement index for individual management districts. A multiplier of 2.5 expands this index to an estimate of the district's total escapement." This statement is incorrect. In reality, there is no simple way to convert the index series to an estimate of total escapement. The escapement indices are less than total escapements (Hofmeister 1990). The streams that are surveyed make up about one-third of the pink salmon producing streams (Jones et al. 1998). Another important factor to consider in relating total run size to index series of escapement is the relationship between the total fish that spawn and die and the number of fish that are present in the creek at the time of the *peak observation* (Bue et al. 1998). This factor has not been well studied for systems in Southeast Alaska. Based on the hypothetical modeling of Quinn and Gates (1997), the peak count might be expected to represent something on the order of one-tenth of the total spawning stock size—and be highly variable. Although this ratio would not be expected to be similar from year to year, it would be highly dependent on the number of fish in the escapement. Unpublished measurements from Traitors Creek in Southast Alaska provide ratios of peak to total escapement much smaller than expected, and quite variable. Average conversions of peak aerial survey to *total* escapement ranged from 0.7 to 4.9 over 7 years.

We previously mentioned that there are 718 *index streams* in Southeast Alaska (selected from over 2,500 known pink salmon spawning streams in the region). Each of these was designated as an index stream if it was surveyed a minimum of 7 different years between 1986 and 1997. The index streams are not simply the largest streams in the area; all stream sizes are represented (Table 4.1) based on peak counts, although stream size in the index set does not necessarily match the distribution of stream size within the entire region.

Area management biologists and their assistants estimate pink salmon spawning stock size by visual observation during aerial surveys, at intervals, during the entire migration period. These surveys are predominately done using small, fixed wing aircraft, usually a Piper Supercub[a], as this aircraft can fly at slower speeds and observers have excellent visibility on either side. The air speed during surveys is kept at about 90 to 150 km $\cdot$ hr^{-1} at an altitude of 100 to 200 m.

For each survey, and for each stream, fish counts are divided into 4 categories: mouth, intertidal, stream live, and stream dead. Mouth counts normally consist of fish in saltwater that are in proximity to the stream being surveyed. Intertidal counts include fish in the area from low tide to

[a] Product names used in this publication are included for scientific completeness but do not constitute product endorsement.

the approximate high tide mark. Stream counts normally include any fish above the high tide mark.

Table 4.1. Pink salmon escapement index stream distribution by group size based on 1960 to 2001 average of *peak count* by stream.

Escapement Index Group Size	Number of Streams
< 500	21
510 - 2,499	173
2,500 - 4,999	141
5,000 - 9,999	161
10,000 - 24,999	140
25,000 - 100,000	77
> 100,000	5
Total Streams	**718**

Since 1997, each survey has also been qualified based on visibility and timing, and categorized into one of 3 groups: 1) not useful for indexing or estimating escapement; 2) potentially useful for indexing or estimating escapement; and 3) potentially useful as a peak escapement count. This grouping is used later in the estimation process to filter out inadequate surveys from the pool of survey observations.

The individual "raw survey" counts are entered into the ADF&G Southeast Alaska Integrated Fisheries Database.

Pink salmon production in the Yakutat area is much lower than in Southeast Alaska. Pink salmon escapements have been recorded in the department's database for 20 Yakutat area streams since 1961. However, only 2 systems have been consistently monitored. These streams, the Situk River and Humpy Creek, are 2 of the more substantial producers in the area and each supports a terminal set gillnet fishery, though the Situk fishery targets other species and the Humpy Creek fishery has not been active in recent years. Escapements in the Situk River have been assessed with aerial and boat surveys and with a weir, although there is some spawning that occurs downstream from the weir. Escapements into Humpy Creek have been assessed by foot, boat, and aerial surveys, although these assessments have been limited in the late 1990s.

"Bias Adjusting" Raw Surveys in Southeast Alaska

Individual observers track absolute abundance within the streams, but each observer tends to count at his or her own rate or bias (Dangel and Jones 1988; Jones 1995; Jones et al. 1998; Bue et al. 1998). Beginning in 1995, raw stream survey counts were standardized to remove as much "observer bias" as possible—not by removing bias, but rather by adjusting all observer counts within a management area to the same bias level. Each observer's counts are converted to the counting rate of a major observer (typically the current area management biologist). The major observer's rate is set at 1.0. To implement bias adjustments:

1) We identified every instance where one observer and the major observer from the same management area surveyed the same stream within 3 days of one another. Each paired observation was expressed as a ratio of the count of the one observer to the count for the major observer.
2) The median of the ratios of all such paired observations was used to generate a "bias adjustment" for each observer.
3) Surveys by all observers were then multiplied by their bias adjustment.

These observer calibrations have not been updated for several years, but in the future they will be updated annually, once a statistically stable method has been developed to combine annual estimates with the historical measurements each observer has for his or her entire career.

The actual process of generating the estimates requires some subjective judgment. The principal research biologist in charge of this index retrieves the counts from the Integrated Fisheris Database and chooses which of the different data types and which of the observations over time to use for the peak count, for each stream. "Mouth-only" counts are usually eliminated from consideration. Previous studies showed that pink salmon mill about and frequently spawn in streams in other than the stream mouth where they were first observed (Jones and Thomason 1984). There are a few streams where "mouth-only" counts are accepted, as the stream canopy cover is too dense to allow in-stream counts later in the season. The analyst considers the entire series of counts for each stream through the season. For example, if the analyst sees evidence that a large school entered a stream, but then backed out and moved elsewhere, the count of the fish that moved is excluded from consideration for the peak. Or if the peak in-river count appears to have been missed because of poor weather, the analyst may make some adjustments. Prior to final tabulation, all peak counts by stream are reviewed by the area management biologists for obvious errors in data entry.

The final observer-calibrated peak count (or adjusted peak count) is stored in the regional database, and is used as the primary datum on pink salmon abundance for each index stream. These adjusted peak counts are then assembled into the overall escapement index, as mentioned above, by summing the peak counts for all index streams in the stock group.

Adjustments for Missing Surveys in Southeast Alaska

If a particular index stream is missing escapement counts for any given year, an iterative EM algorithm (McLachlan and Krishnan 1997) is used to interpolate a peak count. Missing counts are interpolated by assuming that the expected count for a given year is equal to the sum of all counts for that stream, divided by the sum of all counts over all years for all the streams in the unit (i.e., row total times column total divided by grand total). This assumes a multiplicative relation between yearly count and unit count, with no interaction.

Definitions of Pink Salmon Stock Groups in Southeast Alaska

In 1997, the Southeast Alaska index streams were divided into 45 management "stock groups" (in the sense of Ricker 1975: "The part of a fish population which is under consideration from the point of view of actual or potential utilization."). Stock groups were created by managers to correspond to spawning aggregations they actively managed. Stock groups are organized into 4 management areas (Juneau, Petersburg, Sitka, and Ketchikan) that correspond to department area offices in charge of managing commercial fisheries on these stocks. The management areas are shown in Appendix Figure 4.9. Stock group boundaries within each management area are shown in Appendix 4.10–4.13. There are an additional 7 stock group areas in Southeast Alaska that complete the regional division. These areas are Annette and Suemez-Dall (Ketchikan area), SW Baranof, W Kruz, and W Yakobi (Sitka area), and Dundas Bay and Glacier Bay (Juneau area). These 7 areas are indicated in Appendix Figures 4.10–4.13 but do not have index streams or associated escapement targets. The Annette area is managed exclusively by the Metlakatla Indian Community as a reservation. The state has no jurisdiction in this area. The other 6 areas each have a few small pink salmon streams with very little production, it would be cost prohibitive to survey these outlying areas on a regular basis, and there are no directed fisheries on stocks from these specific areas. Even so, the streams in these 6 areas are surveyed occasionally. These escapement observations are available in the Integrated Fisheries Database, although we have not used them in our analysis.

Harvest Estimation

Commercial harvests are recorded on legal documents called *fish tickets*. A fish ticket is made for each salmon landing. The total weight of the harvest is recorded and serves as the basis of payment on the part of the processor to the fishers. The fish ticket also captures both temporal and spatial information about the harvest, as well as information about the vessel making the harvest and sale. Harvests in units of total weight are converted into units of fish numbers by the processors, based on their own individual methods of determining the average weight of individual fish. Fish tickets are required by regulation to be delivered to the ADF&G within 7 days of initial record. Information from these tickets are reviewed for obvious errors by a member of the management staff and then entered into the electronic ADF&G Fish Ticket Database System. Harvest data from 1960 to present is contained within the database. This system has automated error checking that flags obvious inconsistencies. The estimated total weight and the estimated total number of commercially harvested salmon are then available to individual biologists in various time and spatial summaries.

ESCAPEMENT GOALS

History of Escapement Goals

Escapement goals for 2 pink salmon streams in the Yakutat area were established in the last decade. Pink salmon escapement goals for the remainder of the Southeast Alaska area were originally established in the early 1970s and have subsequently been modified several times.

Yakutat Area Escapement Goals

Clark (1995) used Ricker-type stock recruit analyses to establish escapement goals for pink salmon in the Situk River and Humpy Creek in the Yakutat area. He compared weir counts to peak aerial and boat counts in the Situk River, and assumed a 3-fold conversion factor to scale peak counts to the total escapement. He used a model-based approach to apportion the harvest in the Yakutat Bay set gillnet fishery to stock of origin, using relative abundance of inshore returns of the 2 stocks. Based on this analysis, he recommended the *biological escapement goal* ranges presented in Table 4.2.

Table 4.2. Recommended pink salmon *biological escapement goal* ranges for the Situk River and Humpy Creek in the Yakutat area.

Stock	Goal	(Range)	Survey Type
Situk River (even-year)	22,000	(14,000-35,000)	Peak Aerial or Boat
Situk River (even-year)	66,000	(42,000-105,000)	Weir
Situk River (odd-year)	30,000	(18,000-67,000)	Peak Aerial or Boat
Situk River (odd-year)	90,000	(54,000-200,000)	Weir
Humpy Creek (even-year)	5,700	(3,300-8,000)	Peak Aerial or Foot
Humpy Creek (odd-year)	12,000	(7,000-18,000)	Peak Aerial or Foot

Southeast Alaska Escapement Goals

Although escapement indices were calculated starting in 1960, escapement-index goals were first set in 1970 (Valentine et al. 1970). The harvest originating from each stock group, or from any specific area in Southeast Alaska, could not be estimated because of uncertainties in the number of fish intercepted outside of their home districts or areas. Goals were developed for 2 sub-regions, Northern (NSE) and Southern (SSE), because tagging studies documented different migration routes for pink salmon stocks destined for the northern and southern areas (Nakatani et al. 1975). This differential migration routing was later verified by further marine tagging studies in the early 1980s by Hoffman et al. (1984). Southern Southeast is made up of Districts 101 through 108 and northern Southeast is made up of Districts 109 through 115. In 1998, the Northern index was further divided into Northern Inside (NSEI) and Northern Outside (NSEO). The Northern Outside area includes all waters of District 113, except Subdistricts 113-51 through 113-59 (Peril Straits and Hoonah Sound).

The first index goals were 5 million for SSE and 3 million for NSE. The goals were not the result of a formal statistical analysis, but rather from observations that in southern Southeast escapement indices of less than 4 million had produced fair to poor returns, and escapements in excess of 4 million generally produced good returns. In addition, a SSE escapement index that exceeded 5 million resulted in the largest return in many years. The pattern of returns from NSE was more variable than SSE and the index goal was set at 3 million. In 1971, the SSE index goal was raised from 5 to 6 million and the NSE goal was raised from 3 to 4 million (Durley and Seibel 1972).

The SSE and NSE goals were adjusted upward in later years based on an analysis of the harvest and index of escapement. The SSE index goal became a range of 6 to 9 million, and the NSE index goal became a range of 3.9 to 5.7 million.

Goals were most recently expressed in terms of districts. The SSE goal was divided into individual goals for each of Districts 101–107, and the NSE goal was divided into individual goals for each of Districts 109–114 (Table 4.3).

Table 4.3. Previous sustainable escapement goals for pink salmon, in units of escapement index (the sum of the peak, bias-adjusted, aerial observations in streams in the index sample, in millions), for Southeast Alaska, by district and sub-region.

District	Lower Goal	Upper Goal
101	2.00	3.00
102	0.60	1.10
103	1.70	2.55
104	No Escapement Goal	
105	0.50	0.65
106	0.60	0.85
107	0.60	0.85
108	No Escapement Goal	
SSE Total	6.00	9.00
109	0.50	0.70
110	0.80	1.20
111	0.40	0.60
112	0.50	0.70
113 Inside	0.49	0.74
114	0.40	0.60
115	No Escapement Goal	
NSE Inside Total	3.09	4.54
113 Outside	0.81	1.16
NSE Outside Total	0.81	1.16
NSE Total	3.90	5.70
SE Total	9.90	14.70

Revision of Escapement Goals

In Alaska, escapement goals are frequently developed using Ricker analysis (Hilborn and Walters 1992; Quinn and Deriso 1999). This approach is based on the premise that an analyst can, on a brood year basis, develop a reliable statistical relationship between the breeding stock size and the subsequent adult production that resulted from that breeding stock. This statistical relationship is then used to forecast the level of harvest associated with each breeding stock size. The stock size with the forecast for the largest average sustainable harvest is then recommended as the *biological escapement goal*, as it is referred to in the Alaska Board of Fisheries' Escapement Goal Policy. In the case of Southeast Alaskan pink salmon, total escapement cannot be accurately estimated. The index escapement measures that are available represent an unknown and random fraction of the total escapement. For this reason, a Ricker analysis is not possible without making some unproven and possibly ill-advised assumptions. Hilborn and Walters (1992) suggest what they call a rough and ready "tabular method" for setting escapement goals when the form of the stock-recruit relationship is not known, and when there might be errors that would complicate traditional statistical approaches. They do caution that this approach requires large sample sizes, which we have. In essence, their approach is to graphically look at potential yield in several escapement categories. We simply used several "cases" to look at these potential yields under several assumptions about the relationship between the escapement index and actual total escapement.

We implemented this approach in 5 steps. First, the catch and escapement index values were organized into the 3 sub-regions: Northern Southeast Outside, Northern Southeast Inside, and Southern Southeast. Next, within each sub-region the data were partitioned into a variable number of escapement intervals that were not mutually exclusive—that is, an observation could fall into 2 different categories. Next, the escapement index values were multiplied by a factor of 1.0, 2.5, 5.0, 7.5, and 10.0 to expand the index to an estimate of total escapement and create the 5 cases. We added the estimated total escapement to the catch to represent a presumption of what the total return might have been. Finally, potential yield was calculated as the return (catch plus expanded escapement) minus the brood year escapement that produced that return. In each sub-region, the different cases were remarkably similar in the escapement index categories that produced the highest potential yields (Figure 4.2; Appendix 4.2 and 4.3).

Based on a visual analysis of Figure 4.2, we recommend a *biological escapement goal* of 4 to 9 index spawners (millions of summed peak counts) in the Southern Southeast sub-region, 2.5 to 5.5 in the Northern Inside sub-region, and 0.75 to 1.75 in the Northern Outside sub-region.

The revised goals are intended for analysis and management at the sub-region level only. We calculated the allocation of these sub-region goals to the 12 districts that had previous goals (Table 4.4). However, the district allocations will be used as “management target ranges” to assist in meeting the sub-region goals.

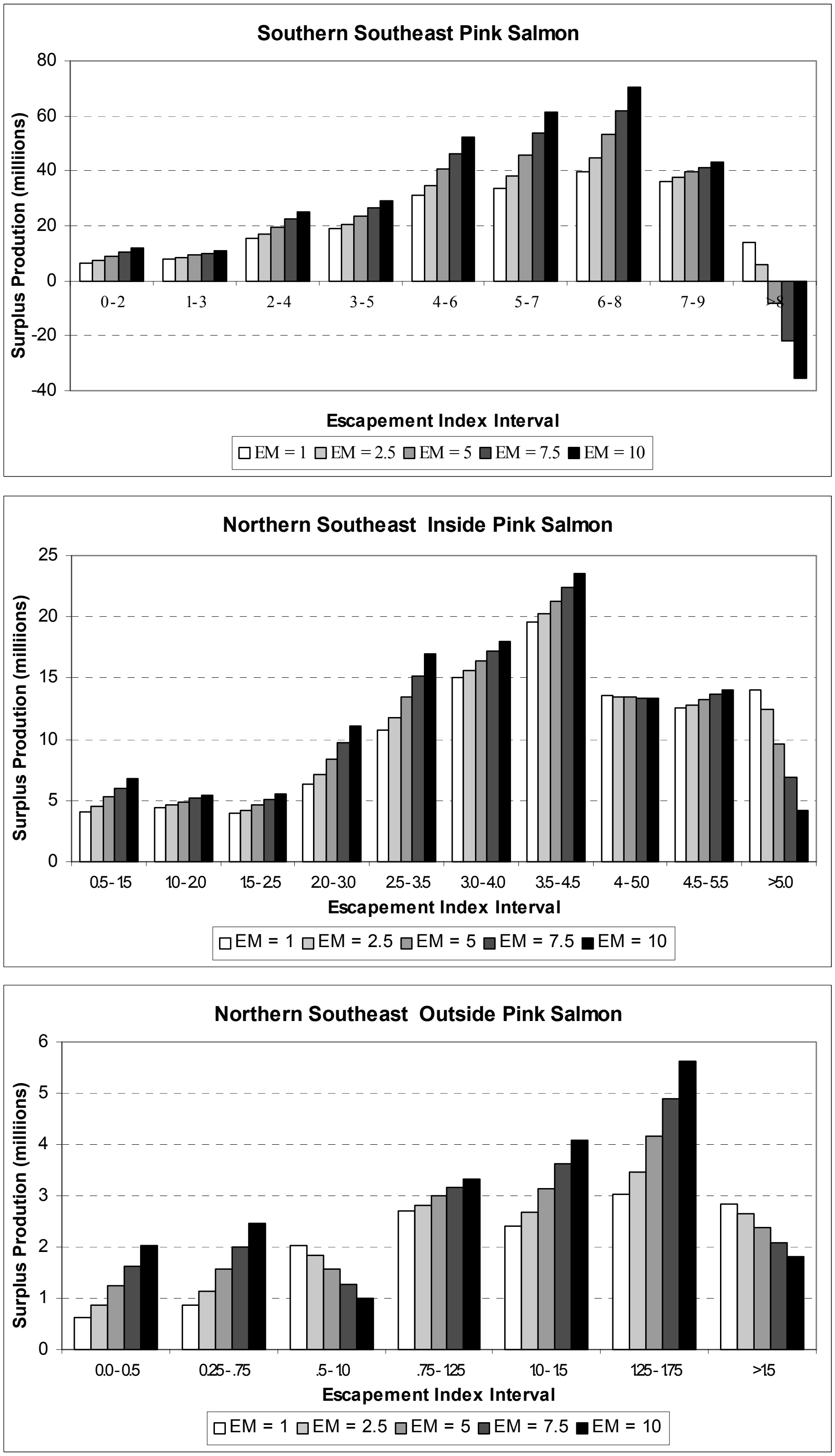

Figure 4.2. Surplus production (potential harvest) in 5 cases, as a function of index escapement, for the 3 sub-regions of Southeast Alaska. The "EM" denotes the level of expansion applied to the escapement index to approximate the total escapement.

Table 4.4. Management target ranges by district, in units of escapement index (the sum of the peak, bias-adjusted, aerial observations in streams in the index sample, in millions), for Southeast Alaska pink salmon.

District	Lower Target	Upper Target
101	1.33	3.00
102	0.40	1.10
103	1.13	2.55
104	No Escapement Target	
105	0.33	0.65
106	0.40	0.85
107	0.40	0.85
108	No Escapement Target	
SSE Total	4.00	9.00
109	0.40	0.85
110	0.65	1.45
111	0.32	0.73
112	0.40	0.85
113 Inside	0.40	0.90
114	0.32	0.73
115	No Escapement Target	
NSE Inside Total	2.50	5.50
113 Outside	0.75	1.75
NSE Outside Total	0.75	1.75
NSE Total	3.25	7.25
SE Total	7.25	16.25

We then reformatted the revised district-wide escapement targets, and we have now expressed them on the basis of the 45 stock groups (Table 4.5). These stock-group target ranges are more meaningful because they represent managed units of production. To reformat the district-specific escapement targets to stock group targets we calculated the 40-year median index escapement in each area that corresponds to a specific stock group. We then converted these medians to a percent of the district-total management target. The district's escapement target was then partitioned out to each stock group based on each stock group's percent of the total of the 40-year medians. Although these management targets represent a finer scale resolution of the district targets, when pooled together either on a district-wide basis or on a sub-regionwide basis they do not differ. Again, to be clear, we consider our recommended escapement goals by sub-region (the sub-district totals in Table 4.4) to be *biological escapement goals*, and we consider our recommended escapement targets, by district and by stock group (Tables 4 and 5), to be an aid to management in achieving these sub-region goals. In other words, we do not consider the district or stock-group management targets to be escapement goals, under the definition of the Statewide Salmon Escapement Goal Policy (5 AAC 39.223).

Table 4.5. Recommended pink salmon management targets for Southeast Alaska, by stock group, in relation to district and the sub-region *biological escapement goals*, with redistribution based on 1960 to 2001 median count for each group in units of escapement index (the sum of the peak aerial observations in streams in the index sample, in millions).

Sub-region	District	Stockgroup	Median[a] (60-01)	Percent of District[b]	Lower Target	Upper Target
SSE	101	Portland	197,995	12.4%	0.17	0.37
SSE	101	E Behm	1,003,782	62.9%	0.84	1.89
SSE	101	W Behm	394,896	24.7%	0.33	0.74
SSE	102	Moira	78,202	15.4%	0.06	0.17
SSE	102	Kasaan	427,988	84.6%	0.34	0.93
SSE	103	E Dall	190,985	14.3%	0.16	0.36
SSE	103	Hetta	356,054	26.7%	0.30	0.68
SSE	103	Klawock	614,668	46.0%	0.52	1.17
SSE	103	Sea Otter Sound	173,780	13.0%	0.15	0.33
SSE	105	Shipley Bay	72,269	41.2%	0.14	0.27
SSE	105	Affleck Canal	103,293	58.8%	0.20	0.38
SSE	106	Burnett	45,556	24.1%	0.10	0.20
SSE	106	Ratz Harbor	46,501	24.6%	0.10	0.21
SSE	106	Totem Bay	34,418	18.2%	0.07	0.15
SSE	106	Whale Pass	62,514	33.1%	0.13	0.28
SSE	107	Union Bay	61,063	19.7%	0.08	0.17
SSE	107	Anan	248,680	80.3%	0.32	0.68
SSE	108	Stikine	14,639		No Escapement Target	
NSEI	109	SE Baranof	46,050	12.5%	0.05	0.11
NSEI	109	E Baranof	60,995	16.5%	0.07	0.14
NSEI	109	Tebenkof	119,521	32.4%	0.13	0.27
NSEI	109	Saginaw Bay	66,570	18.0%	0.07	0.15
NSEI	109	Eliza Harbor	76,285	20.6%	0.08	0.18
NSEI	110	Portage Bay	16,329	5.6%	0.04	0.08
NSEI	110	Farragut Bay	5,661	2.0%	0.01	0.03
NSEI	110	Houghton	177,603	61.2%	0.40	0.89
NSEI	110	Pybus/Gambier	90,384	31.2%	0.20	0.45
NSEI	111	Seymour Canal	139,528	56.3%	0.18	0.41
NSEI	111	Stephens	108,201	43.7%	0.14	0.32
NSEI	112	SW Admiralty	113,635	19.8%	0.08	0.17
NSEI	112	W Admiralty	55,286	9.7%	0.04	0.08
NSEI	112	Tenakee	250,237	43.7%	0.18	0.37
NSEI	112	Freshwater Bay	87,700	15.3%	0.06	0.13
NSEI	112	Kelp Bay	37,446	6.5%	0.03	0.06
NSEI	112	Lynn Canal[c]	28,393	5.0%	0.02	0.04
NSEI	113	Hoonah Sound	216,374	100.0%	0.40	0.90
NSEO	113	Whale Bay	24,272	7.0%	0.05	0.12
NSEO	113	W Crawfish	6,909	2.0%	0.01	0.03
NSEO	113	Sitka Sound	98,759	28.5%	0.21	0.50
NSEO	113	Salisbury Sound	71,685	20.7%	0.16	0.36
NSEO	113	Slocum Arm	94,743	27.3%	0.21	0.48
NSEO	113	Portlock	15,781	4.6%	0.03	0.08
NSEO	113	Lisianski	34,329	9.9%	0.07	0.17
NSEI	114	Homeshore	22,709	14.2%	0.05	0.10
NSEI	114	N Chichagof	136,691	85.8%	0.28	0.62
NSEI	115	Lynn Canal[b]	28,637		No Escapement Target	

[a] The column labeled "Median (60-01)" provides the median escapement index value for years between 1960 and 2001.
[b] The column labeled "Percent of District" denotes the percent each stock group contributes to the sum of all stock group medians, for each specific district. Except for Hoonah Sound, which is the only NSEI stock group in District 113.
[c] Lynn Canal stock group consists of streams in both Districts 112 and 115. This table breaks them out by district but District 115 streams in the Lynn Canal stock group have no escapement goal.

STOCK STATUS

Pink salmon runs in Southeast Alaska appear to be at their highest level since harvest and escapement records of the runs began. Pink salmon production in the Yakutat area is much more limited but pink salmon runs and harvests in this area appear to be sustainable as well.

Stock Status of Pink Salmon in the Yakutat Area

Clark (1995) estimated both odd- and even-year escapement levels that he expected to produce *maximum sustainable yield* for the 2 principal pink salmon stocks in the Yakutat area. He concluded that escapements into the Situk River and into Humpy Creek were generally above the level needed for sustained yield. Specifically, he stated, "Review of the past escapement surveys for pink salmon in the Situk River and in Humpy Creek reveal that 52% of annual escapements have exceeded the escapement ranges predicted to provide 90% or more of *maximum sustainable yield* (29 of 56 cases)." Clark recommended an escapement through the Situk River weir of 66,000 in even-numbered years, and 90,000 in odd-numbered years (Table 2). Since the time of that recommendation, the pink salmon escapement during even-numbered years has been measured at 157,000, 97,000, 332,000, and 99,000, and during odd-numbered years measured at 466,000, 27,000, and 121,000 fish (Appendix 4.4). Clark also made recommendations for Humpy Creek, but because of very low exploitation, Humpy Creek escapement has not been consistently monitored since the mid-1990s. Due to the very low commercial fishing effort and generally non-directed nature of harvests in the Yakutat area, we have not examined trends in the Yakutat commercial fishery harvests. Based on the information we have about pink salmon escapement in the Yakutat area, it appears escapements have been far above levels needed to sustain these runs.

Stock Status of Pink Salmon in Southeast Alaska

Unlike the Yakutat area, large, regionwide fisheries target pink salmon in Southeast Alaska. We therefore provide analyses of harvest trends for this area, as well as trends in escapement.

Analysis of Escapement Trends in Southeast Alaska

For all of Southeast Alaska, 8 of the top 10 index escapements have occurred within the last 10 years (Figure 4.3). In over 100 years of commercial exploitation, the pink salmon harvests in Southeast Alaska are recently at the highest levels observed, yet the number of fish escaping the fishery to breed is also at very high levels—at the highest level since statehood, when records began.

A 1996 American Fisheries Society sponsored study of salmon stocks at risk found the size of breeding populations of both odd- and even-year lines of pink salmon to be increasing or stable in over 96% of the spawning aggregations they examined in Southeast Alaska (Baker et al. 1996). Van Alen (2000) examined escapement trends on the level of individual streams from 1960 to 1996. He also noted a general upward trend in pink salmon abundance, harvest, and escapement, and noted only one of the 652 streams he examined had a "significant downward trend," although he was referring to statistical, rather than biological, significance.

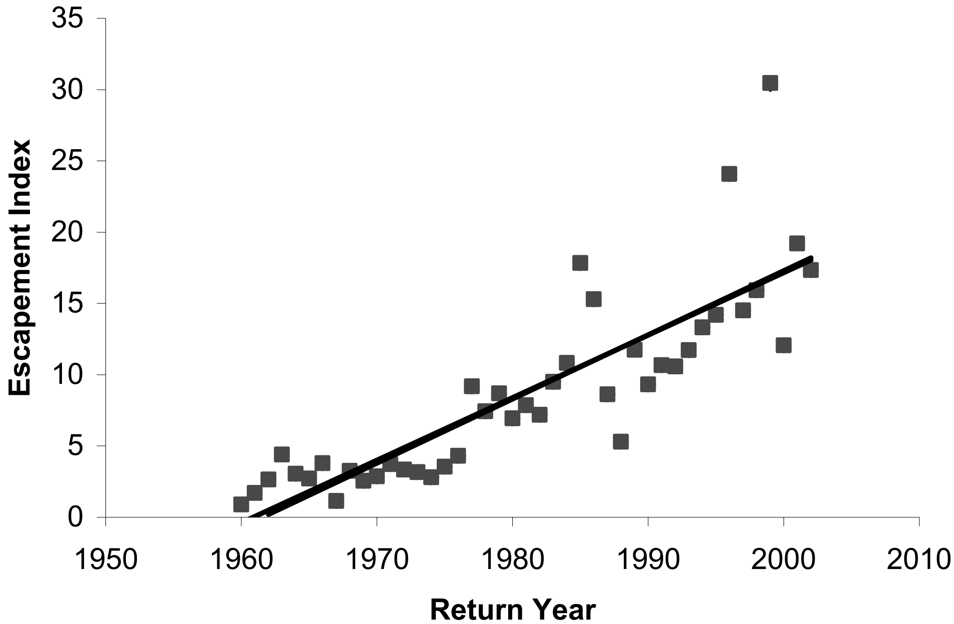

Figure 4.3. Overall index of pink salmon escapement for all of Southeast Alaska since statehood (*y* axis), plotted by return year (*x* axis). The index is not total spawning stock size; it is the sum of the observed peak abundance (in millions of fish), in a set of index streams that are observed over a series of years.

Although odd- and even-year lines of pink salmon are genetically isolated (Gharrett and Smoker 1990) and biologically separate populations, data from both lines were pooled for our analysis of escapement trends because they are managed as if they were a single population. Escapement goals in Southeast Alaska are the same for both brood lines, although the goals for the Yakutat area are specific for each line. Looking at the entire 42-year series for the Southeast Alaska systems, the escapement index shows a general upward trend in every case (Figures 4.4–4.7), when plotted on a stock group basis.

Since 1990, the escapement index has been larger than the lower end of the current escapement goal in approximately 75% of the available cases, when escapements are examined on a district-specific basis. The district escapement indices were greater than the midpoint of the target range approximately 60% of the time. In general, when escapement targets were not reached, they were missed by proportionately small amounts. The years 1991, 1992, and 2000 were the years with the most missed management targets, although all targets were met in 1999 and 2001. In 1999 and 2001, district-specific escapement indices were generally above the upper end of the management target range.

Geiger and Zhang (2002) recommend using 21 years of escapement index values for analysis of escapement trends for pink salmon when both brood lines are pooled. They note that marine environment changes on an inter-decadal scale, and they suggest 15 or 21 years provides some balance between sample size needs and a comparison of escapement under similar conditions. We combined both odd and even years into a 21-year series for this purpose. We then regressed escapement on time using a resistant regression line, based on medians. The back-cast estimate of what the escapement was in year zero of the series (22 years into the past) is a nonparametric escapement benchmark called the *year-zero reference point*. We would conclude that an escapement decline was biologically meaningful when the estimated underlying annual decline was more than 3% of the year-zero escapement, based on the recommendation of Geiger and Zhang. Using this method of reviewing escapement trends, 42 of the 45 stock groups showed an upward trend in annual escapement over the 21-year series, and no stocks showed a meaningful decline (Appendix 4.5–4.8). We were unable to estimate this reference point for 5 stocks because of a very steep, nonlinear, increase in escapement level over the 21-year series. Only 3 stocks indicated any decline in escapement at all; the largest estimated decline was less that 0.3% of the year-zero escapement. We consider this level of decline to be equivalent to stock stability.

Taken as a whole, the trend in the escapement index was increasing, with an estimated increase of nearly 7% of the underlying escapement level from the reference year (1980), over the entire 21-year series. If this index were accurately tracking total annual escapement, a sustained 7% increase over 21 years would equate to an underlying escapement level in the present of approximately 250% of the level of escapements 21 years ago. However, there is not a linear relationship between total escapement and the escapement index; small changes at low escapements produce relatively larger changes in the escapement index, and small changes at very high escapement levels produce proportionally very small increases in the index (Jones et al. 1998). In other words, current escapement levels, overall, are probably much higher than 250% of the escapement levels 21 years ago.

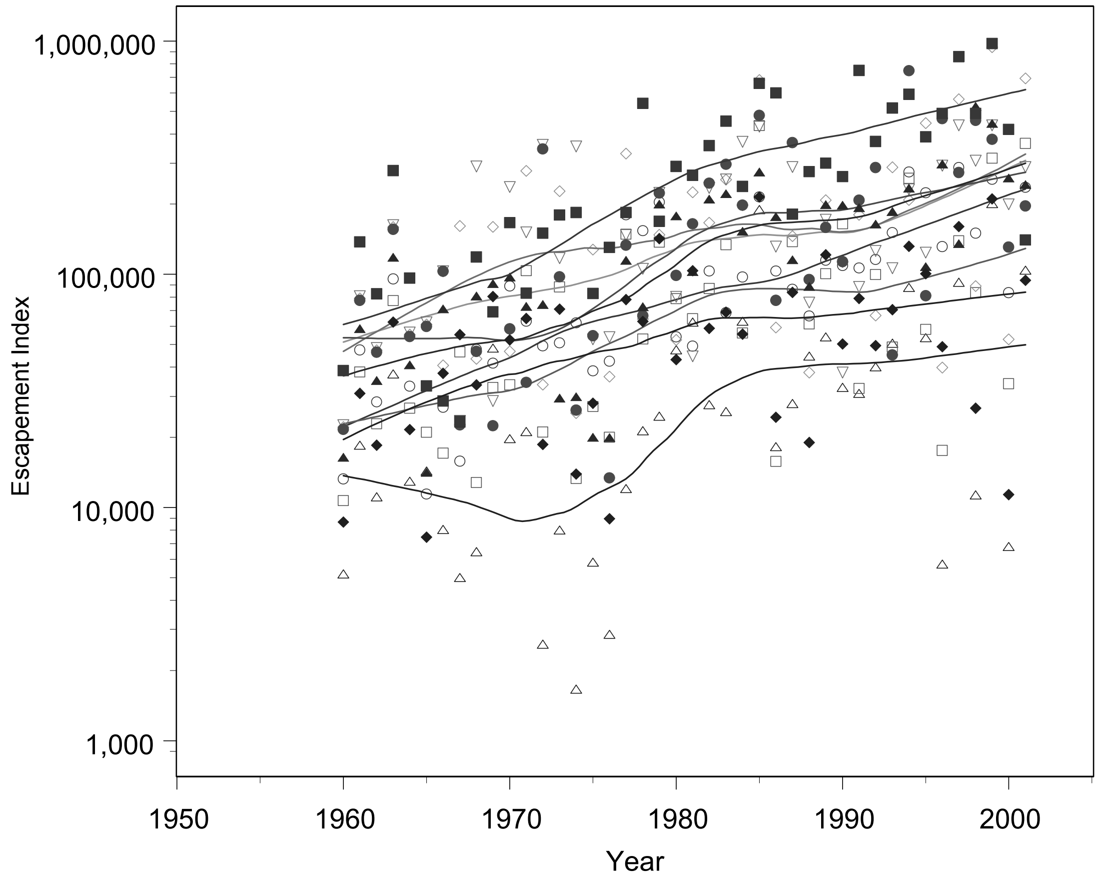

Figure 4.4. Pink salmon escapement indices for stock groups in the Juneau management area in northern Southeast Alaska. The *y*-axis is an escapement index, expressed on a logarithmic scale, based on first adjusting a series of observers to a standard level, choosing the largest count for the year, and then summing these "peak observations" across a series of standard index streams by stock group. The magnitude of the index is not the total escapement. The index gives the sum of the manager's visual impression of the number of fish present in the index streams, near the peak of spawning activity. The curves are a nonparametric loess smooth through the data. Only the Lynn Canal stock group (open boxes) did not show an upward trend over the most recent 21 years. The Freshwater Bay stock group (open diamonds) showed the largest increase in trend over the most recent 21 years. All stock groups show a general upward trend over the entire series.

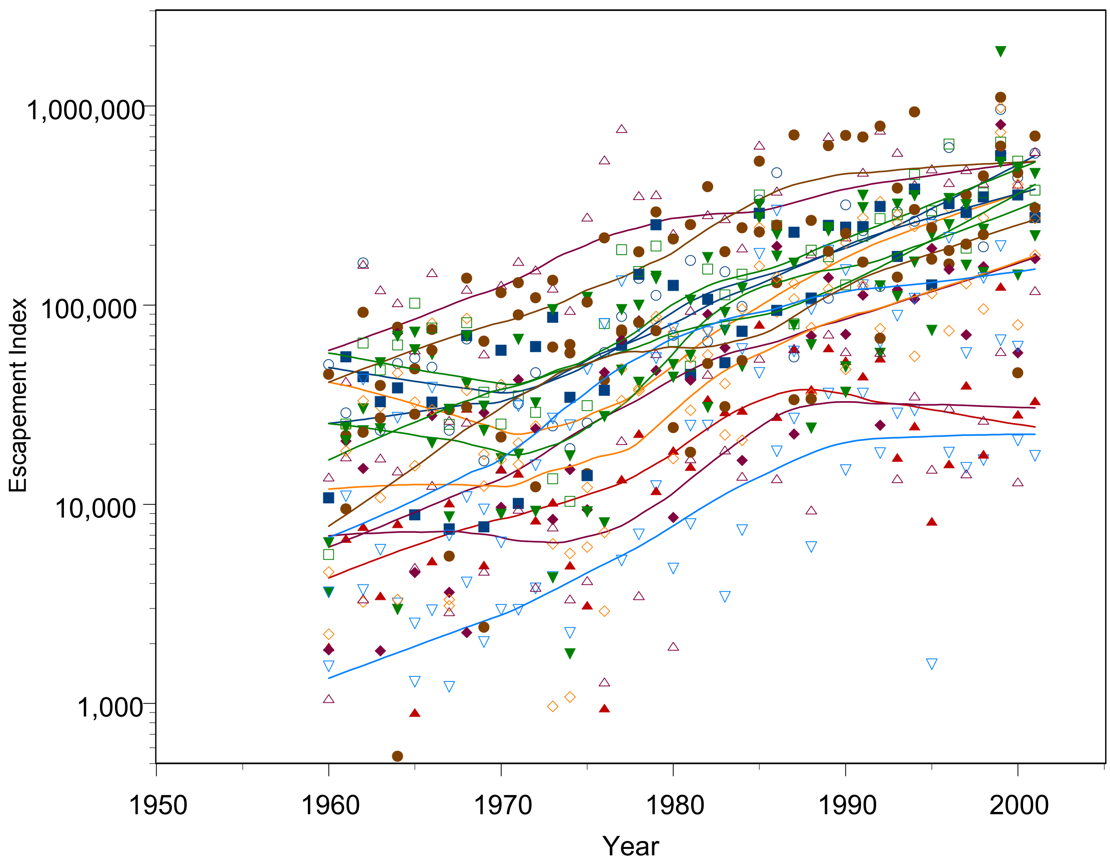

Figure 4.5. Pink salmon escapement indices for the stock groups in the Petersburg management area in northern and southern Southeast Alaska. The *y*-axis is an escapement index, expressed on a logarithmic scale, based on first adjusting a series of observers to a standard level, choosing the largest count for the year, and then summing these "peak observation," across a series of standard index streams by stock group. The magnitude of the index is not the total escapement. The index gives the sum of the manager's visual impression of the number of fish present in the index streams, near the peak of spawning activity. The curves are a nonparametric loess smooth through the data. Only the Farragut Bay (filled triangles) and Portage Bay (inverted open triangles) stock groups did not show an upward trend during the most recent 21-year period. All stock groups show a general upward trend over the entire series.

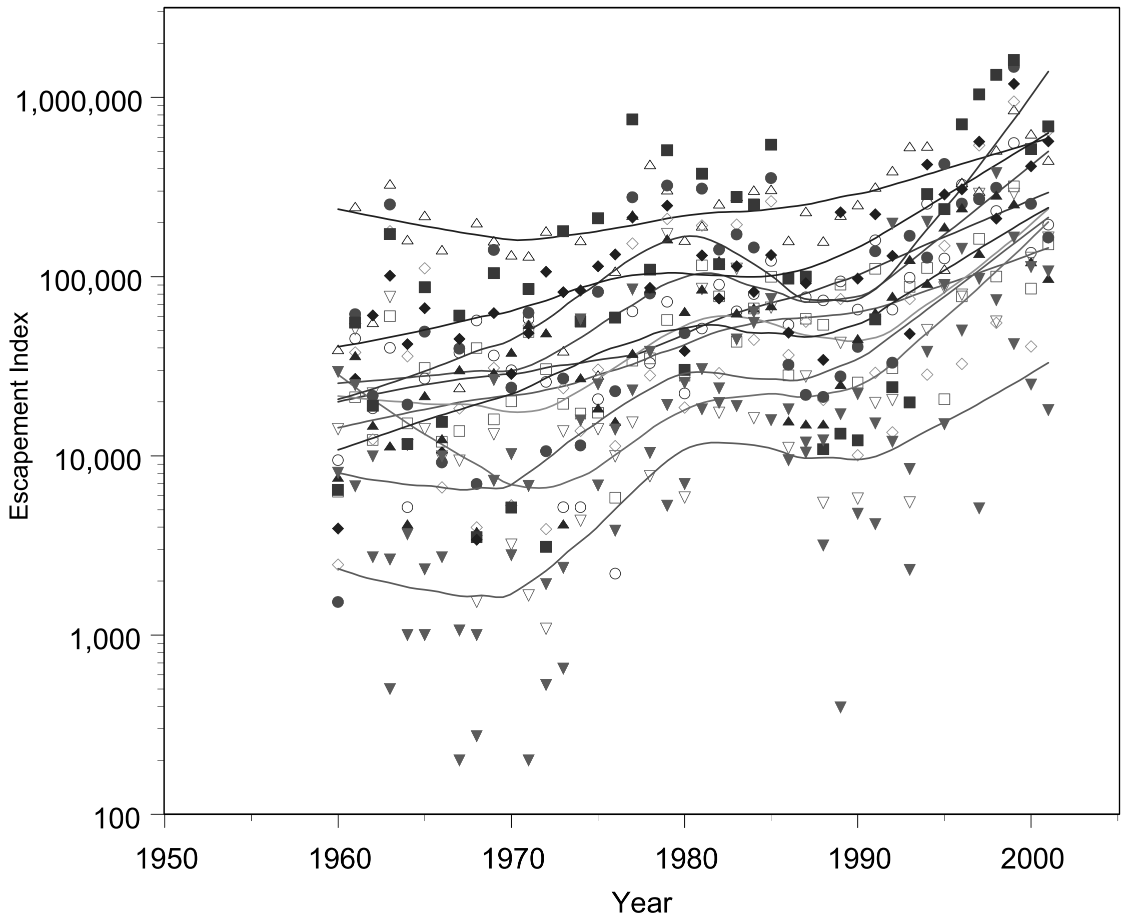

Figure 4.6. Pink salmon escapement indices for the stock groups in the Sitka management area in northern Southeast Alaska. The *y*-axis is an escapement index, expressed on a logarithmic scale, based on first adjusting a series of observers to a standard level, choosing the largest count for the year, and then summing these "peak observations" across a series of standard index streams by stock group. The magnitude of the index is not the total escapement. The index gives the sum of the manager's visual impression of the number of fish present in the index streams, near the peak of spawning activity. The curves are a nonparametric loess smooth through the data. All stock groups show a general upward trend over the most recent 21-year period and over the entire series.

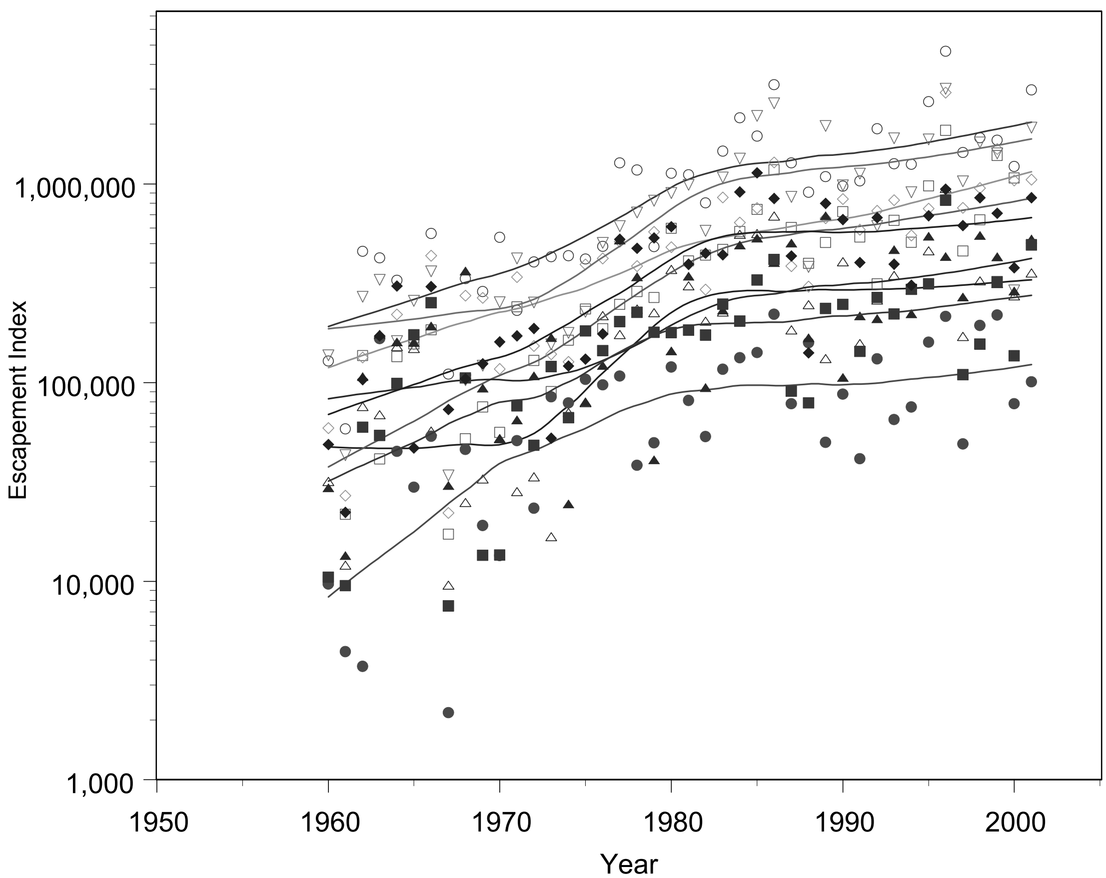

Figure 4.7. Pink salmon escapement indices for the stock groups in the Ketchikan management area in southern Southeast Alaska. The *y*-axis is an escapement index, expressed on a logarithmic scale, based on first adjusting a series of observers to a standard level, choosing the largest count for the year, and then summing these "peak observations" across a series of standard index streams by stock group. The magnitude of the index is not the total escapement. The index gives the sum of the manager's visual impression of the number of fish present in the index streams, near the peak of spawning activity. The curves are a nonparametric loess smooth through the data. All stock groups show an upward trend in both the most recent 21-year period and over the entire series.

Escapement History in Southeast Alaska Relative to *Biological Escapement Goals*

The escapement indices since 1990 are generally within or above the new *biological escapement goals* for each of the 3 sub-regions (Table 4.6), as are the management targets for most of the districts (Table 4.7), as are the management targets for most pink salmon stock groups in Southeast Alaska (Tables 4.8–4.11).

The Portage Bay stock group (Table 4.9) consists of 7 index streams, of which 4 are small and canopy covered making it difficult to enumerate. Many of the surveys for these systems are mouth-only counts. This poor in-stream visibility may be the primary cause of the high incidence of years below the recommended target range. Further analysis and more frequent surveys may bring this stock group back to within the management target range on most years.

During this new analysis we discovered a few stock groups that met the revised management target ranges less than half the time. These stock groups, located in the Cross Sound–Icy Straits area (N. Chichagof, and Homeshore), and the District 113 stock groups, located north of Kruzof Island (Lisianski, Portlock, Slocum Arm, and Salisbury Sound), have dominant odd-year cycles. The even-year cycle averages less than half the odd-year cycle for the past 23 years. Examination of the odd-year cycle shows that the escapement target ranges for these groups have been met quite often since 1980 (Table 4.12).

Hoonah Sound was the other stock group that met the revised target range less than half the time since 1980. The Hoonah Sound stock group is not dominated by odd-year cycles. However, this stock group has been within the target range more often since 1990.

Table 4.6. The count and percentage of the 1980 to 2002 pink salmon annual escapement indices, by sub-region of Southeast Alaska, that were below, within, or above the recommended *biological escapement goal* ranges, as well as the number of occurrences since 1990.

Sub-region	Recommended Biological Escapement Goal Index Range (millions)	Years when Escapement was below Recommended Target Range	Years when Escapement was within Recommended Target Range	Years when Escapement was above Recommended Target Range
SSE	4.0 to 9.0	2 of 23 years (9%) 0 since 1990	14 of 23 years (61%) 8 since 1990	7 of 23 years (30%) 5 since 1990
NSEI	2.5 to 5.5	4 of 23 years (17%) 0 since 1990	16 of 23 years (70%) 11 since 1990	3 of 23 years (13%) 2 since 1990
NSEO	0.75 to 1.75	11 of 23 years (48%) 4 since 1990	7 of 23 years (30%) 4 since 1990	5 of 23 years (22%) 5 since 1990

Table 4.7. The count and percentage of the 1980 to 2002 pink salmon annual escapement indices, by management district in Southeast Alaska, that were below, within, or above the recommended escapement target ranges, as well as the number of occurrences since 1990.

District	Recommended Escapement Target Range (millions)	Years When Escapement was below Recommended Target Range	Years when Escapement was within Recommended Target Range	Years when Escapement was above Recommended Target Range
101	1.34 to 3.00	1 of 23 years (4%) 0 since 1990	14 of 23 years (61%) 8 since 1990	8 of 23 years (35%) 5 since 1990
102	0.40 to 1.10	1 of 23 years (4%) 0 since 1990	15 of 23 years (66%) 7 since 1990	7 of 23 years (30%) 6 since 1990
103	1.13 to 2.55	1 of 23 years (4%) 0 since 1990	11 of 23 years (48%) 6 since 1990	11 of 23 years (48%) 7 since 1990
105	0.33 to 0.65	8 of 23 years (35%) 1 since 1990	10 of 23 years (43%) 8 since 1990	5 of 23 years (22%) 4 since 1990
106	0.40 to 0.85	9 of 23 years (39%) 2 since 1990	12 of 23 years (52%) 9 since 1990	2 of 23 years (9%) 2 since 1990
107	0.40 to 0.85	8 of 23 years (35%) 1 since 1990	13 of 23 years (57%) 11 since 1990	2 of 23 years (9%) 1 since 1990
109	0.40 to 0.85	3 of 23 years (13%) 0 since 1990	7 of 23 years (30%) 1 since 1990	13 of 23 years (57%) 12 since 1990
110	0.65 to 1.45	10 of 23 years (43%) 3 since 1990	12 of 23 years (52%) 9 since 1990	1 of 23 years (4%) 1 since 1990
111	0.32 to 0.73	8 of 23 years (35%) 4 since 1990	10 of 23 years (43%) 5 since 1990	5 of 23 years (22%) 4 since 1990
112	0.40 to 0.85	0 of 23 years (0%) 0 since 1990	8 of 23 years (35%) 2 since 1990	15 of 23 years (65%) 11 since 1990
113	1.15 to 2.65	11 of 23 years (48%) 4 since 1990	7 of 23 years (30%) 4 since 1990	5 of 23 years (22%) 3 since 1990
114 (Even Years)	0.32 to 0.73	12 of 12 years (100%) 7 since 1990	0 of 12 years (0%) 0 since 1990	0 of 12 years (0%) 0 since 1990
114 (Odd Years)	0.32 to 0.73	5 of 11 years (45%) 1 since 1990	3 of 11 years (27%) 3 since 1990	3 of 11 years (27%) 2 since 1990

Table 4.8. The count and percentage of the 1980 to 2002 pink salmon annual escapement indices, by stock group in the Ketchikan management area of Southeast Alaska that were below, within, or above the recommended escapement target ranges, as well as the number of occurrences since 1990.

Sub-Region	District	Stock Group	Recommended Escapement Target Range (millions)	Years when Escapement was below Recommended Target Range	Years when Escapement was within Recommended Target Range	Years when Escapement was above Recommended Target Range
SSE	101	Portland	0.17 to 0.37	3 of 23 years (13%) 1 since 1990	8 of 23 years (35%) 5 since 1990	12 of 23 years (52%) 7 since 1990
SSE	101	E Behm	0.84 to 1.89	1 of 23 years (4%) 0 since 1990	15 of 23 years (66%) 8 since 1990	7 of 23 years (30%) 5 since 1990
SSE	101	W Behm	0.33 to 0.74	2 of 23 years (9%) 1 since 1990	13 of 23 years (56%) 9 since 1990	8 of 23 years (35%) 3 since 1990
SSE	102	Moira	0.06 to 0.17	4 of 23 years (17%) 1 since 1990	15 of 23 years (66%) 8 since 1990	4 of 23 years (17%) 3 since 1990
SSE	102	Kasaan	0.34 to 0.93	2 of 23 years (9%) 0 since 1990	14 of 23 years (61%) 7 since 1990	7 of 23 years (30%) 6 since 1990
SSE	103	E Dall	0.16 to 0.36	2 of 23 years (9%) 1 since 1990	13 of 23 years (56%) 8 since 1990	8 of 23 years (35%) 4 since 1990
SSE	103	Hetta	0.30 to 0.68	0 of 23 years (0%) 0 since 1990	15 of 23 years (65%) 7 since 1990	8 of 23 years (35%) 6 since 1990
SSE	103	Klawock	0.52 to 1.17	2 of 23 years(9%) 1 since 1990	10 of 23 years (43%) 5 since 1990	11 of 23 years (48%) 7 since 1990
SSE	103	Sea Otter Sound	0.15 to 0.33	5 of 23 years (22%) 3 since 1990	15 of 23 years (65%) 8 since 1990	3 of 23 years (13%) 2 since 1990

Table 4.9. The count and percentage of the 1980 to 2002 pink salmon annual escapement indices, by stock group in the Petersburg management area of Southeast Alaska that were below, within, or above the recommended escapement target ranges, as well as the number of occurrences since 1990.

Sub-Region	District	Stock Group	Recommended Escapement Target Range (millions)	Years when Escapement was below Recommended Target Range	Years when Escapement was within Recommended Target Range	Years when Escapement was above Recommended Target Range
SSE	105	Shipley Bay	0.14 to 0.27	10 of 23 years (44%) 3 since 1990	7 of 23 years (30%) 5 since 1990	6 of 23 years (26%) 5 since 1990
SSE	105	Affleck Canal	0.20 to 0.38	10 of 23 years (44%) 1 since 1990	7 of 23 years (30%) 7 since 1990	6 of 23 years (26%) 5 since 1990
SSE	106	Burnett	0.10 to 0.20	11 of 23 years (48%) 3 since 1990	8 of 23 years (35%) 6 since 1990	4 of 23 years (17%) 4 since 1990
SSE	106	Ratz Harbor	0.10 to 0.21	11 of 23 years (48%) 4 since 1990	10 of 23 years (43%) 8 since 1990	2 of 23 years (9%) 1 since 1990
SSE	106	Totem Bay	0.07 to 0.15	8 of 23 years (35%) 2 since 1990	11 of 23 years (48%) 8 since 1990	4 of 23 years (17%) 3 since 1990
SSE	106	Whale Pass	0.13 to 0.28	10 of 23 years (43%) 3 since 1990	10 of 23 years (43%) 7 since 1990	3 of 23 years (13%) 3 since 1990
SSE	107	Union Bay	0.08 to 0.17	9 of 23 years (39%) 3 since 1990	7 of 23 years (30%) 6 since 1990	7 of 23 years (30%) 4 since 1990
SSE	107	Anan	0.32 to 0.68	8 of 23 years (35%) 1 since 1990	13 of 23 years (56%) 11 since 1990	2 of 23 years (9%) 1 since 1990
NSEI	109	Tebenkof	0.13 to 0.27	5 of 23 years (22%) 1 since 1990	7 of 23 years (30%) 3 since 1990	11 of 23 years (48%) 9 since 1990
NSEI	109	Saginaw Bay	0.07 to 0.15	4 of 23 years (17%) 1 since 1990	5 of 23 years (22%) 3 since 1990	14 of 23 years (61%) 9 since 1990
NSEI	109	Eliza Harbor	0.08 to 0.18	5 of 23 years (22%) 0 since 1990	8 of 23 years (35%) 3 since 1990	10 of 23 years (43%) 10 since 1990
NSEI	110	Portage Bay	0.04 to 0.08	16 of 23 years (70%) 8 since 1990	6 of 23 years (26%) 4 since 1990	1 of 23 years (4%) 1 since 1990
NSEI	110	Farragut Bay	0.01 to 0.03	6 of 23 years (26%) 1 since 1990	13 of 23 years (57%) 8 since 1990	4 of 23 years (17%) 4 since 1990
NSEI	110	Houghton	0.40 to 0.89	11 of 23 years (48%) 4 since 1990	10 of 23 years (43%) 7 since 1990	2 of 23 years (9%) 2 since 1990
NSEI	110	Pybus/ Gambier	0.20 to 0.45	9 of 23 years (39%) 2 since 1990	13 of 23 years (57%) 10 since 1990	1 of 23 years (4%) 1 since 1990

Table 4.10. The count and percentage of the 1980 to 2002 pink salmon annual escapement indices, by stock group in the Sitka management area of Southeast Alaska that were below, within, or above the recommended escapement target ranges, as well as the number of occurrences since 1990.

Sub-Region	District	Stock Group	Recommended Escapement Target Range (millions)	Years when Escapement was below Recommended Target Range	Years when Escapement was within Recommended Target Range	Years when Escapement was above Recommended Target Range
NSEI	109	SE Baranof	0.05 to 0.11	4 of 23 years (17%) 1 since 1990	11 of 23 years (48%) 5 since 1990	8 of 23 years (35%) 7 since 1990
NSEI	109	E Baranof	0.07 to 0.14	5 of 23 years (22%) 2 since 1990	10 of 23 years (43%) 3 since 1990	8 of 23 years (35%) 8 since 1990
NSEO	113	Whale Bay	0.05 to 0.12	11 of 23 years (48%) 3 since 1990	6 of 23 years (26%) 4 since 1990	6 of 23 years (26%) 6 since 1990
NSEO	113	W Crawfish	0.01 to 0.03	8 of 23 years (35%) 5 since 1990	9 of 23 years (39%) 3 since 1990	6 of 23 years (26%) 5 since 1990
NSEO	113	Sitka Sound	0.21 to 0.50	10 of 23 years (43%) 4 since 1990	5 of 23 years (22%) 2 since 1990	8 of 23 years (35%) 7 since 1990
NSEO	113	Salisbury Sound	0.16 to 0.36	11 of 23 years (48%) 4 since 1990	9 of 23 years (39%) 6 since 1990	3 of 23 years (13%) 3 since 1990
NSEI	113	Hoonah Sound	0.40 to 0.90	16 of 23 years (70%) 6 since 1990	7 of 23 years (30%) 7 since 1990	0 of 23 years (0%) 0 since 1990
NSEO	113	Slocum Arm	0.21 to 0.48	12 of 23 years (52%) 3 since 1990	8 of 23 years (35%) 7 since 1990	3 of 23 years (13%) 3 since 1990
NSEO	113	Portlock	0.03 to 0.08	11 of 23 years (48%) 4 since 1990	5 of 23 years (22%) 3 since 1990	7 of 23 years (30%) 6 since 1990
NSEO	113	Lisianski	0.07 to 0.17	13 of 23 years (92%) 7 since 1990	4 of 23 years (8%) 3 since 1990	6 of 23 years (0%) 3 since 1990

Table 4.11. The count and percentage of the 1980 to 2002 pink salmon annual escapement indices, by stock group in the Juneau management area of Southeast Alaska that were below, within, or above the recommended escapement target ranges, as well as the number of occurrences since 1990.

Sub-Region	District	Stock Group	Recommended Escapement Target Range (millions)	Years when Escapement was below Recommended Target Range	Years when Escapement was within Recommended Target Range	Years when Escapement was above Recommended Target Range
NSEI	111	Seymour Canal	0.18 to 0.41	10 of 23 years (43%) 5 since 1990	10 of 23 years (43%) 6 since 1990	3 of 23 years (13%) 2 since 1990
NSEI	111	Stephens	0.14 to 0.32	7 of 23 years (30%) 4 since 1990	10 of 23 years (44%) 5 since 1990	6 of 23 years (26%) 4 since 1990
NSEI	112	SW Admiralty	0.08 to 0.17	0 of 23 years (0%) 0 since 1990	7 of 23 years (30%) 3 since 1990	16 of 23 years (70%) 10 since 1990
NSEI	112	W Admiralty	0.04 to 0.08	5 of 23 years (22%) 3 since 1990	9 of 23 years (39%) 5 since 1990	9 of 23 years (39%) 5 since 1990
NSEI	112	Tenakee	0.18 to 0.37	1 of 23 years (4%) 1 since 1990	8 of 23 years (35%) 1 since 1990	14 of 23 years (61%) 11 since 1990
NSEI	112	Freshwater Bay	0.06 to 0.13	2 of 23 years (9%) 0 since 1990	11 of 23 years (48%) 4 since 1990	10 of 23 years (43%) 9 since 1990
NSEI	112	Kelp Bay	0.03 to 0.06	4 of 23 years (17%) 2 since 1990	4 of 23 years (17%) 1 since 1990	15 of 23 years (66%) 10 since 1990
NSEI	112	Lynn Canal	0.02 to 0.04	2 of 23 years (9%) 1 since 1990	2 of 23 years (9%) 2 since 1990	19 of 23 years (82%) 10 since 1990
NSEI	114	Homeshore	0.05 to 0.10	14 of 23 years (61%) 8 since 1990	6 of 23 years (26%) 3 since 1990	3 of 23 years (13%) 2 since 1990
NSEI	114	N Chichagof	0.28 to 0.62	17 of 23 years (74%) 8 since 1990	3 of 23 years (13%) 3 since 1990	3 of 23 years (13%) 2 since 1990

Table 4.12. The count and percentage of the 1980 to 2002 pink salmon annual escapement indices, for Cross Sound–Icy Strait and the northern District 113 stock groups, by distinct even- and odd-years that were below, within, or above the recommended escapement target ranges, as well as the number of occurrences since 1990.

Sub-Region	District	Stock Group	Recommended Escapement Target Range (millions)	Years when Escapement was below Recommended Target Range	Years when Escapement was within Recommended Target Range	Years when Escapement was above Recommended Target Range
NSEO	113	Lisianski (Even Years)	0.07 to 0.17	11 of 12 years (92%) 6 since 1990	1 of 12 years (8%) 1 since 1990	0 of 12 years (0%) 0 since 1990
NSEO	113	Lisianski (Odd Years)	0.07 to 0.17	2 of 11 years (18%) 1 since 1990	3 of 11 years (27%) 2 since 1990	6 of 11 years (55%) 3 since 1990
NSEO	113	Portlock (Even Years)	0.03 to 0.08	7 of 12 years (58%) 2 since 1990	3 of 12 years (25%) 3 since 1990	2 of 12 years (17%) 2 since 1990
NSEO	113	Portlock (Odd Years)	0.03 to 0.08	3 of 11 years (27%) 2 since 1990	2 of 11 years (17%) 0 since 1990	6 of 11 years (55%) 4 since 1990
NSEO	113	Slocum Arm (Even Years)	0.21 to 0.48	7 of 12 years (58%) 2 since 1990	5 of 12 years (42%) 5 since 1990	0 of 12 years (0%) 0 since 1990
NSEO	113	Slocum Arm (Odd Years)	0.21 to 0.48	5 of 11 years (45%) 1 since 1990	3 of 11 years (27%) 2 since 1990	3 of 11 years (27%) 3 since 1990
NSEO	113	Salisbury Sound (Even Years)	0.16 to 0.36	8 of 12 years (67%) 3 since 1990	3 of 12 years (25%) 3 since 1990	1 of 12 years (8%) 1 since 1990
NSEI	113	Salisbury Sound (Odd Years)	0.16 to 0.36	3 of 11 years (27%) 1 since 1990	6 of 11 years (55%) 3 since 1990	2 of 11 years (18%) 2 since 1990
NSEI	114	Homeshore (Even Years)	0.05 to 0.10	10 of 12 years (83%) 6 since 1990	2 of 12 years (17%) 1 since 1990	0 of 12 years (0%) 0 since 1990
NSEI	114	Homeshore (Odd Years)	0.05 to 0.11	4 of 11 years (36%) 2 since 1990	4 of 11 years (36%) 2 since 1990	3 of 11 years (28%) 2 since 1990
NSEI	114	N Chichagof (Even Years)	0.28 to 0.62	12 of 12 years (100%) 7 since 1990	0 of 12 years (0%) 0 since 1990	0 of 12 years (0%) 0 since 1990
NSEI	114	N Chichagof (Odd Years)	0.28 to 0.62	5 of 11 years (46%) 1 since 1990	3 of 11 years (27%) 3 since 1990	3 of 11 years (27%) 2 since 1990

Harvest Trends in Southeast Alaska

Harvests in southern Southeast Alaska and northern Southeast Alaska increased dramatically beginning in the 1980s.

Alexandersdottir (1987) describes the pink salmon populations in southern Southeast Alaska as more stable and capable of sustaining higher harvest rates than those in northern Southeast Alaska. The average harvest in both sub-regions has increased since the time of her analysis, although the harvest in southern Southeast Alaska has increased further, and has supported a more stable harvest (Figure 4.8; Appendix 4.1). Overall, 5 of the top 10 harvest levels in the 109-year harvest history have occurred in the last 10 years, including the highest harvest of 78 million fish in 1999, and the second highest harvest of 67 million in 2001. Currently, commercial pink salmon harvests in both SSE and NSE are at their highest levels in the historical series. Many harvests during the past 10 years could have been higher—as indicated by the high escapements. However, processor capacity, not stock abundance, has now become the limit on high harvests.

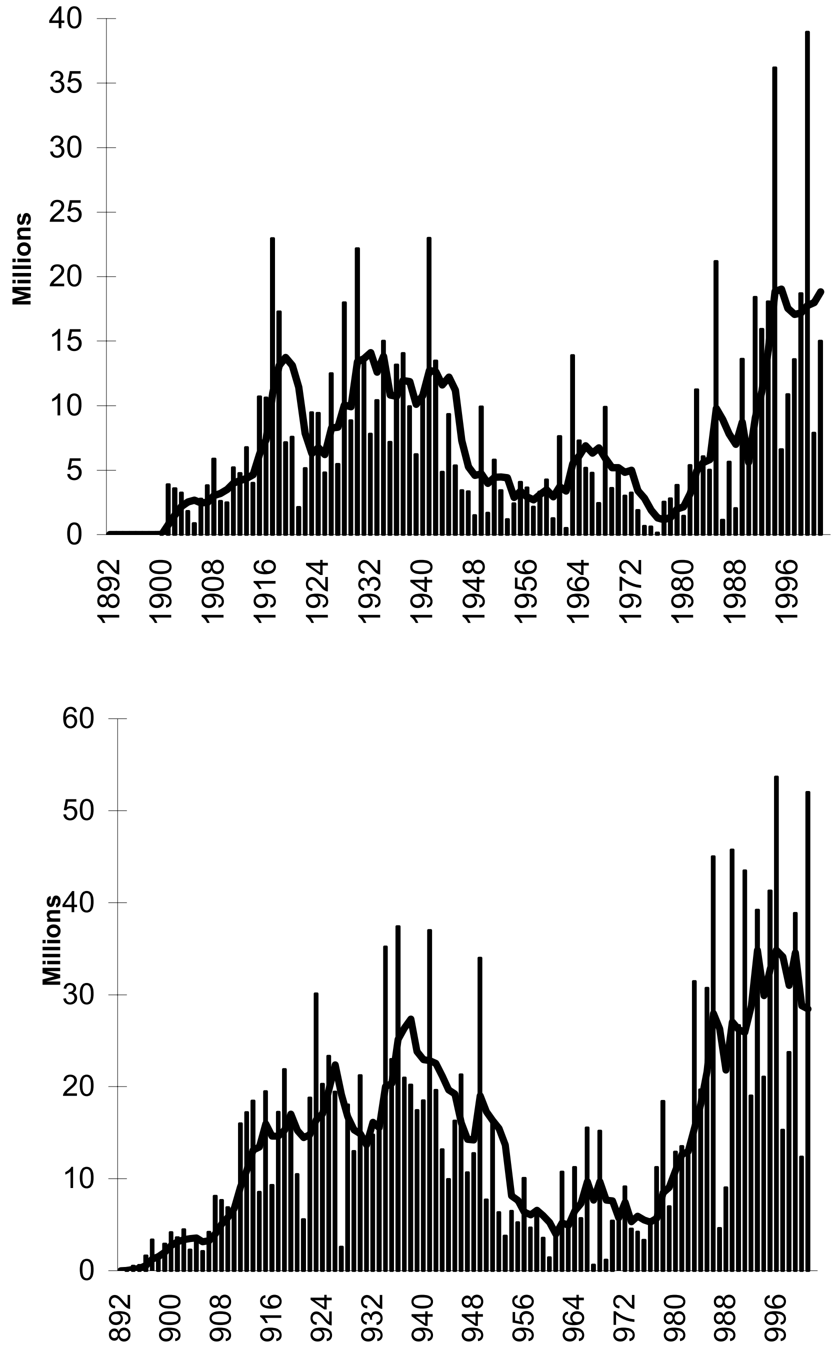

Figure 4.8. Annual commercial harvest of pink salmon in northern Southeast (top) and southern Southeast (bottom) Alaska from 1892 to 2001 with the 5-year running average (bold line through peaks).

DISCUSSION

The status of pink salmon in Southeast Alaska and Yakutat is biologically very favorable—especially in Southeast Alaska. No pink salmon stocks in either area are considered *stocks of concern* under the definition of the Sustainable Salmon Policy (5 AAC 39.222). Escapement indices in Southeast Alaska are at their all-time highest levels; recent harvests have usually been among the larger harvests in the historical record, with the all-time record in 1999. Undoubtedly, favorable environmental conditions deserve part of the credit for improved returns (Quinn and Marshall 1989; Beamish and Bouillon 1993; Mantua et al. 1997, and many others). However, it appears that pink salmon managers have made good use of these conditions by allowing improved and well-distributed escapements throughout the region. The recent sustained yields of pink salmon were unimagined in the 1960s and early 1970s.

Our measures of escapement are imperfect, but we believe they are fully adequate to assess the health of this resource. Considering the difficulty measuring such dispersed salmon production, substantial improvements to the monitoring program would only lead to modest improvements in the quality of the stock assessment information—which is not true for other species of salmon in Southeast Alaska. The consistency of all of our indicators gives us confidence in our assessment of pink salmon. This is especially true of the consistency in the increase in harvest.

As we mentioned several times already, the *biological escapement goals* discussed in this paper are recommended at the sub-region level. We have not found a defendable way to establish escapement goals at the district or stock group level, based on the existing information. Again, the management targets we provided are intended as an aid to managers, and as an aid to the Board of Fisheries and the public in judging whether or not escapements are well distributed within Southeast Alaska. These targets will be carefully reviewed prior to the next Board of Fisheries meeting in 2006. We will continue to evaluate and report on pink salmon escapement at the sub-region, district, and stock group scales, but in evaluating our charges under the Sustainable Salmon Fisheries Policy for the next Board of Fisheries meeting, escapement performance will be formally judged in relation to the index-based escapement goals on the sub-region level.

We will continue to improve the escapement estimation process, and try to better understand the relationship between the current escapement index and total escapement in the region. ADF&G received funding from the Southeast Sustainable Salmon Fund, starting in 2002, to increase the aerial survey coverage of the region. In addition, there are ongoing research programs to assess individual observer counting rates, their relationship to other observers, and the relationship of adjusted peak counts to the total spawning population for individual streams.

We may wish to update the *biological escapement goals* in the future, although given the limits of the data, the apparent changes and improvements in ocean environment, and the practical constraints on salmon management, we doubt that we can improve yield by further statistical analysis of the stock assessment record for these pink salmon.

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APPENDIX

Appendix 4.1. Commercial harvests[a] of pink salmon in Southeast Alaska and Yakutat by sub-region from 1892 to 2002.

Year	SSE Harvest	NSE Harvest	Yakutat Harvest	Total Harvest	Year	SSE Harvest	NSE Inside Harvest	NSE Outside Harvest	Yakutat Harvest	Total Harvest	Year	SSE Harvest	NSE Inside Harvest	NSE Outside Harvest	Yakutat Harvest	Total Harvest	Hatchery Contributio[b]
1892	0.01			0.01	1929	13.00	8.85			21.85	1966	15.56	4.76	0.02		20.35	
1893	0.19			0.19	1930	21.23	22.18		0.07	43.48	1967	0.64	2.32	0.11	0.03	3.11	
1894	0.53			0.53	1931	13.57	13.68			27.24	1968	15.19	9.84	0.04		25.08	
1895	0.61			0.61	1932	14.78	7.82			22.61	1969	1.20	3.49	0.12	0.06	4.87	
1896	1.63			1.63	1933	15.24	10.42		0.12	25.78	1970	5.41	5.18	0.06		10.65	
1897	3.37			3.37	1934	35.20	15.02		0.11	50.33	1971	6.25	2.93	0.09	0.08	9.34	
1898	1.56			1.56	1935	22.98	7.18		0.09	30.25	1972	9.15	3.20	0.04		12.40	
1899	2.91			2.91	1936	37.43	13.15		0.17	50.75	1973	4.56	1.63	0.25	0.02	6.46	
1900	4.18	0.14		4.32	1937	20.99	14.05		0.13	35.17	1974	4.22	0.61	0.05		4.88	
1901	3.64	3.89		7.53	1938	20.21	9.95		0.13	30.29	1975	3.33	0.05	0.56	0.08	4.03	
1902	4.49	3.58	0.04	8.10	1939	17.45	6.23		0.04	23.72	1976	5.16	0.05	0.10	0.03	5.33	
1903	2.28	3.25		5.53	1940	18.49	10.49		0.11	29.09	1977	11.24	0.35	2.18	0.08	13.84	0.09
1904	3.25	1.82	0.11	5.18	1941	37.02	22.98		0.07	60.06	1978	18.42	2.65	0.13	0.04	21.24	
1905	2.13	0.89	0.05	3.06	1942	19.61	13.46		0.06	33.13	1979	6.99	2.12	1.72	0.15	10.98	0.06
1906	4.21	2.77	0.06	7.04	1943	13.17	4.84		0.03	18.04	1980	12.92	1.36	0.07	0.14	14.50	0.01
1907	8.11	3.81	0.05	11.97	1944	9.95	9.33		0.06	19.34	1981	13.53	2.69	2.68	0.14	19.04	0.15
1908	7.66	5.88	0.05	13.59	1945	16.29	5.34		0.02	21.65	1982	12.96	10.77	0.47	0.01	24.21	0.02
1909	6.88	2.60	0.05	9.53	1946	21.32	3.44		0.06	24.82	1983	31.45	3.52	2.54	0.03	37.53	0.17
1910	6.91	2.47	0.04	9.42	1947	10.68	3.34		0.02	14.04	1984	19.68	3.78	1.23	0.02	24.70	0.25
1911	16.01	5.22	0.18	21.41	1948	12.77	1.48		0.10	14.35	1985	30.71	15.60	5.58	0.07	51.95	0.91
1912	17.23	4.75	0.03	22.01	1949	33.98	9.92		0.02	43.92	1986	45.02	0.93	0.21	0.01	46.17	0.45
1913	18.49	6.76	0.05	25.30	1950	7.74	1.69			9.42	1987	4.63	5.21	0.41	0.02	10.28	1.46
1914	8.57	3.99	0.01	12.57	1951	16.39	5.79		0.04	22.22	1988	9.05	1.97	0.06	0.13	11.21	0.23
1915	19.50	10.69	0.16	30.35	1952	6.33	3.43		0.04	9.80	1989	45.76	12.74	0.87	0.09	59.46	1.13
1916	9.30	10.60	0.04	19.94	1953	3.80	1.17		0.01	4.98	1990	26.68	5.44	0.16	0.05	32.34	1.42
1917	17.27	22.97	0.09	40.33	1954	6.46	2.41		0.04	8.91	1991	43.50	18.05	0.37	0.01	61.92	2.20
1918	21.91	17.27	0.12	39.29	1955	5.25	4.06		0.03	9.33	1992	19.01	15.53	0.40	0.03	34.96	3.42
1919	17.16	7.15	0.02	24.33	1956	10.08	3.63		0.02	13.73	1993	39.22	17.02	1.04	0.01	57.30	0.96
1920	10.49	7.58	0.04	18.12	1957	4.68	2.16		0.02	6.86	1994	21.06	35.21	0.99	0.01	57.27	5.49
1921	5.57	2.13	0.03	7.73	1958	6.46	3.32		0.06	9.84	1995	41.32	4.85	1.75	0.06	47.96	2.02
1922	18.79	5.14	0.07	24.00	1959	3.57	4.27		0.01	7.85	1996	53.67	9.01	1.86	0.03	64.57	2.34
1923	30.11	9.48	0.29	39.88	1960	1.44	1.26		0.01	2.71	1997	15.30	10.83	2.75	0.09	28.98	2.48
1924	20.30	9.42	0.31	30.03	1961	3.77	7.62		0.06	11.46	1998	23.75	12.86	5.84	0.09	42.54	2.24
1925	23.34	4.80	0.10	28.25	1962	10.74	0.43	0.06	0.03	11.26	1999	38.86	36.35	2.61	0.03	77.85	4.09
1926	19.45	12.50	0.25	32.19	1963	5.14	12.61	1.29	0.08	19.12	2000	12.38	5.32	2.56	0.06	20.31	0.44
1927	2.58	5.48	0.10	8.16	1964	11.26	7.21	0.07	0.04	18.58	2001	52.01	13.01	1.99	0.03	67.05	2.35
1928	18.06	17.99		36.05	1965	5.71	4.56	0.61		10.87	2002	23.32	18.99	3.01	0.02	45.33	N/A

[a] Unallocated harvests found in Byerly et al. (1999) were proportionally allocated to the 2 sub-regions based on known harvest each year. NSE Outside harvests were not discernable from NSE Inside harvests until after statehood, starting in 1962. Offshore harvests in Districts 150 and 152 are assigned to SSE, Districts 154–157 are assigned to NSE outside, and Districts 182–192 are assigned to Yakutat.

[b] Hatchery contributions are included in the total harvest; numbers were retrieved from ADF&G, Alaska Fisheries Enhancement Program Annual Reports.

Appendix 4.2. A summary of the Hilborn and Walters "tabular approach" for pink salmon in 3 sub-regions of Southeast Alaska. Spawner Intervals are non-exclusive categories of observed escapement. *N* denotes the number of observation in each category; because the categories not exclusive, the sum of *N* is more that the total number of observations. The mean of recruits and harvest is the average over several assumed ratios of the index escapement to total escapement.

Southern Southeast Alaska Pink Salmon Stocks

Spawner Interval	N	Mean Escapement	Mean Recruits	Mean Yield	Range of Yield	
0–2	12	1.32	7.65	6.33	-0.48	12.01
1–3	13	1.84	9.70	7.86	-0.48	16.36
2–4	7	2.86	18.22	15.36	4.10	29.56
3–5	7	4.18	23.08	18.89	7.73	32.56
4–6	9	5.25	36.34	31.09	11.71	65.61
5–7	10	5.89	39.29	33.40	11.71	65.61
6–8	9	6.74	46.30	39.56	19.12	65.61
7–9	4	7.97	44.30	36.33	9.97	50.25
> 8	6	12.43	26.44	14.01	–0.77	48.97

Northern Southeast Alaska Inside Pink Salmon Stocks

Spawner Interval	N	Mean Escapement	Mean Recruits	Mean Yield	Range of Yield	
0–2	19	1.05	13.67	5.81	–4.41	20.07
1–3	19	1.95	22.56	7.91	–4.41	39.29
2–4	14	2.84	34.77	13.44	–5.21	53.52
3–5	9	3.90	44.72	15.48	–5.21	53.52
4–6	6	4.86	54.34	17.93	–14.89	68.86
5–7	3	5.74	60.02	17.00	–14.89	68.86
>6	2	8.03	47.09	-13.14	–23.32	-2.96

Northern Southeast Alaska Inside Pink Salmon Stocks

Spawner Interval	N	Mean Escapement	Mean Recruits	Mean Yield	Range of Yield	
0.0–0.5	27	0.25	0.88	0.62	–0.12	3.21
0.25–.75	16	0.37	1.25	0.88	–0.20	3.21
.5–1.0	3	0.79	2.81	2.02	–0.20	6.10
.75–1.25	4	1.00	3.72	2.71	0.15	6.10
1.0–1.5	6	1.34	3.73	2.39	–0.72	4.27
1.25–1.75	6	1.47	4.49	3.02	–0.72	6.69
>1.5	5	2.81	5.64	2.83	–1.37	6.69

Appendix 4.3. Calculated potential yield for Southeast Alaska pink salmon, based on the "tabular approach" of Hilborn and Walters. Table entries show yield under 5 cases, which represent assumed ratios of index escapement to total escapement (the EM levels). The spawner intervals represent non-mutually exclusive categories of observed index escapement. Yield is based on 1960 to 2000 brood year catch and escapement index observations.

Southern Southeast Alaska Pink Salmon Stocks

Spawner Interval	Mean Yield EM = 1	EM = 2.5	EM = 5	EM = 7.5	EM = 10
0–2	6.33	7.31	8.93	10.55	12.17
1–3	7.86	8.38	9.25	10.12	10.98
2–4	15.36	16.99	19.71	22.43	25.15
3–5	18.89	20.61	23.48	26.35	29.22
4–6	31.09	34.61	40.49	46.37	52.25
5–7	33.40	38.05	45.80	53.55	61.30
6–8	39.56	44.73	53.35	61.97	70.59
7–9	36.33	37.50	39.44	41.38	43.32
> 8	14.01	5.74	-8.04	–21.82	–35.60

Northern Southeast Alaska Inside Pink Salmon Stocks

Spawner Interval	Mean Yield EM = 1	EM = 2.5	EM = 5	EM = 7.5	EM = 10
0–2	4.26	4.62	5.22	5.81	6.41
1–3	5.58	6.12	7.02	7.91	8.80
2–4	9.79	10.63	12.04	13.44	14.85
3–5	14.39	14.64	15.06	15.48	15.90
4–6	15.77	16.26	17.10	17.93	18.76
5–7	15.99	16.23	16.61	17.00	17.39
>6	7.81	2.97	–5.08	–13.14	–21.20

Northern Southeast Alaska Outside Pink Salmon Stocks

Spawner Interval	Mean Yield EM = 1	EM = 2.5	EM = 5	EM = 7.5	EM = 10
0.0–0.5	0.62	0.85	1.24	1.63	2.01
0.25–.75	0.88	1.14	1.57	2.01	2.45
.5–1.0	2.02	1.85	1.57	1.28	1.00
.75–1.25	2.71	2.82	2.99	3.16	3.33
1.0–1.5	2.40	2.68	3.14	3.61	4.08
1.25–1.75	3.02	3.46	4.17	4.89	5.61
>1.5	2.83	2.66	2.38	2.09	1.81

Appendix 4.4. Pink salmon escapement indices for Yakutat area streams from 1961 to 2002.

	Situk River			Humpy Creek[d]		
Year[a]	Count	Type	Estimated Total Escapement[b,c]	Count	Type	Estimated Total Escapement
1961	30,000	Aerial	90,000	25,000	Foot	75,000
1962	70,000	Aerial	210,000	23,000	Foot	69,000
1963	192,359	Extrapolated	192,359	63,278	Extrapolated	63,278
1964	70,000	Aerial	210,000	11,000	Foot	33,000
1965	30,000	Aerial	90,000	3,000	Foot	3,000
1966	5,000	Aerial	15,000	n/a	Extrapolated	28,186
1967	80,000	Aerial	240,000	63,278	Extrapolated	63,278
1968	n/a	Extrapolated	156,735	n/a	Extrapolated	28,186
1969	11,500	Aerial	34,500	29,169	Foot	29,169
1970	n/a	Extrapolated	156,735	n/a	Extrapolated	28,186
1971	27,184	Weir	27,184	63,278	Foot	63,278
1972	10,000	Boat	30,000	1,630	Foot	4,890
1973	80,000	Boat	240,000	3,969	Foot	3,969
1974	20,000	Boat	60,000	2,000	Foot	6,000
1975	44,600	Boat	133,800	39,000	Foot	39,000
1976	38,081	Weir	38,081	4,672	Foot	14,016
1977	177,712	Weir	177,712	36,000	Foot	36,000
1978	120,000	Boat	360,000	5,000	Foot	15,000
1979	450,000	Weir	450,000	45,000	Foot	45,000
1980	250,000	Weir	250,000	10,000	Foot	30,000
1981	300,000	Weir	300,000	210,000	Foot	210,000
1982	40,300	Weir	40,300	8,700	Foot	26,100
1983	183,577	Weir	183,577	90,000	Foot	90,000
1984	113,161	Weir	113,161	16,000	Foot	48,000
1985	366,000	Weir	366,000	225,000	Foot	225,000
1986	85,000	Boat	85,000	10,233	Foot	30,699
1987	24,000	Boat	72,000	6,000	Aerial	6,000
1988	78,753	Weir	78,753	10,000	Aerial	30,000
1989	288,246	Weir	288,246	60,600	Foot	60,600
1990	175,000	Boat	175,000	13,800	Foot	41,400
1991	n/a	Extrapolated	192,359	24,150	Foot	24,150
1992	3,000	Boat	9,000	4,500	Foot	13,500
1993	n/a	Extrapolated	192,359	39,000	Aerial	39,000
1994	n/a	Extrapolated	156,735	11,000	Aerial	33,000
1995	66,273	Weir	66,273	n/a	Aerial	3,800
1996	157,012	Weir	157,012	n/a	Aerial	8,500
1997	466,267	Weir	466,267	n/a		
1998	97,392	Weir	97,392	n/a		
1999	27,386	Weir	27,386	n/a		
2000	331,510	Weir	331,510	n/a		
2001	121,267	Weir	121,267	n/a		
2002	98,790	Weir	98,790	n/a		

[a] Data for 1961 through 1994 is from Clark (1995). Data for remaining years is from IFDB.
[b] Aerial and foot surveys were expanded by 3.0 to estimate total escapement, as per Clark (1995).
[c] Years where survey type method is "extrapolated," total escapements are derived by Clark (1995).
[d] Data not collected for Humpy Creek in systematic manner since 1996 due to low exploitation of run.

Appendix 4.5. Escapement index series for the pink salmon stock groups in the Juneau management area, together with summary statistics from 1960 to 2002.

JUNEAU									
Year	Freshwater Bay	Homeshore	Lynn Canal	N Chichagof	Seymour Canal	Stephens	SW Admiralty	Tenakee	W Admiralty
1960	13,274	5,124	10,697	22,117	22,577	21,675	16,201	38,630	8,661
1961	47,321	18,268	38,134	78,846	80,486	77,270	57,757	137,713	30,877
1962	28,376	10,954	22,867	47,280	48,263	46,335	34,634	82,580	18,515
1963	95,645	36,923	77,077	159,366	162,680	156,180	116,739	278,348	62,409
1964	33,124	12,787	26,693	55,191	56,339	54,088	40,429	96,397	21,613
1965	11,425	14,136	21,021	61,014	62,282	59,794	13,945	33,250	7,455
1966	26,861	7,940	17,106	40,730	103,056	103,141	70,259	28,593	37,641
1967	15,800	4,938	46,543	161,358	23,546	22,605	22,726	23,404	55,086
1968	47,650	6,385	12,800	43,458	290,276	46,748	79,707	118,590	33,580
1969	41,599	47,632	32,681	160,004	28,656	22,417	89,962	69,131	80,380
1970	89,087	19,471	33,619	46,789	236,557	58,399	96,042	166,765	52,366
1971	62,970	20,879	103,730	277,949	151,605	34,385	71,953	83,014	64,727
1972	49,291	2,563	21,078	33,653	359,722	345,349	73,367	150,142	18,632
1973	50,779	7,901	88,231	227,641	117,342	97,614	29,064	179,528	70,946
1974	61,999	1,641	13,345	25,371	353,986	26,187	29,499	184,237	13,931
1975	38,601	5,748	27,102	127,684	52,601	54,614	19,745	82,859	27,995
1976	42,433	2,821	20,010	36,451	53,868	13,385	19,711	130,636	8,958
1977	179,982	11,895	148,555	329,424	147,309	133,510	113,237	184,030	78,088
1978	153,918	21,085	52,843	64,354	105,699	66,488	71,672	541,648	62,871
1979	204,161	24,332	137,465	147,849	223,703	223,219	197,653	168,984	142,393
1980	53,922	46,897	78,613	52,353	80,147	99,005	175,895	289,975	43,053
1981	49,174	61,591	64,449	225,158	44,458	164,788	101,385	265,860	103,735
1982	103,393	27,239	86,847	166,508	234,825	246,318	207,450	356,456	58,679
1983	68,390	25,496	133,964	254,743	255,541	296,681	219,209	454,038	68,855
1984	97,298	62,153	56,055	198,047	370,857	198,348	151,240	238,037	55,486
1985	214,818	187,212	434,809	682,013	429,401	480,770	271,062	659,660	214,929
1986	103,391	17,987	15,782	59,083	131,746	77,274	174,341	599,530	24,407
1987	86,313	27,521	138,005	145,698	288,786	367,392	114,033	181,130	83,674
1988	66,344	44,010	61,356	37,958	75,757	95,072	87,574	275,646	19,035
1989	114,950	53,178	100,751	207,797	171,552	158,881	196,504	299,547	121,374
1990	109,044	32,312	164,581	113,035	37,986	113,261	195,206	262,438	50,232
1991	106,630	30,492	32,379	180,368	88,291	208,075	190,596	748,267	78,796
1992	115,937	39,667	99,741	66,719	125,925	287,450	161,931	371,377	49,512
1993	151,038	50,000	48,861	287,904	106,362	45,126	183,442	517,577	70,588
1994	274,943	86,591	258,190	208,517	231,926	747,349	230,997	592,599	131,826
1995	223,980	52,838	58,006	445,207	124,072	81,048	106,391	388,557	100,695
1996	131,628	5,649	17,584	39,796	292,645	464,972	293,319	489,032	48,873
1997	286,958	91,249	139,262	563,072	436,109	273,165	133,680	857,419	160,563
1998	150,125	11,176	83,378	89,084	307,505	458,048	517,969	489,188	26,658
1999	255,711	198,700	314,444	943,212	435,631	380,050	437,769	977,621	210,733
2000	83,492	6,721	33,990	52,711	199,571	130,925	255,551	418,919	11,349
2001	236,222	102,911	364,852	692,144	288,995	196,245	239,345	140,491	94,229
2002	155,887	13,112	88,108	180,504	216,859	258,555	207,205	602,388	22,498
Avg. 1960-1980	64,201	15,729	49,058	104,709	131,462	83,924	68,581	146,117	44,770
Avg. 1981-2001	144,275	57,843	128,918	269,465	222,759	260,535	212,809	456,352	84,963
Upper 80th percentile	153,342	52,271	136,765	249,323	290,020	284,593	205,491	489,157	92,118
Min. 1960-2001	11,425	1,641	10,697	22,117	22,577	13,385	13,945	23,404	7,455
Max. 1960-2001	286,958	198,700	434,809	943,212	436,109	747,349	517,969	977,621	214,929
Estimated Yr-Zero Level	45,874	21,564	92,715	80,344	189,030	205,027	143,021	301,454	57,954
Decline as % of Yr-Zero Level[a]			<0.01%						
Robust Estimate of Annual Decline[b]			248						
Increase as % of Yr-Zero Level	20%	8%		22%	1%	1%	4%	3%	3%
Robust Estimate of Annual Increase	9,049	1,808		17,654	2,650	1,918	5,801	9,470	1,812

[a] The year-zero escapement level and the robust estimate of stock decline (or increase) are based on the most recent 21 years (1981 to 2001) of data, and not the entire series.

[b] Declines (or increases) as a percent of year-zero level shows the size of a stock decline (or increase) relative to the size of the stock trend at the beginning of the series.

Appendix 4.6. Escapement index series for the pink salmon stock groups in the Petersburg management area, together with summary statistics from 1960 to 2002.

PETERSBURG

Year	Affleck Canal	Anan	Burnett	Eliza Harbor	Farragut Bay	Houghton	Portage Bay	Pybus/ Gambier
1960	50,276	13,489	1,548	2,232	1,534	44,947	1,894	10,762
1961	28,747	40,905	271	24,752	250	22,095	6,642	54,988
1962	162,801	157,755	4,475	3,229	3,713	92,194	7,619	43,705
1963	23,506	117,475	5,159	30,886	250	39,474	3,414	32,824
1964	50,955	101,414	164,450	45,698	3,182	77,372	7,870	38,349
1965	54,154	58,636	21,398	32,566	1,286	47,885	886	8,859
1966	48,815	143,558	16,037	81,158	2,933	75,586	5,116	32,578
1967	23,504	26,014	3,547	3,093	1,213	29,880	10,011	7,519
1968	67,516	118,318	45,572	85,626	4,058	136,580	29,850	70,375
1969	16,509	55,996	2,676	12,355	2,040	65,768	4,887	7,705
1970	38,584	123,831	11,094	39,885	2,960	115,446	14,806	59,337
1971	32,007	163,365	15,383	20,317	2,960	129,657	14,107	10,106
1972	45,893	147,745	25,627	24,720	3,790	108,761	8,185	61,824
1973	24,726	119,884	34,841	6,332	4,310	133,127	10,102	86,746
1974	19,045	92,704	24,000	5,668	2,263	57,524	4,867	34,487
1975	25,562	272,283	37,053	6,113	348	14,249	3,068	13,944
1976	57,785	527,733	103,809	2,914	459	42,179	936	37,295
1977	87,541	759,337	115,530	47,832	5,223	73,069	13,157	62,935
1978	135,900	349,458	45,539	38,182	7,067	185,116	22,298	142,521
1979	111,756	353,300	60,446	82,517	12,344	293,445	11,526	253,262
1980	70,602	225,798	43,009	73,219	4,764	214,542	18,376	125,728
1981	167,667	92,626	22,531	54,444	7,977	253,649	15,234	44,847
1982	65,860	280,497	14,559	75,318	24,850	392,525	33,192	106,955
1983	146,868	267,823	22,038	40,293	3,427	185,506	28,687	51,339
1984	98,542	190,981	26,757	95,518	7,420	244,470	29,150	73,854
1985	336,711	625,600	123,047	156,813	45,724	528,018	78,951	288,886
1986	461,376	368,561	123,800	92,430	18,497	129,492	27,113	94,021
1987	54,841	229,537	33,545	128,130	27,000	715,699	59,910	231,729
1988	108,126	177,979	45,889	77,251	6,100	265,901	37,198	108,477
1989	108,043	690,479	80,861	166,935	35,963	631,212	59,950	251,180
1990	318,582	216,770	110,343	204,968	14,890	709,659	51,876	246,290
1991	236,130	457,433	101,511	274,216	35,943	697,196	43,395	247,469
1992h	124,104	743,391	54,278	330,366	18,079	792,748	53,300	312,448
1993	293,600	575,780	77,635	259,446	28,600	386,937	16,948	175,573
1994	263,418	396,276	163,800	248,100	29,600	934,688	24,367	382,300
1995	284,810	476,254	77,062	170,807	1,577	170,090	8,095	126,478
1996	617,412	407,131	256,256	308,920	18,208	161,085	15,709	323,335
1997	302,139	472,528	105,211	285,884	15,235	357,621	39,030	291,857
1998	196,225	404,021	171,833	273,964	16,674	445,229	17,600	349,639
1999	960,756	596,483	777,935	736,736	66,660	1,104,046	122,100	562,300
2000	436,835	398,712	138,865	403,469	20,921	462,123	27,886	357,385
2001	579,400	580,405	244,100	177,971	17,550	707,150	32,586	275,399
2002	549,105	420,406	210,637	178,211	24,100	743,538	28,560	368,353
Avg. 1960-1980	56,009	189,000	37,213	31,871	3,188	95,185	9,505	56,945
Avg. 1981-2001	293,402	411,870	131,993	217,237	21,947	489,288	39,156	233,417
Upper 80th percentile	291,842	475,509	121,544	239,474	20,436	514,839	36,397	270,972
Min. 1960-2001	16,509	13,489	271	2,232	250	14,249	886	7,519
Max. 1960-2001	960,756	759,337	777,935	736,736	66,660	1,104,046	122,100	562,300
Est. Year-Zero Level[a]	45,447	238,422	-20,838	56,805	22,293	314,831	34,470	41,433
Decline as % of Year-Zero Level[b]					0.30%		0.30%	
Robust Est. of Annual Decline					68		90	
Increase as % of Year –Zero Level	45.60%	6.10%	Not defined	24.30%		4.30%		39.50%
Robust Est. of Annual Increase	20,712	14,622	10,363	13,818		13,684		16,380

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Appendix 4.6 (Page 2 of 2).

PETERSBURG

Year	Ratz Harbor	Saginaw Bay	Shipley Bay	Stikine	Tebenkof	Totem Bay	Union Bay	Whale Pass
1960	1,861	6,416	3,611	1,044	5,597	4,571	3,620	488
1961	20,753	24,283	20,867	17,030	25,292	18,557	10,978	9,495
1962	15,144	23,374	30,111	3,303	64,493	33,137	42,338	23,011
1963	1,839	23,966	51,407	16,840	47,242	10,794	5,911	27,127
1964	72,193	69,806	2,966	14,503	63,096	3,324	27,217	543
1965	4,549	73,184	59,722	4,752	102,286	15,642	2,525	28,369
1966	27,922	20,309	56,651	12,255	76,636	29,877	38,528	59,294
1967	3,611	8,646	29,984	2,846	25,165	3,330	6,982	5,487
1968	2,274	40,283	69,738	25,519	81,504	37,375	10,875	30,852
1969	28,902	23,480	31,090	4,554	36,527	17,826	9,439	2,415
1970	9,669	8,924	16,910	14,789	25,285	16,781	6,443	21,751
1971	42,322	17,872	67,247	9,315	34,969	15,855	31,117	89,149
1972	24,004	32,257	9,230	3,774	28,916	360	15,733	12,229
1973	8,391	4,272	95,023	7,590	13,415	968	26,981	61,486
1974	14,960	1,780	17,506	3,303	10,355	1,079	24,977	63,541
1975	9,402	9,172	109,349	4,074	31,264	12,170	47,562	103,724
1976	46,020	8,074	27,574	1,263	80,833	7,241	80,660	217,645
1977	66,965	47,101	94,838	20,581	189,845	33,149	131,754	75,126
1978	83,410	40,976	99,865	3,427	147,557	37,173	78,055	81,892
1979	46,981	135,706	139,347	56,267	198,090	87,673	54,157	74,286
1980	8,601	50,271	43,492	1,909	65,671	17,009	76,137	24,235
1981	41,964	55,995	105,993	16,689	49,302	29,706	24,775	18,258
1982	89,752	173,180	30,613	44,270	151,786	56,183	73,150	50,860
1983	61,126	91,742	74,799	18,467	112,571	22,289	79,344	30,874
1984	16,604	121,751	49,215	13,635	143,072	21,006	60,244	52,669
1985	233,646	273,861	319,841	53,284	356,800	244,957	180,930	232,364
1986	197,500	226,933	175,900	13,264	250,979	137,673	298,610	252,299
1987	22,510	162,602	79,306	59,380	80,694	107,392	58,600	33,545
1988	70,000	63,333	24,126	9,228	188,687	35,687	95,258	33,823
1989	137,480	236,113	244,783	70,481	174,840	120,754	187,599	186,115
1990	71,300	48,873	36,551	57,617	126,472	47,538	149,800	228,789
1991	112,340	309,005	356,000	123,269	221,357	125,098	126,100	164,233
1992h	24,920	124,941	57,272	57,103	271,936	76,235	64,858	68,157
1993	119,500	110,656	320,800	13,269	283,871	284,850	88,300	138,188
1994	107,200	354,292	164,615	34,500	451,796	55,433	107,800	301,890
1995	192,700	74,550	225,583	14,775	297,357	114,324	252,257	244,741
1996	151,360	342,434	253,108	29,956	643,566	74,259	218,104	188,064
1997	71,000	158,397	318,785	14,036	192,917	128,146	57,452	202,601
1998	156,012	240,140	145,581	26,050	366,369	95,586	136,909	225,234
1999	806,472	520,618	1,869,197	57,591	657,582	980,251	197,756	628,094
2000	57,596	491,030	141,708	12,775	526,943	79,467	61,882	45,657
2001	171,300	222,827	457,500	116,395	377,306	272,209	299,600	307,676
2002	159,000	536,221	135,068	8,476	592,215	138,159	136,561	89,244
Avg. 1960-1980	25,703	31,912	51,263	10,902	64,478	19,233	34,857	48,197
Avg. 1981-2001	138,680	209,680	259,585	40,764	282,200	148,050	134,254	173,054
Upper 80th percentile	118,068	226,112	215,646	51,481	281,484	112,938	135,878	214,636
Min. 1960-2001	1,839	1,780	2,966	1,044	5,597	360	2,525	488
Max. 1960-2001	806,472	520,618	1,869,197	123,269	657,582	980,251	299,600	628,094
Est. Year-Zero Level[a]	33,559	114,971	29,118	27,915	63,204	36,565	28,331	9,768
Decline as % of Year-Zero Level[b]								
Robust Est. of Annual Decline								
Increase as % of Year –Zero Level	20.20%	4.80%	42.60%	1.90%	26.50%	11.40%	31.40%	127.50%
Robust Est. of Annual Increase	6,778	5,538	12,414	542	16,731	4,153	8,900	12,455

[a] The year-zero escapement level and the robust estimate of stock decline (or increase) are based on the most recent 21 years (1981 to 2001) of data, and not the entire series.

[b] Declines (or increases) as a percent of year-zero level shows the size of a stock decline (or increase) relative to the size of the stock trend at the beginning of the series.

Appendix 4.7. Escapement index series for the pink salmon stock groups in the Sitka management area, together with summary statistics from 1960 to 2002.

SITKA											
Year	E Baranof	Hoonah Sound	Kelp Bay	Lisianski	Portlock	Salisbury Sound	SE Baranof	Sitka Sound	Slocum Arm	W Crawfish	Whale Bay
1960	9,463	38,606	6,307	2,467	14,099	1,527	7,482	6,458	3,939	8,045	29,428
1961	45,023	241,834	21,251	37,808	51,000	61,746	35,599	55,498	26,859	6,768	24,758
1962	18,399	54,538	12,263	12,355	22,300	21,644	14,548	19,031	60,789	2,718	9,943
1963	40,000	322,862	60,194	179,232	77,000	252,759	11,154	172,512	101,025	500	2,641
1964	5,171	157,959	15,175	36,059	11,500	19,286	4,089	11,630	42,005	1,000	3,658
1965	27,000	215,621	30,939	111,479	14,087	49,190	21,349	87,280	66,726	1,000	2,331
1966	15,513	138,976	11,979	6,653	9,629	9,178	12,266	15,477	10,459	2,714	9,928
1967	37,617	23,611	13,758	18,415	9,377	39,644	29,744	60,451	44,941	200	1,059
1968	56,882	196,608	39,917	3,992	1,537	6,966	3,718	3,519	3,404	273	1,000
1969	36,198	155,947	15,967	30,966	13,191	141,063	28,621	104,398	62,544	7,244	26,498
1970	30,000	129,806	20,138	5,303	3,202	23,941	37,180	5,155	28,629	2,795	10,223
1971	58,000	127,960	49,000	53,262	1,665	62,945	53,000	85,324	48,290	200	6,800
1972	25,855	176,439	30,452	3,902	1,085	10,600	47,861	3,102	106,443	526	1,923
1973	5,171	37,850	19,499	23,862	13,700	27,001	4,089	179,084	81,883	649	2,373
1974	5,171	156,176	17,212	13,811	4,339	11,424	26,802	56,177	83,772	15,772	57,694
1975	20,684	27,708	17,410	30,226	14,087	82,134	18,163	211,588	114,334	6,844	25,036
1976	2,200	105,496	5,829	11,348	9,914	22,929	15,315	58,936	132,903	3,823	13,983
1977	64,121	216,215	33,916	152,719	15,368	276,560	36,642	751,626	213,960	23,188	84,821
1978	33,000	416,054	34,976	28,104	7,684	80,425	84,000	109,466	86,551	10,383	37,981
1979	72,395	300,384	57,233	209,988	172,887	322,500	160,000	506,616	249,000	5,257	19,231
1980	22,278	156,736	27,966	18,600	5,868	48,383	62,805	30,206	38,477	6,974	25,510
1981	51,350	188,968	115,340	192,701	85,320	308,890	83,740	375,311	131,535	18,170	30,503
1982	90,060	251,185	77,420	28,905	17,401	141,568	120,870	117,368	75,445	19,750	23,785
1983	63,990	275,815	43,213	195,026	110,600	172,220	61,620	277,769	114,076	18,960	44,585
1984	79,790	298,159	66,360	44,405	16,195	145,360	65,570	252,929	82,160	63,200	55,300
1985	122,450	301,512	99,540	262,660	67,150	355,105	67,545	545,041	131,930	15,800	75,050
1986	53,799	156,501	28,124	36,512	11,060	32,209	15,378	97,392	48,726	9,480	18,170
1987	76,630	226,967	58,065	56,135	27,650	21,883	14,773	100,126	92,035	11,850	10,430
1988	73,533	155,248	53,720	20,571	5,460	21,315	14,773	10,886	34,276	3,160	12,224
1989	93,958	216,532	90,060	75,050	42,660	27,705	24,648	13,286	228,508	395	17,064
1990	65,362	247,973	25,675	10,063	5,767	40,448	44,240	12,207	97,452	4,740	22,103
1991	159,321	310,075	110,600	29,072	19,750	138,487	62,015	57,623	223,019	4,153	15,193
1992	65,362	383,211	30,800	13,527	20,500	33,101	76,500	24,168	130,375	12,000	197,250
1993	98,580	521,726	87,690	75,000	5,507	168,822	122,500	19,841	47,923	2,310	8,450
1994	254,380	526,083	111,590	28,407	50,450	127,830	90,160	288,788	421,880	38,000	202,400
1995	126,000	108,161	20,668	148,476	87,000	425,168	186,000	237,776	287,500	15,000	90,000

-continued-

Appendix 4.7.(Page 2 of 2)

SITKA											
Year	**E Baranof**	**Hoonah Sound**	**Kelp Bay**	**Lisianski**	**Portlock**	**Salisbury Sound**	**SE Baranof**	**Sitka Sound**	**Slocum Arm**	**W Crawfish**	**Whale Bay**
1996	325,778	328,900	77,500	32,600	79,400	255,000	238,000	708,268	307,000	50,000	143,000
1997	270,000	295,125	162,161	540,000	290,000	272,256	132,500	1,038,900	567,000	5,100	97,000
1998	232,000	500,488	100,100	55,148	56,000	313,000	280,000	1,334,879	211,000	74,000	377,000
1999	557,361	840,707	319,094	946,000	290,000	1,480,500	251,000	1,615,142	1,190,500	42,000	165,500
2000	135,666	615,484	85,585	40,845	127,000	254,672	118,842	514,239	413,111	25,000	112,882
2001	195,407	439,720	151,300	652,000	165,000	165,200	96,000	689,227	568,000	18,000	106,976
2002	186,208	529,871	72,630	147,432	120,536	439,114	70,795	972,882	272,686	81,000	323,366
Avg. 1960-1980	30,007	161,780	25,780	47,169	22,549	74,850	34,020	120,644	76,521	5,089	18,896
Avg. 1981-2001	151,942	342,311	91,172	165,862	75,232	233,369	103,175	396,722	257,307	21,479	86,898
Upper 80th Percentile	125,290	327,692	89,586	151,870	78,290	254,934	114,274	480,355	227,410	18,802	88,964
Min. 1960-2001	2,200	23,611	5,829	2,467	1,085	1,527	3,718	3,102	3,404	200	1,000
Max. 1960-2001	557,361	840,707	319,094	946,000	290,000	1,480,500	280,000	1,615,142	1,190,500	74,000	377,000
Est. Year-Zero Level[a]	12,120	185,525	58,207	5,118	-19,927	52,984	9,905	-30,753	-40,434	10,408	-11,244
Decline as % of Year-Zero Level[b]											
Robust Est. of Annual Decline											
Increase As % of Year-Zero Level	91.6%	7.3%	4.1%	128.9%	not defined	17.1%	86.8%	not defined	not defined	4.7%	not defined
Robust Est. of Annual Increase	11,098	13,467	2,410	6,596	7,096	9,064	8,602	32,524	22,934	488	-5,884

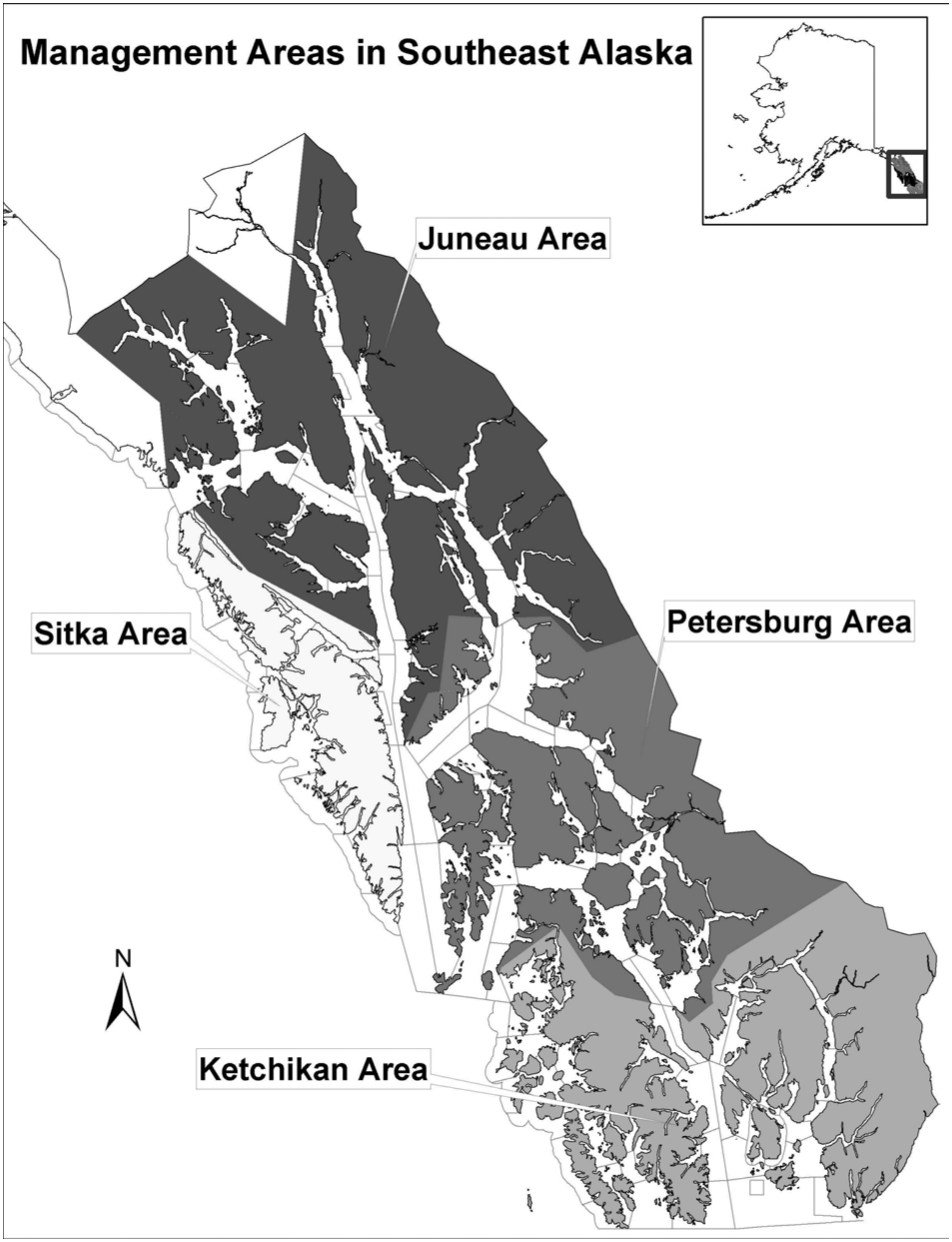
[a] The year-zero escapement level and the robust estimate of stock decline (or increase) are based on the most recent 21 years (1981 to 2001) of data, and not the entire series.
[b] Declines (or increases) as a percent of year-zero level shows the size of a stock decline (or increase) relative to the size of the stock trend at the beginning of the series.

Appendix 4.8. Escapement index series for the pink salmon stock groups in the Ketchikan management area, together with summary statistics from 1960 to 2002.

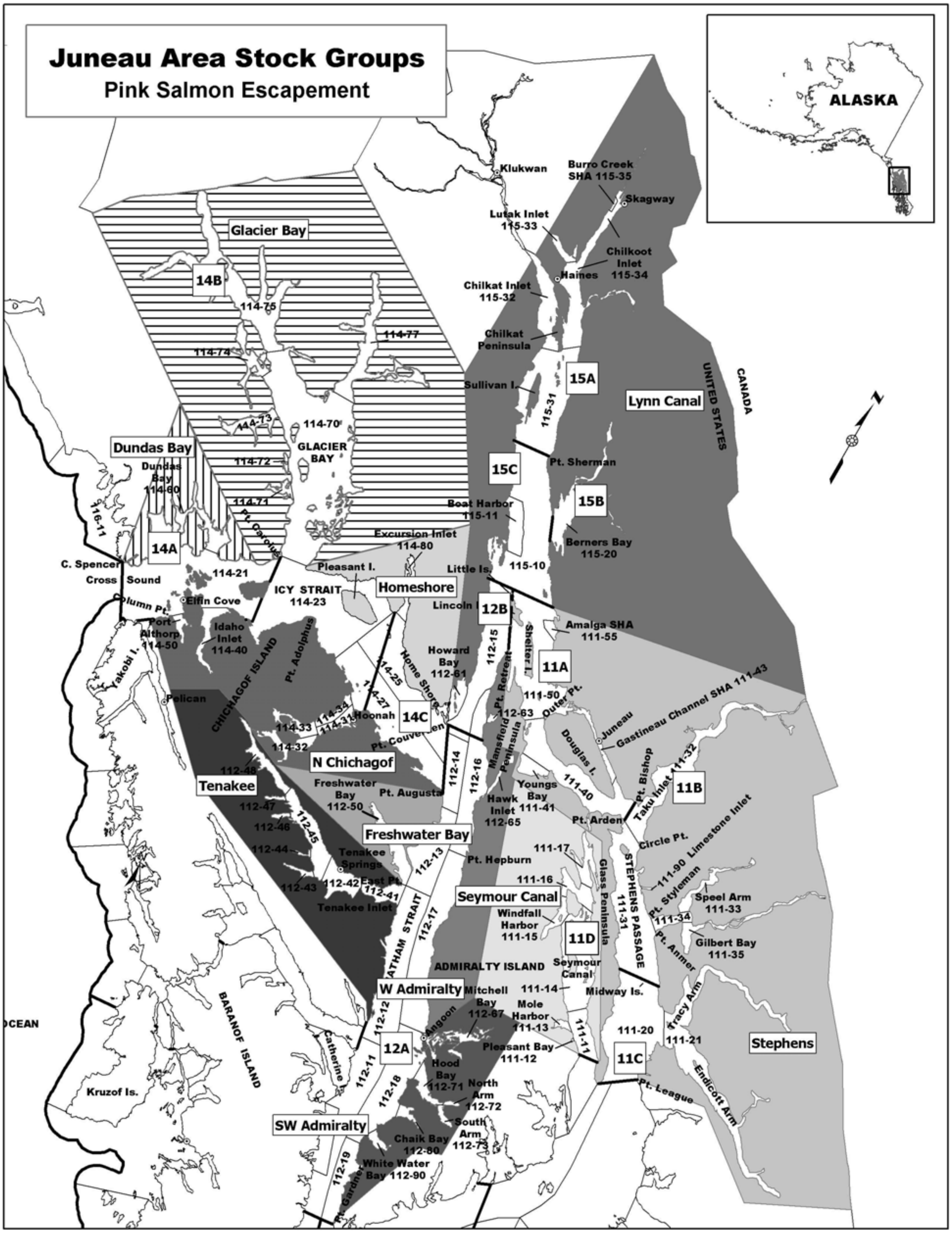
KETCHIKAN									
Year	**E Behm**	**E Dall**	**Hetta**	**Kasaan**	**Klawock**	**Moira**	**Portland**	**Sea Otter Sound**	**W Behm**
1960	128,231	31,282	10,078	59,019	136,993	9,683	29,074	10,469	48,716
1961	58,490	11,864	21,718	26,920	43,064	4,417	13,262	9,481	22,221
1962	457,998	74,623	136,603	133,638	270,863	3,719	105,574	59,634	103,474
1963	424,743	67,843	41,181	169,986	329,263	166,396	172,470	54,216	172,009
1964	326,624	149,517	134,895	219,935	161,780	45,008	157,672	98,846	306,208
1965	163,799	146,241	156,237	155,604	257,774	29,745	156,797	173,858	46,760
1966	563,257	56,098	184,157	434,740	363,547	53,711	189,751	252,107	303,903
1967	110,331	9,401	17,209	22,073	34,124	2,181	29,806	7,513	73,291
1968	333,839	24,540	52,155	273,581	102,786	46,018	358,131	105,455	104,535
1969	287,197	32,202	75,295	266,765	121,765	19,055	92,345	13,484	124,382
1970	537,660	51,418	56,136	117,231	253,872	13,445	51,365	13,523	160,182
1971	230,772	27,831	240,193	339,882	421,775	51,013	63,952	76,311	171,693
1972	403,976	33,004	129,046	152,586	253,385	23,263	106,574	48,273	187,432
1973	429,521	16,460	89,993	138,957	155,646	84,745	165,965	120,520	52,421
1974	435,141	69,674	163,531	127,083	177,750	79,038	24,093	66,510	121,084
1975	419,241	77,928	234,202	393,354	227,429	103,816	78,806	181,730	131,182
1976	485,290	213,848	186,365	421,236	504,925	97,313	119,887	144,705	175,616
1977	1,276,742	171,756	247,792	511,959	613,438	107,751	512,756	202,383	527,250
1978	1,173,660	230,837	287,591	385,721	717,727	38,345	335,323	225,877	473,888
1979	483,110	221,488	268,150	573,096	823,349	49,638	40,228	179,301	534,174
1980	1,131,383	365,452	598,405	479,966	899,068	119,515	142,100	178,490	609,760
1981	1,113,992	302,281	409,941	393,530	991,121	81,343	337,805	183,939	394,972
1982	802,113	200,472	438,345	293,786	580,478	53,421	92,860	173,702	447,684
1983	1,462,362	223,117	467,702	854,113	1,078,101	116,827	227,980	248,467	439,892
1984	2,151,342	548,992	574,446	638,932	1,340,913	133,470	485,032	203,961	910,715
1985	1,742,320	554,298	743,953	755,813	2,200,923	141,500	525,320	328,200	1,136,482
1986	3,155,245	678,433	1,177,742	1,282,946	2,546,753	220,943	395,677	416,837	843,406
1987	1,275,659	181,498	603,839	385,444	859,679	78,279	494,986	90,453	434,004
1988	907,106	243,157	398,476	303,736	382,349	158,530	165,225	78,976	141,318
1989	1,087,877	129,885	507,056	672,641	1,960,301	50,090	679,689	235,611	798,357
1990	972,996	399,813	724,589	838,051	983,319	87,311	104,411	247,658	661,948
1991	1,034,569	154,760	540,320	588,126	1,127,551	41,320	213,086	143,539	401,725
1992	1,895,361	256,570	313,633	733,334	615,899	131,717	206,240	267,988	676,757
1993	1,265,437	341,228	655,218	829,924	1,697,904	65,192	458,708	221,190	394,820
1994	1,254,007	287,776	508,260	550,855	908,305	75,248	218,720	294,805	308,929
1995	2,593,276	453,205	976,230	750,447	1,673,682	159,784	537,100	314,301	691,781
1996	4,647,575	935,879	1,857,934	2,885,635	3,016,390	215,258	424,199	827,305	940,591
1997	1,439,244	167,811	459,062	759,265	1,030,349	49,024	265,502	109,492	617,649
1998	1,708,862	319,584	660,034	951,587	1,615,746	194,020	542,495	156,096	852,598
1999	1,659,673	310,281	1,389,791	1,497,486	1,426,652	218,996	422,598	322,356	712,248
2000	1,222,724	268,757	1,072,180	1,042,230	291,288	78,124	284,817	136,431	378,030
2001	2,977,408	350,997	496,180	1,052,729	1,918,907	100,894	519,969	492,699	851,675
2002	2,014,774	442,577	1,001,849	1,574,728	1,427,089	107,937	568,299	271,355	662,657
Avg. 1960-1980	469,572	99,205	158,616	257,302	327,158	54,658	140,282	105,842	211,913
Avg. 1981-2001	1,731,864	348,038	713,092	860,029	1,345,077	116,728	362,020	261,619	620,742
Upper 80th Percentile	1,620,211	336,899	644,942	815,792	1,409,504	133,120	451,806	251,379	688,776
Min. 1960-2001	58,490	9,401	10,078	22,073	34,124	2,181	13,262	7,513	22,221
Max. 1960-2001	4,647,575	935,879	1,857,934	2,885,635	3,016,390	220,943	679,689	827,305	1,136,482
Est. Year-Zero Level[a]	1,226,022	279,216	370,625	467,723	803,287	83,534	321,910	164,596	312,681
Decline as Percent of Year-Zero Level[b]									
Robust Est. of Annual Decline									
Increase as % of Year-Zero Level	1.4%	0.4%	7.7%	6.2%	4.8%	3.7%	0.6%	4.8%	6.0%
Robust Est. Of Annual Increase	17,607	1,236	28,699	28,807	38,403	3,068	2,037	7,881	18,897

[a] The year-zero escapement level and the robust estimate of stock decline (or increase) are based on the most recent 21 years (1981 to 2001) of data, and not the entire series.

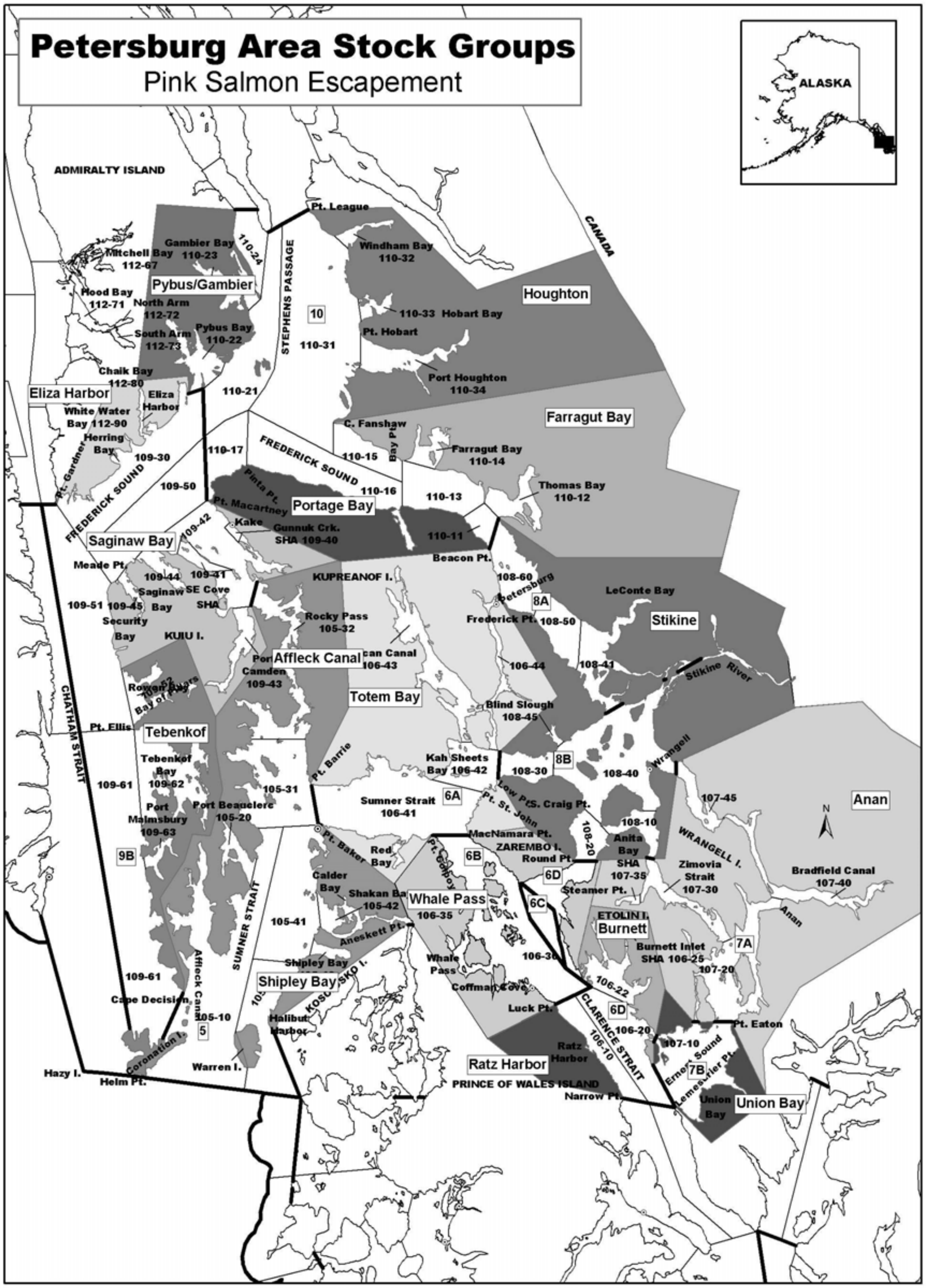
[b] Declines (or increases) as a percent of year-zero level shows the size of a stock decline (or increase) relative to the size of the stock trend at the beginning of the series.



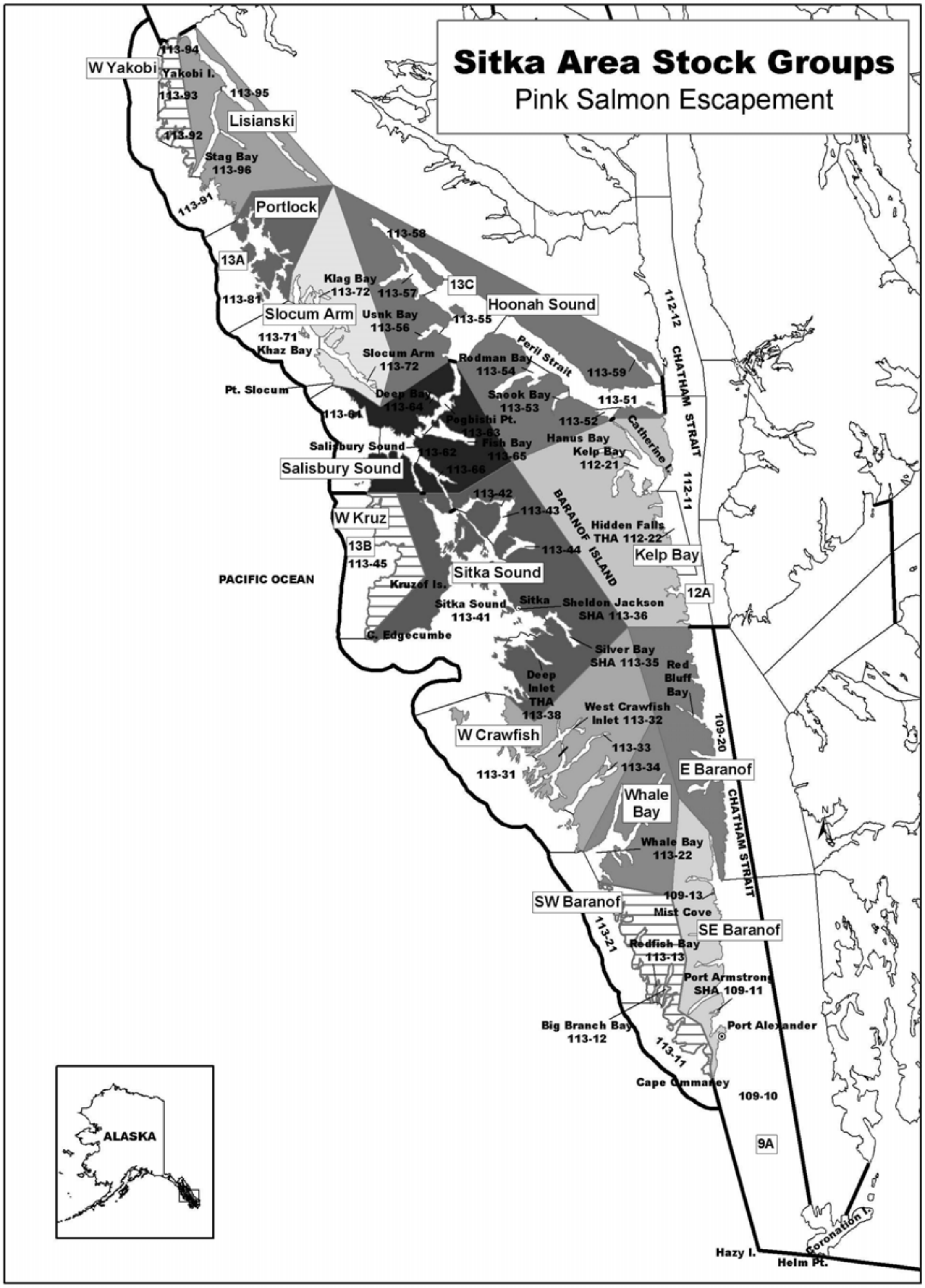
Appendix 4.9. Southeast Alaska salmon management areas.



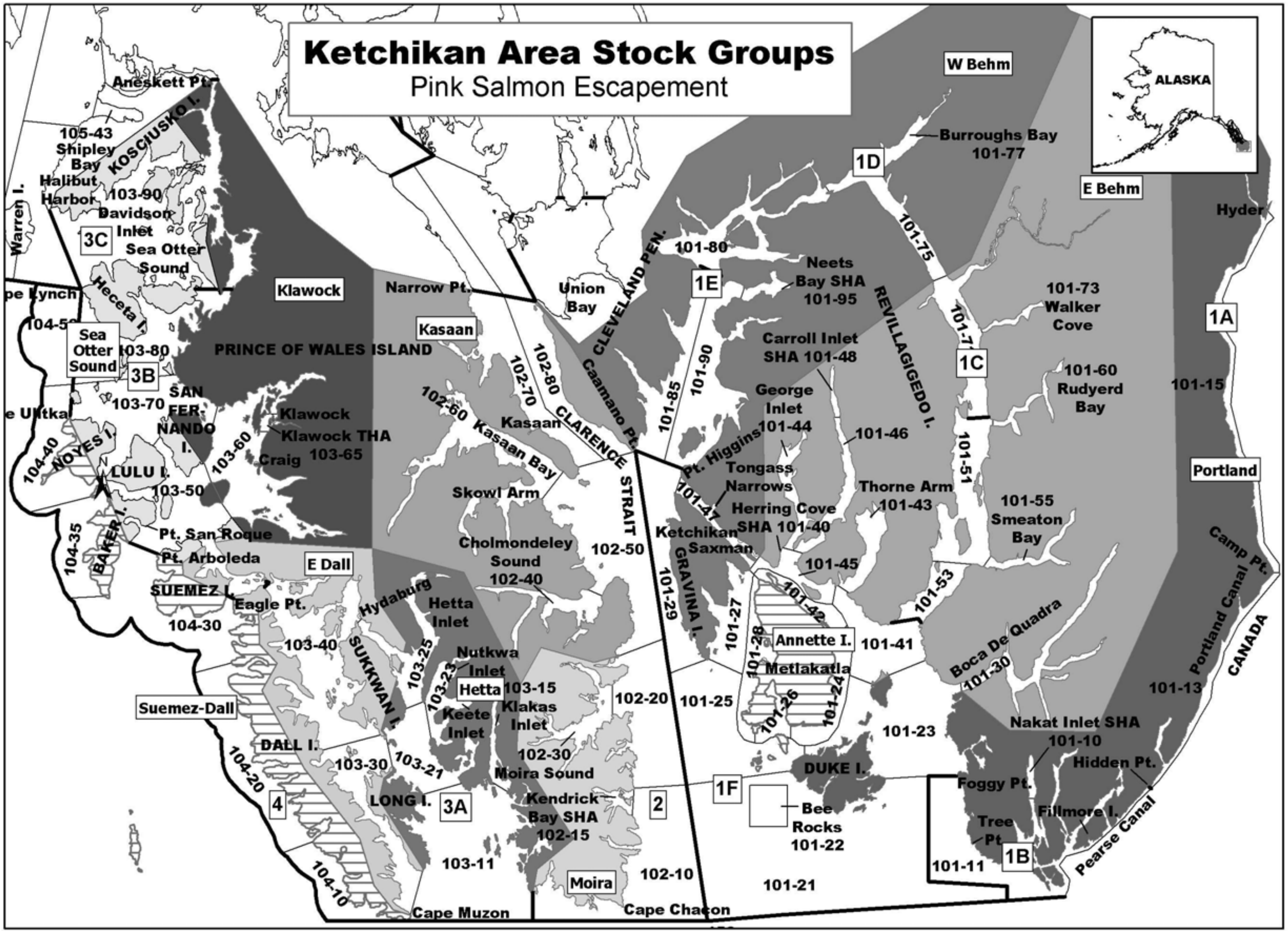
Appendix 4.10. Juneau management area pink salmon escapement stock group areas. Hatched stock groups indicate areas with no index streams or escapement targets.



Appendix 4.11. Petersburg management area pink salmon escapement stock group areas.



Appendix 4.12. Sitka management area pink salmon escapement stock group areas. Hatched stock groups indicate areas with no index streams or escapement targets.



Appendix 4.13. Ketchikan management area pink salmon escapement stock group areas. Diagonal hatched stock groups indicate areas with no index streams or escapement targets.

Chapter 5: Chum Salmon
Stock Status and Escapement Goals in Southeast Alaska

by
Steven C. Heinl,
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Andrew J. McGregor,
and
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ABSTRACT

Chum salmon harvests in Southeast Alaska commercial fisheries reached high levels in the 1910s, exhibited a long-term decline through the 1970s, and then increased dramatically to record levels in the 1990s. Most chum salmon currently harvested in Southeast Alaska are hatchery produced, and enhancement has helped raise the commercial catch to twice the historical level of the early 20th century. Chum salmon escapement estimates in Southeast Alaska are primarily obtained from aerial surveys, although a small number of systems are monitored using foot surveys and other methods. Most chum salmon escapement data in the region are of limited use, because aerial surveys are generally directed at estimating pink salmon abundance, and numbers of chum salmon in many streams are obscured by the recent high abundance of pink salmon. Long-term, up-to-date series of chum salmon escapement surveys exist for only about 6% of Southeast Alaska streams. Our examination of 21 years of peak survey estimates for 82 streams shows that escapements of most wild-stock chum salmon appear to be stable or increasing: 71 (87%) exhibited stable or increasing trends (27 streams showed a significant increase), while 11 (13%) exhibited declines (8 of which we considered biologically meaningful). We examined the stock status of 6 other streams or areas (Fish Creek—near Hyder, East Alsek River, Tenakee Inlet, Cholmondeley Sound, Taku River, and Chilkat River) using a variety of information including multiple foot surveys, fish wheel catches, and near-terminal area harvests. We noted large, persistent declines in escapement or harvest of Chilkat, East Alsek, and Taku River fall chum salmon. Although these declines warrant attention, the Alaska Department of Fish and Game does not recommend any chum salmon stocks in Southeast Alaska be considered as candidates for *stock of concern* status under the Sustainable Salmon Fisheries Policy—principally, because of a lack of reliable escapement measures. We found reference in department records for escapement goals for 5 chum salmon streams in Southeast Alaska. We found no scientific justification for the goals, because neither escapement or harvest are reliably measured on a system-specific basis. Therefore, we do not recommend any formal *biological* or *sustainable escapement goals* for chum salmon in Southeast Alaska at this time. We recommend that improvements be made to the chum salmon escapement monitoring program in the region; some improvements are already underway.

Key words: Chum salmon, Oncorhynchus keta, escapement, escapement goals, escapement goal ranges, stock status, Fish Creek, Tenakee Inlet, Cholmondeley Sound, Chilkat River, Taku River, East Alsek River, Fish Creek, Taku Inlet, Lynn Canal, Chilkat River, Klehini River, Dixon Entrance, Disappearance Creek, Lagoon Creek, Northern Lynn Canal.

INTRODUCTION

Chum salmon (*Oncorhynchus keta*) spawn in approximately 1,500 short, coastal streams throughout Southeast Alaska (Figure 5.1). Chum salmon are harvested in the greatest numbers in large commercial purse seine and drift gillnet fisheries, but are also taken by other commercial fishing gears, and in sport, personal use, and subsistence fisheries. The exvessel value of chum salmon in Southeast Alaska averaged approximately $19 million between 1990 and 2001, and it exceeded $25 million in 1995 and 2000.

Annual commercial harvests of chum salmon in Southeast Alaska were historically at high levels in the early 1900s (maximum, 9.4 million in 1918), gradually declined to their lowest levels in the 1970s (minimum, 600,000 in 1969), and reached their all-time maximum of 16 million fish in the mid-late 1990s (Figure 5.2). As noted by Van Alen (2000), the great increase in chum salmon harvests beginning in the 1990s is due largely to the production and release of hatchery fish by Southern Southeast Regional Aquaculture Association (at Nakat Inlet, Earl West Cove, Neets Bay, and Kendrick Bay), Northern Southeast Regional Aquaculture Association (at Hidden Falls and Deep Inlet); and Douglas Island Pink and Chum, Inc. (at Amalga Harbor, Gastineau Channel, and Limestone Inlet; and combined Douglas Island Pink and Chum/Northern Southeast Regional Aquaculture Association releases at Boat Harbor). Hatchery fish have accounted for an average of 69% of the commercial harvest of chum salmon over the past 10 years, with a peak contribution of 12 million fish in 1996 (McNair 1998). While apparently somewhat cyclical, and still nowhere near the high harvest levels of the early 1900s, annual commercial harvests of wild chum salmon have increased considerably since 1975, and have averaged 2.7 million fish since 1985 (Figure 5.2).

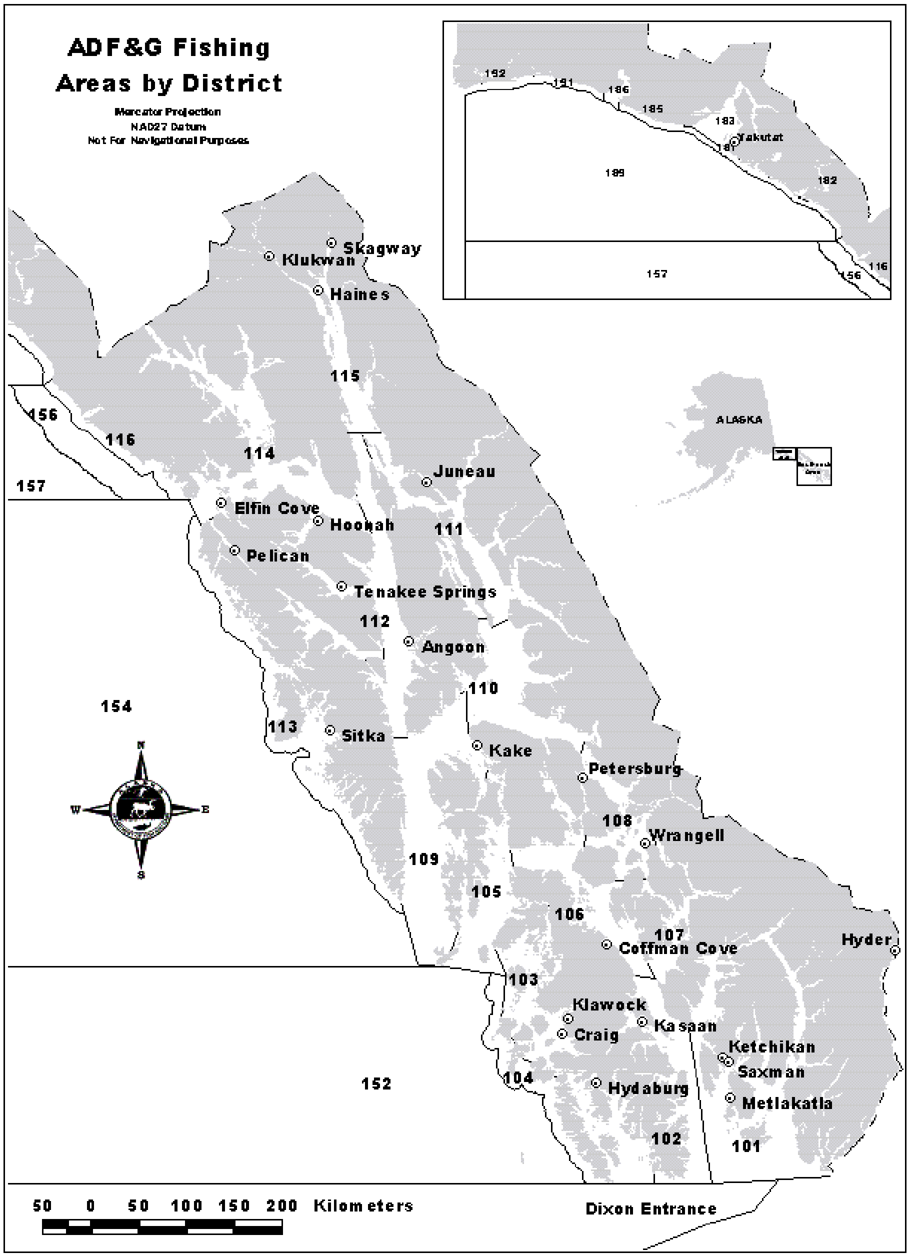

Figure 5.1. Map of Southeast Alaska, showing the ADF&G commercial salmon regulatory district, and major population centers.

A 1996 American Fisheries Society sponsored study of salmon stocks at risk in Southeast Alaska identified 1,516 chum salmon spawning locations (Baker et al. 1996). They estimated that 50% of those locations had some escapement data, and only 45 spawning locations (3% of the total) possessed enough information for formal evaluation using their methods. Of the 45 locations, they evaluated, Baker et al. (1996) classified 8 (18%) as increasing, 27 (60%) as stable, 9 (20%) as declining, and 1 (2%) in precipitous decline. Although they did not single out chum salmon as a species with any stocks at risk, they did state: "little is known about the actual abundance and escapement of the vast majority of spawning aggregations in Southeast Alaska. This is especially true for steelhead, chum, and coho salmon..." Van Alen (2000) examined stock trends for Pacific salmon in Southeast Alaska, and also noted the lack of stock-specific information for chum salmon.

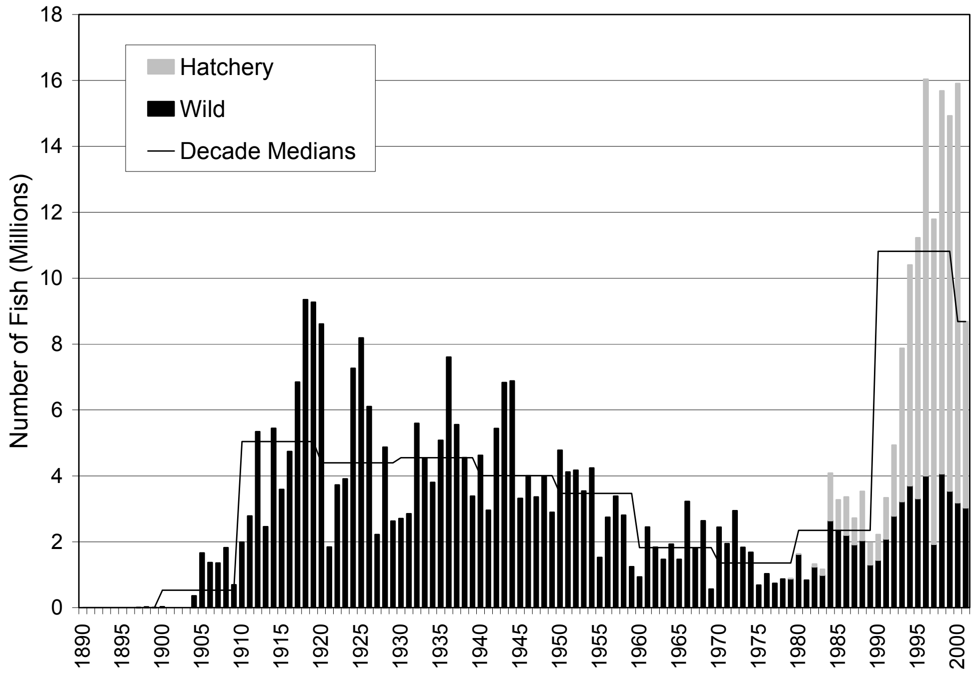

Figure 5.2. Annual harvest of chum salmon in Southeast Alaska from 1890 to 2001, showing the harvest of both hatchery-produced and wild chum salmon.

The Alaska Department of Fish and Game (ADF&G) has long-term standardized survey programs to estimate spawning abundance, or to estimate an index of spawning abundance for only a handful of chum salmon streams in Southeast Alaska. Several stocks have been monitored annually by foot surveys (e.g., Dry Bay Creek, near Petersburg, and several Juneau and Sitka area streams) or a series of foot surveys (e.g., Fish Creek, near Hyder); in-river fish wheel counts have been used to monitor salmon escapements in 2 large, glacial, mainland river systems (Taku and Chilkat Rivers). However, the vast majority of ADF&G's information about the region's chum salmon escapements comes from aerial surveys.

Aerial escapement surveys are conducted by ADF&G Division of Commercial Fisheries management staff, primarily to estimate escapements of pink salmon (*O. gorbuscha)* in conjunction with management of the purse seine fishery. The purse seine fishery is generally directed at pink salmon. Thus, most estimates of chum salmon have been conducted incidentally, or secondarily, to pink salmon. Chum salmon in Southeast Alaska are generally divided into 2 runs based on migration timing: summer-run fish peak from mid-July to mid-August, and fall-run fish peak in September or later. Chum salmon are most easily observed early in the season when there are few pink salmon in the streams. As the season progresses, and large numbers of pink salmon enter streams, it frequently becomes much more difficult to see and count chum salmon. Peak annual counts of chum salmon for many streams have been limited to the period before pink salmon become abundant in the streams. Counts of chum salmon are not possible, and sometimes not even attempted, late in the season in those 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).

The Sustainable Salmon Fisheries Policy (5 AAC 39.222) requires 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. Here we provide an overview of the status of chum salmon in Southeast Alaska in two parts: 1) an overview of trends in Southeast Alaska chum salmon streams, based on trends in escapement survey data; and 2) an overview of chum salmon systems that have been monitored more intensely, support directed fisheries, or warrant more attention (Fish Creek summer chum, Tenakee Inlet summer chum, Cholmondeley Sound fall chum, Taku River fall chum, Chilkat-Klehini River fall chum, and East Alsek River fall chum). The first Alaska Board of Fisheries meeting on Southeast Alaska salmon issues since the new Sustainable Salmon Fisheries Policy has been in effect takes place in February 2003. This document has been developed to meet the major reporting requirements of the Sustainable Salmon Fisheries Policy and Escapement Goal Policy as they relate to chum salmon in the Southeast Alaska and Yakutat area.

OVERALL STOCK STATUS IN SOUTHEAST ALASKA

Estimation of the Catch

Salmon landings from individual commercial fishers are recorded on fish tickets. Information recorded on the tickets includes the vessel name, Commercial Fisheries Entry Commission permit number, total weight of the harvest by species, and date and area of harvest. Catch in units of total weight are converted into units of fish numbers by the processors, based on their own, individual, methods of determining the average weight of individual fish. When actual numbers of fish are not recorded on the grounds on fish tickets, the number of each species is entered on the tickets using the average weights determined by the individual processors. Fish tickets are legal documents and serve as the basis of payment on the part of the processors to the fishers. State regulations require fish tickets to be delivered to ADF&G within 7 days of a landing. Information from these tickets is entered into the ADF&G Fish Ticket Database System, and the total weight and the estimated total number of commercially harvested salmon is available in electronic format to biologists in various time and spatial summaries for all years since 1960. Estimates of the annual harvest of chum salmon prior to statehood were taken from Byerly et al. (1999).

The annual estimated contributions of hatchery fish to the commercial fisheries were obtained from the hatchery operators, as reported to ADF&G (e.g., McNair 2002, and previous reports in that series). Hatchery operators provided the total number of fish harvested for cost recovery purposes, and broodstock, and estimates of the contribution of their fish to the common property fisheries, broken out by troll, drift gillnet, and purse seine gears. The methods used to calculate common property harvests are not reported, however, and the accuracy of the contribution is unknown. Most operators used some combination of mark–recovery (coded wire tags or thermal otolith marks) to calculate contribution to traditional mixed stock fisheries, and terminal harvest areas were considered to be 100% hatchery fish. Estimates of the total harvest of wild chum salmon were then calculated by subtracting the total cost recovery harvest, and the estimated contribution of hatchery fish to the common property fisheries, from the total commercial harvest of chum salmon. We assume that harvest levels are known without substantial error. However, there is some error in these estimates, particularly for estimates of the contribution of hatchery fish. 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.

Escapement Surveys

There are about 1,200 streams and rivers in Southeast Alaska for which ADF&G has a record of at least one adult chum salmon count, in at least one year, since 1960 (data retrieved from the ADF&G Integrated Fisheries Database on October 22, 2002). Those counts were obtained primarily from aerial surveys conducted from small, fixed wing aircraft (e.g., Piper Super Cub[a]) flown at an altitude of 150 to 200 m, and a speed of 90 km · hr^{-1}. Other survey types include foot, boat, and helicopter surveys, and weir counts.

For each survey, and for each stream, surveyors record their estimates of fish abundance in 4 categories: mouth, intertidal, stream live, and stream dead. *Mouth counts* consist of any fish observed in saltwater that are in immediate proximity to, but not in, the stream being surveyed. *Intertidal counts* include fish observed in the area from low tide to the approximate high tide mark, and *stream counts* normally include all fish observed above the high tide mark. Since 1997, each survey has additionally been qualified based on visibility and timing as: 1) not useful for indexing or estimating escapement; 2) potentially useful for indexing or estimating escapement; and 3) potentially useful as a peak escapement count. The vast majority of the approximately 1,200 streams retrieved from the ADF&G database do not have a long time series of data—probably because most are not significant producers of chum salmon, and survey effort has been directed at the more productive chum salmon streams.

These data have many limitations, but the primary limitation is that these subjective, raw survey data can only be used *as is* at this point in time. Commonly, in other areas of Alaska or with other species, aerial observations are statistically manipulated to account for observer bias (Bue et al. 1998) or to standardize observers to a principal observer (Zadina et al. *in this volume*). No effort has been made to standardize these chum salmon survey data. The "peak" escapement estimates that we use here underestimate the true escapement, and should only be considered a relative indicator of escapement magnitude (Van Alen 2000). The majority of aerial surveys have been conducted to monitor inseason development of pink salmon escapements for management purposes, not to estimate total escapements.

In order to look at trends in peak escapement estimates, the large amount of available information must be reduced to the streams with consistent and long-term series of surveys. Van Alen (2000) looked at broad trends in chum salmon escapement in Southeast Alaska by confining his analysis to the 180 streams that had "peak" aerial survey estimates for at least 10 years, between 1960 and 1996. Peak survey estimates of chum salmon included any combination of mouth, intertidal, and stream live and dead counts.

We further reduced the total to 82 streams (76 summer-run chum salmon streams and 6 fall-run chum salmon streams; Appendix 5.1) based on the following criteria:

1) Those streams that had peak survey estimates for at least 16 of the most recent 21 years, from 1982 to 2002; i.e., there were useful survey counts available for 75% of the most recent 21 years. The exception to this is that we did not use streams that had a gap in the time series of more than 3 years.

[a] Product names used in this publication are included for scientific completeness but do not constitute product endorsement.

2) For each stream, only one type of survey data was used for the entire series; i.e., we did not mix survey types for any one stream, even if a foot survey estimate was higher than an available aerial survey estimate for a given year, or only a foot survey estimate was available. In general, foot surveys are not comparable to aerial surveys, as aerial surveyors may not be able to see the entire stream due to riparian cover, and do not see the stream from the same perspective as surveyors on the ground. We used peak aerial survey estimates for 78 streams, and peak foot survey estimates for 4 streams. (Very few streams have a long time series of foot surveys.)
3) Survey estimates had to be obtained in a fairly consistent timing and method year after year. We did not include streams that had primarily in-stream counts for a period of years, and then mouth counts for another period of years; or streams that had been surveyed primarily in late July–early August for a period of years, and then surveyed primarily in late August–early September for another period. Ideally, there would be at least several years with multiple surveys over the course of the season that established good timing for a peak survey for a given stream.

Other authors have used interpolation to predict missing peak survey counts in a given year for streams that were not surveyed, or for which an acceptable survey was not completed (e.g., Van Alen 2000, Zadina et al. 2003). We did not find it necessary to interpolate for missing peak survey counts, because we used only streams with a fairly complete time series. We experimented with limited interpolation, but interpolating for the few missed counts did not affect the results of the analysis we present here, and we chose to avoid interpolation for missing values.

The 82 streams that we have chosen represent spawning escapements of wide ranging magnitude, based on the 21-year-median escapement estimate for each stream (Table 5.1). The minimum 21-year-median escapement estimate for an individual stream was 305 fish (Windfall Harbor W. Side; ADF&G Stream Number 111-15-024), and the maximum was 22,000 fish (Disappearance Creek; ADF&G Stream Number 102-40-043). About one-third of the streams had 21-year-median escapement survey estimates of 1,000 fish or less.

Table 5.1. Distribution of chum salmon index streams by size, based on the 21-year median survey estimate for each stream.

Median Survey Estimate	Number of Streams	Proportion of Total
<500	11	13%
500 to 1,000	19	23%
1,000 to 2,000	17	21%
2,000 to 3,000	6	7%
3,000 to 4,000	5	6%
4,000 to 5,000	6	7%
5,000 to 6,000	2	2%
6,000 to 7,000	5	6%
7,000 to 8,000	2	2%
8,000 to 10,000	4	5%
10,000 to 15,000	3	4%
15,000 to 22,000	2	2%
Total	82	

Trends in Catch and Escapement

Salmon recruitment is strongly influenced by oceanographic processes that cause the stocks to periodically increase or decrease (Quinn and Marshall 1989; Beamish and Bouillon 1993; Adkison et al. 1996; Mantua et al. 1997, and many others). As all salmon stocks are generally increasing or decreasing, we used a nonparametric approach, described by Geiger and Zhang (2002), to evaluate the most recent 21 years of escapement index values for each chum salmon stream, to attempt to classify stock declines as meaningful or not (Appendix 5.1). This method provides a robust estimate of a stock's increase or decline over a given time series, by fitting a resistant regression trend line to the data. The regression line is then used to back-cast to an estimate of an escapement at year zero, which we call the *year-zero reference point*, and the slope of the line is a robust estimate of the stock's decline (or increase). We would conclude that an escapement decline was *biologically meaningful* when the estimated underlying annual decline was more than 3% of the year-zero escapement, based on the recommendation of Geiger and Zhang. A sustained 21-year, overall decline that is 3% of the back-cast year-zero reference point would result in the stock declining by more than 60% (Geiger and Zhang 2002). We also used Spearman's rho rank correlation coefficient, a nonparametric correlation coefficient, to test for significant ($\alpha = 0.05$, two tailed) relationships between peak survey estimates and time (Conover 1980).

Taken as a whole, the chum salmon stocks that we chose as index streams showed a statistically significant, increasing trend in peak escapement survey estimates since 1982 (Spearman's rank: $r_s = 0.797$; $P = 0.0001$; $n = 21$), and an annual increase that was 5.2% of the year-zero reference point per year, over the 21-year series (Figure 5.3). Using the same Geiger and Zhang (2002) analysis of the annual catch, we see that it too has followed a similar increasing trend; 3% of the year-zero reference point per year since 1982 (Figure 5.3). Most ADF&G commercial salmon regulatory districts also showed an increase in trends for the groups of chum salmon streams that we chose (Table 5.2). The one exception was District 109, which showed a robust estimate of decline (although not statistically significant) in peak survey estimates of 0.7% per year (Table 5.2). Districts 111, 112 and 114 showed significant increasing trends in peak escapement survey estimates ($P < 0.05$).

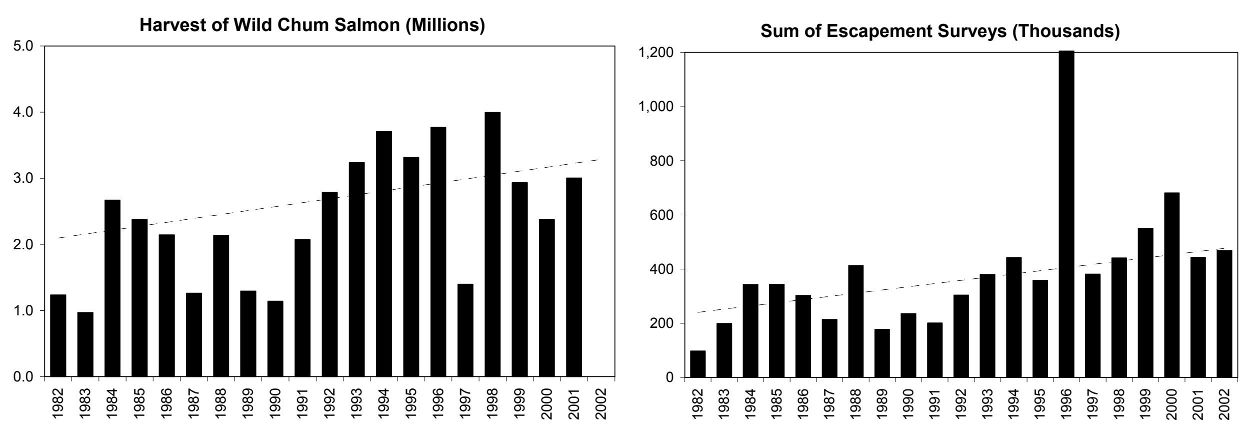

Figure 5.3. Annual estimated commercial harvest and overall escapement index, of wild chum salmon in Southeast Alaska from 1981 to 2002 (harvest data not available for 2002). The dotted line is found by the "resistant regression," and the slope of the line is a robust estimate of increase or decline relative to the size of the harvest at the beginning of the series; in this case an annual increase of 3.0% in the harvest, and 5.2% in the escapement, over the 21-year series.

Table 5.2. Median escapement survey counts of chum salmon by year and ADF&G commercial salmon regulatory district, from 1982 to 2002, together with summary statistics.

District No. of Streams	101 8	102 2	107 2	108 1	109 9	110 12	111 9	112 19	113 6	114 9	115 5
1982	525	NA	2,790	840	650	100	475	500	500	1,220	2,490
1983	2,150	3,500	14,100	812	680	150	225	2,875	2,250	2,250	825
1984	6,000	14,000	8,740	3,470	2,095	1,100	1,800	1,800	17,000	3,250	800
1985	5,425	18,500	10,295	1,826	1,650	600	2,400	2,500	3,750	4,025	1,655
1986	3,300	14,000	1,200	1,068	4,500	550	850	2,000	3,250	3,100	600
1987	5,000	22,100	5,300	1,040	1,550	600	391	1,000	3,500	2,150	800
1988	18,750	21,000	6,505	1,280	1,200	3,375	609	1,600	3,500	950	800
1989	5,800	17,400	14,000	404	1,300	450	300	1,000	1,610	855	225
1990	2,750	15,150	1,665	4,095	960	1,500	600	1,500	3,250	1,750	750
1991	5,000	23,000	14,850	265	1,800	700	200	1,000	1,228	1,500	900
1992	7,600	18,250	7,825	708	2,900	850	650	4,000	1,570	2,700	450
1993	5,500	29,000	16,400	926	1,100	1,300	450	6,000	1,780	4,100	800
1994	7,750	21,350	2,275	740	600	950	3,500	2,500	3,000	3,400	1,925
1995	6,500	17,500	5,450	570	1,200	525	700	4,200	2,708	4,300	115
1996	12,000	30,750	15,300	2,530	3,200	2,160	6,595	21,000	5,400	9,200	5,700
1997	4,500	15,400	NA	1,420	1,950	800	1,325	5,300	8,000	5,600	535
1998	10,000	29,250	3,550	NA	1,100	600	3,338	3,050	2,516	4,000	1,063
1999	5,000	50,000	13,950	NA	1,400	700	1,635	9,475	8,000	6,500	645
2000	7,500	15,750	7,150	2,280	2,200	2,875	2,250	8,950	28,500	4,000	250
2001	8,000	22,500	8,000	820	1,000	1,050	1,150	3,750	9,200	6,050	6,000
2002	3,000	15,000	2,525	881	300	1,050	3,000	8,000	4,250	4,500	2,900
Estimated Year-Zero Level [a]	4,136	14,089	6,461	789	1,501	480	-136	-771	891	885	665
Robust Estimate of Annual Decline	-179	-446	-76	-25	11	-32	-117	-443	-321	-239	-19
Decline as % of Year-Zero Level					1%						
Increase as % of Year-Zero Level	4%	3%	1%	3%		7%	NA	NA	36%	27%	3%
Spearman's rho rank correlation trend test [b]:											
r_s	0.368	0.393	0.002	-0.058	-0.065	0.418	0.510	0.736	0.415	0.695	0.046
P	0.10	0.09	1.00	0.81	0.79	0.06	0.02	<0.01	0.06	<0.01	0.84
n	21	20	20	19	21	21	21	21	21	21	21

[a] Decline as a percent of year-zero reference point shows the size of a stock decline (or increase) relative to the size of the stock trend at the beginning of the series. District 109 streams show a decrease of 1% per year; all other districts are trending up over the 21-year series.

[b] The Spearman's rho (r_s) is a nonparametric correlation coefficient describing a relationship between peak survey estimates and time. The P-value is the significance level for a test that Spearman's rho is exactly equal to zero (α=0.05, two tailed). The sample size (n) denotes the number of years used for the Spearman's rho statistic.

A total of 67 of the 76 (88%) summer chum salmon stocks showed stable or increasing trends in survey counts (Appendix 5.1). Nine of the 76 (12%) summer chum salmon index streams showed a robust estimate of decline in peak escapement surveys over the last 21 years, and 6 of those streams showed declines of 3% to 4% of the reference point per year, which we considered biologically meaningful under Geiger and Zhang's criteria: Hidden Inlet (ADF&G Stream Number 101-11-101), Tombstone (ADF&G Stream Number 101-15-019), Tyee Head East (ADF&G Stream Number 109-30-016), Sample Creek (ADF&G Stream Number 109-62-014), St. James Bay NW Side (ADF&G Stream Number 115-10-042), and Clear River-Kelp Bay (ADF&G Stream Number 112-21-005). Four of the fall chum salmon index streams were stable or showed increasing trends in peak survey counts, while 2 showed a robust estimate of decline in peak escapement surveys over the past 21 years: 5% of the reference point per year at Port Camden S Head (ADF&G Stream Number 109-43-006), and 4% of the reference point per year at Port Camden W Head (ADF&G Stream Number 109-43-008). Of the 82 index stocks we examined, these 2 streams were the only ones that showed a statistically significant decline in peak survey counts over the past 21 years ($P < 0.05$).

Thus, 71 of the 82 (87%) chum salmon index streams that we examined showed no statistically detectable trend or an increasing trend in peak survey estimates over the past 21 years, and 27 (33%) of those streams showed a statistically significant increasing trend ($P < 0.05$). Increasing trends were particularly pronounced for many streams in northern areas of the region. Fifteen of the 19 index streams in District 112 showed a statistically increasing trend in peak survey counts, as did 5 of 9 index streams in District 114, 3 of 6 index streams in District 113, and 3 of 9 index streams in District 111.

Although chum salmon numbers have probably increased in Districts 111, 112, and 114, the rate of increase may be biased high due to changes in surveyors and survey methods over the last decade. The ADF&G Juneau Management Biologist is responsible for conducting aerial surveys in those districts. A long-term management biologist with a high counting bias retired in the early 1990s, and was replaced by a biologist with a lower-than-average counting bias (Jones 1995). That is, one person who consistently estimated lower numbers of fish than other management staff was replaced by a person who tended to estimate higher numbers of fish than other management staff. Streams in District 112 have been surveyed more often in the same year in the 1990s than they were in the 1980s, and, as a result, surveys conducted in the 1990s were probably better at approximating the “peak” in those streams. The management staff has remained fairly stable over the past 20 years in other areas. Many of the peak survey estimates for streams in the Ketchikan and Petersburg areas were obtained by the same one or two people.

EXAMINATION OF SPECIFIC STOCKS

The following section includes a more detailed summary of available information on several stocks or groups of stocks of chum salmon in Southeast Alaska and the Yakutat area. Specifically included are several stock groups that support directed commercial fisheries, stocks for which escapement assessment programs are based on methods other than aerial surveys, and stocks that appear to have experienced declines in production in recent years.

Fish Creek Summer Chum Salmon

Portland Canal is located along the Canadian border in southern Southeast Alaska. Chum salmon spawning in Portland Canal were specifically identified in the 1985 Pacific Salmon Treaty (Pacific Salmon Treaty, Annex IV, Chapter 2, 1985 and all subsequent revisions) as stocks that “require rebuilding, [and] the Parties agree in 1985 to jointly reduce interception of these stocks to the extent practicable and to undertake assessments to identify possible measures to restore and enhance these stocks. On the basis of such assessments, the Parties shall instruct the Commission to identify long-term plans to rebuild stocks.” In the revised 1999 Treaty Annex IV, the parties agreed to not conduct directed net fisheries in certain waters of Alaska Section 1-A and 1-B, and Canadian areas 3-11 and 3-13, unless agreed otherwise by the parties.

The summer-run chum salmon at Fish Creek (ADF&G Stream Number 101-15-085), near Hyder, has been studied by the National Marine Fisheries Service since the early 1970s (Helle 1984; Helle and Hoffman 1995, 1998), and ADF&G conducted a coded wire tagging study there from 1988 to 1995 (Heinl et al. 2000). The tagging study showed that Fish Creek chum salmon were harvested in the highly mixed-stock waters in and around Dixon Entrance. From 1991 to 1995, the average exploitation rate on Fish Creek chum salmon was 56.7% (range 38.1 to

67.8%). The harvest of Fish Creek chum salmon was distributed about equally between the U.S. (average 53.8%;) and Canada (average 46.2%), though the distribution was quite variable from year to year between the predominant intercepting fisheries (Alaskan District 101-11 drift gillnet and District 104 purse seine; and Canadian Area 3 gillnet and seine). Harvest data do not exist for any other years, and there is not sufficient information to establish a formal *biological escapement goal* for Fish Creek chum salmon.

Foot surveys have been conducted for many years at Fish Creek (Helle and Hoffman 1998), forming one of the best escapement records for any chum salmon system in southern Southeast Alaska. The total escapement is estimated annually from a series of 3 foot surveys conducted over the course of the season (Heinl et al. 2000; Table 5.3). Estimated escapements of Fish Creek chum salmon have been highly variable, and show a downward (but not biologically meaningful) trend over the past 21 years, from 1982 to 2002 (i.e., a robust estimate of decrease of 1.7% per year; Figure 5.4). Examination of either the peak August foot survey estimates alone, or the peak August aerial survey estimates alone, both show a robust estimate of decline of just over 3% of the reference point per year (Table 5.3). Recent estimated escapements have generally been below the 32-year average of 25,000 fish; including the 2 lowest estimated escapements in 1997 (2,838), and 1999 (5,350). As already noted, 2 other chum salmon index streams in Portland Canal have also shown a robust estimate of decline over the past 21 years: Hidden Inlet (ADF&G Stream Number 101-11-101; 3% per year) and Tombstone River (ADF&G Stream Number 101-15-019; 4 % per year; Appendix 5.1).

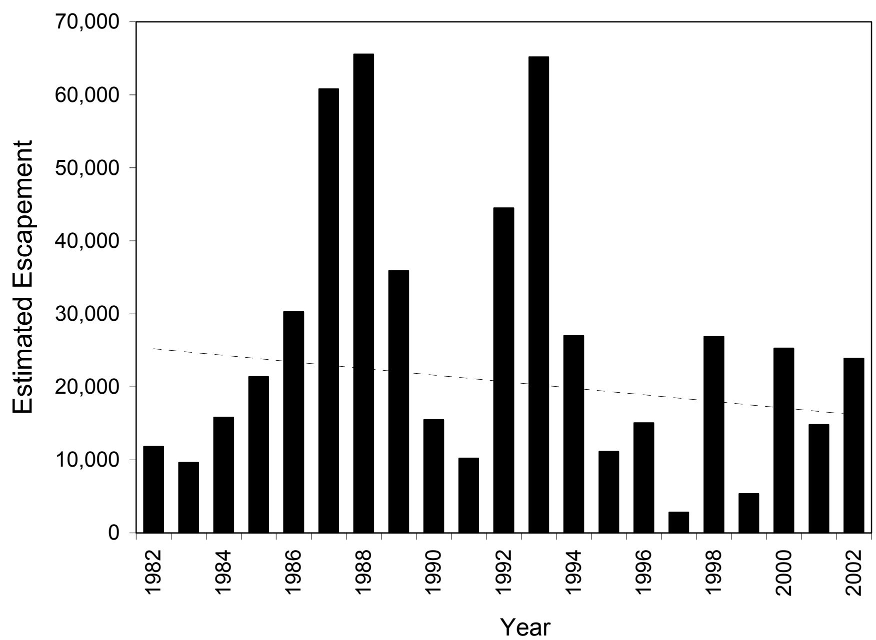

Figure 5.4. Annual estimated escapement of chum salmon in Fish Creek (ADF&G Stream Number 101-15-085) from 1982 to 2002. The dotted line is found by the "resistant regression," and the slope of the line is a robust estimate of increase or decline relative to the size of the escapement at the beginning of the series; in this case an annual decrease of 1.7% over the 21-year series.

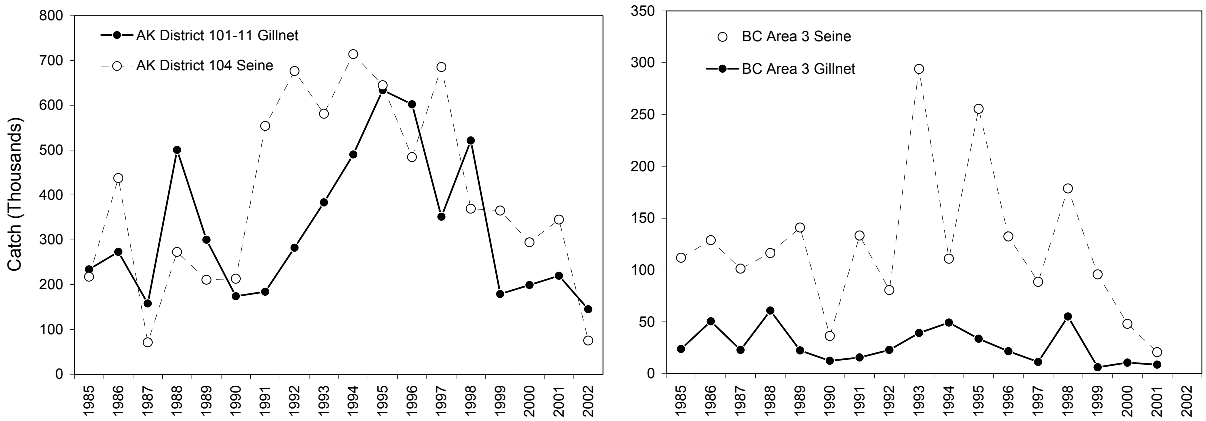

Figure 5.5. Annual commercial harvest of chum salmon in Alaska and British Columbia net fisheries in the Dixon Entrance area from 1985 to 2002.

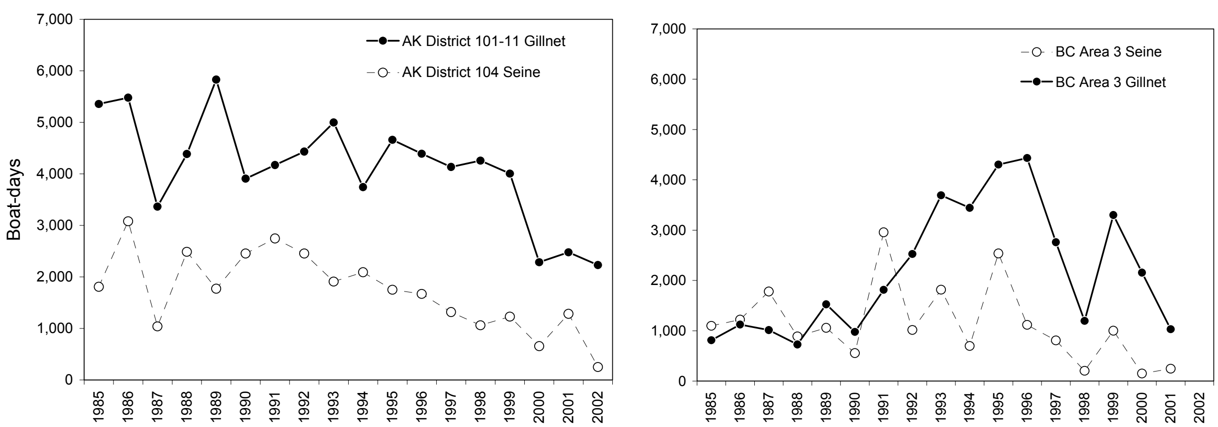

Figure 5.6. Fishing effort (boat-days) in Alaska and British Columbia commercial net fisheries in the Dixon Entrance area from 1985 to 2002.

The impact that commercial fisheries in the Dixon Entrance area have on Portland Canal chum salmon runs is complex and difficult to assess. Fisheries in the area generally target mixed stocks, catches have been influenced by hatchery production over the last decade, and there is substantial variation in fishing effort and the length of the fishing season, not only among different fisheries in the same year, but also in the same fishery in different years. Both the harvest of chum salmon and fishing effort have generally declined since the mid-1990s in the fisheries where most Portland Canal chum salmon are harvested (Figures 5.5 and 5.6); however, catch-per-unit-effort (CPUE) of chum salmon has not declined, indicating that chum salmon abundance has remained fairly stable (Figure 5.7).

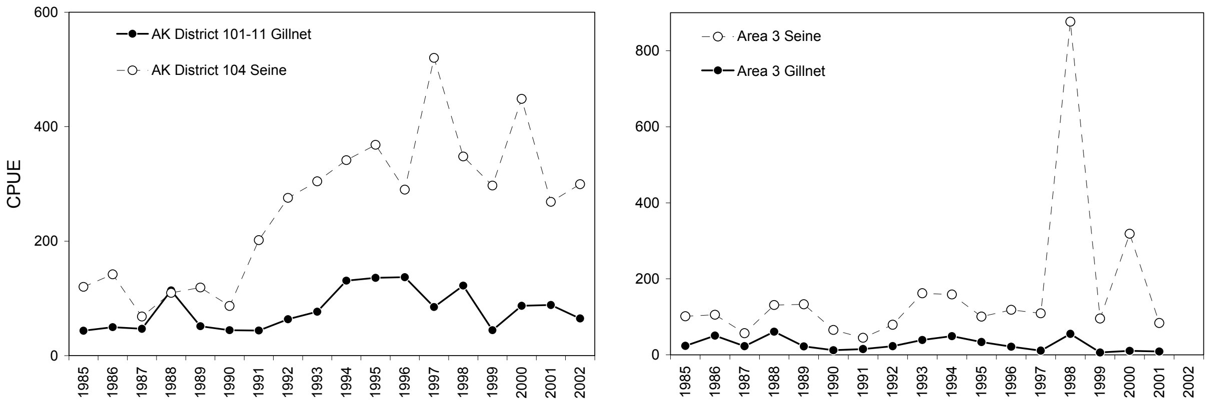

Figure 5.7. Catch-per-unit-effort (CPUE) of chum salmon in Alaska and British Columbia commercial net fisheries in the Dixon Entrance area from 1985 to 2002.

Table 5.3. Fish Creek (ADF&G Stream Number 101-15-085) chum salmon escapements estimated from foot survey counts, together with summary statistics, 1971 to 2002.

Year	Estimated Escapement	95% Pred. Interval -	95% Pred. Interval +	Weir Count	Peak August Foot Survey	Peak August Aerial Survey
1971	20,583	14,206	29,821			
1972	38,197	26,363	55,342		7,300	
1973	18,805	12,979	27,245		3,200	1,100
1974	28,530	19,691	41,336		8,000	400
1975	35,964	24,822	52,106		1,300	
1976	17,347	11,973	25,133		2,321	2,700
1977	15,631	10,789	22,648		2,734	
1978	7,439	5,134	10,778		3,418	1,600
1979	66,214	45,700	95,934		19,581	2,400
1980	19,520	13,473	28,282		6,805	3,025
1981	10,274	7,091	14,886		1,797	825
1982	11,829	8,165	17,139		4,069	1,400
1983	9,633	6,648	13,956		3,300	
1984	15,824	10,922	22,927		3,549	5,700
1985	21,383	14,758	30,980		5,685	
1986	30,277	20,897	43,868		6,753	1,300
1987	60,795	41,961	88,084		8,141	3,000
1988	65,548	45,241	94,970		23,476	11,800
1989	35,903	24,780	52,018		13,593	
1990	15,494	10,694	22,448		3,666	2,950
1991	10,230	7,060	14,821	9,996	1,061	1,500
1992	44,502	30,715	64,478	46,971	15,236	2,500
1993	65,184	44,990	94,442	60,447	25,807	4,200
1994	27,014	18,645	39,139	32,319	6,047	
1995	11,147	7,694	16,151	9,742	3,667	2,200
1996	15,067	10,399	21,830		3,243	3,000
1997	2,838	1,959	4,112		582	200
1998	26,912	18,575	38,992			1,400
1999	5,350	3,692	7,751		1,380	400
2000	25,282	17,450	36,630		7,468	2,150
2001	14,823	10,231	21,476		1,770	800
2002	23,904	16,498	34,633		5,392	5,000
Estimated Year-Zero Level [a]	26,117				7,244	3,557
Robust Estimate of Annual Decline	451				227	114
Decline as % of Year-Zero Level	1.7%				3.1%	3.2%
Spearman's rho rank correlation trend test [b]:						
r_s	-0.136				-0.220	-0.269
P	0.56				0.35	0.30
n	21				20	17

[a] The year-zero reference point and the robust estimate of stock decline are based on the most recent 21 years (1982-2002) of data, and not the entire series. Decline as a percent of year-zero reference point shows the size of a stock decline (or increase) relative to the size of the stock trend at the beginning of the series.

[b] The Spearman's rho (r_s) is a nonparametric correlation coefficient describing a relationship between peak survey estimates and time. The P-value is the significance level for a test that Spearman's rho is exactly equal to zero (α=0.05, two tailed). The sample size (n) denotes the number of years used for the Spearman's rho statistic.

Tenakee Inlet Summer Chum Salmon

Tenakee Inlet, located along the Chatham Strait shoreline of Chichagof Island, is among the largest producers of wild summer chum salmon in the Alexander Archipelago. A series of river systems drain into Tenakee Inlet from the south side and head of the inlet. Summer-run chum salmon return and spawn in each of these river systems as well as several other smaller streams that drain into the inlet. This area supports one of the few directed commercial purse seine fisheries on wild summer-run chum salmon in Southeast Alaska. Early season management of the Tenakee Inlet commercial purse seine fishery is based primarily on chum salmon returns from late June through early July (thereafter, management emphasis for the fishery switches to pink salmon). Chum salmon harvests in the purse seine fishery in Tenakee Inlet have increased substantially since the late 1970s. Catches averaged 40,000 fish from 1977 to 1989, but increased to an average of 134,000 fish from 1990 to 2002, including several years when catches exceeded 300,000 chum salmon (Figure 5.8). 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.

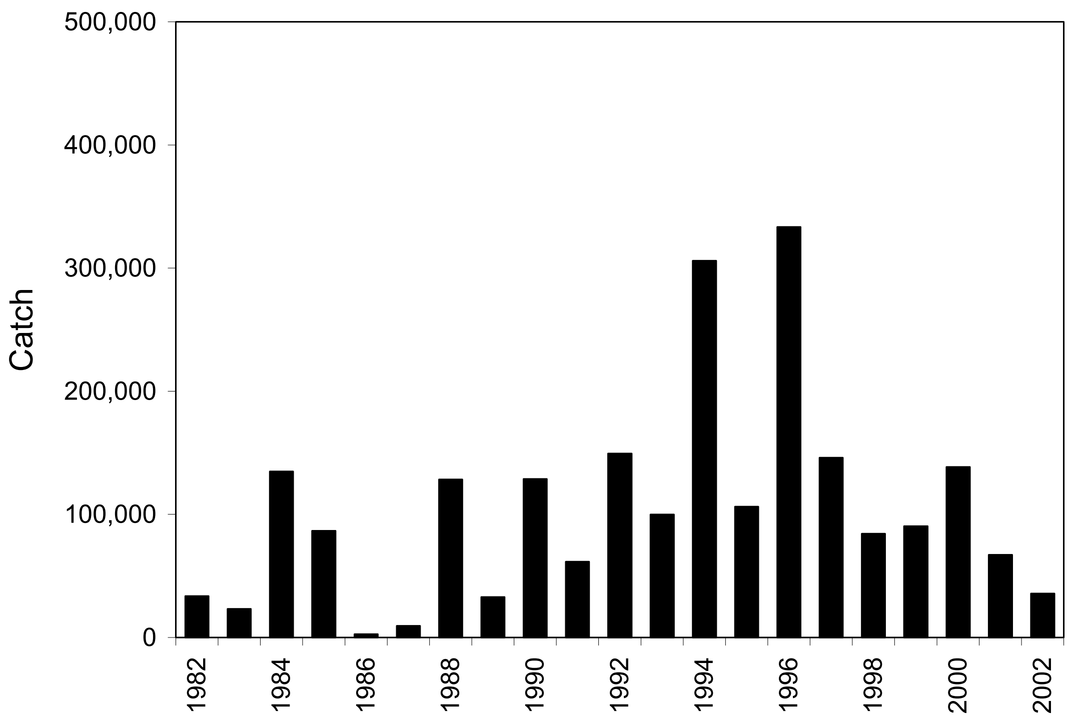

Figure 5.8. Annual harvest of chum salmon in the Tenakee Inlet (District 112; Subdistricts 41, 42, and 45) commercial purse seine fishery from 1982 to 2002.

Tenakee Inlet chum salmon escapements were historically monitored using a combination of aerial and foot surveys, and a counting weir on the Kadashan River (ADF&G Stream Number 112-42-025) from 1969 to 1988. Operation of the Kadashan River weir was discontinued for budgetary reasons, and aerial surveys now serve as the primary method for monitoring escapements to all of the major Tenakee Inlet chum salmon systems. Aerial survey data show a large increase in the annual peak estimates in all 8 of the major chum salmon index streams in the inlet (Appendix 5.1: Kadashan River, Saltery Bay, Seal Bay, Long Bay, Big Goose, Little Goose, West Bay Head, and Tenakee Inlet Head) between 1982 and 2002. Pooled data for those streams show a combined increasing trend in peak escapement estimates over the past 21 years (Figure 5.9). Although it is possible that escapement trends in recent years may be influenced by changes in surveyors over the last decade, trends in the commercial harvest of chum salmon in the Tenakee Inlet fishery follow a similar pattern as escapement estimates (Figure 5.8). Despite the data limitations, it is apparent that production of Tenakee Inlet summer chum salmon has exhibited an upward trend over the last several decades.

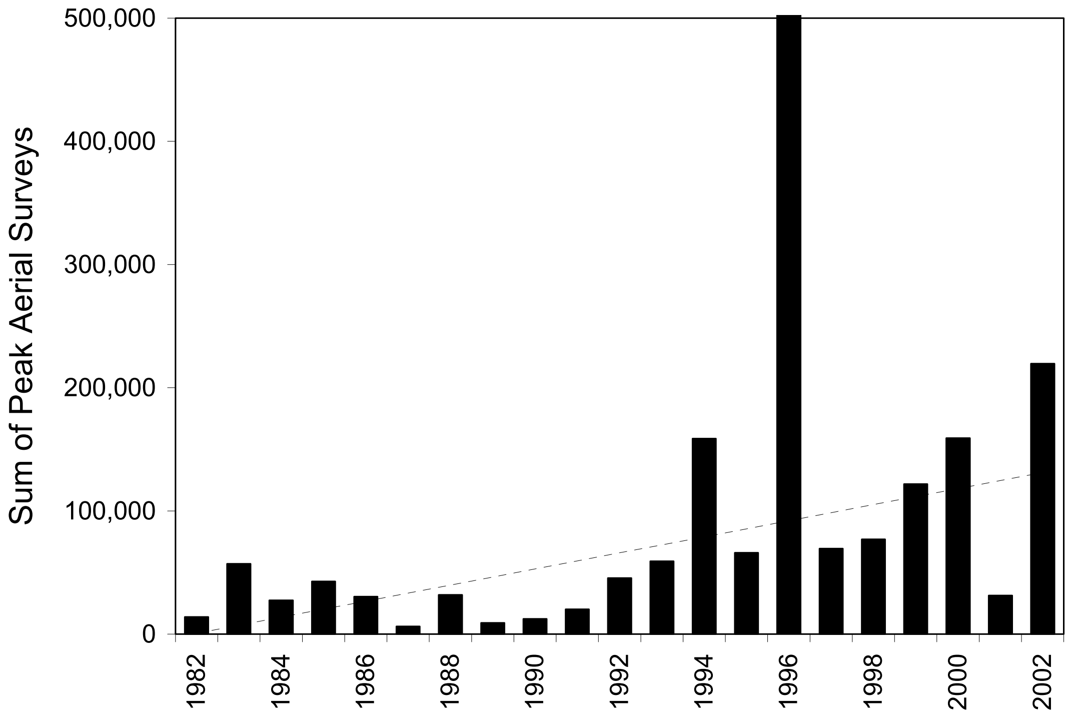

Figure 5.9. Sum of annual peak aerial survey estimates of chum salmon on 8 Tenakee Inlet (District 112; Subdistricts 42, 44, 46, 47, and 48) chum salmon index streams from 1982 to 2002. The dotted line is found by the "resistant regression," and the slope of the line is a robust estimate of increase or decline relative to the size of the escapement at the beginning of the series; in this case an annual increase of 111% over the 21-year series.

Cholmondeley Sound Fall Chum Salmon

Cholmondeley Sound (District 102-40) is located on the eastern side of Prince of Wales Island, in southern Southeast Alaska. Management of the fall chum salmon commercial purse seine fishery in Cholmondeley Sound, for the past 25 years, has been 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; P. Doherty, Area Management Biologist, ADF&G, Ketchikan, personal communication). 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.

Since 1985, the escapement at Disappearance Creek has been monitored using aerial surveys, with peak estimates ranging from 16,000 to 50,000 fish (5.1). Peak aerial survey estimates at Lagoon Creek since 1983 have ranged from 4,000 to 50,000 fish. Pooled data for the systems show a combined increasing trend in peak escapement estimates over the past 21 years (a robust estimate of increase of 3.4% of the reference point per year; Figure 5.10). The fall commercial purse seine fishery in District 102, which targets returns to these 2 rivers, also shows an increasing trend in harvests since statehood (Figure 5.11). Although our stock assessment methods for Cholmondeley Sound fall chum salmon do not allow an accounting of total runs for the 2 major contributing stocks, trends in escapement and commercial harvests indicate the runs are healthy and producing at high levels.

Chilkat River Fall Chum Salmon

The Chilkat River drainage supports a fall run of chum salmon—one of the largest 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 chum salmon stocks are primarily harvested in the Lynn Canal (District 115) commercial drift gillnet fishery. The run timing of the fall-run fish is well segregated from the return of summer-run chum salmon, which is a mixture of wild and enhanced fish (Figure 5.12).

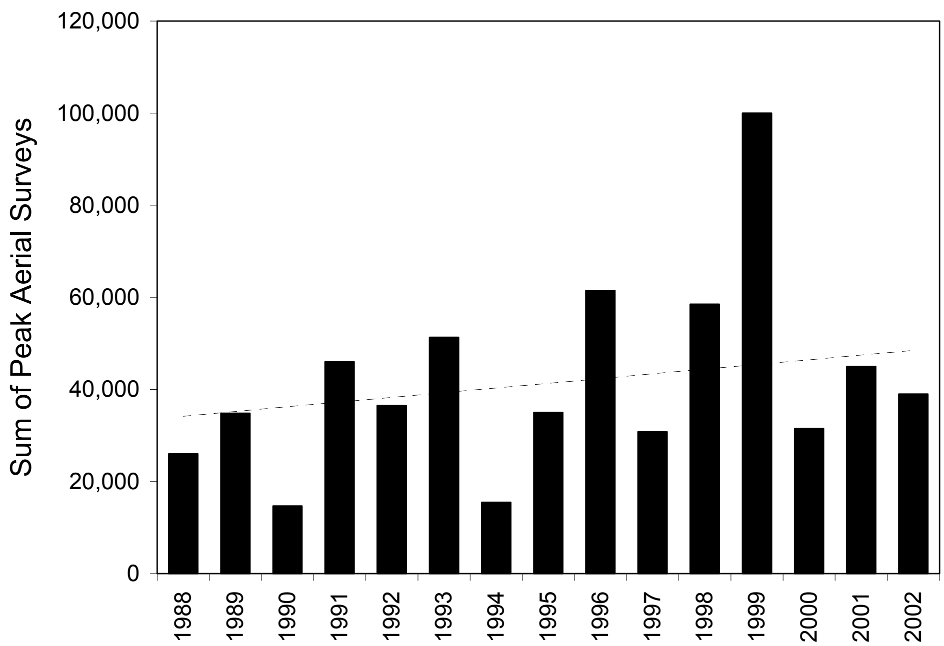

Figure 5.10. Sum of annual peak aerial survey counts of chum salmon in Disappearance Creek (ADF&G Stream Number 102-40-043) and Lagoon Creek (ADF&G Stream Number 102-40-060), Cholmondeley Sound from 1988 to 2002. The dotted line is found by the "resistant regression," and the slope of the line is a robust estimate of increase or decline relative to the size of the trend at the beginning of the series; in this case an annual increase of 3.4% over the 15 years of data.

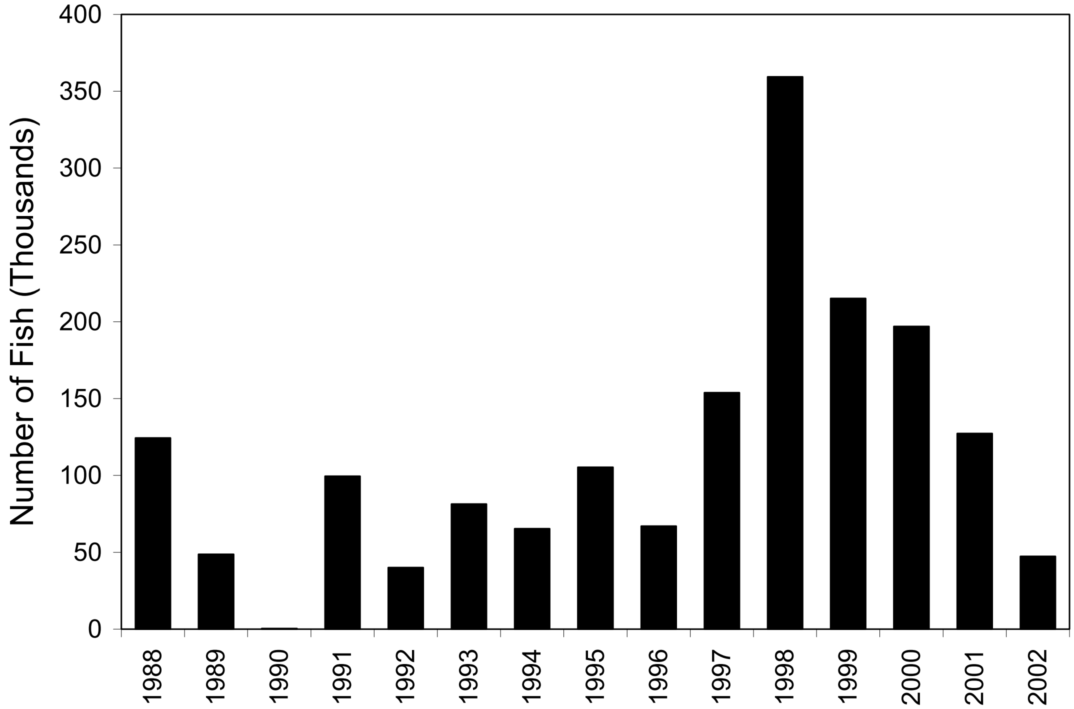

Figure 5.11. Annual harvest of chum salmon in the Cholmondeley Sound (District 102-40) commercial fall chum salmon purse seine fishery from 1988 to 2002.

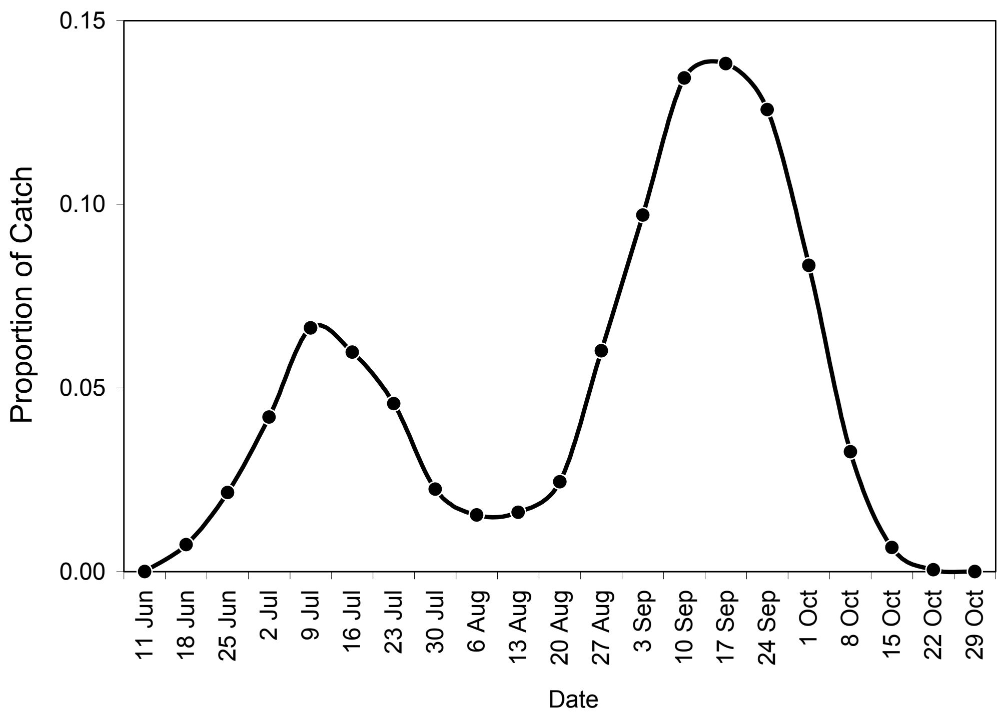

Figure 5.12. Mean run timing of chum salmon in the Lynn Canal (District 115) commercial drift gillnet fishery, illustrated by plotting the mean weekly proportion of the total annual harvest of chum salmon in the fishery, from 1960 to 2002. All chum salmon harvested in Statistical Week 32 (average mid-week date August 6) and later are considered fall-run fish.

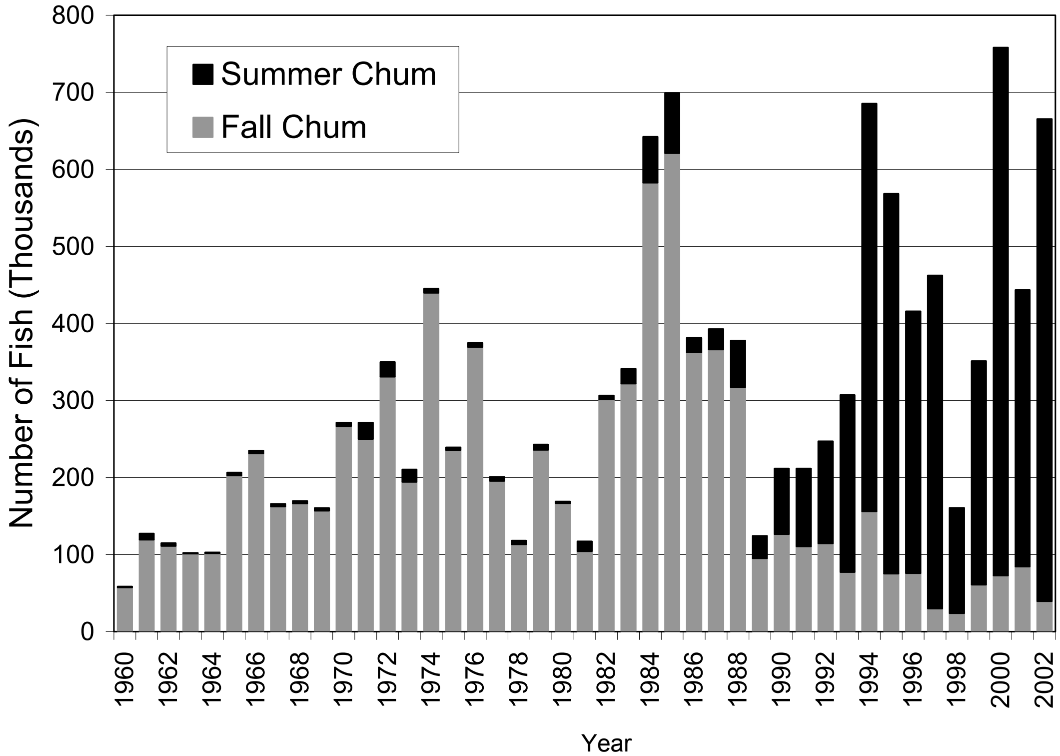

Figure 5.13. Annual harvests of summer and fall chum salmon in the Lynn Canal (District 115) commercial drift gillnet fishery from 1960 to 2002.

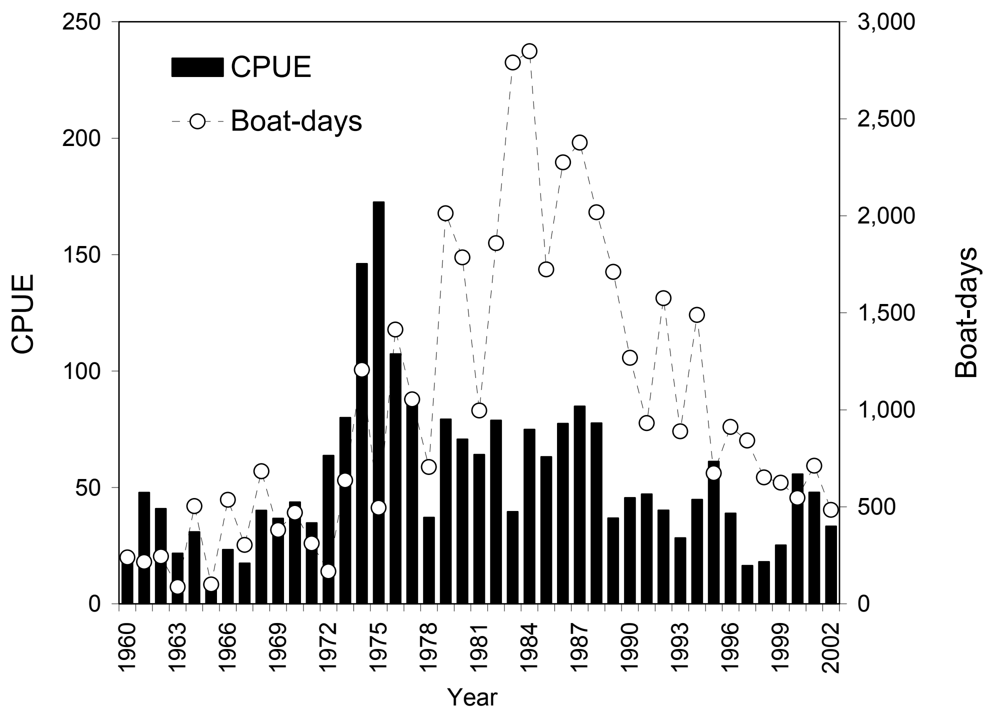

Figure 5.14. Effort (boat-days) and catch-per-unit-effort (CPUE) of fall-run chum salmon in the Northern Lynn Canal (District 115-31) commercial drift gillnet fishery during Statistical Week 32 (average mid-week date August 6) and later, from 1960 to 2002. Catches in this area are thought to reflect the abundance of Chilkat and Klehini River stocks.

Harvests and fisheries performance measures for the Chilkat River fall chum stock are substantially below levels of the 1970s and 1980s, but similar to levels seen in the 1960s (Table 5.4; Figures 5.13 and 5.14). Fishery managers have taken specific management actions in the last decade to limit harvests of Chilkat River chum salmon in the Lynn Canal drift gillnet fishery. In recent years, fishing time and area have been limited during peak weeks of the fall chum salmon return, despite the presence of substantial surpluses of co-migrating Chilkat River and Berners Bay coho salmon *O. kisutch* (and, in some years, late-run Chilkat Lake sockeye salmon *O. nerka*) that are targeted by the fishery. As a result, the escapement goals for Berners River coho salmon and Chilkat Lake late-run sockeye salmon have routinely been exceeded.

Table 5.4. Chum salmon harvests in the Taku Inlet (111-32) and Lynn Canal (District 115) commercial drift gillnet fisheries, from 1960 to 2002. Chum salmon harvested in week 34 (average mid-week date August 20) and later in Taku Inlet, and in week 32 (average mid-week date August 6) and later in Lynn Canal, are considered to be fall-run fish.

	Taku Inlet		Lynn Canal	
Year	Summer	Fall	Summer	Fall
1960	4,540	28,720	1,180	57,382
1961	6,860	14,876	8,016	119,334
1962	5,402	11,812	3,733	111,303
1963	8,085	7,071	983	101,385
1964	3,919	7,822	1,192	101,855
1965	3,604	7,691	4,108	202,454
1966	4,350	27,327	3,657	231,515
1967	1,569	20,463	3,477	162,397
1968	4,646	15,597	3,519	166,096
1969	4,230	9,926	3,545	157,015
1970	14,208	77,026	4,555	266,860
1971	30,905	54,720	21,345	250,077
1972	46,000	60,513	19,044	330,850
1973	30,810	61,025	16,238	194,221
1974	6,474	51,063	5,747	439,612
1975	1,638	31	3,487	235,729
1976	3,766	42,843	5,173	369,614
1977	5,461	43,432	5,581	195,557
1978	7,142	18,101	5,011	113,417
1979	4,314	46,142	7,006	235,826
1980	25,779	131,272	2,295	166,750
1981	10,407	40,212	13,215	104,169
1982	11,504	18,393	5,347	301,325
1983	3,202	7,813	19,303	321,842
1984	28,237	27,967	59,567	582,701
1985	35,997	40,610	77,926	621,074
1986	14,646	24,790	18,987	362,395
1987	32,451	30,019	26,698	366,240
1988	26,431	27,040	60,380	317,388
1989	15,256	15,491	29,038	95,298
1990	88,350	29,131	85,039	126,708
1991	99,498	12,486	101,353	110,484
1992	57,011	11,649	132,634	114,456
1993	101,356	7,760	229,494	77,565
1994	129,350	12,280	529,380	156,069
1995	192,408	8,786	493,279	75,089
1996	295,286	5,245	340,021	75,556
1997	143,354	1,936	432,345	29,985
1998	192,057	2,800	136,515	24,154
1999	327,706	2,641	290,325	60,926
2000	453,147	1,311	685,542	72,709
2001	141,715	1,012	358,987	84,538
2002	108,171	671	625,743	39,518

Chum salmon escapement to the Chilkat River drainage was monitored historically via repeated aerial surveys (Table 5.5); however, the department considers the aerial surveys of the drainage to be unreliable due to the highly glacial nature of the system. In 1990, the department established peak aerial survey escapement goals of 70,000 to 100,000 chum salmon for the Chilkat River, and 20,000 for the Klehini River. There was no scientific basis for the goals and the goals have been eliminated. The best information currently available on chum salmon escapement in the drainage is from the department's Chilkat River fish wheels, which were operated for several years in the 1970s and 1980s, and annually since 1994. The fish wheels have been operated specifically to collect information on sockeye salmon, but limited information has also been collected for chum salmon (Table 5.6). Fish wheel catches from 1999 to 2002 suggest improved escapements in those years.

Table 5.5. Peak aerial survey counts of fall-run chum salmon in the Chilkat (ADF&G Stream Number 115-32-025) and Klehini Rivers (ADF&G Stream Number 115-32-046).

	Chilkat River			Klehini River		
Year	Date of Peak Count	Peak Count	No. of Surveys	Date of Peak Count	Peak Count	No. of Surveys
1966	26-Oct-66	40,000	1	NA	NA	NA
1969	23-Oct-69	17,500	1	NA	NA	NA
1970	21-Oct-70	80,000	1	21-Oct-70	10,000	1
1971	20-Oct-71	73,000	1	20-Oct-71	6,000	1
1972	2-Nov-72	85,000	3	20-Oct-72	2,000	1
1973	16-Oct-73	65,000	2	25-Sep-73	11,000	3
1974	30-Oct-74	7,000	2	30-Oct-74	300	1
1975	22-Oct-75	40,000	4	14-Oct-75	10,000	3
1976	21-Oct-76	120,000	3	21-Oct-76	15,000	3
1978	9-Nov-78	40,000	6	24-Sep-78	2,000	8
1979	6-Nov-79	121,000	4	15-Oct-79	400	4
1980	5-Dec-80	43,000	9	28-Sep-80	12,350	9
1981	17-Nov-81	82,000	15	1-Oct-81	9,000	13
1982	19-Oct-82	98,000	11	29-Sep-82	15,600	12
1983	14-Oct-83	176,000	15	27-Sep-83	13,000	7
1984	29-Nov-84	61,600	6	24-Sep-84	38,500	2
1985	16-Oct-85	91,000	14	20-Sep-85	25,000	2
1987	9-Oct-87	850	1	22-Sep-87	7,500	4
1988	24-Oct-88	15,000	11	22-Sep-88	22,500	4
1989	30-Nov-89	16,200	9	14-Oct-89	1,250	2
1990	30-Oct-90	19,500	9	3-Oct-90	9,850	3
1991	12-Dec-91	29,900	17	27-Sep-91	4,500	2
1992	4-Dec-92	11,000	6	23-Sep-92	24,000	2
1993	NA	NA	NA	11-Oct-93	4,200	1
1994	14-Oct-94	7,000	3	14-Oct-94	7,000	1
1995	20-Sep-95	3,500	2	NA	NA	NA
1996	10-Oct-96	5,500	6	2-Oct-96	3,600	1
1997	30-Oct-97	4,000	2	30-Oct-97	200	1
1998	28-Sep-98	100	2	28-Sep-98	5,000	1
1999	29-Sep-99	220	1	29-Sep-99	8,170	2
2000	8-Nov-00	61,200	2	26-Sep-00	16,900	1
2001	4-Oct-01	3,240	1	4-Oct-01	1,550	1
2002	1-Nov-02	61,800	2	25-Sep-02	1,500	2

Table 5.6. Chum salmon catch and dates of operation for the Taku and Chilkat River fish wheels.

	Taku River		Chilkat River	
Year	Dates of Operation	Chum Catch	Dates of Operation	ChumCatch
1977	N/O[a]		21 Aug-21 Oct	604
1978	N/O		14 Aug-9 Nov	1,586
1982	N/O		5-26 Oct	254
1983	N/O		9 Aug-3 Oct	176
1984	15 Jun-18 Sep	316	N/O	
1985	16 Jun-21 Sep	1,376	N/O	
1986	14 Jun-25 Aug	80	N/O	
1987	15 Jun-20 Sep	1,533	N/O	
1988	11 May-19 Sep	1,089	N/O	
1989	5 May-1 Oct	645	N/O	
1990	3 May-23 Sep	748	14 Aug-25 Oct	3,025
1991	8 Jun-15 Oct	1,063	N/O	
1992	20 Jun-24 Sep	189	N/O	
1993	12 Jun-29 Sep	345	N/O	
1994	10 Jun-21 Sep	367	18 Jun-11 Sep	196
1995	4 May-27 Sep	218	16 Jun-16 Sep	2,288
1996	3 May-20 Sep	388	22 Jun-16 Sep	430
1997	3 May-1 Oct	485	11 Jun-9 Oct	1,315
1998	2 May-15 Sep	179	8 Jun-13 Oct	1,947
1999	3 May-3 Oct	164	7 Jun-8 Oct	4,250
2000	23 Apr-3 Oct	423	9 Jun-7 Oct	4,045
2001	27 May-5 Oct	250	6 Jun-7 Oct	4,680
2002	24 Apr-7 Oct	205	7 Jun-19 Oct	2,892

[a] N/O = fish wheels not operated.

In summary, the limited information available (fishery performance, aerial surveys, and fish wheel catches) indicates chum salmon production from the Chilkat River drainage in the last decade has been well below levels observed in the 1970s and 1980s, and measures ADF&G has taken to reduce the exploitation rate on these fish have been appropriate. Escapements in recent years appear to have improved but no estimates of total escapement are available, and although harvest levels have also improved, they continue to be well below historic levels. Given the lack of reliable escapement information and lack of a meaningful escapement goal, the department has not recommended Chilkat River chum salmon as a candidate *stock of concern*, as identified in the Sustainable Salmon Fisheries Policy.

Taku River Fall Chum Salmon

The transboundary Taku River (ADF&G Stream Number 111-32-032) supports a fall run of chum salmon that spawn in Canada. Taku River fall chum salmon stocks are primarily harvested in the Taku Inlet (District 111-32) commercial drift gillnet fishery, but are also harvested incidentally in the Canadian in-river coho salmon drift gillnet fishery. The run-timing of the fall-run fish is well segregated from the return of summer-run chum salmon, which is a mixture of wild and enhanced origin fish (Figure 5.15).

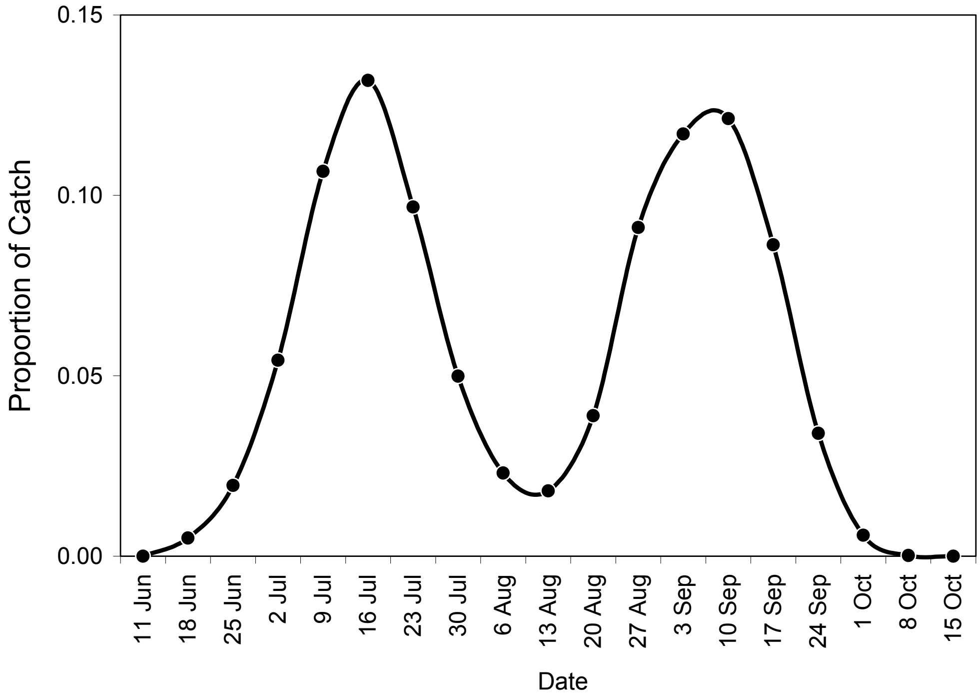

Figure 5.15. Mean run timing of chum salmon in the Taku Inlet (District 111-32) commercial drift gillnet fishery, illustrated by plotting the mean weekly proportion of the total annual harvest of chum salmon in the fishery, from 1960 to 2002. All chum salmon harvested in Statistical Week 34 (average mid-week date August 20) and later are considered fall-run fish.

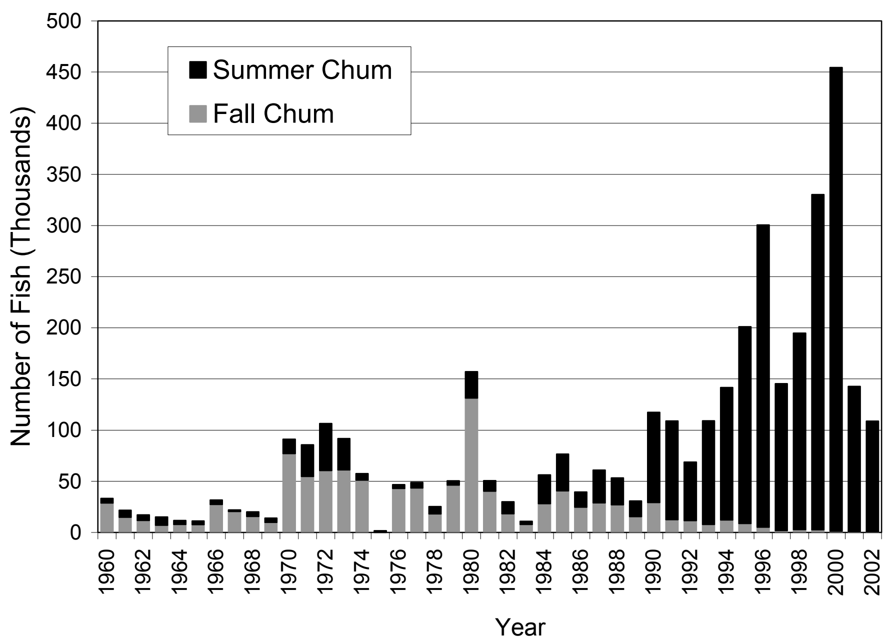

Figure 5.16. Annual harvests of chum salmon in the Taku Inlet (District 111-32) commercial drift gillnet fishery from 1960 to 2002.

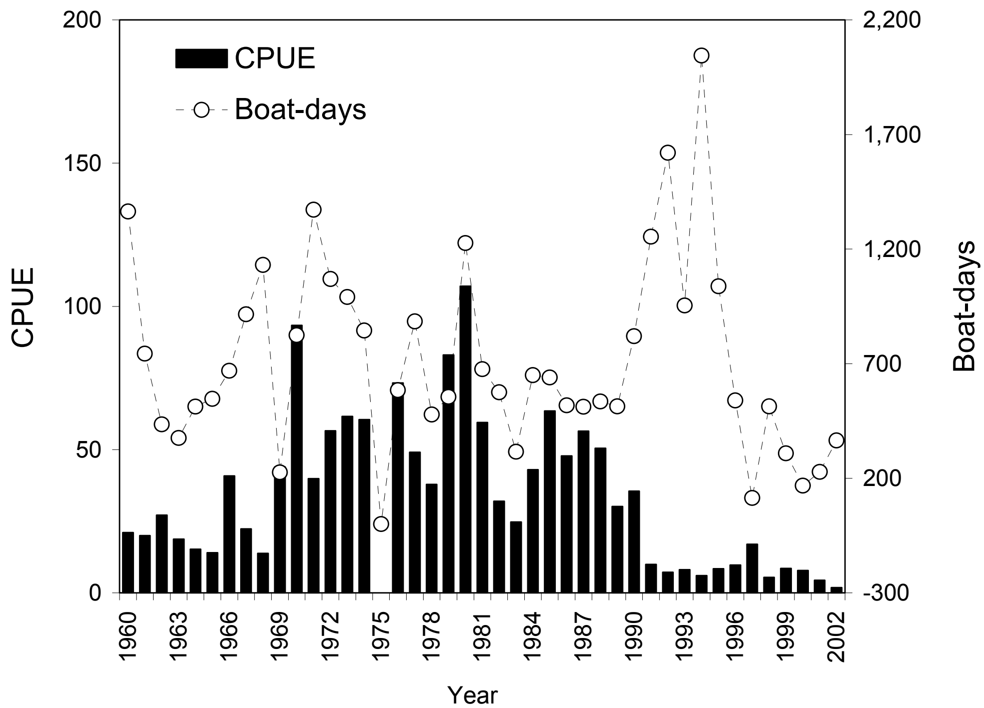

Figure 5.17. Effort (boat-days) and catch-per-unit-effort (CPUE) of fall-run chum salmon in the Taku Inlet (District 111-32) commercial drift gillnet fishery during Statistical Week 34 (average mid-week date August 20) and later, from 1960 to 2002.

The Transboundary Technical Committee established an interim escapement goal of 50,000 to 80,000 chum salmon for the Taku River in the 1980s (Pacific Salmon Commission 1993). There is no scientific basis for the goal, which was established by professional judgment based on perceived run sizes at the time. Attempts by the ADF&G and CDFO to estimate escapement through mark–recapture methods and aerial index surveys have been unsuccessful. Fish wheels operated jointly by ADF&G and CDFO provide the only index of escapement available for Taku River chum salmon. These counts represent a highly variable proportion of the run, and are subject to serious limitations as water levels drop in the fall and fish wheels become inoperative. Because the escapement goal has no biological basis, and because escapement of Taku River chum salmon has not been successfully estimated, the escapement goal is not a useful management target.

Since the early 1990s, both harvest and fishery performance measures have declined (Table 5.4; Figures 5.16 and 5.17). Over the past 10 years the fall chum gillnet catch in District 111 has averaged only 14% (7,700 fish) of the 1970s and 1980s average (54,000 fish). Commercial harvests continued to decline to an average of 3,700 fish from 1997 to 2001, although some of this decline can be attributed to fishery restrictions specifically implemented to protect this stock by reducing effort in the fishery. The decline in the historical CPUE follows a similar pattern as that of Chilkat River stocks, though the decline is greater than for Chilkat stocks. Little or no Canadian harvest has been reported in recent years, partially due to the inconsistent operation of the fishery in the fall, as well as a recent prohibition on retention of chum salmon in the fishery. Fish wheel counts, the only escapement indicator for the Taku, also declined in the early 1990s and have since remained stable at a lower level (Table 5.6; Figure 5.18).

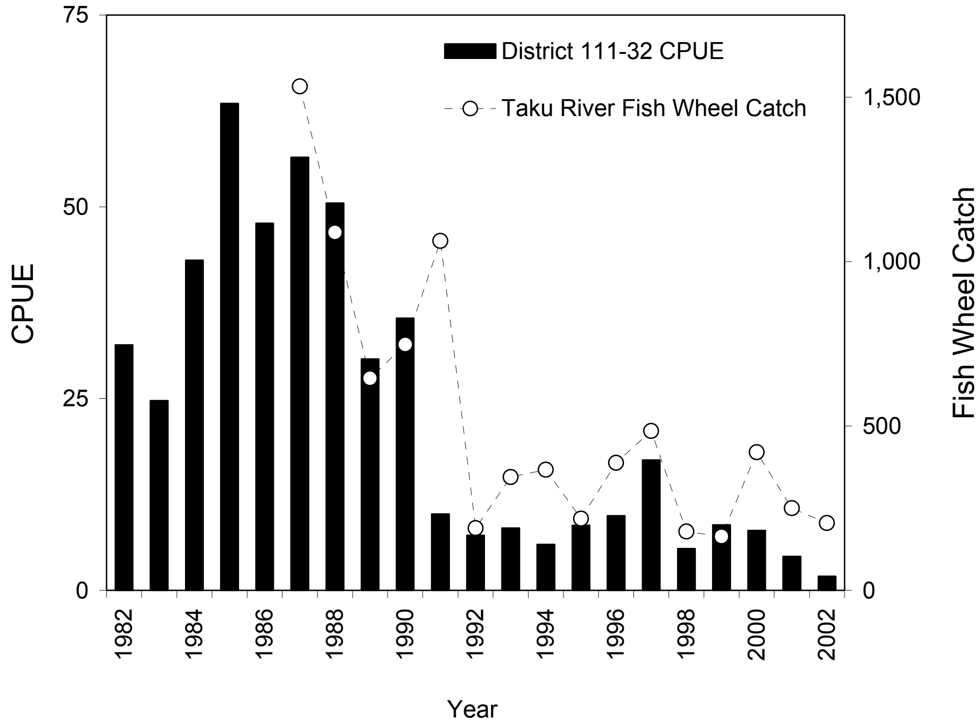

Figure 5.18. Catch-per-boat-day (CPUE) of fall-run chum salmon in the Taku Inlet (District 111-32) commercial drift gillnet fishery during Statistical Week 34 (average mid-week date August 20) and later, plotted with the Taku River fish wheel catch of all chum salmon from 1982 to 2002.

Reasons for the decline in Taku River chum salmon production are poorly understood. Possible contributing factors include hydrological changes in spawning areas in the upper drainage, inter-specific competition, over-harvest, and reduced survival due to interactions with hatchery releases of chum salmon that have increased during this period (Jensen 1999, Tobler 2002). ADF&G has taken direct management action in recent years to limit harvests of Taku River chum salmon in the District 111 gillnet fishery by limiting fishing time during peak weeks of the return, despite the presence of substantial surpluses of co-migrating Taku River coho salmon that are targeted by the fishery. As a result, the interim escapement goal for Taku River coho salmon has routinely been exceeded.

In summary, yields from this stock are well below levels of the 1970s and 1980s. ADF&G is concerned with this reduced production and our limited understanding of the contributing reasons, and intends to continue to limit harvest of this stock through conservative fishery management. Given the current lack of reliable escapement information and lack of a meaningful escapement goal, ADF&G has not recommended Taku River chum salmon as a candidate *stock of concern*.

East Alsek River Chum Salmon

The East Alsek River (ADF&G Stream Number 182-20-010) is a small river that flows 16 km southwest through the Malaspina coastal plain to a lagoon 90 km southeast of Yakutat. Salmon are harvested in a terminal set gillnet fishery in the lower 2 miles of the river and in the adjacent ocean out to the surf line within 2 miles in each direction of the mouth (ADF&G 1993). The East

Alsek River was the most productive sockeye salmon system in the Yakutat area for a brief period from the late 1970s through the early 1990s, with average annual harvests of 124,000 fish between 1985 and 1994. A *biological escapement goal* range of 26,000 to 57,000 (peak aerial survey count) sockeye salmon was established for the East Alsek in 1995 (Clark et al. 1995). Sockeye salmon returns to the East Alsek River began to decline dramatically in the mid-1990s. The sockeye salmon escapement goal was not met from 1999 to 2001, and the fishery was closed during those years. It is hypothesized that the lack of flooding from the nearby Alsek River and resultant reduction in the quality and quantity of spawning habitat is responsible for the reduced productivity of the system (Burkholder and Woods 1998; Clark et al. 2003). The East Alsek River sockeye salmon escapement goal has been lowered, based on an updated stock-recruit analysis, taking into account the lowered productivity of the system (Clark et al. 2003).

Although of a much smaller magnitude than the East Alsek River sockeye run, the chum salmon run to the East Alsek River has also declined considerably over the past decade. Chum salmon harvests averaged 6,000 in the 1960s and 1970s, increased to 12,000 in the 1980s, and averaged 2,000 in the 1990s (Table 5.7; Figure 5.19). The commercial set net fishery in the East Alsek River was closed during the 1999 through 2001 seasons for conservation reasons and very limited fishing was allowed during several weeks of the fall in 2002 to harvest surplus coho salmon. The CPUE of chum salmon declined in step with the decline in total harvest, even while the total fishing effort increased from the early 1980s to 1994 (Figure 5.20).

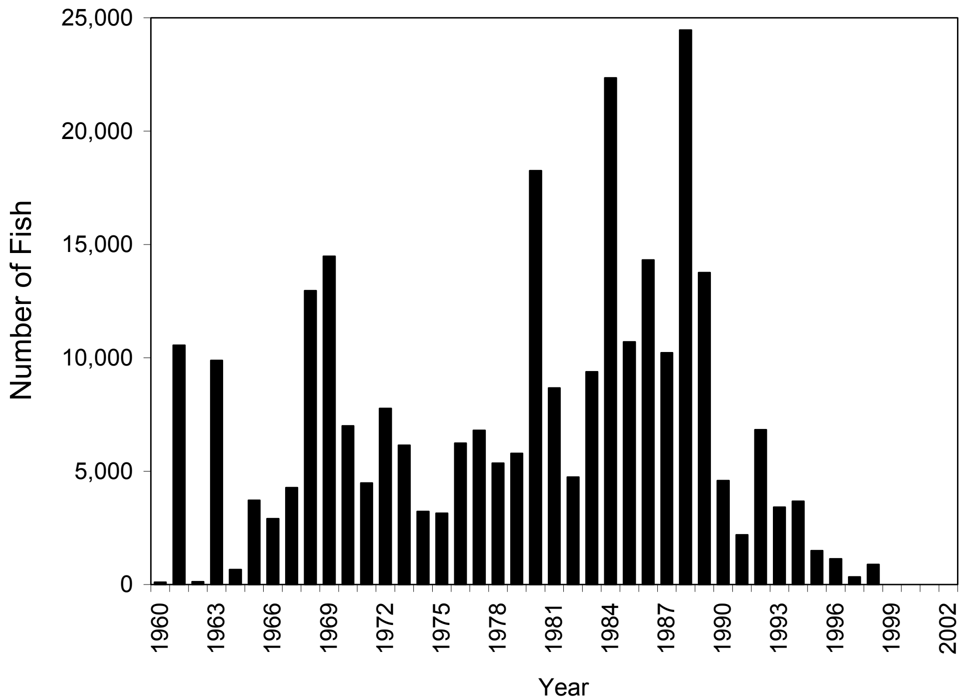

Figure 5.19. Commercial harvest of chum salmon in the East Alsek River (ADF&G Stream Number 182-20-010) set gillnet fishery from 1960 to 2002.

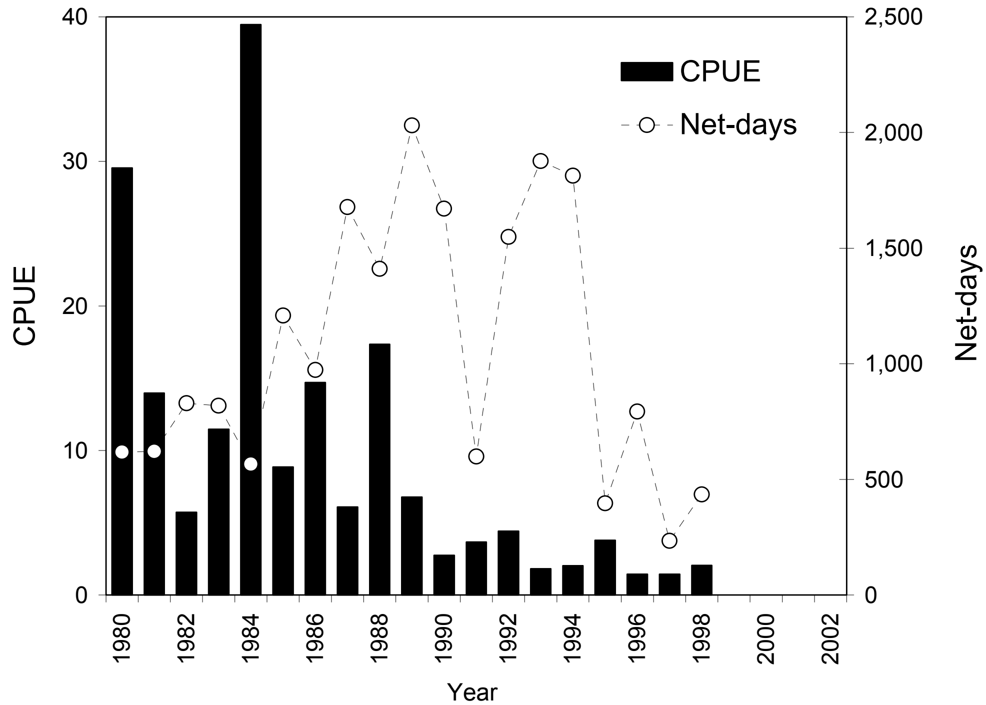

Figure 5.20. Effort (net-days) and catch-per-unit-effort (CPUE) of chum salmon in the East Alsek River (ADF&G Stream Number 182-20-010) commercial set gillnet fishery from 1980 to 2002.

Salmon escapements to the East Alsek River have been estimated annually by 1 to 3 aerial surveys, typically conducted between late August and early October (Table 5.7). Peak survey estimates are not comparable across all years (e.g., the only survey with a chum salmon estimate in 1982 was an observation of 3,000 fish on August 29; probably well before the peak of the chum salmon run). Even so, peak counts averaged 13,000 in the 1970s (range 2,000 to 40,000), and 9,000 in the 1980s (range 3,000 to 20,000). Chum salmon numbers have dropped to low levels in the last decade, and while they have been observed in the river, they are difficult to separate from other species from the air (Weiland and Woods 1994). ADF&G has not made separate escapement counts of chum salmon since 1991 (G. Woods, ADF&G, Yakutat, personal communication). Our assessment conflicts with the conclusions of Van Alen (2000), who showed chum salmon escapement in the Yakutat area generally increasing in the late 1990s.

It is likely that the environmental conditions that have negatively impacted sockeye salmon in the East Alsek River have also affected the chum salmon run (G. Woods, ADF&G, Yakutat, personal communication). However, because run timing of chum salmon overlaps that of the late running sockeye salmon (Figure 5.21), and it is possible that increased fishing effort in the late 1980s and early 1990s (to harvest surplus sockeye and coho salmon) had a negative impact on the smaller chum salmon run (Burkholder and Woods 1998). The current pattern of limiting exploitation of the run should be continued to allow the run to rebuild.

Table 5.7. Commercial set gillnet catch and maximum aerial chum salmon escapement survey counts for the East Alsek River (ADF&G Stream Number 182-20-010).

		Escapement Data			
Year	Catch	Max. Survey Count	Max Survey Date	No. of Surveys	Survey Dates
1960	109	2,000	20 Nov	1	20 Nov
1961	10,564	13,700	22 Sep	5	27 Aug-27 Sep
1962	133	32,500	13 Oct	4	12 Sep-13 Oct
1963	9,894				
1964	665	25,000	24 Sep	3	22 Aug-24 Sep
1965	3,727	8,000	29 Sep	2	10-29 Sep
1966	2,908	8,000	9 Sep	1	9 Sep
1967	4,282	11,000	27 Sep	3	4-27 Sep
1968	12,967				
1969	14,487	10,000	28 Sep	2	5-28 Sep
1970	7,010				
1971	4,482				
1972	7,774	8,000	23 Sep	2	29 Aug-23 Sep
1973	6,152	10,000	3 Oct	2	14 Sep-3 Oct
1974	3,231	5,000	29 Sep	1	29 Sep
1975	3,150	2,000	20 Sep	1	20 Sep
1976	6,237	20,000	22 Sep	1	22 Sep
1977	6,803	20,000	4 Oct	1	4 Oct
1978	5,363	8,000	17 Sep	2	9-17 Sep
1979	5,791	3,000	19 Sep	2	3-19 Sep
1980	18,255	40,000	20 Sep	3	6-20 Sep
1981	8,672	10,000	22 Sep	3	4-22 Sep
1982	4,746	3,000	29 Aug	1	29 Aug
1983	9,392	10,000	15 Sep	1	15 Sep
1984	22,354	15,000	23 Sep	2	17 Aug-23 Sep
1985	10,709	7,000	14 Sep	1	14 Sep
1986	14,323	20,000	20 Aug	3	20 Aug-16 Sep
1987	10,227	600	17 Aug	2	17 Aug-9 Oct
1988	24,461	5,000	27 Sep	6	13 Aug-27 Sep
1989	13,762	7,000	11 Sep	3	28 Aug-11 Sep
1990	4,590	3,000	11 Sep	2	22 Aug-11 Sep
1991	2,196	3,000	27 Aug	2	24-27 Aug
1992	6,838	NA[a]			
1993	3,423	NA			
1994	3,674	NA			
1995	1,501	NA			
1996	1,143	NA			
1997	338	NA			
1998	891	NA			
1999	0[b]	NA			
2000	0	NA			
2001	0	NA			
2002	NA[c]	NA			

[a] Chum salmon have been present, but not observed in the survey, since 1992.
[b] No commercial set gillnet fishery was conducted in the East Alsek River from 1999 to 2001.
[c] Catch data for 2002 are confidential due to low effort.

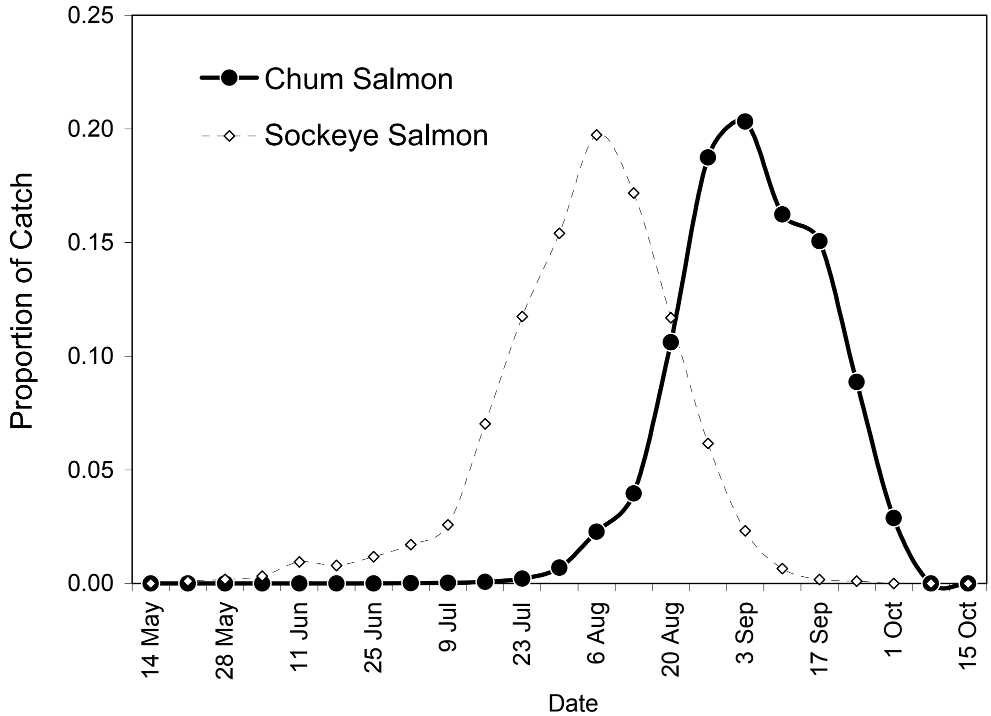

Figure 5.21. Mean run timing of sockeye and chum salmon in the East Alsek River (ADF&G Stream Number 182-20-010) commercial set gillnet fishery, illustrated by plotting the mean weekly proportion of the total annual harvest of sockeye salmon and the mean weekly proportion of the total annual harvest of chum salmon in the fishery, from 1960 to 1994.

ESCAPEMENT GOALS

In our review of existing escapement goals for chum salmon in Southeast Alaska, we found reference to 4 escapement goals which were established for Lynn Canal in 1991 (fall-run Chilkat mainstem, 70,000 to 100,000; fall-run Klehini River, part of the Chilkat system, 20,000 fish; summer-run Sawmill Creek, 1,000 to 8,000; and summer-run West Lynn Canal, 4,000 to 8,000), and the 1985 interim escapement goal of 50,000 to 80,000 chum salmon for the Taku River. These goals were based on the professional judgment of the fisheries managers at the time, rather than a technical analysis of biological data. In addition, the department does not currently have the ability to accurately measure the chum salmon escapement into those systems. Those escapement goals have been discarded because of a lack of scientific justification, and because it is not possible to determine if the goals have been achieved on an annual basis.

Therefore, we do not recommend any formal biological or sustainable escapement goals for chum salmon in Southeast Alaska at this time. The quality of existing escapement and stock-specific production measures would need to be significantly improved to develop meaningful and technically supportable escapement goals for specific streams or areas.

DISCUSSION

Annual harvests of wild chum salmon have increased since the 1970s (Figures 2 and 3), but are still far below their historic harvests from the early 20th century. An obvious question is, why are the recent harvests smaller? In a U.S. Forest Service review of the biological characteristics of Pacific salmon in Southeast Alaska, Halupka et al. (2000) attribute part of the differences in the sizes of the commercial catch, from its peak in the early 1900s to the present, to a restructuring of the fisheries, and the elimination of much of the directed chum salmon fishing. Although current catches of wild chum salmon are much smaller than they were at their peak, those early high catches likely represented overfishing that is not sustainable on an annual basis.

More recent changes to the commercial fisheries have probably also resulted in a reduction of the harvest of wild chum salmon. Modifications in the management of the pink salmon fishery in Cross Sound, Icy Strait, and northern Chatham Strait (Ingledue 1989), have probably resulted in reduced harvests of wild chum salmon in those areas since the late 1970s. Similarly, reduction in the fishing effort in the District 104 purse seine fishery during the first 3 weeks of July, due to early season treaty obligations for conservation of Nass and Skeena River sockeye salmon, has probably also reduced early season harvests of wild summer-run chum salmon since 1985. Although enhancement by hatcheries has led to a great increase in the total harvest of chum salmon in Southeast Alaska, most hatchery chum salmon in the region are taken in directed chum salmon fisheries—specifically in terminal harvest areas near release sites where interactions with wild stocks are minimized. These terminal fisheries have also attracted substantial effort away from mixed-stock fisheries, and have possibly reduced harvest rates on many wild summer-run chum salmon and early-run pink salmon stocks. Most wild chum salmon harvested in Southeast Alaska are not caught in directed chum salmon fisheries.

The majority of the chum salmon stocks for which we have sufficient survey data appear to be stable or increasing over the past 2 decades (Figure 3; Appendix 5.1). Analysis of survey data point to a couple of areas where chum salmon streams have shown a decline in peak survey estimates over the past 21 years; e.g., Portland Canal (Hidden Inlet and Tombstone River, as well as Fish Creek) and Lower Chatham Strait (4 streams in District 109). We wish to point out, however, that with few exceptions, these data have not been collected or synthesized in a standardized manner, and do not represent total escapements. At best, they identify streams that may warrant more attention. Some runs of chum salmon may merit a level of concern, although none of the formal categories of *stocks of concern*, as defined in the Sustainable Salmon Fisheries Policy, appear to be appropriate. The limited information available (fishery performance, aerial surveys, and fish wheel catches) indicates that chum salmon production from the Chilkat and Taku River drainages has been well below levels observed in the 1970s and 1980s. The reasons for this decline are not obvious, and some of the declines may be due to natural hydrological processes affecting salmon habitat.

Improved escapement estimation procedures are needed to monitor chum salmon runs in Southeast Alaska. ADF&G has, during the past year, been pursuing additional funding to begin such studies. ADF&G has received funding from the Southeast Sustainable Salmon Fund to conduct detailed mark–recapture studies on Chilkat River chum salmon in conjunction with fish wheel operation for the 2002 through 2005 seasons to allow development of a long-term escapement index program that can better monitor chum salmon escapements to this system. ADF&G has also received funds to conduct escapement studies on the Taku River and will gather data on East Alsek River chum salmon during studies directed at sockeye and coho salmon runs on that system. Monitoring of chum salmon escapements would also be improved by formally identifying a set of chum salmon spawning streams throughout the region, and developing methods to standardize and calibrate annual survey estimates. This would enable meaningful analyses of long-term data series. These studies could be patterned after similar pink salmon directed studies the department has conducted in the past (Jones 1995).

Most hatchery-produced chum salmon in Southeast Alaska are now otolith marked during the early stages of development. Mass marking of hatchery released chum salmon should make it possible to conduct much more refined research on hatchery fish than has previously been possible, including migratory and feeding habits, fishery contributions, straying, and potential interactions with wild stocks. ADF&G is working cooperatively with the University of Alaska and the National Marine Fisheries Service–Auke Bay Lab to design and implement studies to examine near-shore marine interactions of wild and hatchery chum salmon in the Taku Inlet–Stephens Passage area, which have been funded through the Southeast Sustainable Salmon Fund. The Southeast Sustainable Salmon Fund is also supporting a new research faculty position at the University of Alaska Fairbanks, School of Fisheries, to design and conduct studies on wild-hatchery interactions.

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APPENDICES

Appendix 5.1. Peak escapement index series for select chum salmon streams in Southeast Alaska, with summary statistics from 1982 to 2002.

District	101	101	101	101	101	101	101	101	102	102	107	107
Area	Ketchikan	Ketchikan	Ketchikan	Ketchikan	Ketchikan	Ketchikan	Ketchikan	Ketchikan	Ketchikan	Ketchikan	Petersburg	Petersburg
Survey Type	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial
Run-timing	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Fall	Fall	Summer	Summer
Stream No.	101-11-101	101-15-019	101-30-030	101-30-060	101-45-078	101-55-020	101-55-040	101-71-04K	102-40-043	102-40-060	107-40-025	107-40-049
Stream Name	Hidden Inlet	Tombstone	Keta River	Marten River	Carroll Creek	Wilson River	Blossom	King Creek	Disappearance Creek	Lagoon Creek	Oerns Creek	Harding River
1982	550	550	3,000	300	8,000	500	200	500			280	5,300
1983	3,600	18,500	800	500	3,500	300				3,500		14,100
1984	800	9,250	16,500	300	11,000		4,100	6,000		14,000	1,080	16,400
1985	1,400	5,000	30,000	1,200	5,850	10,700	8,000	5,000	26,000	11,000	590	20,000
1986	430	10,000	46,000	1,000	600	10,000		3,300	16,000	12,000		1,200
1987	1,500	12,800	10,100	1,000	5,000				32,500	11,700	1,300	9,300
1988	1,400	20,000	47,000	17,500	44,000	28,000	5,000	10,000	21,000		490	12,520
1989	500	12,100	11,000			10,800	800	300	19,800	15,000	4,000	24,000
1990	650	4,400	30,000			10,000	1,100	800	22,000	8,300	530	2,800
1991	150	5,500	11,000		5,000	5,000	5,000	300	25,000	21,000	700	29,000
1992	500	2,600	20,000	6,000	13,000	10,000	4,000	9,200	21,000	15,500	150	15,500
1993		22,800	28,000	3,500	5,500	5,000	3,500	7,000	29,000		800	32,000
1994	1,500	7,500	40,100	2,500	3,200	23,000	8,000	15,000	22,700	20,000	50	4,500
1995	5,000	5,000	20,000	950	25,000	800	12,000	8,000	20,000	15,000	900	10,000
1996	2,700	5,200	90,000	4,000	30,000		12,000	12,000	38,000	23,500	1,600	29,000
1997	160	5,500	15,000	1,500	3,500	18,000	1,500	10,000	18,000	12,800		
1998	4,300	8,000	43,000	10,100	8,500	10,000	10,000	35,000	32,500	26,000	1,100	6,000
1999	800	3,000	20,000	1,000	10,000	5,000	5,000	8,000	50,000	50,000	2,900	25,000
2000	600	4,000	22,000	1,000	14,000	16,000	2,000	11,000	21,500	10,000	500	13,800
2001	3,800	4,000	45,000	200	20,000	15,000	12,000	4,000	22,000	23,000	1,000	15,000
2002	700	3,000	20,000		2,000	9,000	5,000	1,500	22,000	8,000	50	5,000
Estimated Year-Zero Level [a]	1,396	11,214	15,179	1,554	3,856	8,869	4,163	3,405	23,679	7,771	419	12,663
Robust Estimate of Annual Decline	43	429	-393	-18	-296	-179	-32	-357	107	-807	-33	-134
Decline as % of Year-Zero Level	3%	4%										
Increase as % of Year-Zero Level			3%	1%	8%	2%	1%	10%	0%	10%	8%	1%
Spearman's rho rank corr. trend test												
r_s	0.139	-0.385	0.347	0.195	0.177	0.221	0.395	0.403	0.166	0.363	0.010	0.074
P	0.56	0.09	0.12	0.45	0.47	0.38	0.11	0.09	0.51	0.14	0.97	0.76
n	20	21	21	17	19	18	18	19	18	18	18	20

[a] Decline as a percent of year-zero level shows the size of a stock decline (or increase) relative to the size of the stock trend at the beginning of the series. (Blank cells denote lack of sufficient survey data.)

[b] The Spearman's rho (r_s) is a nonparametric correlation coefficient describing a relationship between peak survey estimates and time. The *P*-value is the significance level for a test that Spearman's rho is exactly equal to zero (α=0.05, two-tailed). The sample size (n) denotes the number of years used for the Spearman's rho statistic.

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District	108	109	109	109	109	109	109	109	109	109	110	110
Area	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg
Survey Type	Foot	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial
Run-timing	Summer	Summer	Fall	Fall	Summer	Summer	Fall	Summer	Summer	Summer	Summer	Summer
Stream No.	108-41-010	109-30-016	109-43-006	109-43-008	109-44-037	109-44-039	109-45-013	109-45-017	109-52-007	109-62-014	110-13-004	110-22-004
Stream Name	North Arm Creek	Tyee Head East	Port Camden S Head	Port Camden W Head	Saginaw Bay S Head	Saginaw Creek	Salt Chuck - Security	Lookout Point Creek Sec B	Rowan Creek	Sample Creek	Dry Bay Creek	Amber Creek N Arm Pybus
1982	840	700	3,800	1,550	350	650	12,000	30	50	200		40
1983	812		771	680		150	4,830			150	50	50
1984	3470		6,800	3,200	2,590	400	19,000	500	500	1,600	1,000	300
1985	1,826	400	8,700	3,500	2,600		21,000	350	500	700	1,700	160
1986	1,068	7,000	8,200	6,070	1,300	350	12,000	1,150	1,300	4,500	700	500
1987	1,040	6,100	7,400	1,550	1,600	600	11,200	600	150	500	500	250
1988	1,280	13,500	4,100	3,250	500	500	15,500	350	700	1,200	500	300
1989	404	4,000	4,700	2,350	300	50	8,410	1,000	1,300	800	350	
1990	4,095	10,000	3,000	960		50	20,040	800	100		2,400	850
1991	265	600	3,100	1,800			6,000	200			90	200
1992	708	8,500	2,900		600	1,000	19,300			600	300	
1993	926	7,500	5,100	1,700	1,100	300	7,400	800	900	500	1,400	500
1994	740	4,500	3,800	1,150	600	300	4,900	400	300	300		
1995	570	23,300	2,000	1,200	1,540	50	14,000	950	1,200	1,100	250	600
1996	2,530	18,000	3,400	1,350	3,200	3,300	19,000	2,000	650	2,000	1,800	1,200
1997	1,420	1,950	2,000	1,500	300		5,400	300	2,000		800	50
1998		1,050	3,600	2,200	1,100	1,000	31,500	900	2,000	300	250	500
1999		6,300	920	600	3,000		20,000		1,400	400		800
2000	2,280	34,000	1,400	1,100	3,000	800	12,500		3,200	300	1,000	2,100
2001	820	400			400	1,000	3,500		2,100			450
2002	881	100	300	150			6,000	400			125	
Estimated Year-Zero Level	789	8,444	7,874	3,510	895	110	10,577	448	-45	825	418	169
Robust Estimate of Annual Decline	-25	296	364	141	-43	-39	-36	-16	-107	25	-14	-29
Decline as % of Year-Zero Level		4%	5%	4%						3%		
Increase as % of Year-Zero Level	3%				5%	36%	0%	4%	NA		3%	17%
Spearman's rho rank corr. trend test												
r_s	-0.058	-0.011	-0.588	-0.512	0.098	0.363	-0.094	0.215	0.743	-0.050	-0.052	0.597
P	0.81	0.97	0.01	0.03	0.71	0.17	0.69	0.42	<0.01	0.85	0.84	0.01
n	19	19	20	19	17	16	21	16	17	16	17	17

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District	110	110	110	110	110	110	110	110	110	110	111	111
Area	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Petersburg	Juneau	Juneau
Survey Type	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial
Run-timing	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer
Stream No.	110-22-012	110-22-014	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
Stream Name	Donkey Creek	Cannery Cove Pybus Bay	Johnston Creek	Bowman Creek	Snug Cove Gambier Bay	East of Snug Cove	Chuck River Windham B	Lauras Creek	Glen Creek	Sanborn Creek	Mole River	Windfall Harbor W
1982	1,600	220	10	20	150	30		2,000	50	1,200	400	300
1983	1,300	150	600	80			25	200		350	150	
1984	2,600	1,000	2,500	400	750	1,200	700	3,500	1,200	1,900	400	1,500
1985	1,455	150	400			600		900	700	400	500	
1986	450	350	600	500	700	1,500	300	1,500	500	900	300	300
1987	3,300	1,515	800	400	300			700	405	2,000		200
1988	6,300	3,350	8,000	3,460	2,300	4,300	2,600	3,520	900	3,400	700	350
1989	600		400	100		150		500	600	500		
1990	2,800	700	2,000	400	950	1,650	600	1,500		2,400	500	200
1991	1,200	100	700		450	1,150	30	1,050	900	1,000	200	100
1992	1,500	1,500	500		700	150	1,000	1,800	800	900	300	700
1993	6,000	2,700	1,200	500	800	800	1,000	1,400	1,600	2,900	200	250
1994	3,900	2,400		250			500	1,500	850	950	4,000	200
1995	7,900	1,600	550	300	180	320	400	800	500	1,600	340	20
1996	13,000	4,800	7,200	2,000	800	1,200	7,100	2,320	500	14,300		3,000
1997	11,000	1,800	500	300	600		2,000	180	3,000	1,000		
1998	12,000	2,900	600			400		500	725	1,000		3,000
1999	10,500	3,400	600	400	450	800	300	900	100	700	6,000	1,100
2000	15,000	6,200	2,700	1,100	900	1,100	3,050	4,800	4,000	8,200	2,010	600
2001	4,500	2,800	1,050	500	1,000	400	1,100	1,300	500	2,500	875	2,500
2002	2,100	1,525			400	900	200		1,800	1,200	3,100	1,950
Estimated Year-Zero Level	-2,252	-404	507	321	700	1,145	42	1,648	618	1,133	-602	-604
Robust Estimate of Annual Decline	-671	-182	-16	-7	0	25	-75	29	-9	0	-154	-138
Decline as % of Year-Zero Level						2%		2%				
Increase as % of Year-Zero Level	NA	NA	3%	2%	0%		180%		1%	0%	NA	NA
Spearman's rho rank corr. trend test												
r_s	0.638	0.716	0.242	0.390	0.146	-0.081	0.275	-0.064	0.260	0.294	0.547	0.442
P	<0.01	<0.01	0.32	0.14	0.59	0.78	0.30	0.79	0.28	0.20	0.03	0.08
n	21	20	19	16	16	17	16	20	19	21	16	17

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Appendix 5.1. (page 4 of 7)

District	111	111	111	111	111	111	111	112	112	112	112	112
Area	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Lynn Canal	Juneau	Sitka	Sitka	Juneau
Survey Type	Aerial	Aerial	Aerial	Aerial	Aerial	Foot	Foot	Aerial	Aerial	Aerial	Aerial	Aerial
Run-timing	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer
Stream No.	111-15-030	111-16-040	111-17-010	111-33-010	111-41-005	111-50-010	111-50-069	112-15-062	112-19-010	112-21-005	112-21-006	112-42-025
Stream Name	Pack Creek	Swan Cove Creek	King Salmon River	Prospect Creek, Speel	Admiralty Creek	Peterson Ck Favor C	Fish Creek Douglas I	Robinson Creek	Wilson River	Clear Rive Kelp Bay	Ralphs Creek	Kadashan Creek
1982	950	350	500	500	450		1,219	500	200	5,000	3,000	
1983	100		300	75	520		1,466	3,200		8,000	6,000	
1984	1,000	2,100	4,150	800	5,100		3,380	550	3,800	4,000	1,000	
1985	2,400	300	3,200		1,500	2,675	6,683	500	160	2,000	5,000	3,000
1986	700	1,000	4,750	500	1,000		2,047	1,200	500	12,000	4,200	1,800
1987	1,000	200	2,000	200	500	1,901	281	500	400	23,000		
1988	300	600	1,300	1,750	250	3,366	609	350	350	25,000	100	7,600
1989			300	50	200	874	1,187	400	500	1,000	3,000	1,000
1990	600	550	1,050	300	800	1,980	1,486	1,200	500	8,000	2,000	2,100
1991	200	100	1,300	200	200		2,194	1,000		2,000		1,000
1992	600		1,300	400	200	760	1,839	1,000	1,900	4,000	1,100	2,000
1993	800		1,000	400	500	32	639	1,800	6,000	3,500	4,000	3,500
1994	3,500	1,200	5,800	500	500	6,766	3,943	1,500	2,000	5,000	2,000	6,200
1995	800		2,200	600	200	3,862	2,941	400	2,200	8,000	10,800	3,600
1996	8,000	900	9,000		900	13,050	6,595	2,750	5,600	5,000	6,000	43,000
1997	6,500	200	3,400	321	50	1,325	1,890	4,000	500	12,000	7,000	3,500
1998	8,000	2,000	7,100	5,000	700	3,675	849	1,000	3,100	3,000	6,000	3,000
1999	4,000	500	3,500	500		1,700	1,570	2,000	4,000	15,000	18,600	2,500
2000	2,600	625	4,110	2,250	300	9,630	7,915	1,350	5,700	3,600	7,400	10,800
2001	1,500	100	1,150	1,000	5,500	5,940	815		2,000	5,500	6,500	700
2002	5,000	1,000	2,800	3,000	3,500	3,230	146	4,750	3,100	3,000	9,000	19,000
Estimated Year-Zero Level	-965	432	1,088	-42	287	1,807	1,543	-182	-333	8,024	1,695	2,474
Robust Estimate of Annual Decline	-289	-11	-107	-80	-20	-71	-7	-134	-195	214	-243	-36
Decline as % of Year-Zero Level										3%		
Increase as % of Year-Zero Level	NA	2%	10%	NA	7%	4%	0%	NA	NA		14%	1%
Spearman's rho rank corr. trend test												
r_s	0.617	-0.016	0.355	0.496	-0.017	0.382	-0.044	0.495	0.616	-0.095	0.666	0.312
P	<0.01	0.95	0.11	0.03	0.94	0.14	0.85	0.03	0.01	0.68	<0.01	0.22
n	20	16	21	19	20	16	21	20	19	21	19	17

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District	112	112	112	112	112	112	112	112	112	112	112	112
Area	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau
Survey Type	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial
Run-timing	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer
Stream No.	112-44-010	112-46-009	112-47-010	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
Stream Name	Saltery Bay Head	Seal Bay Head	Long Bay Head	Big Goose Creek	Little Goose Creek	West Bay Head Creek	Tenakee Inlet Head	Kennel Creek	Freshwater Creek	Greens Creek	Weir Creek N Arm Hood	Weir Creek S Arm Hood
1982		2,800	5,000	3,000	10	1,000	300	140	250		450	500
1983	12,300	7,700	12,000	14,100		2,000	4,000	500	600	500	700	500
1984	250	6,200	8,430	7,600		1,600	1,000	1,400	600	1,800	1,800	1,600
1985	400	5,000	7,000	10,050	100	15,300	1,900	2,000	2,000	4,000	5,000	2,500
1986	1,000	4,500	10,000	10,000	50	2,000	1,050	2,200	750	6,500	1,300	3,000
1987	300	1,000	1,000	1,300		1,000	1,100	450		1,750	630	1,800
1988	200	6,200	6,000	5,400	130	4,300	1,925	1,100	300	800	1,600	500
1989	500	1,000	1,200	2,100		1,800	1,300	500	300	500	700	400
1990	200	2,700	2,200	3,050	100	500	1,500	4,050	300	4,150	1,000	500
1991	1,000	5,500	3,200	5,000		2,000	2,000	2,050	100	200	1,000	200
1992	1,100	9,300	10,100	8,300	200	8,400	6,100	3,150	1,000	600	8,300	4,300
1993	1,050	7,000	7,100	19,700	1,000	10,500	9,200	8,900	1,650	1,000	7,700	2,200
1994	2,800	19,000	42,500	39,200	1,500	29,510	18,000	1,300	1,300	1,100	2,300	500
1995	2,000	7,000	10,000	22,000	500	7,900	13,000	4,200	6,000	900	650	1,500
1996	32,700	89,000	105,000	84,000	2,000	57,000	103,000	39,300	2,600	11,500	22,000	13,000
1997	3,500	5,700	19,900	9,400	1,400	15,000	11,000	7,000	500	2,000		4,900
1998	400	11,000	15,000	10,000	7,700	23,000	6,700	2,700		500	500	550
1999	1,100	20,000	28,000	21,000	2,150	32,000	15,000	3,300		1,200	13,000	6,000
2000	10,500	22,500	28,500	25,000	4,800	42,000	15,000	3,000		2,300	3,000	16,500
2001	4,150	5,000	2,275	2,935	1,000	5,200	10,000	5,000	1,000	1,500	3,900	3,600
2002	21,000	55,000	42,000	23,000	7,500	23,500	28,500	2,950	4,750	1,450	8,000	4,050
Estimated Year-Zero Level	-1,136	-1,119	-2,467	1,771	-722	-5,760	-3,521	788	190	1,608	-904	-260
Robust Estimate of Annual Decline	-271	-1,071	-1,500	-957	-148	-1,536	-993	-157	-86	20	-332	-236
Decline as % of Year-Zero Level										1%		
Increase as % of Year-Zero Level	NA	NA	NA	54%	NA	NA	NA	20%	45%		NA	NA
Spearman's rho rank corr. trend test												
r_s	0.567	0.588	0.501	0.435	0.873	0.710	0.841	0.681	0.515	0.036	0.476	0.550
P	0.01	0.01	0.02	0.05	<0.01	<0.01	<0.01	<0.01	0.03	0.88	0.03	0.01
n	20	21	21	21	16	21	21	21	17	20	20	21

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District	112	112	113	113	113	113	113	113	114	114	114	114
Area	Juneau	Juneau	Sitka	Sitka	Sitka	Sitka	Sitka	Sitka	Juneau	Juneau	Juneau	Juneau
Survey Type	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Foot	Aerial	Aerial	Aerial	Aerial	Aerial
Run-timing	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer	Summer
Stream No.	112-80-028	112-90-014	113-22-015	113-32-005	113-53-003	113-72-005	113-73-003	113-81-011	114-23-070	114-25-010	114-27-030	114-31-013
Stream Name	Chaik Bay Creek	Whitewater Creek	Whale Bay Gr Arm Hd	W Crawfish NE Arm Hd	Saook Bay West Head	Sister Lake SE Head	Lake Stream Ford Arm	Black River	Mud Bay River	Homeshore Creek	Spasski Creek	Game Creek
1982	1,600	300	3,900	400	400	3,000		500	500		800	2,500
1983	2,000	2,550	2,500	500			2,000	10,000	400	550	500	8,000
1984	6,900	3,000	1,500	30,000	1,500	41,500		17,000	220	600	3,250	12,200
1985	2,500	2,000	2,000	2,500	5,000	11,000	450	15,000			3,500	4,300
1986	8,300	2,000	5,500	18,000	1,000	3,500	400	3,000		515	2,300	3,900
1987	2,000	700	4,000	4,100	500	3,000	651	5,000	150		500	8,000
1988	6,500	1,800	6,500	3,500	3,500	5,000	1,033	3,000	100	150	950	5,600
1989	2,000	2,000	1,300	500		4,000	1,610	8,000		100	910	1,500
1990	1,500	1,700	4,000	3,000	3,500	11,000	959	2,500		300	2,500	2,000
1991	500		200	50	2,000	15,000	1,456	1,000	200	600	1,500	2,300
1992	11,200	5,000	4,000	1,000	2,000	10,000	1,140	500	50	700	3,000	3,000
1993	23,600	9,900	500	2,000		5,000	1,559		2,000	1,100	3,700	11,900
1994	6,500	2,500	3,400	3,000	500	4,000	3,000	1,000	300	2,200	4,600	3,400
1995	6,300	4,100	7,550	5,000	100	4,000	1,416	300	300	4,000	3,200	4,800
1996	21,000	4,500	4,200	10,500	6,600	9,000	1,271	1,000	1,100	1,050	9,700	35,100
1997	8,100	3,000	11,000	6,000	1,700	10,000	2,955	20,000	1,000	200	4,500	9,000
1998	5,000	2,000	1,300	7,000	4,000	1,000	2,631	2,400	200	400	4,200	4,000
1999	10,000	8,950	5,000	8,000		8,000	1,697	9,000	3,500	500	2,000	7,000
2000	21,700	5,300	27,000	33,000	6,700	30,000	844	31,000	350	500	900	4,100
2001	12,000	1,700	18,300	8,900	9,500	1,000	5,900	23,000	4,500	1,300	9,500	12,100
2002	10,750	1,500	1,000	3,500	5,500	5,000	1,927	6,000	2,250	1,100	9,400	2,000
Estimated Year-Zero Level	35	1,981	3,236	964	-671	2,804	342	1,857	-151	603	27	4,100
Robust Estimate of Annual Decline	-589	-71	-79	-321	-343	-268	-91	-286	-63	2	-254	-100
Decline as % of Year-Zero Level												
Increase as % of Year-Zero Level	NA	4%	2%	33%	NA	10%	27%	15%	NA	0%	926%	2%
Spearman's rho rank corr. trend test												
r_s	0.591	0.259	0.265	0.425	0.564	-0.066	0.519	0.151	0.525	0.277	0.568	0.064
P	<0.01	0.27	0.25	0.06	0.02	0.78	0.02	0.57	0.03	0.27	0.01	0.78
n	21	20	21	21	17	20	19	20	17	18	21	21

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District	114	114	114	114	114	115	115	115	115	115
Area	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau	Juneau
Survey Type	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial	Aerial
Run-timing	Summer	Summer	Summer	Summer	Fall	Summer	Summer	Summer	Summer	Summer
Stream No.	114-32-004	114-33-023	114-34-010	114-40-035	114-80-020	115-10-042	115-10-046	115-10-080	115-20-010	115-20-052
Stream Name	Seagull Creek	Neka River	Humpback Creek	Trail River	Excursion River	St James Bay NW Side	St. James River	Endicott River	Berners River	Sawmill Cr. Berners R.
1982	220	2,500	2,300	370	1,640	400				4,580
1983	1,550	24,500	2,250	3,000	3,300	825	5,000			250
1984	2,400	10,550	4,000	1,650	7,750	800	60	500	800	2,500
1985	5,300	7,000	3,700	500	4,025	2,910	100		5,400	400
1986	500	12,500	4,500	400	9,150	700	360	210	1,070	600
1987	2,300	8,000	2,500	500	2,000	1,000		400	600	1,500
1988	600	4,000	550	2,500	3,700	1,900	492	2,563	406	800
1989	200	2,800	800	500	2,050	350		5,000	100	100
1990	110	11,000	1,500	200	5,100	750	150	4,600	500	1,150
1991	1,200	4,400	2,800	7,400	900	1,100		900		430
1992	1,200	9,700	4,400	400	2,700	600	200	2,550	220	450
1993	4,100	12,500	5,500	800	8,200	700	250	1,500	800	1,150
1994	1,700	9,300	6,300	300	4,300	600		800	4,000	3,050
1995	1,700	9,700	4,600		6,140	105			125	
1996	7,000	24,800	27,000	500	9,200	850	2,400	10,000	5,900	5,700
1997	7,800	9,500	5,600	1,400	34,400	300	200		770	1,000
1998	300	8,600	4,000	500	8,000	100		2,000	1,025	1,100
1999	3,000	20,000	6,500	8,000	10,000	50	510	1,900	780	
2000	1,250	29,000	7,400	4,000	17,000	550	72	200	250	2,979
2001	3,000	23,000	6,050	200	17,750		6,000	1,100	10,000	
2002	4,500	11,500	4,350	6,500	4,680	2,800	1,200	3,000	3,400	
Estimated Year-Zero Level	777	3,138	1,527	76	1,050	931	83	296	552	239
Robust Estimate of Annual Decline	-104	-857	-254	-64	-450	29	-35	-107	-16	-89
Decline as % of Year-Zero Level						3%				
Increase as % of Year-Zero Level	13%	27%	17%	84%	43%		43%	36%	3%	37%
Spearman's rho rank corr. trend test										
r_s	0.369	0.437	0.677	0.173	0.618	-0.351	0.286	0.176	0.168	0.254
P	0.10	0.05	<0.01	0.47	<0.01	0.13	0.32	0.51	0.51	0.33
n	21	21	21	20	21	20	14	16	18	17