CHUM SALMON STOCK STATUS AND ESCAPEMENT GOALS

IN SOUTHEAST ALASKA

by

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Regional Information Report No.[1] 1J03-08

Alaska Department of Fish and Game
Division of Commercial Fisheries
Juneau

February 2003

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ACKNOWLEDGEMENTS

We would like to thank William N. Davidson, Phillip S. Doherty, Randall L. Bachman, William R. Bergmann, Bert A. Lewis, Andrew W. Piston, Leon Shaul, Kimberly A. Vicchy, and Gordon Woods for their helpful reviews and comments.

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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 (eight of which we considered biologically meaningful). We examined the stock status of six 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 five 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: aerial survey, Chilkat River, Cholmondeley Sound, chum salmon, East Alsek River, escapement goal, Fish Creek, *Oncorhynchus keta*, Southeast Alaska, stock status, Taku River, Tenakee Inlet

INTRODUCTION

Chum salmon *Oncorhynchus keta* spawn in approximately 1,500 short, coastal streams throughout Southeast Alaska (Figure 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.

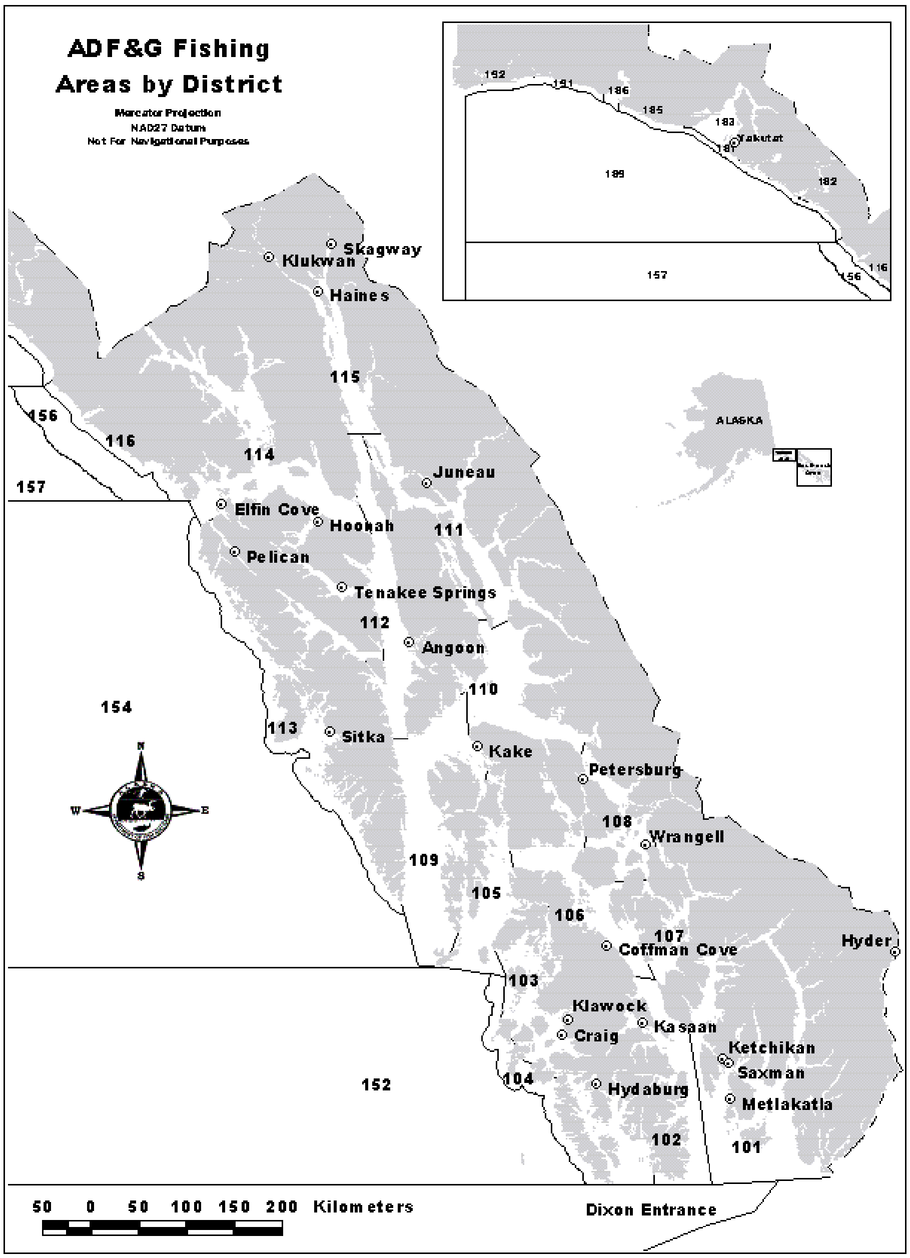

Figure 1. Map of Southeast Alaska, showing the ADF&G commercial salmon regulatory districts, and major population centers.

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 thousand in 1969), and reached their all-time maximum of 16 million fish in the mid-late 1990s (Figure 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 (SSRAA; at Nakat Inlet, Earl West Cove, Neets Bay, and Kendrick Bay), Northern Southeast Regional Aquaculture Association (NSRAA; at Hidden Falls and Deep Inlet); and Douglas Island Pink and Chum, Inc. (DIPAC; at Amalga Harbor, Gastineau Channel, and Limestone Inlet; and combined DIPAC/NSRAA 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 2).

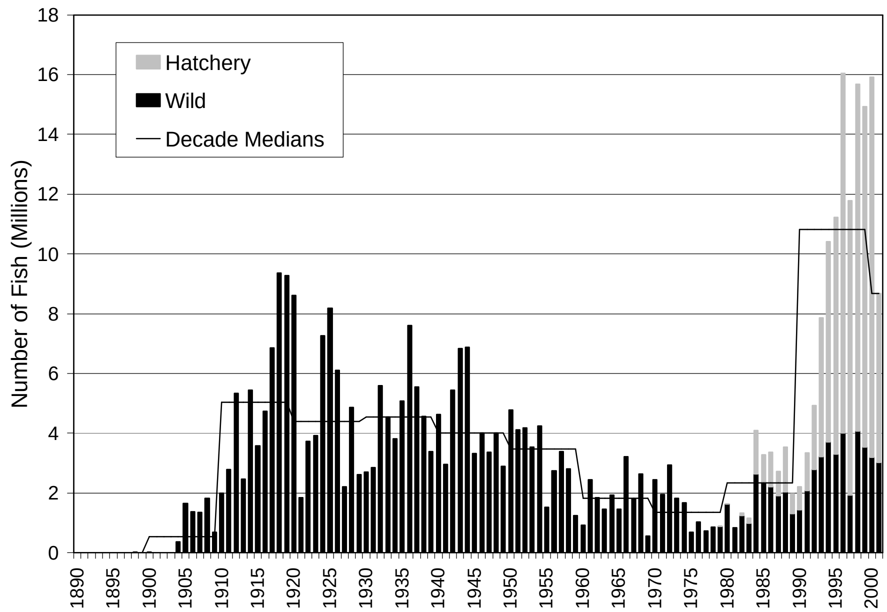

Figure 2. Annual harvest of chum salmon in Southeast Alaska, 1890–2001, showing the harvest of both hatchery-produced and wild chum salmon.

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.

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), and in-river fish wheel counts have been used to monitor salmon escapements in two large, glacial, mainland river systems (Taku and Chilkat Rivers). However, the vast majority of the department'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 two 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, CFEC 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 seven 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[2]) flown at an altitude of 150 to 200 m, and a speed of 90 $km \cdot hr^{-1}$. 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 four 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.

[2] Product names used in this publication are included for scientific completeness but do not constitute product endorsement.

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. 2003). 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 Table 1) based on the following criteria:

1) Those streams that had peak survey estimates for at least 16 of the most recent 21 years, 1982–2002; 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 three years.
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 four 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 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 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 - 1,000	19	23%
1,000 – 2,000	17	21%
2,000 – 3,000	6	7%
3,000 - 4,000	5	6%
4,000 - 5,000	6	7%
5,000 - 6,000	2	2%
6,000 - 7,000	5	6%
7,000 - 8,000	2	2%
8,000 - 10,000	4	5%
10,000 - 15,000	3	4%
15,000 - 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 Table 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 (a=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 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 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 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 2). Districts 111, 112 and 114 showed significant increasing trends in peak escapement survey estimates (P<0.05).

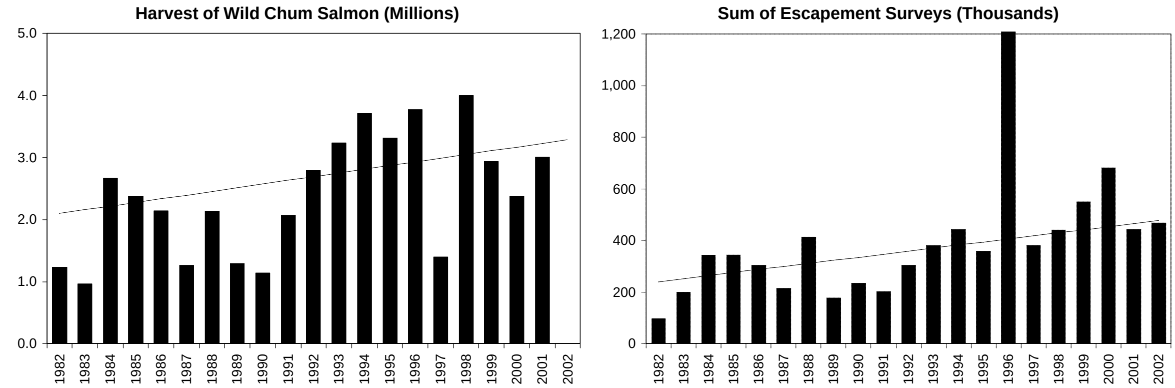

Figure 3. Annual estimated commercial harvest and overall escapement index, of wild chum salmon in Southeast Alaska, 1981–2002 (harvest data not available for 2002). The dotted line is found by the "resistant regression," and the slope of the line is a robust estimate of increase or decline relative 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 2. Median escapement survey counts of chum salmon by year and ADF&G commercial salmon regulatory district, 1982–2002, together with summary statistics.

District	101	102	107	108	109	110	111	112	113	114	115
No. of Streams	8	2	2	1	9	12	9	19	6	9	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 (a=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 Table 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 six 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 two 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 two 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 five of nine index streams in District 114, three of six streams in District 113, and three of nine 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 three foot surveys conducted over the course of the season (Heinl et al. 2000; Table 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, 1982–2002 (i.e., a robust estimate of decrease of 1.7% per year; Figure 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 3). Recent estimated escapements have generally been below the 32-year average of 25,000 fish; including the two lowest estimated escapements in 1997 (2,838), and 1999 (5,350). As already noted, two 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 Table 1).

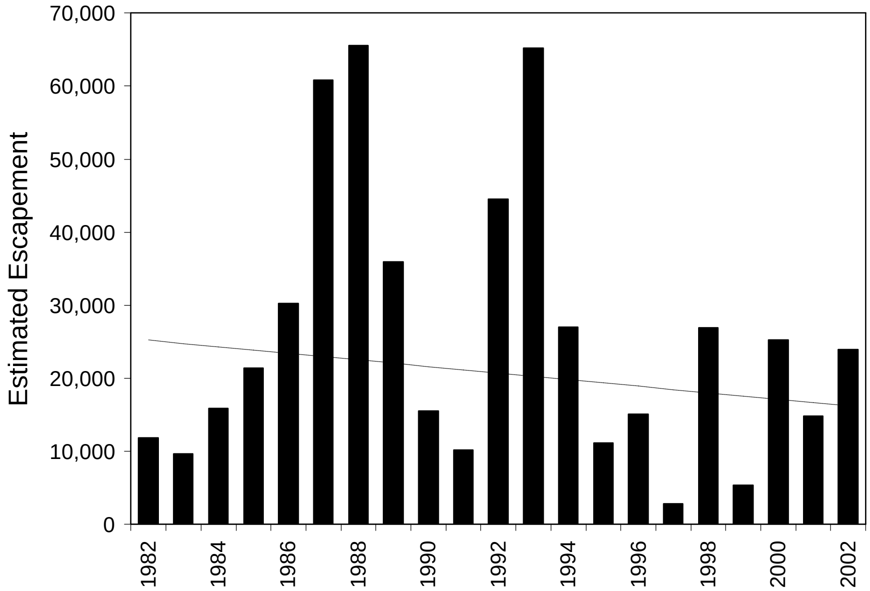

Figure 4. Annual estimated escapement of chum salmon in Fish Creek (ADF&G Stream Number 101-15-085), 1982–2002. The dotted line is found by the "resistant regression," and the slope of the line is a robust estimate of increase or decline relative to the size of the escapement at the beginning of the series; in this case an annual decrease of 1.7% over the 21-year series.

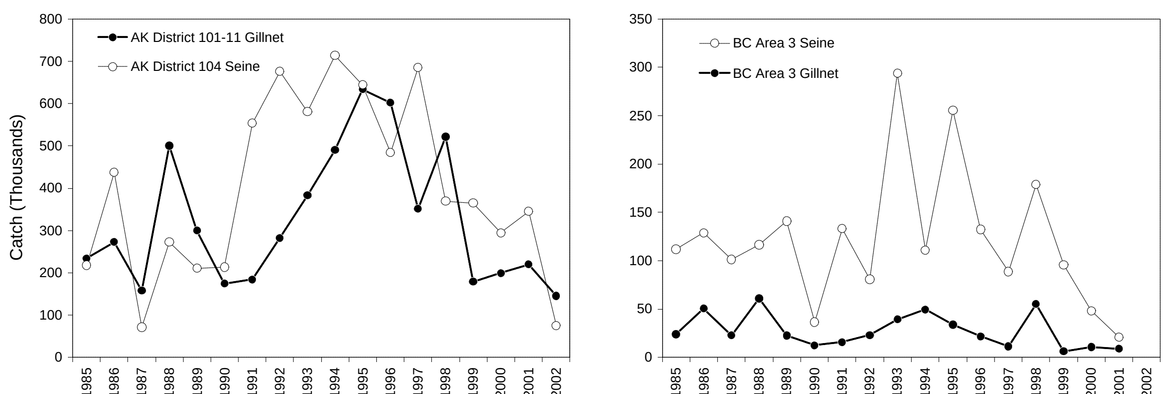

Figure 5. Annual commercial harvest of chum salmon in Alaska and British Columbia net fisheries in the Dixon Entrance area, 1985–2002.

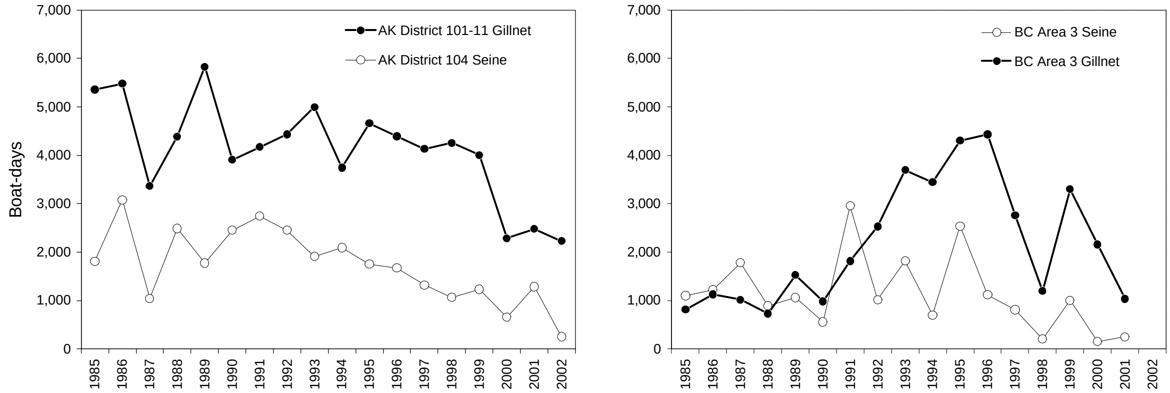

Figure 6. Fishing effort (boat-days) in Alaska and British Columbia commercial net fisheries in the Dixon Entrance area, 1985–2002.

Table 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 (a=0.05, two-tailed). The sample size (n) denotes the number of years used for the Spearman's rho statistic.

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 and 6); however, catch-per-unit-effort (CPUE) of chum salmon has not declined, indicating that chum salmon abundance has remained fairly stable (Figure 7).

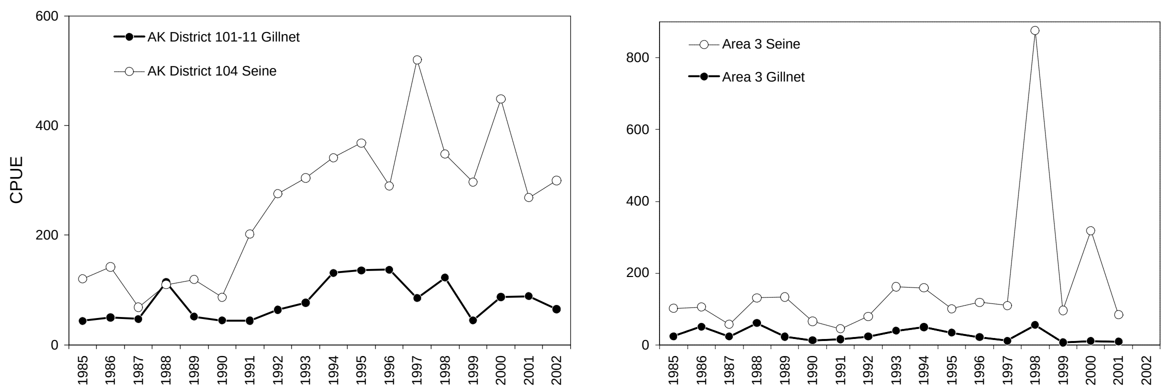

Figure 7. Catch-per-unit-effort (CPUE) of chum salmon in Alaska and British Columbia commercial net fisheries in the Dixon Entrance area, 1985–2002.

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 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.

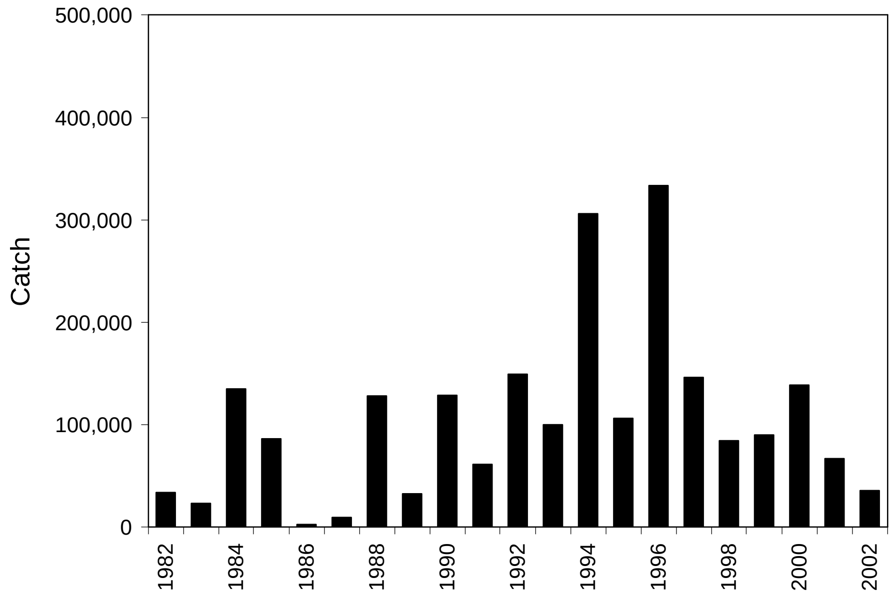

Figure 8. Annual harvest of chum salmon in the Tenakee Inlet (District 112; Subdistricts 41, 42, and 45) commercial purse seine fishery, 1982–2002.

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 eight of the major chum salmon index streams in the inlet (Appendix Table 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 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 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.

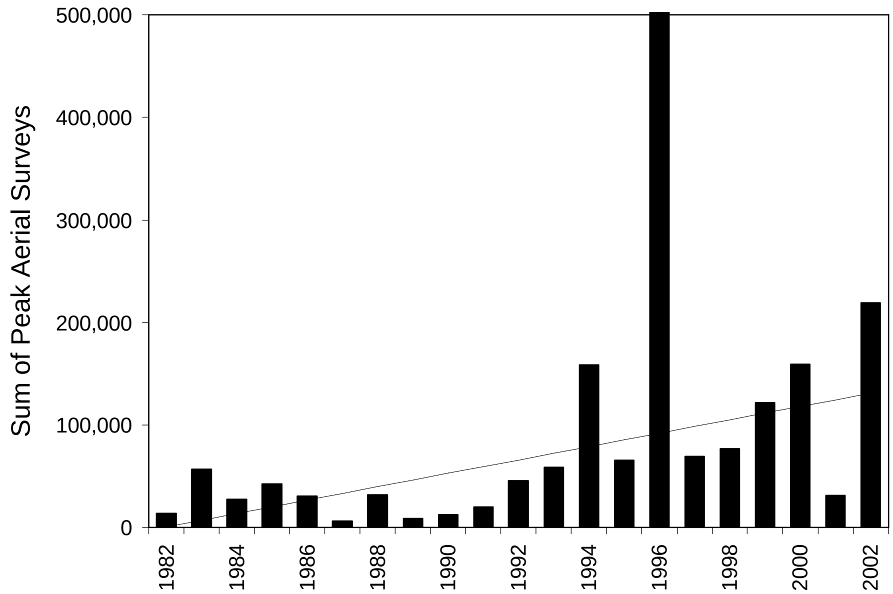

Figure 9. Sum of annual peak aerial survey estimates of chum salmon on eight Tenakee Inlet (District 112; Subdistricts 42, 44, 46, 47, and 48) chum salmon index streams, 1982–2002. The dotted line is found by the "resistant regression," and the slope of the line is a robust estimate of increase or decline 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 10,000–15,000 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 (Appendix Table 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 10). The fall commercial purse seine fishery in District 102, which targets returns to these two rivers, also shows an increasing trend in harvests since statehood (Figure 11). Although our stock assessment methods for Cholmondeley Sound fall chum salmon do not allow an accounting of total runs for the two major contributing stocks, trends in escapement and commercial harvests indicate the runs are healthy and producing at high levels.

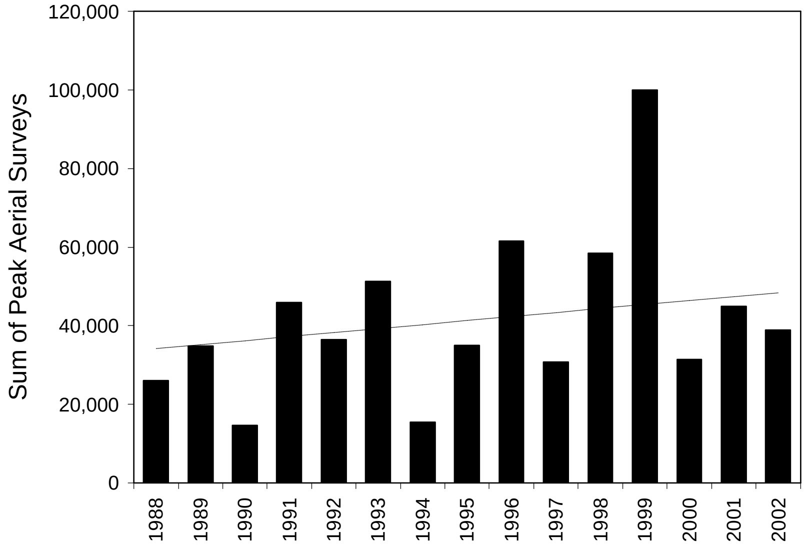

Figure 10. Sum of annual peak aerial survey counts of chum salmon in Disappearance Creek (ADF&G Stream Number 102-40-043) and Lagoon Creek (ADF&G Stream Number 102-40-060), Cholmondeley Sound, 1988–2002. The dotted line is found by the "resistant regression," and the slope of the line is a robust estimate 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.

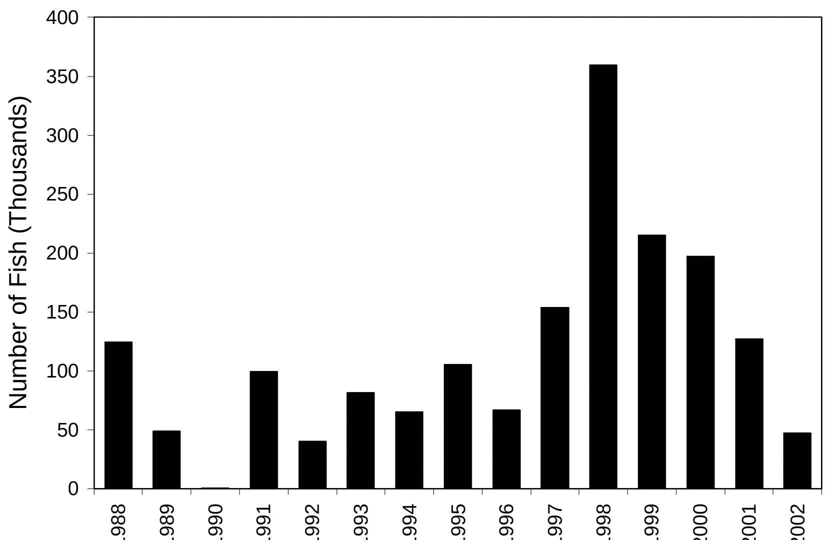

Figure 11. Annual harvest of chum salmon in the Cholmondeley Sound (District 102-40) commercial fall chum salmon purse seine fishery, 1988–2002.

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 12).

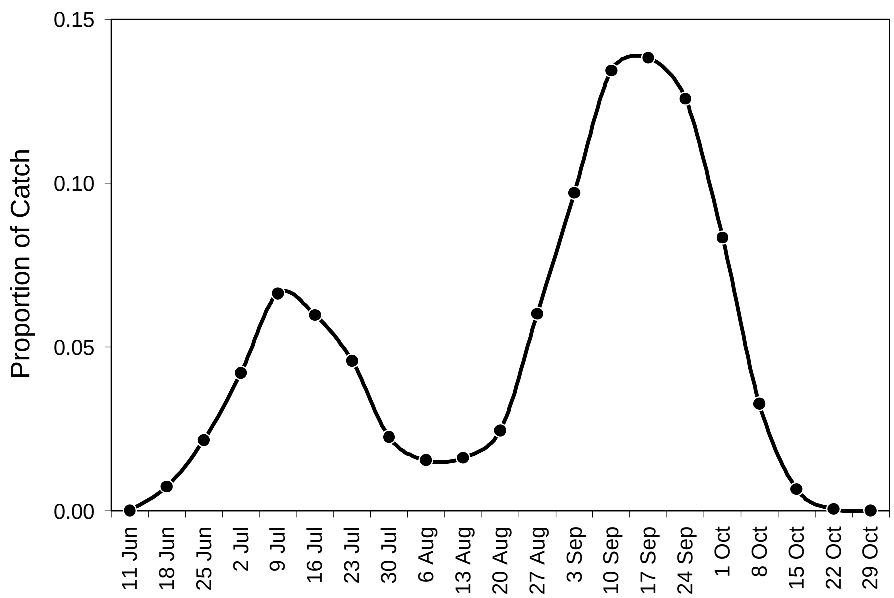

Figure 12. Mean run timing of chum salmon in the Lynn Canal (District 115) commercial drift gillnet fishery, illustrated by plotting the mean weekly proportion of the total annual harvest of chum salmon in the fishery, 1960–2002. All chum salmon harvested in Statistical Week 32 (average mid-week date August 6) and later are considered fall-run fish.

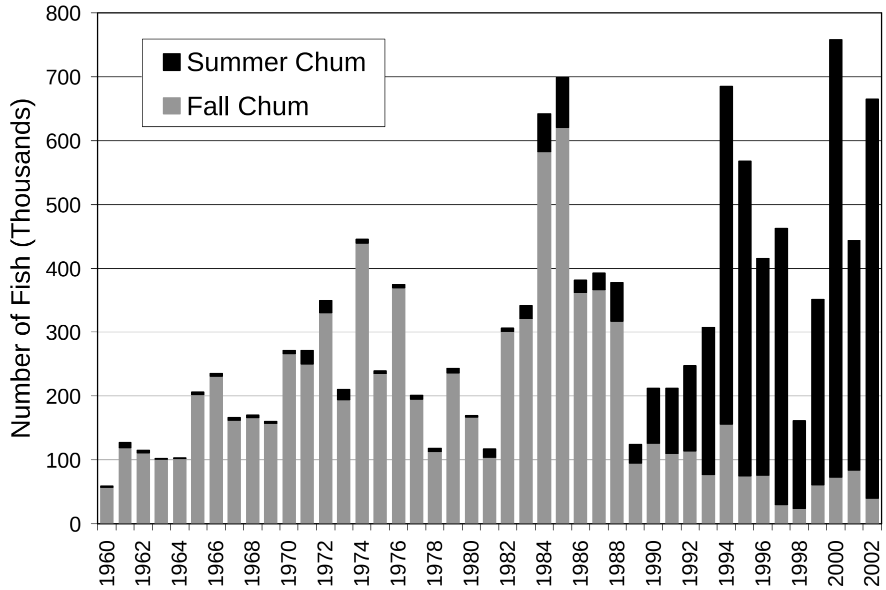

Figure 13. Annual harvests of summer and fall chum salmon in the Lynn Canal (District 115) commercial drift gillnet fishery, 1960–2002.

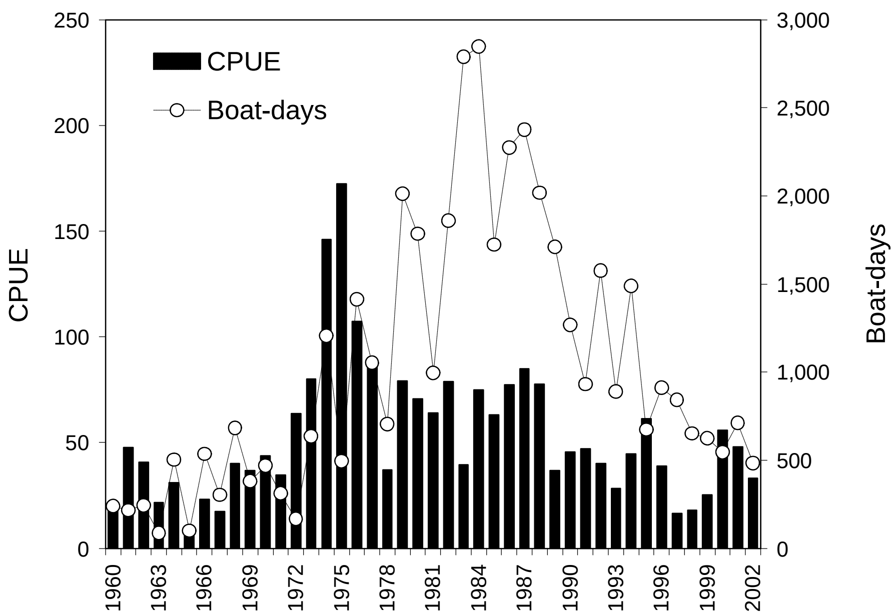

Figure 14. Effort (boat-days) and catch-per-unit-effort (CPUE) of fall-run chum salmon in the Northern Lynn Canal (District 115-31) commercial drift gillnet fishery during Statistical Week 32 (average mid-week date August 6) and later, 1960–2002. Catches in this area are thought to reflect the abundance 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 4; Figures 13 and 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 4. Chum salmon harvests in the Taku Inlet (111-32) and Lynn Canal (District 115) commercial drift gillnet fisheries, 1960–2002. 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); 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 70,000–100,000 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 6). Fish wheel catches from 1999 to 2002 suggest improved escapements in those years.

Table 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 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	Chum Catch
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 the department 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 15).

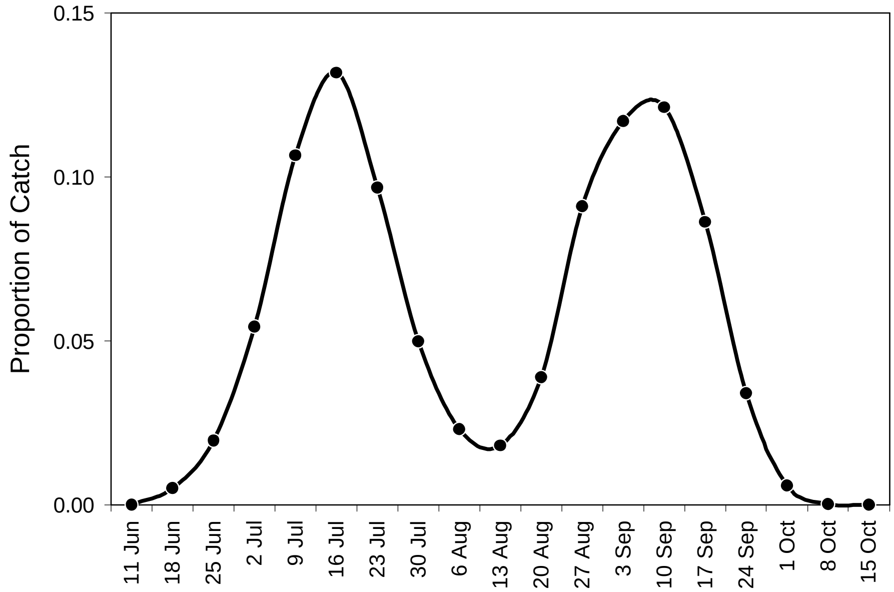

Figure 15. Mean run timing of chum salmon in the Taku Inlet (District 111-32) commercial drift gillnet fishery, illustrated by plotting the mean weekly proportion of the total annual harvest of chum salmon in the fishery, 1960–2002. All chum salmon harvested in Statistical Week 34 (average mid-week date August 20) and later are considered fall-run fish.

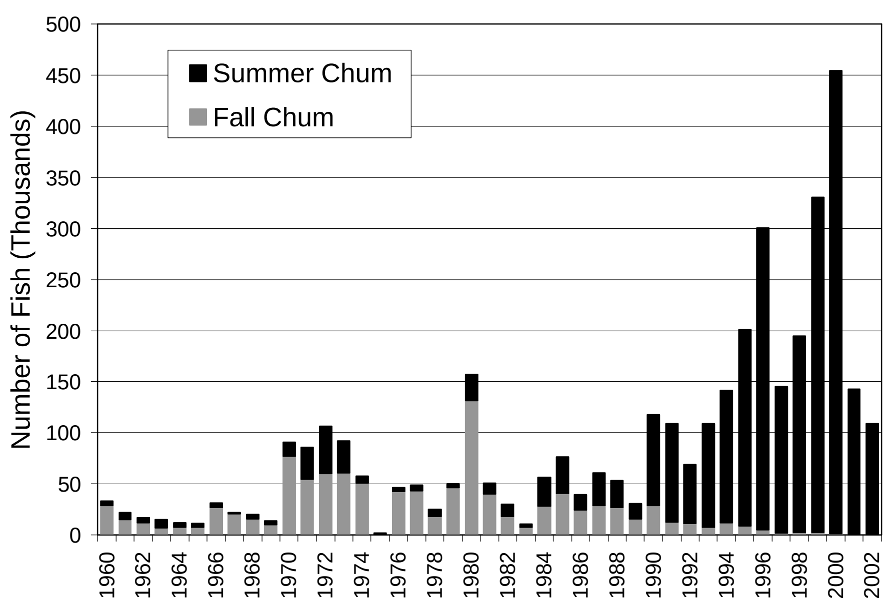

Figure 16. Annual harvests of chum salmon in the Taku Inlet (District 111-32) commercial drift gillnet fishery, 1960–2002.

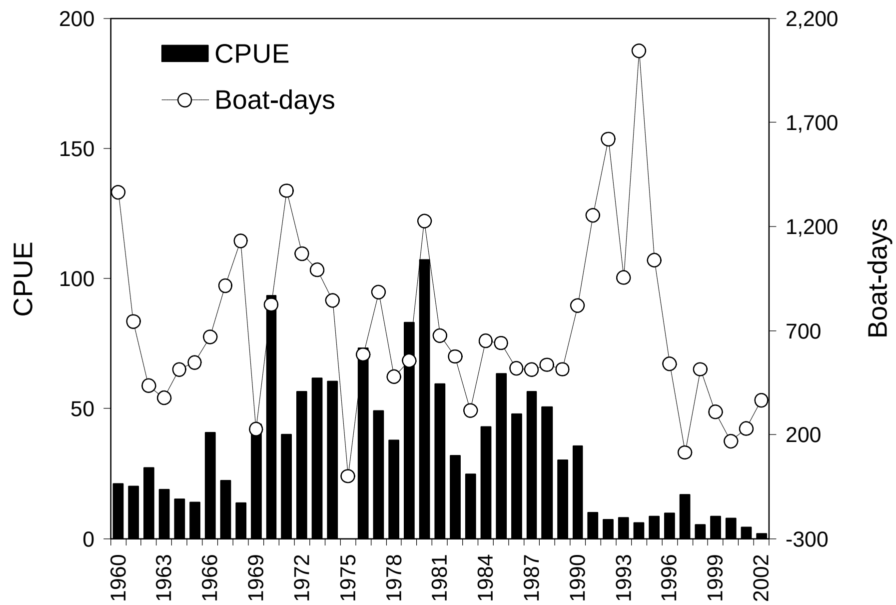

Figure 17. Effort (boat-days) and catch-per-unit-effort (CPUE) of fall-run chum salmon in the Taku Inlet (District 111-32) commercial drift gillnet fishery during Statistical Week 34 (average mid-week date August 20) and later, 1960–2002.

The Transboundary Technical Committee established an interim escapement goal of 50,000–80,000 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 Canadian Department of Fisheries and Oceans (DFO) to estimate escapement through mark-recapture methods and aerial index surveys have been unsuccessful. Fish wheels operated jointly by ADF&G and DFO 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 4; Figures 16 and 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 6; Figure 18).

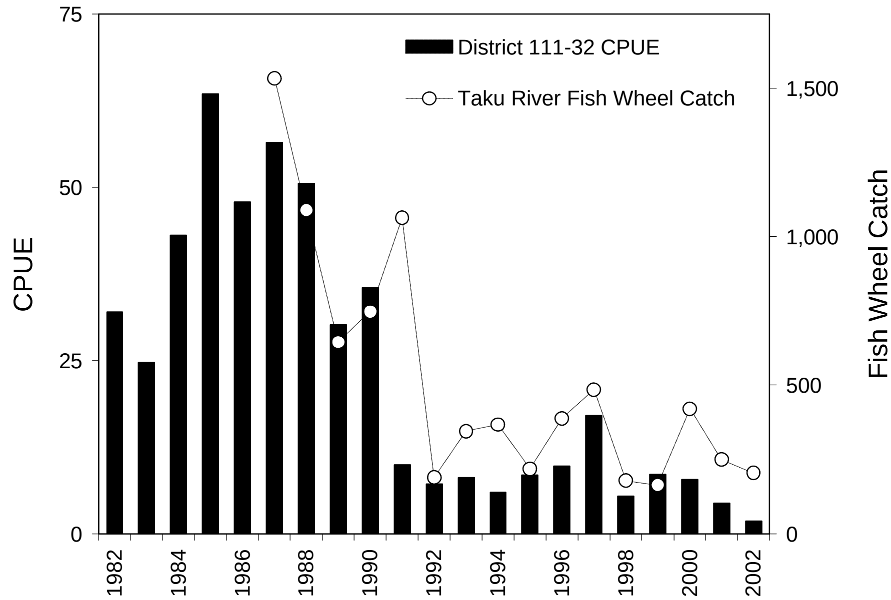

Figure 18. Catch-per-boat-day (CPUE) of fall-run chum salmon in the Taku Inlet (District 111-32) commercial drift gillnet fishery during Statistical Week 34 (average mid-week date August 20) and later, plotted with the Taku River fish wheel catch of all chum salmon, 1982–2002.

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. The department 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, the department 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 two miles of the river and in the adjacent ocean out to the surf line within two 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. *in prep.*). 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. *in prep.*).

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 7; Figure 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 20).

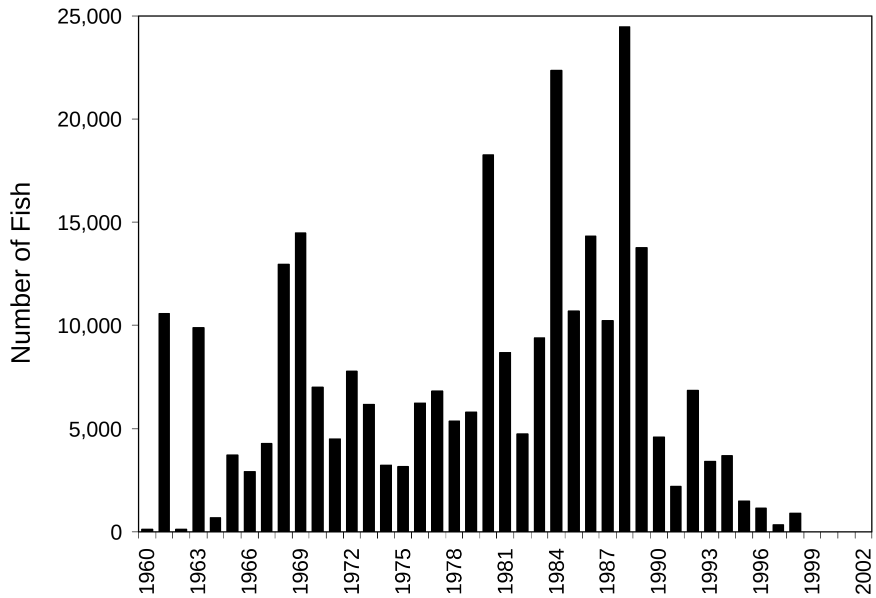

Figure 19. Commercial harvest of chum salmon in the East Alsek River (ADF&G Stream Number 182-20-010) set gillnet fishery, 1960–2002.

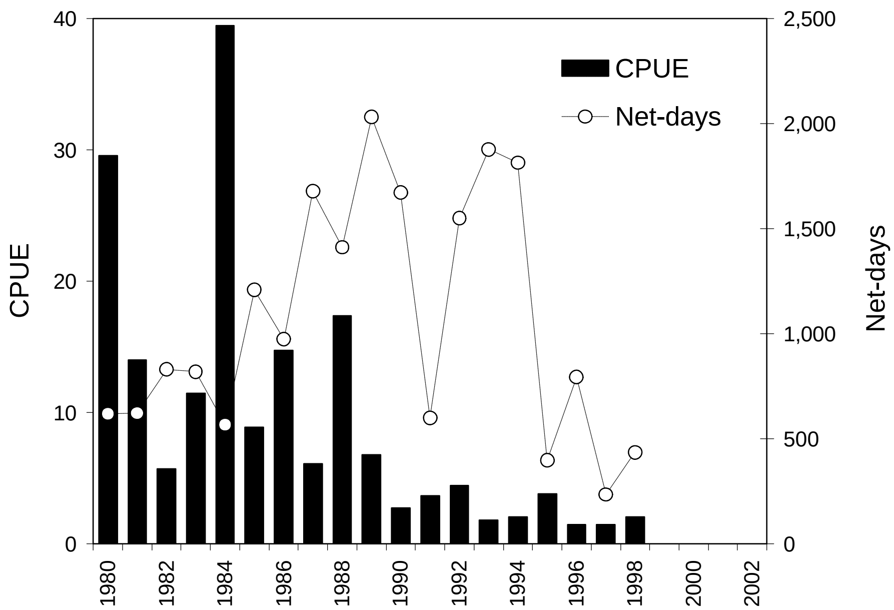

Figure 20. Effort (net-days) and catch-per-unit-effort (CPUE) of chum salmon in the East Alsek River (ADF&G Stream Number 182-20-010) commercial set gillnet fishery, 1980–2002.

Table 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 counted, 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.

Salmon escapements to the East Alsek River have been estimated annually by one to three aerial surveys, typically conducted between late August and early October (Table 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 2,000–40,000), and 9,000 in the 1980s (range 3,000–20,000). 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 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.

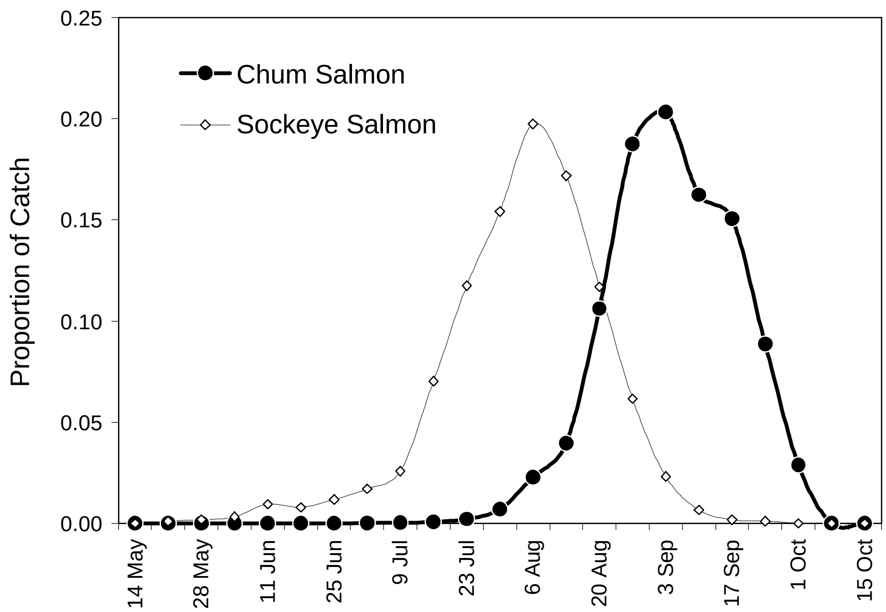

Figure 21. Mean run timing of sockeye and chum salmon in the East Alsek River (ADF&G Stream Number 182-20-010) commercial set gillnet fishery, illustrated by plotting the mean weekly proportion of the total annual harvest of sockeye salmon and the mean weekly proportion of the total annual harvest of chum salmon in the fishery, 1960–1994.

ESCAPEMENT GOALS

In our review of existing escapement goals for chum salmon in Southeast Alaska, we found reference to four escapement goals which were established for Lynn Canal in 1991 (fall-run Chilkat mainstem, 70,000–100,000; fall-run Klehini River, part of the Chilkat system, 20,000 fish; summer-run Sawmill Creek, 1,000–8,000; and summer-run West Lynn Canal, 4,000–8,000), and the 1985 interim escapement goal of 50,000–80,000 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 an independent 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 three 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 two decades (Figure 3; Appendix Table 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 (four 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 have 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. The department has, during the past year, been pursuing additional funding to begin such studies. The department 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. The department 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 methodologies 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. The department 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 Table 1. Peak escapement index series for select chum salmon streams in Southeast Alaska, with summary statistics, 1982–2002.

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%
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 (a=0.05, two-tailed). The sample size (n) denotes the number of years used for the Spearman's rho statistic.

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Appendix Table 1. (page 2 of 7)

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 Cr 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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Appendix Table 1. (page 3 of 7)

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 Table 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 River - 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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Appendix Table 1. (page 5 of 7)

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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Appendix Table 1. (page 6 of 7)

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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Appendix Table 1. (page 7 of 7)

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 Crk - 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