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 or complexes of systems, which include 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 Currently there are 14 escapement goals, not including the escapement goal for the Italio River, which was rescinded in 2002 due to major physical and hydrologic change in the drainage.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. With respect to the transboundary rivers, escapement goals are established for the 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 generally been declining for 2 decades and the escapements have consistently been below the lower end of the previous escapement goal range for this system for a decade. The escapement goal for Hugh Smith Lake has been 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. Overall, although yields have declined somewhat in the Yakutat area, probably due to hydrological changes in several rivers reducing productivity, 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.

INTRODUCTION

Sockeye salmon (*Oncorhynchus nerka*) that are 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 production is associated with lakes in which juvenile sockeye salmon rear, but there is also substantial production from riverine areas primarily within region's large glacial systems on the mainland. Van Alen (2000) reports that over 200 sockeye salmon-producing systems in Southeast Alaska and the Yakutat area. Many but not all of these are small producers; however, their combined production is substantial. There is considerable variation in return timing among runs throughout the region, including variation among individual stocks within 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 1a). Long-term stock assessment data has been 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, either on a less intensive or sporadic basis. In the last several years, the Alaska Department of Fish and Game initiated several new studies that were funded by the federal government. Harvest information is recorded on a district specific basis (Figure 1b).

Prior to the industrialization of the salmon fisheries in the 1800s by European Americans, sockeye salmon provided both 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 involved sockeye salmon, more so 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). The first records of substantial commercial sockeye salmon catches dates to 1883, when just over 100 thousand 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 thousand 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, and when 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 through 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 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

salmons in southern Southeast had been more stable and consistent than in northern portions of the region. However catches dropped in both areas at that time (Figure 2). The region's commercial catch of sockeye salmon reached a trough of 490 thousand in 1949 and generally remained below 1 million fish annually through the 1960s.

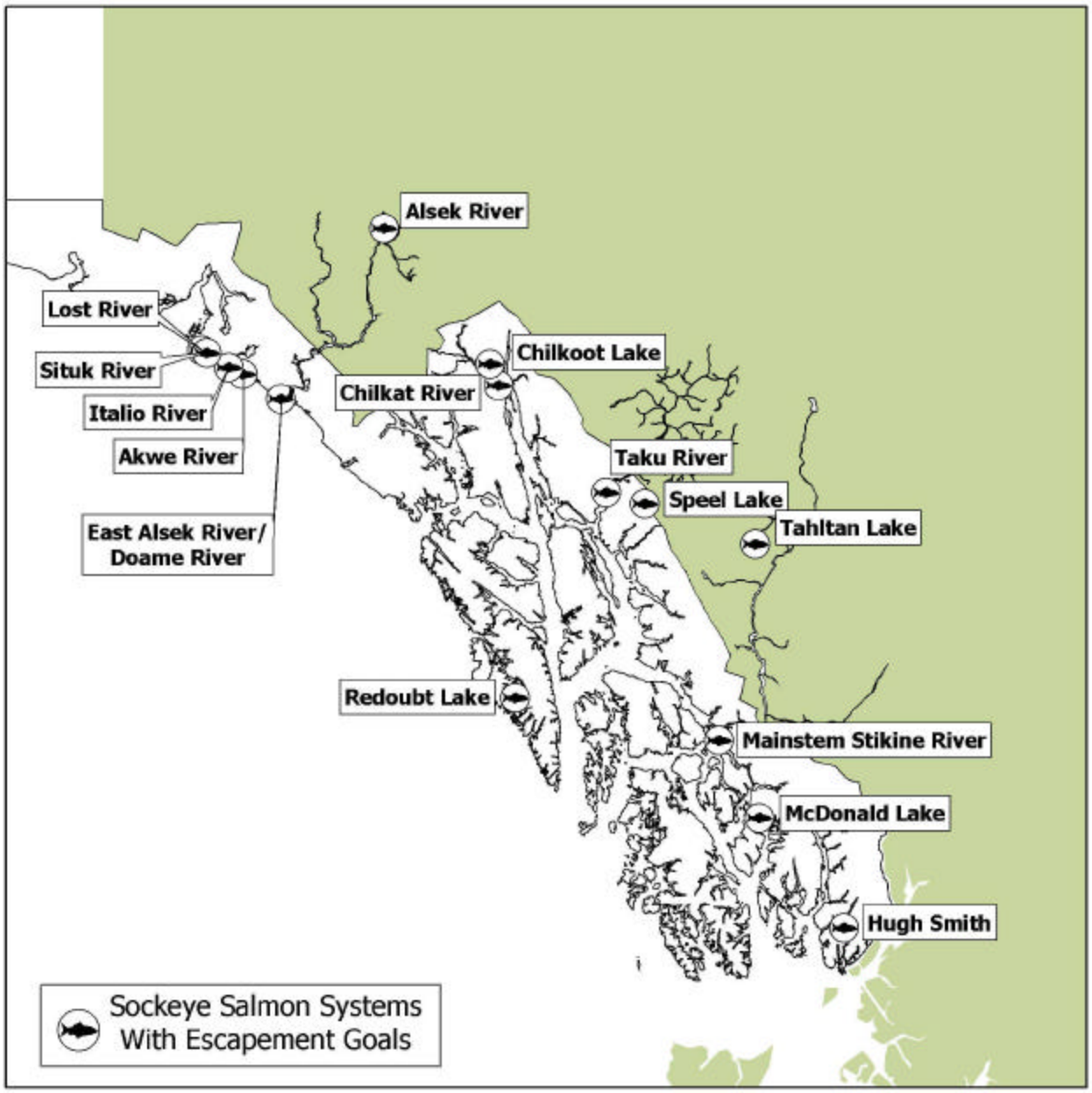

Figure 1a. Sockeye salmon systems with long-term stock assessment programs and escapement goals in Southeast Alaska and the Yakutat area.

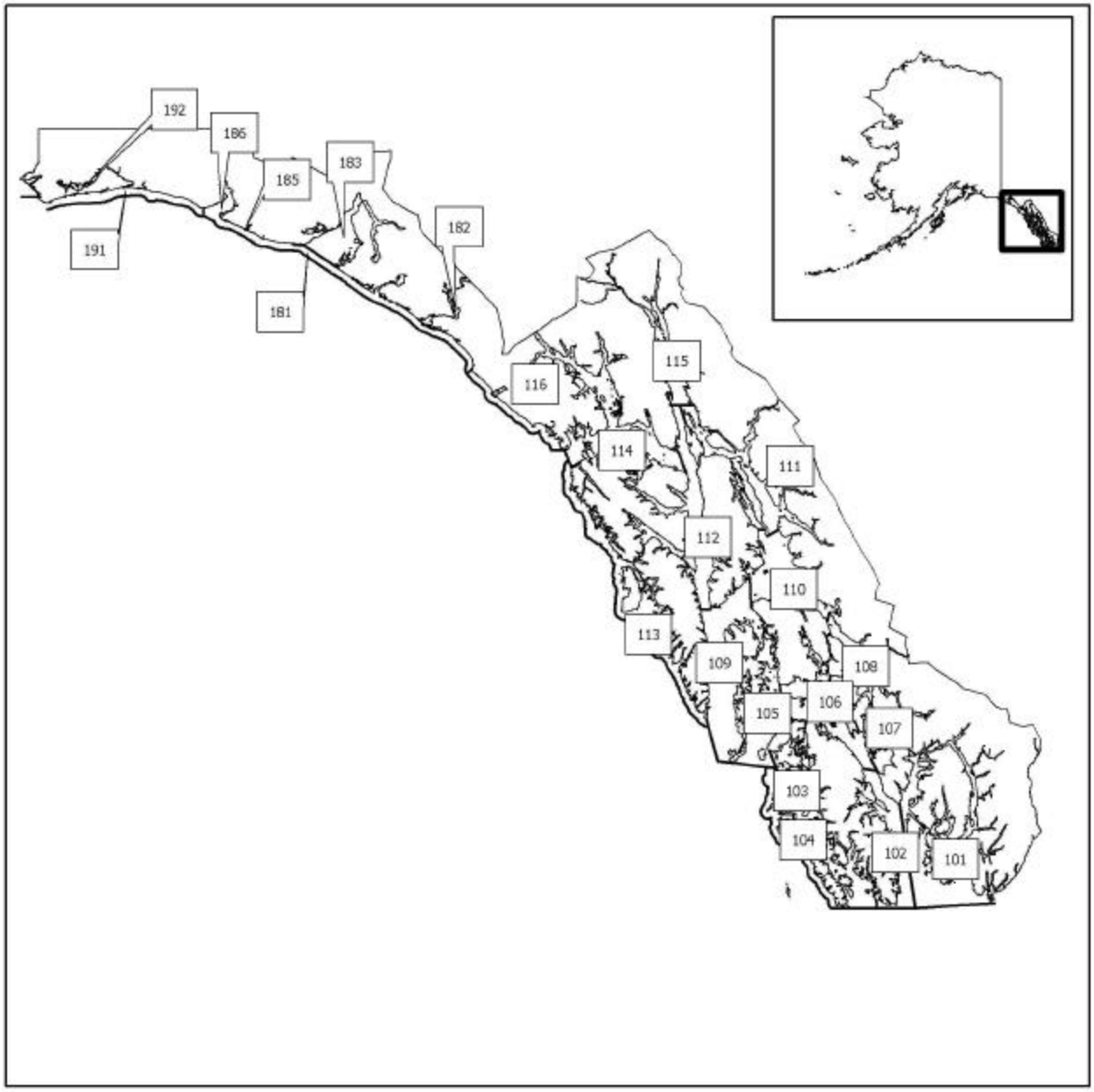

Figure 1b. Fishing districts in Southeast Alaska and the Yakutat area.

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 the case 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.

Among commercial users, harvests by gear type since statehood have been 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 targeted 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. The department 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 (AAH[2]) 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 (TAC[2]) 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 TAC of wild Taku River sockeye salmon and 50% of the TAC 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. The 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 target 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 AAH 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 salmon 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 salmon 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 pre-season management plans published by the department (ADF&G 2002b).

[2] 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.

Set gillnet gear is allowed in the Yakutat area; there are no other 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 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 the department (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.

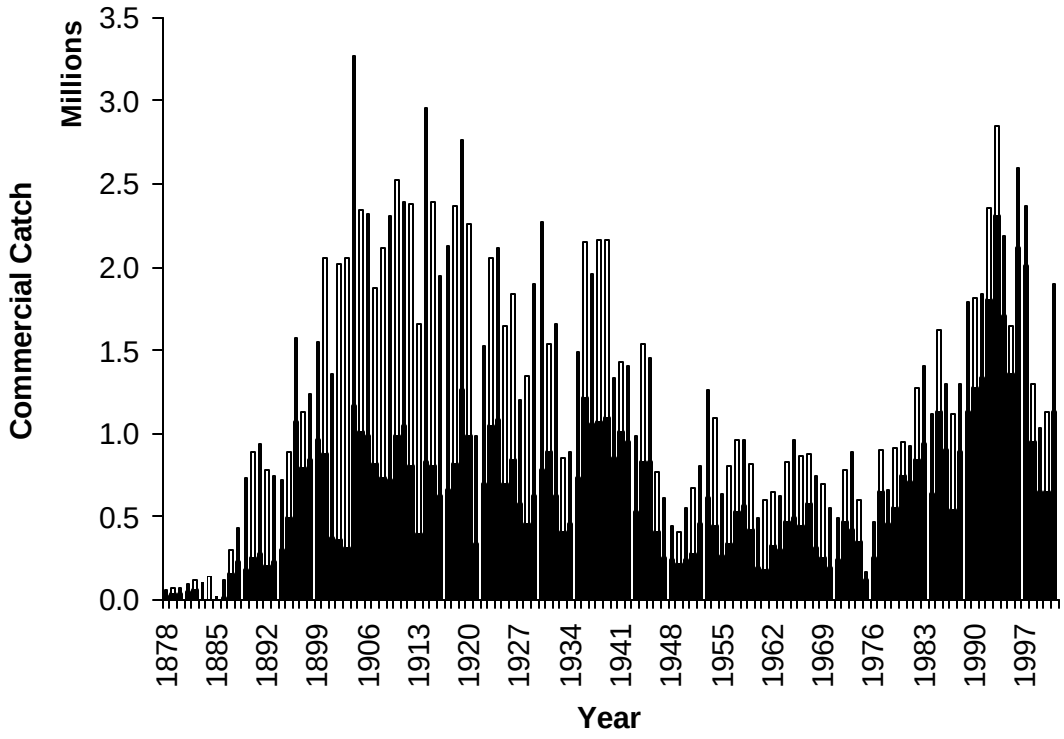

Figure 2. Commercial catch of sockeye salmon in Southeast Alaska (not including the Yakutat area) from 1878 to 2001. Top, lighter bars show the catch in Southern Southeast Alaska, while dark, lower bars denote catch in Northern Southeast Alaska.

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 A–D.

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 (TRTFN), and

the Tahltan First Nation (TFN) help with monitoring escapements into the transboundary rivers. The Douglas Island Pink and Chum Corporation (DIPAC), Northern and Southern Regional Aquaculture Associations (NSRAA and SSRAA), 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 salmon 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 the department will be conducting 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, and 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, the department 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. NSRAA 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 (1982–1993, 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 have been 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 has 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 been operated since 1982, with the exception of 1998.

Because of the dispersed production of sockeye salmon in coastal lakes in southern Southeast Alaska, there have been 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 P.

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 A to O.

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 has been 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 is 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 71,000–80,000 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 have been below the escapement goal range each of the last 5 years. This has been 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 has been closed for the last 2 years during the period when Tahltan fish are 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, the department has not recommended this stock be considered a candidate for *stock of concern* status. Escapements of Mainstem Stikine River sockeye have been 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 the department 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. The department has taken 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 had been below the escapement goal range for 6 of the previous 7 years. Zooplankton populations in the lake have 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, which have exceeded their goal annually for the last 5 years. 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 since the 2002 fishing season. Escapements have been within or above this new *biological escapement goal* range in 3 of the last 5 years. Low escapements in 2000 and 2001 may have been related to an interruption in a long-term lake fertilization program.

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

The McDonald Lake escapement goal has not been updated in the last several years, and the current goal of 65,000 to 85,000 has not been adequately documented. McDonald Lake escapements have been 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. The department 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. There may be a few that are the primary cause of the downward escapement trend, but it may also be the sum of several factors. 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 likely to have failed to add significant production, although it is apparent that 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 tock can be found in Appendix N, and a detailed report on development of the Hugh Smith escapement goal and stock status maybe 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 has been 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]	A	30,000– 70,000	2003	30,000– 70,000
Lost River	B	1,000– 2,300	1995	
Italio River	C	No goal at present	2003	2,500– 7,000
Akwe River	D	600– 1500	1995	
Klukshu River	E	7,500– 15,000	2000	
East Alsek-Doame River	F	13,000– 26,000	2003	26,000– 57,000
Chilkoot Lake	G	50,500– 91,500	1990	
Chilkat Lake	H	52,000– 106,000	1990	
Redoubt Lake	I	10,000– 25,000	2003	No previous goal
Taku River	J	71,000– 80,000	1986	
Speel Lake	K	4,000– 13,000	2003	5,000
Tahltan Lake	L	18,000– 30,000	1993	
Mainstem Stikine River	M	20,000– 40,000	1987	
Hugh Smith	N	8,000– 18,000	2003	15,000– 35,000
McDonald Lake	O	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 A).

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 B). 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 has been withdrawn because the productivity of this system has 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 C).

Akwe River

ADF&G adopted a *biological escapement goal* of 600 to 1,500 peak survey counts for this system in 1995. The escapement goal has not been updated and remains in effect (Clark, Burkholder and Clark 1995; Appendix D). ADF&G has not been able 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 E). 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 River

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. *in press*; Appendix F). 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 have been 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 G).

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 H).

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 I).

Taku River

An escapement goal of 71,000–80,000 sockeye salmon into Canadian spawning areas of the transboundary Taku River was established by the Transboundary Technical Committee (TTC 1986) in 1985 (Appendix J). 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 *in press*). 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 K).

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 L).

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 M).

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 N).

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 65,000–85,000 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 O).

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 noted that 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 has either been recently

implemented (such as the 12 systems described in Appendix P), or the monitoring has been conducted on a more limited time scale or less intensive basis. Weirs are currently being 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 have been 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. Through our own research projects and through cooperative projects with other institutions, 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 A. 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 NO. 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

Number of years in model: 22

Ratio of highest escapement to lowest escapement: 5.7

Parameter estimates: a-parameter = 4.04 (adjusted), $1/\beta \approx 92{,}000$,
(β-parameter $=1.09\ 10^{-5}$)

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

Summary:

The Situk River is a Yakutat forelands stream located near the town of Yakutat, Alaska that 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).

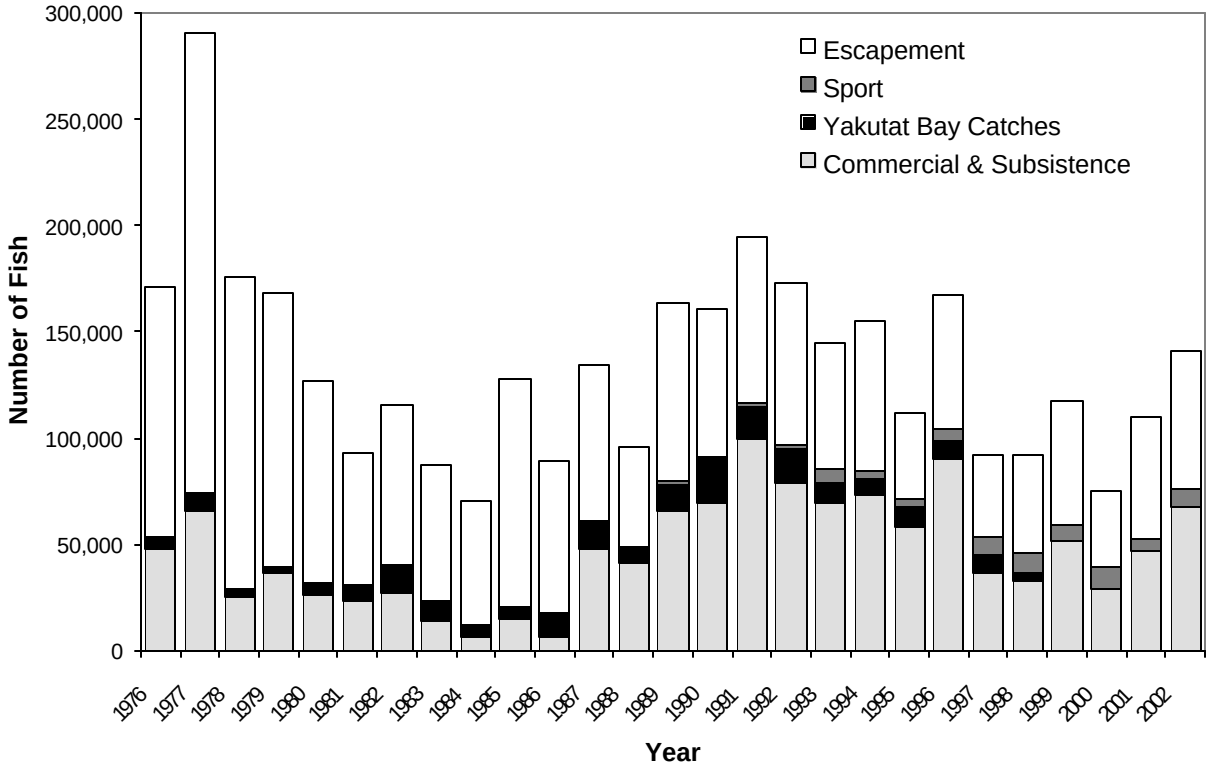
While the Situk River sockeye salmon stock is considered healthy and well managed, in order to achieve the desired annual biological escapement goal, improved information concerning stock composition of the mixed stock catches in the Situk-Ahrnklin Inlet fishery are needed. A research effort to provide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

Appendix A.1. Estimated escapements, harvests, run sizes and exploitation rates for Situk River system sockeye salmon, 1976–2002. 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.

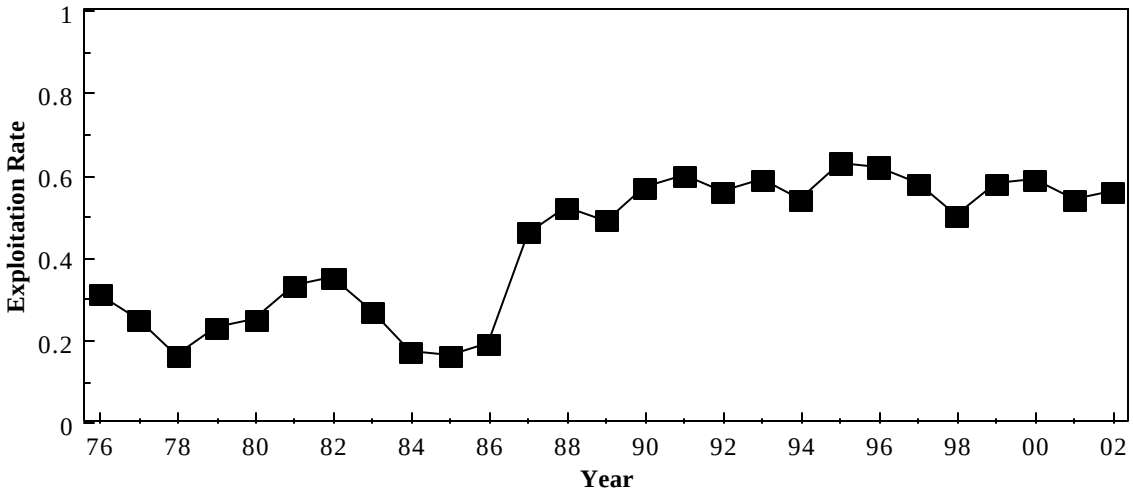
Year	Estimated Escapements	Estimated Sport Harvests	Estimated Commercial & Subsistence Harvests in Situk-Ahrnklin Lagoon	Estimated Yakutat Bay Interceptions Of Situk Origin Fish	Estimated Total Harvests	Estimated Total Runs	Estimated Exploitation Rates
1976	116,989	466	47,954	5,111	53,530	170,519	31%
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 A.2. Estimated total returns (recruits) of Situk River sockeye salmon, brood years 1976–2002.

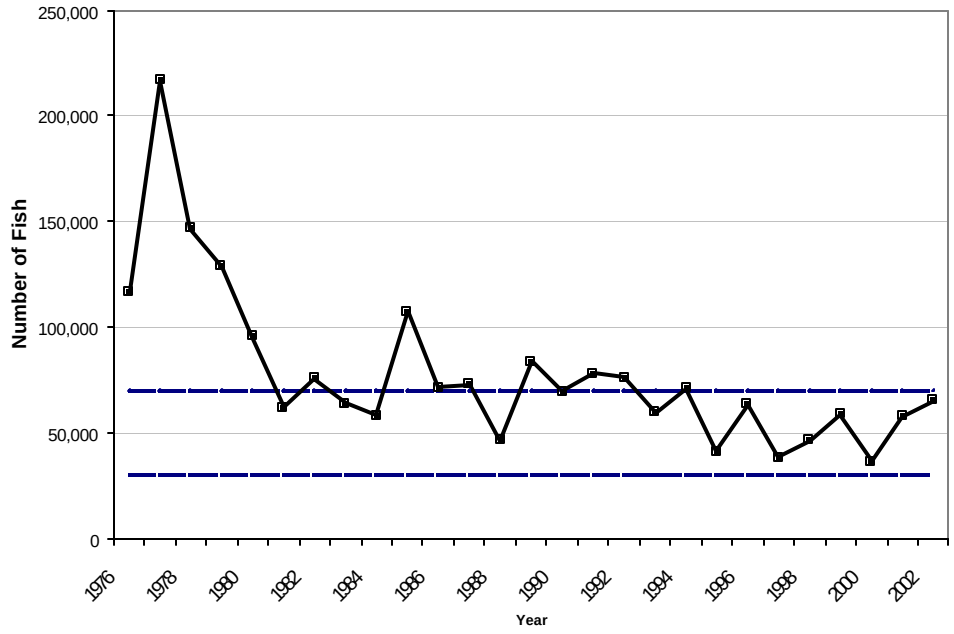
Brood Year	Estimated Total Escapement	Age-2 Returns (recruits)	Age-3 Returns (recruits)	Age-4 Returns (recruits)	Age-5 Returns (recruits)	Age-6 Returns (recruits)	Age-7 Returns (recruits)	Estimated Total Returns	Return Per Spawner
1976	116,989	0	2,047	36,542	51,880	37,306	0	127,775	1.09
1977	216,631	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



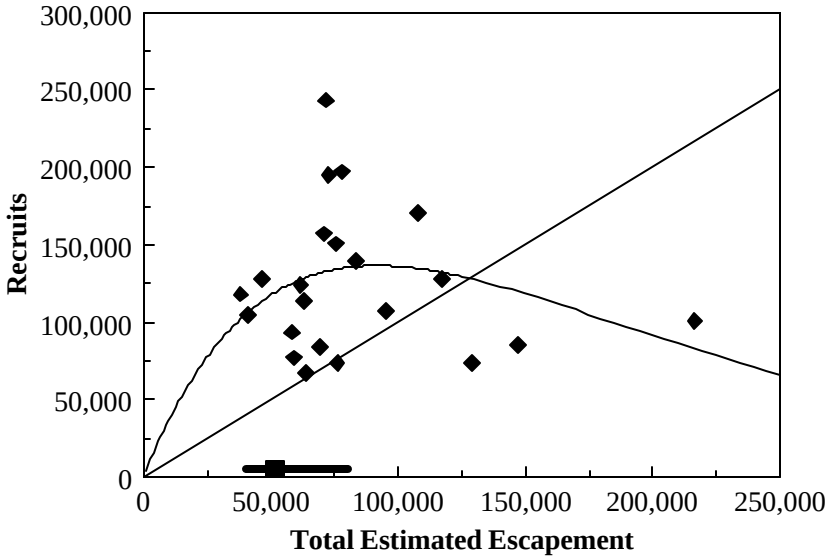
Appendix A.3. Estimated total annual runs of Situk River sockeye salmon, 1976–2002.



Appendix A.4. Estimated exploitation rates for Situk River sockeye salmon, 1976–2002.



Appendix A.5. Estimated total escapements of Situk River sockeye salmon from 1976 to 2002. The region between the 2 horizontal lines, 30,000–70,000 total spawners, represents the biological escapement goal range adopted by ADF&G.



Appendix A.6. Estimated stock-recruit relationship for Situk River sockeye salmon based on brood years 1976–1997. 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 30,000–70,000 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 B. 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., Burkholder A., and J. E. Clark. 1995. Biological escapement goals for five 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.
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

Number of years in model: 14

Ratio of highest escapement to lowest escapement: 5.0

Parameter estimates: a-parameter = 6.34 (adjusted), $1/\beta \approx 3{,}600$ (β-parameter = 0.000279)

Basis of range of escapement goal: Expected yield is at least 90% of maximum sustainable catch

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 it's own lagoon before entering the Gulf of Alaska prior to the winter of 1999–2000. 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 2000–2002. The five-year average (1994–1999) 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 2000–2002.

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, 1994–1998, 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.

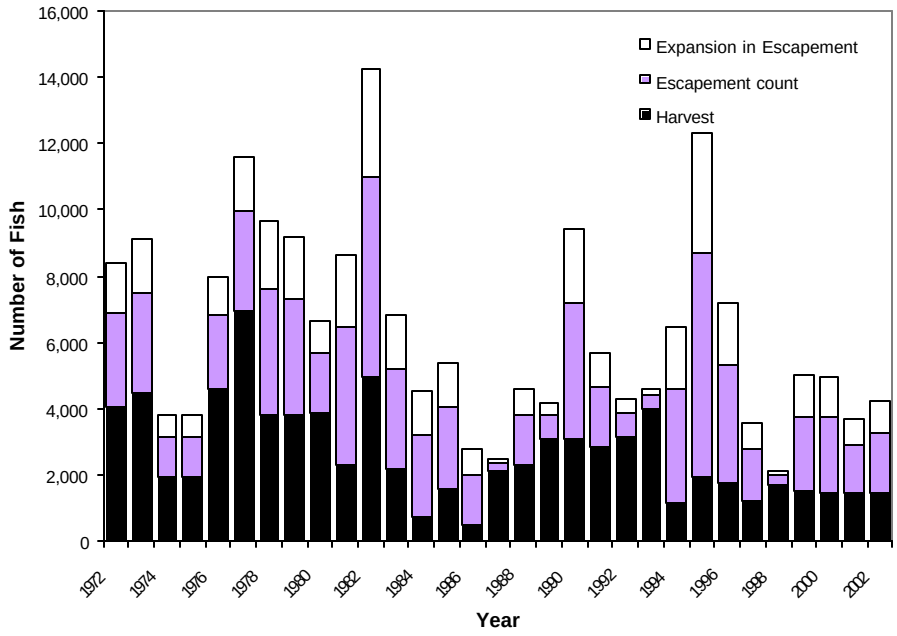
Total exploitation of Lost River origin sockeye salmon since 1972 is estimated to have ranged from 16% in 1995 to 60% in 1977, averaging about 40% in the 24 years for which estimates have been developed. A biological escapement goal was defined and adopted by ADF&G in 1995 as 1,000 to 2,300 sockeye salmon 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.

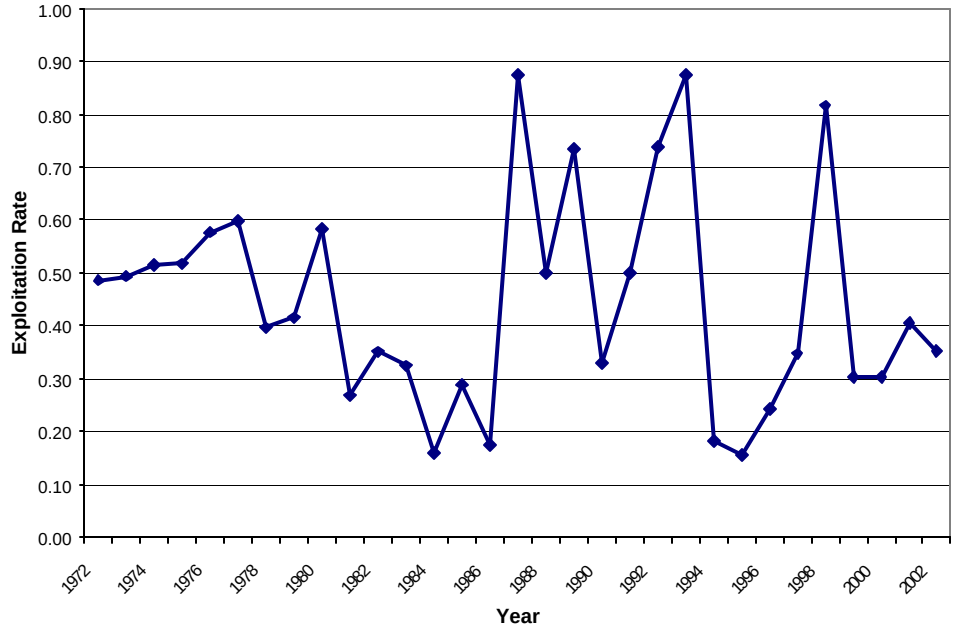
Improvements in the annual stock assessments for Lost River sockeye salmon are planned and are primarily intended to provide direct estimates of total escapement. A second challenge, however, is management of the Situk-Ahrnklin fishery such that adequate escapements of Lost River origin fish, Situk origin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

Appendix B.1. Estimated escapements, harvests, run sizes, and exploitation rates for Lost River system sockeye salmon, 1972–2002. 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 in 1999–2002 are assumed interceptions of Lost River origin fish in the Situk fishery since the Lost River changed channels. Subsistence catches were directly monitored from 1989–2002. 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.

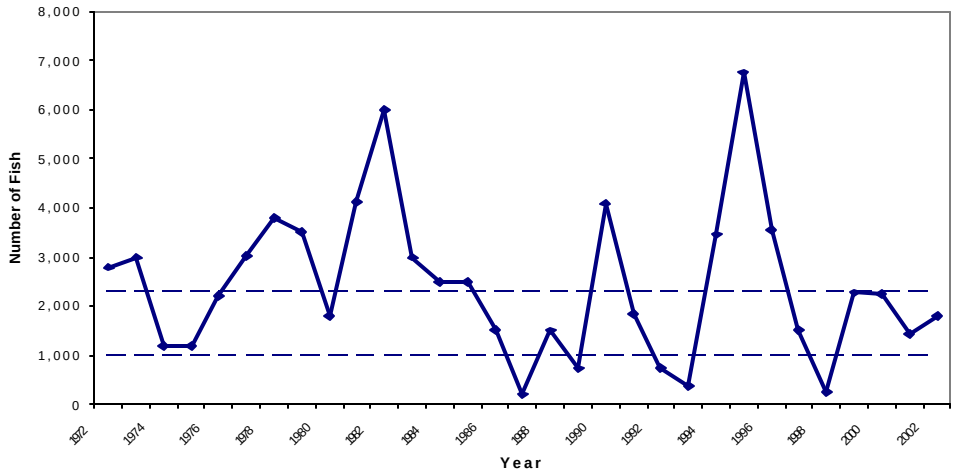
Year	Peak Spawner Count	Assumed Expansion	Estimated Total Escapement	Commercial Set Gillnet Harvest	Subsistence Harvest	Total Harvests	Estimated Total Runs	Estimated Exploitation Rates
1972	2,800	0.65	4,308	4,076	*0*	4,076	8,384	49%
1973	3,000	0.65	4,615	4,495	*0*	4,495	9,110	49%
1974	1,200	0.65	1,846	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%



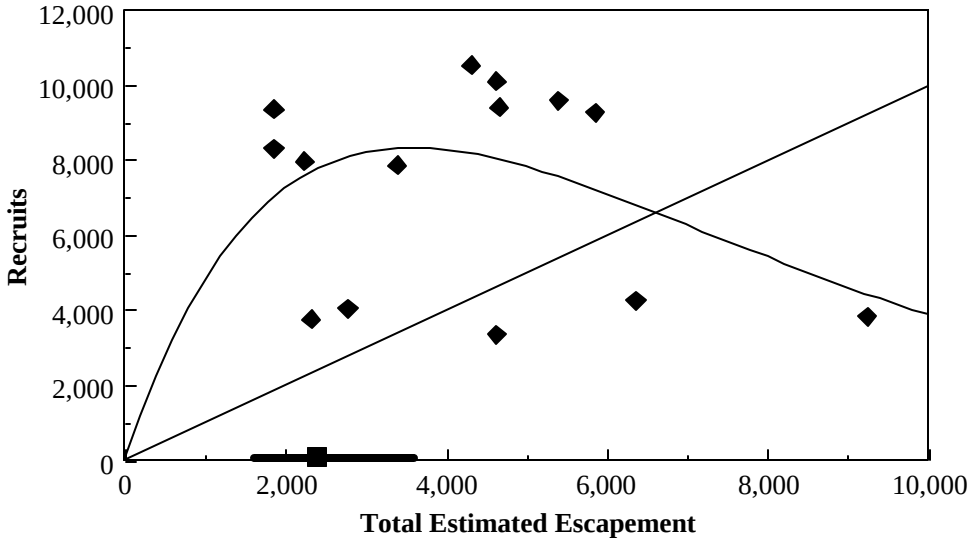
Appendix B.2. Estimated total runs of Lost River sockeye salmon, 1972–2002. The peak escapement count is assumed to be 65% of total escapement. Adequate peak escapement surveys were not completed in 1984, 1985, 1987, 1989, 1992, 1993, and 1998. Harvests in 2000–2002 are assumed to be 1,500 fish per year, from the Situk-Ahrnklin Lagoon.



Appendix B.3. Estimated exploitation rate of Lost River sockeye salmon, 1972–2002.



Appendix B.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 B.5. Estimated stock-recruit relationship for Lost River sockeye salmon estimated with brood years 1972–1983, 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 (1,538–3,538 total spawners or 1,000–2,300 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 C. 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., Burkholder A., and J. E. Clark. 1995. Biological escapement goals for five 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 re-constructions for the years 1972–2001 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

Number of years in model: 10

Ratio of highest escapement to lowest escapement: 5.4

Parameter estimates: *a*-parameter = 5.2 (adjusted), 1/ *ß »* 14,300 , *ß*-parameter = $(6.984 \cdot 10^{-5})$

Basis of range of escapement goal: Expected yield at least 90% of maximum sustainable catch

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 1-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 an escapement 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 1972–1989 brood years (Clark, Burkholder, and Clark 1995).

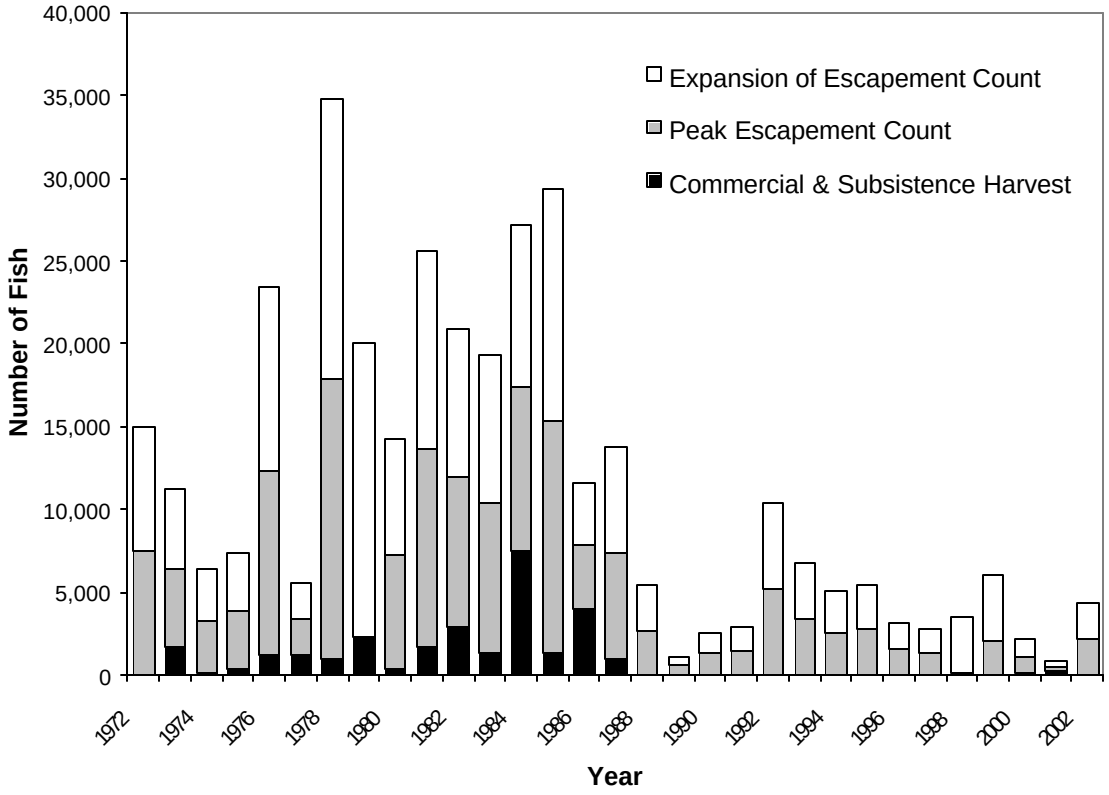
A recent analysis demonstrated that productivity of the stock markedly decreased after the Italio River changed channels, indicating that the escapement objective of 2,500 to 7,000 is no longer germane. Further, productivity has continued to decline since 1986, indicating that use of the recent data 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 C.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, 1972–2002. Total escapement estimates were calculated by adjusting peak counts by average timing and then multiplying those adjusted counts by a factor of two. Estimates of 1979 and 1998 escapements were calculated by mean escapement estimates (1972–1986), 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.

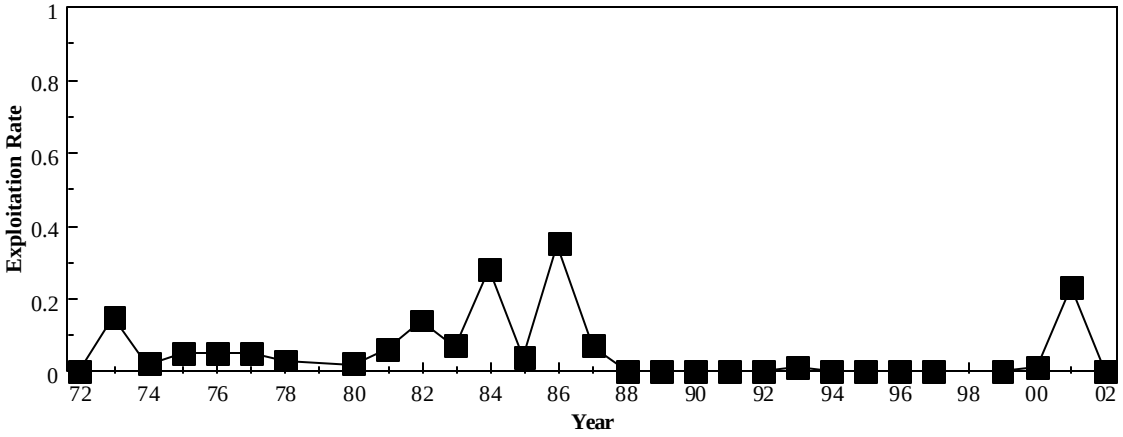
Year	Peak Count	Adjusted Peak Count	Estimated Total Escapement	Comm. Set Gillnet Harvest	Subsistence Harvest	Total Harvest	Estimated Total Run	Estimated Exploitation Rate
1972	7,000	7,473	14,946	0		0	14,946	0%
1973	4,200	4,732	9,463	1,723		1,723	11,186	15%
1974	2,800	3,154	6,309	99		99	6,408	2%
1975	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 C.2. Estimated total returns (recruits) of Italio River system sockeye salmon, brood years 1972–2002. 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.

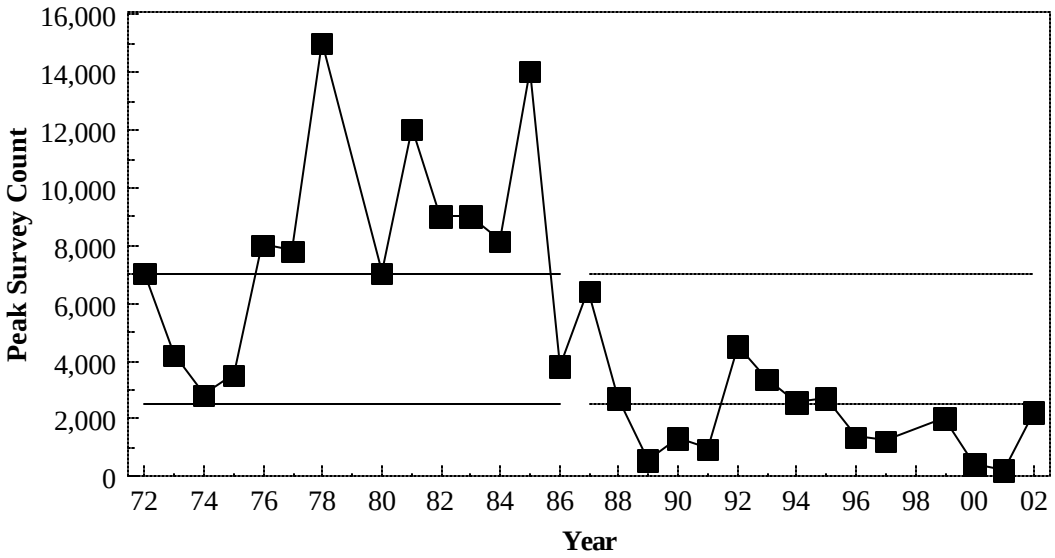
Brood Year	Parent Escapement	Age 4 Return	Age 5 Return	Estimated Total Return	Estimated Return Per Spawner
1972	14,946	11,728	12,762	24,490	1.64
1973	9,463	12,762	17,405	30,167	3.19
1974	6,309	17,405	10,008	27,412	4.35
1975	7,000	10,008	7,151	17,159	2.45
1976	22,250	7,151	12,834	19,985	0.90
1977	24,358	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*	



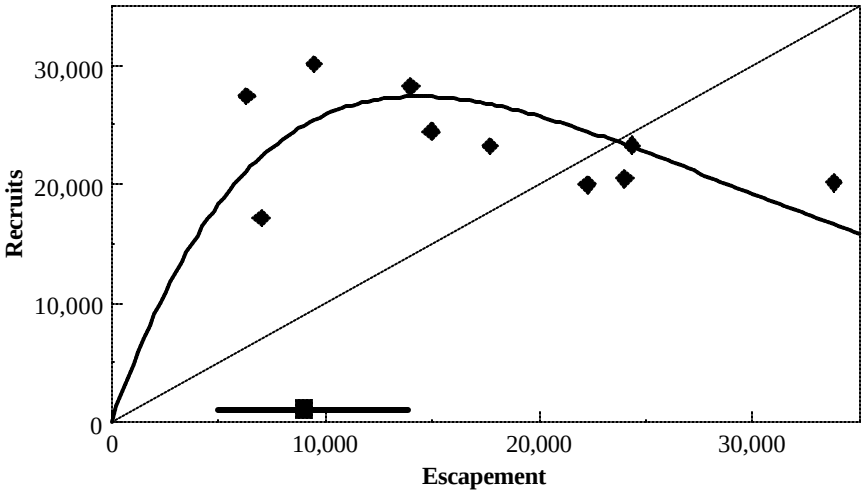
Appendix C.3. Estimated annual runs of Italio River sockeye salmon, 1972–2002.



Appendix C.4. Estimated exploitation rates for Italio River sockeye salmon, 1972–2002.



Appendix C.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 2,500–7,000, 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 C.6. Estimated stock-recruit relationship for Italio River system sockeye salmon, based on brood years 1972–1981. 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 D. Akwe River sockeye salmon stock.

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 five 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.
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

Number of years in model: 13

Ratio of highest escapement to lowest escapement: 20

Parameter estimates: a-parameter = 4.31 (adjusted), $1/\beta \approx 20{,}200$ (β-parameter = $4.96\ 10^{-5}$)

Basis of range of escapement goal: Expected yield is at least 90% of maximum sustainable catch

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.

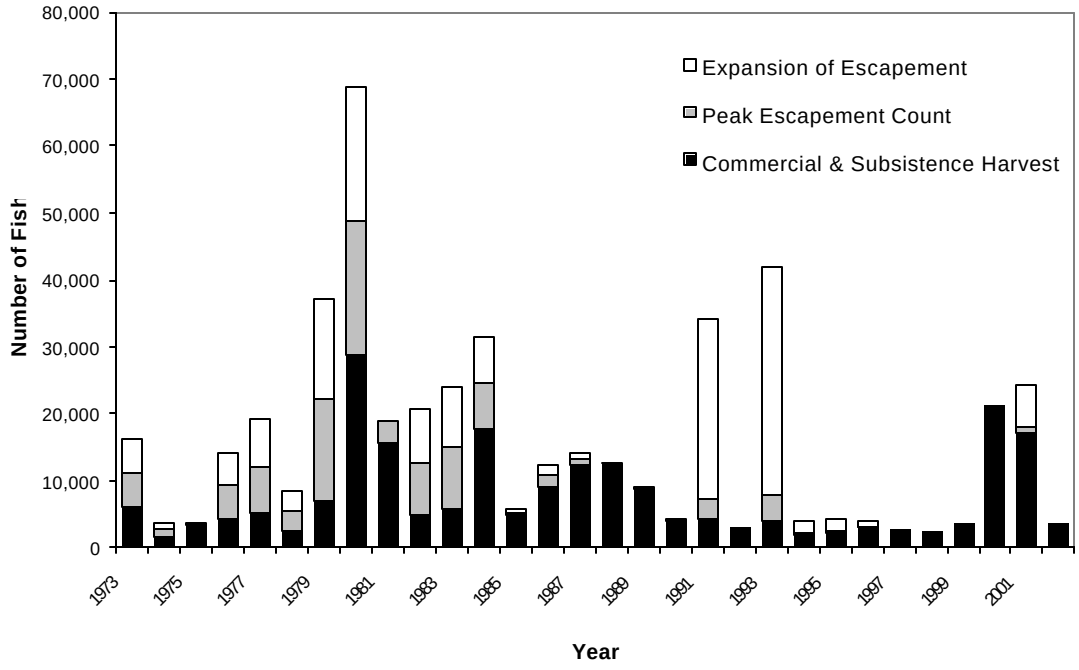
Annual harvests of sockeye salmon in the Akwe fishery were as high as about 28,700 fish in 1980 and averaged about 8,000 fish during the 15-year period of 1972 to 1986. Since 1987 when fishing boundaries were altered, peak annual harvest of sockeye salmon in the Akwe fishery was about 21,000 fish in 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 1973–1984, 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, 1997–2000, 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 (1982–1986). 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.

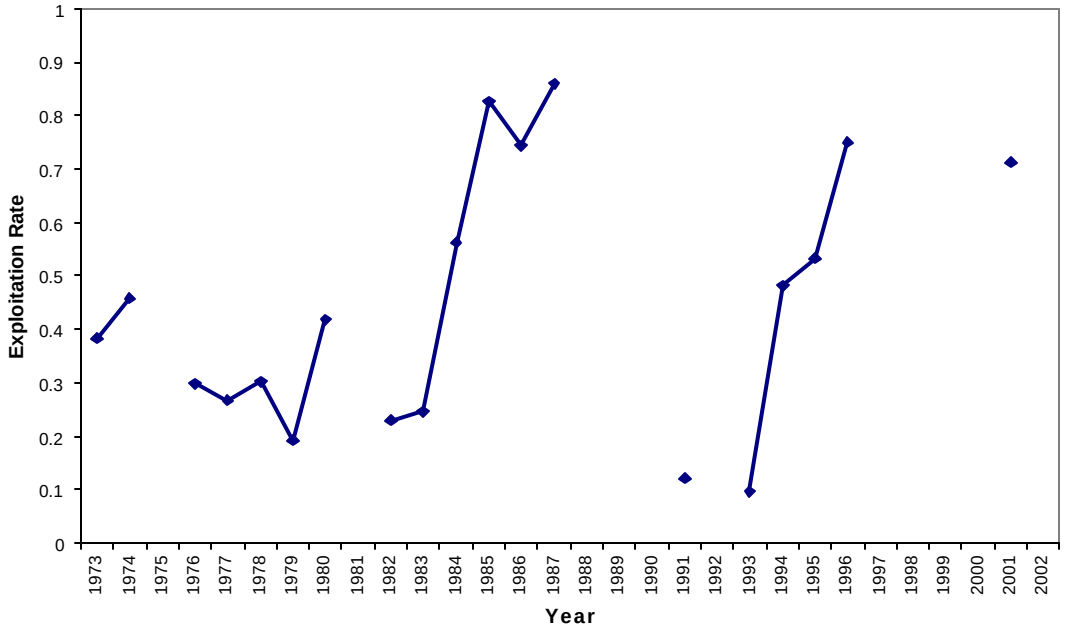
ADF&G adopted a *biological escapement goal* range of 600–1,500 fish counted during a peak survey (current water conditions) in 1995 (Clark, Burkholder, and Clark 1995). This escapement goal has not been updated. The inability of ADF&G to successfully implement surveys over the past several years has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

Appendix D.1. Peak escapement counts, total spawning escapement estimates, harvests, run sizes and exploitation rates for Akwe River system sockeye salmon, 1973–2002. Total escapement estimates are assumed to be two-fold of peak counts in the years 1973–1984 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 1973–1988; estimated mean of 75 fish from 1989–2001 was used as proxy estimates for these years. Subsistence harvest estimate for 2002 not yet available, approximate average of 75 fish from 1989–2001 was used as proxy estimate for 2002.

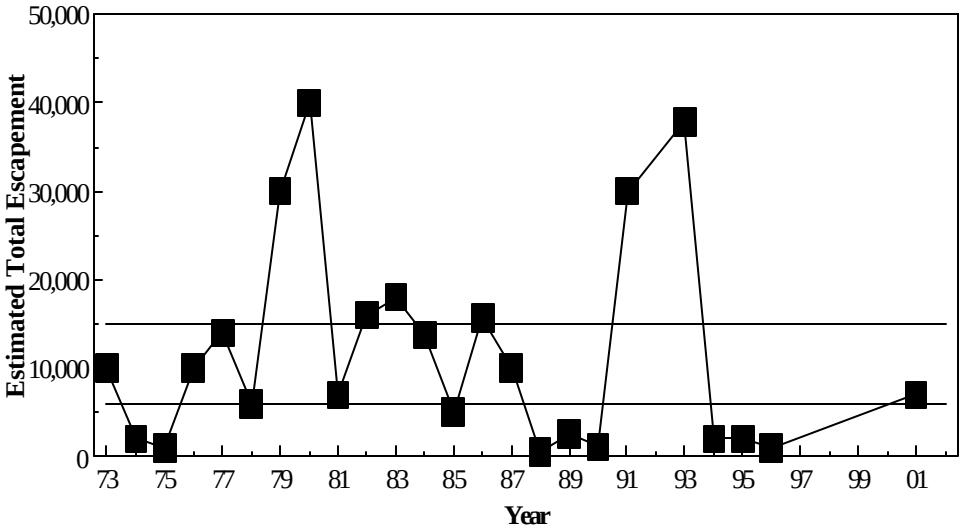
Year	Peak Count	Estimated Total Escapement	Commercial Set Gillnet Harvest	Subsistence Harvest	Total Harvest	Estimated Total Runs	Estimated Exploitation Rate
1973	5,000	10,000	6,132	*75*	6,207	16,207	38%
1974	1,000	2,000	1,620	*75*	1,695	3,695	46%
1975	*500*	1,000	3,177	*75*	3,252	*Unknown*	*Unknown*
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*



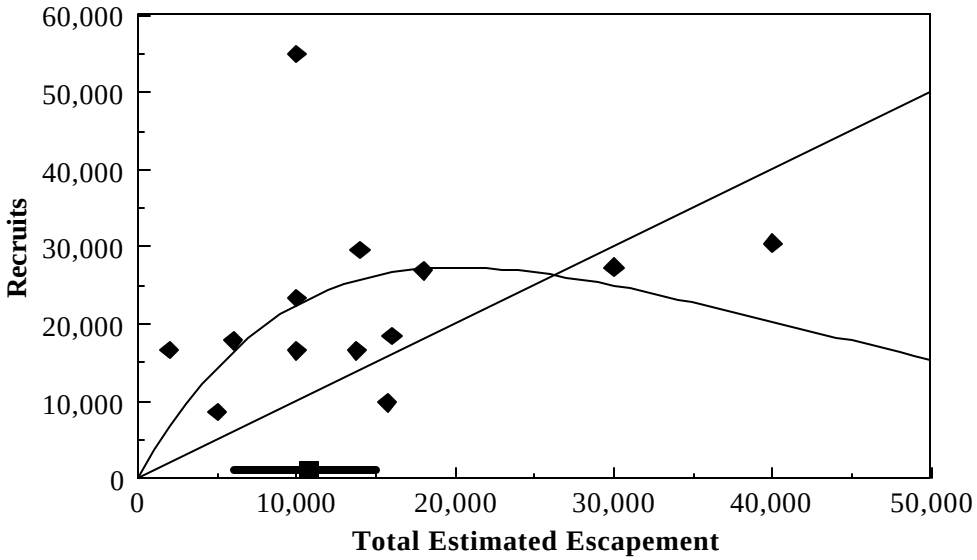
Appendix D.2. Estimated annual runs of Akwe River sockeye salmon, 1973–2002.



Appendix D.3. Estimated exploitation rates for Akwe River sockeye salmon, 1973–2002.



Appendix D.4. Estimated total escapements of Akwe River system sockeye salmon from 1972 to 2002. The region between the 2 horizontal lines, 6,000–15,000 total spawners or a peak count of 600–1,500 under current conditions, represents the biological escapement goal range.



Appendix D.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 (6,000–15,000 total spawners or 600–1,500 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 E. Klukshu River sockeye salmon stock.

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.
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

Number of years in model: 17

Ratio of highest escapement to lowest escapement: 4.1

Parameter estimates: a-parameter = 4.586, 1/ $ß$ » 15,800 ($ß$-parameter = $6.332 \cdot 10^{-5}$)

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

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.

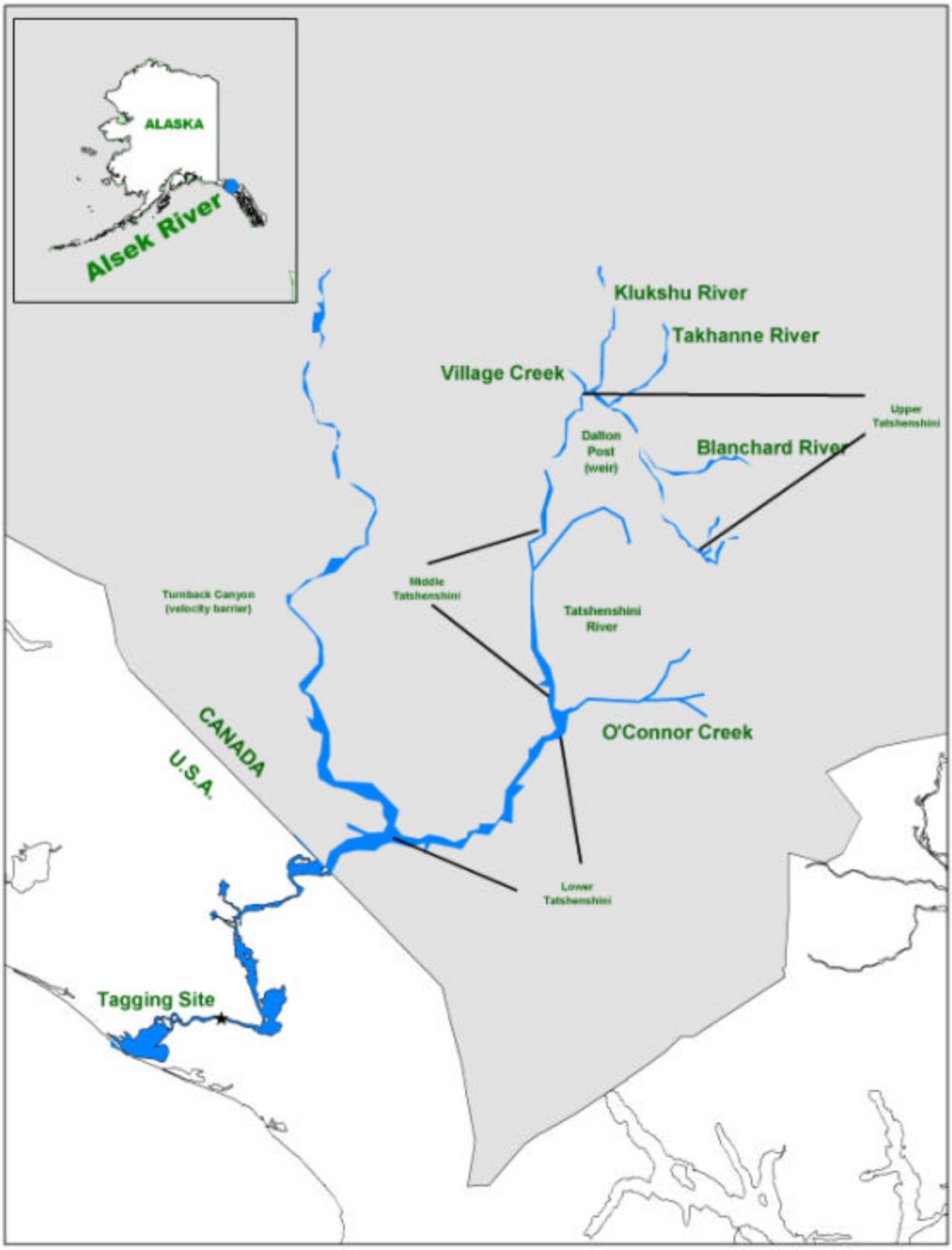
Alsek River salmon stocks provide the basis for U.S. commercial and subsistence fisheries prosecuted inriver with set gillnets. No commercial fishery exists in the Canadian portion of the Alsek River drainage, although both aboriginal (Indian food) and recreational (sport) fisheries occur in the Tatshenshini 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 (PSC) 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 enumerated 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 Canadian Department of Fisheries and Oceans (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 1976–2002 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 PSC, 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.



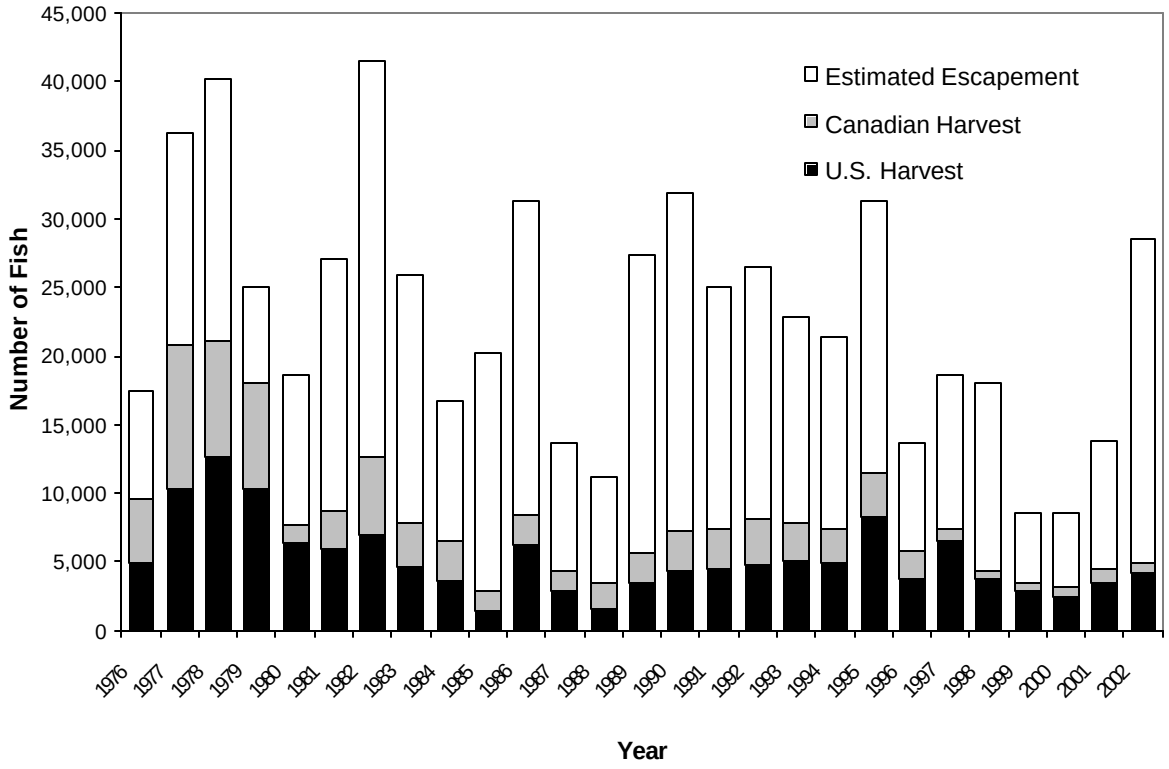
Appendix E.1. Alsek River drainage, showing the tagging site and the approximate location of the adult weir on Klukshu River.

Appendix E.2. Estimated escapements, harvests, run sizes and exploitation rates for Klukshu River system sockeye salmon, 1976–2002. 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 1976–1988; a proxy value of 100 is used and represents the approximate average catch from 1989–2001. Subsistence harvest estimate for 2002 was not available, this harvest is assumed to be 100 fish.

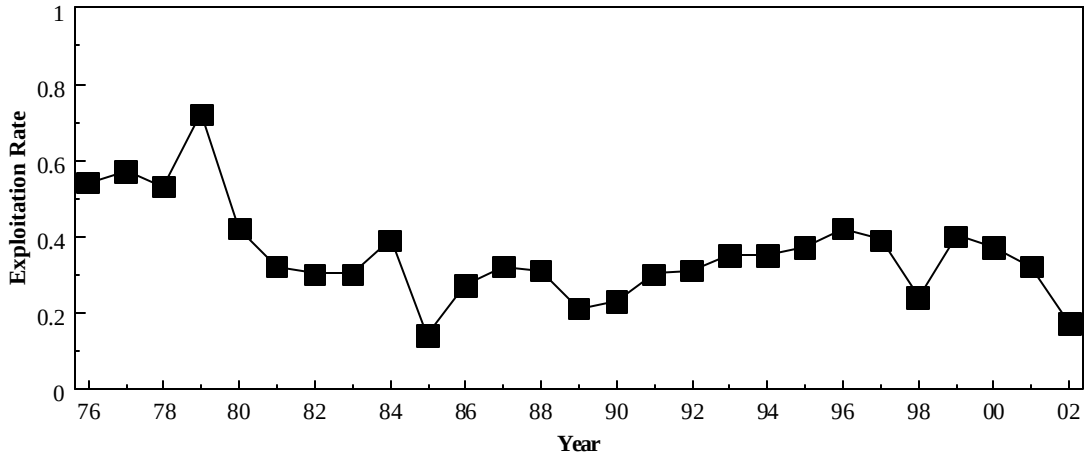
Year	Estimated Escapement	Canadian Harvest	U.S. Comm. Harvest	U.S. Subsist. Harvest	U. S. Total Harvest	25% of U.S. Harvest	Estimated Total Harvest	Estimated Total Run	Estimated Exploitation Rate
1976	7,941	4,540	19,775	*100*	19,875	4,969	9,509	17,450	54%
1977	15,441	10,450	41,075	*100*	41,175	10,294	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 E.3. Estimated total returns (recruits) of Klukshu River sockeye salmon, brood years 1976–2002. 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 1976–1997 estimates. Average ages from that report were used for annual 1998–2002 estimates.

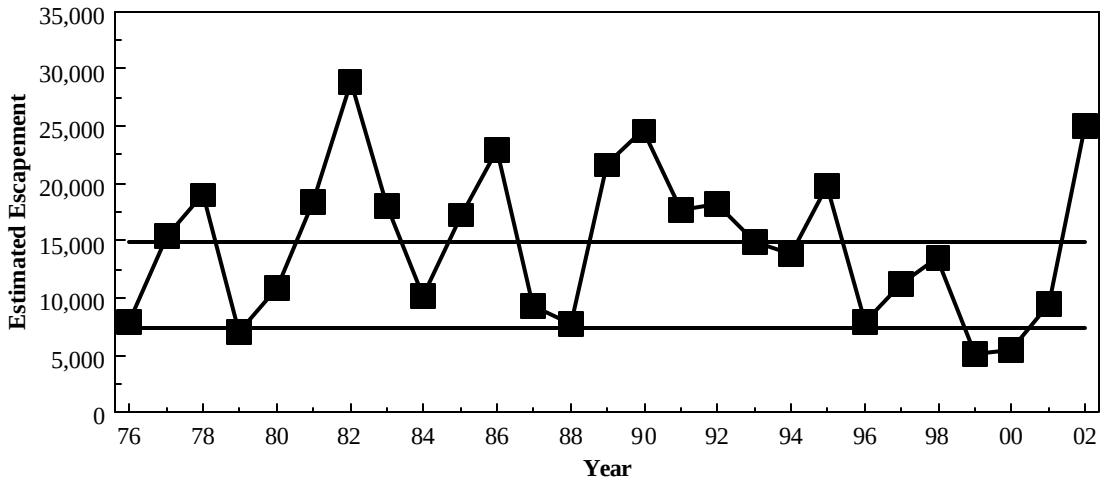
Brood Year	Estimated Total Escapement	Age 3 Returns (recruits)	Age 4 Returns (recruits)	Age 5 Returns (recruits)	Age 6 Returns (recruits)	Estimated Total Returns	Return Per Spawner
1976	7,941	103	4,322	16,369	828	21,622	2.72
1977	15,441	64	10,174	33,381	-	43,619	2.82
1978	19,017	271	7,187	24,211	334	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*	



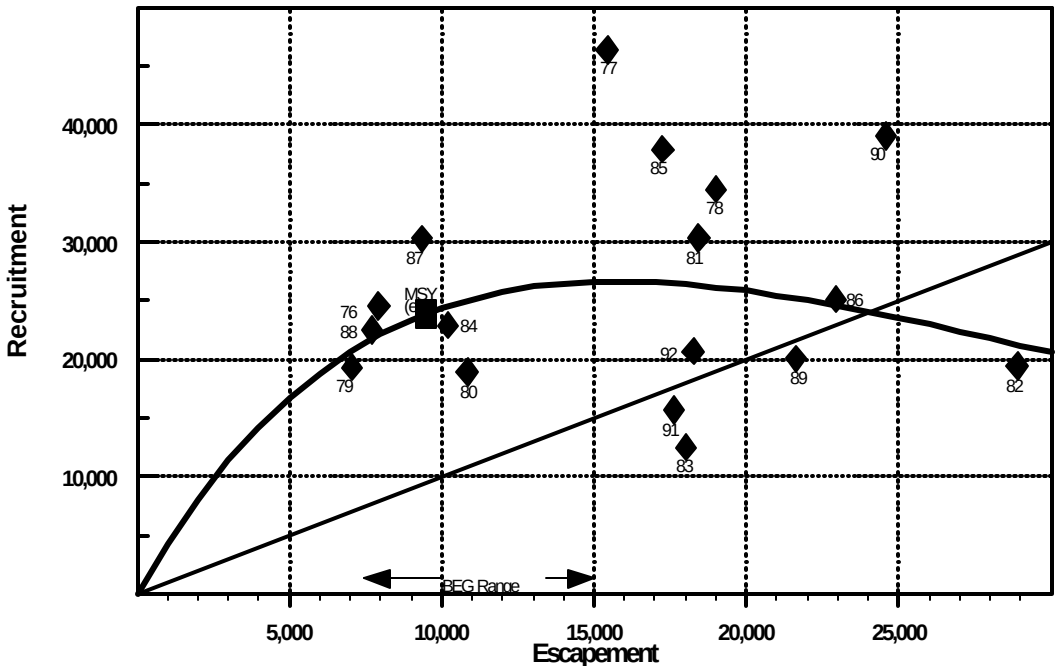
Appendix E.4. Estimated annual runs of Klukshu River sockeye salmon, 1976–2002.



Appendix E.5. Estimated exploitation rates for Klukshu River sockeye salmon, 1976–2002.



Appendix E.6. Estimated total escapements of Klukshu River sockeye salmon from 1976 to 2002. The region between the 2 solid horizontal lines, 7,500–15,000 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 E.7. Estimated stock-recruit relationship for Klukshu River sockeye salmon, based on brood years 1976–1992. The curve represents production predicted with Ricker's model; solid diamonds are brood year 1976–1992 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 F. 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 five 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., 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 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: a-parameter = 5.72 (adjusted), $1/\beta \approx 85{,}500$, (β-parameter = $4.96 \cdot 10^{-5}$)

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

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 have similar in life history patterns to chum salmon. Virtually all East Alsek sockeye salmon are "zero checks": they migrate 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 grew to a magnitude of in excess of about 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 and by the early 1990s, the spawning habitat of the East Alsek River had deteriorated considerably. Emergent vegetation and the silting in of the gravel beds has greatly deteriorated the quality of the spawning habitat. 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, likely never exceeding total runs in excess of about 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.

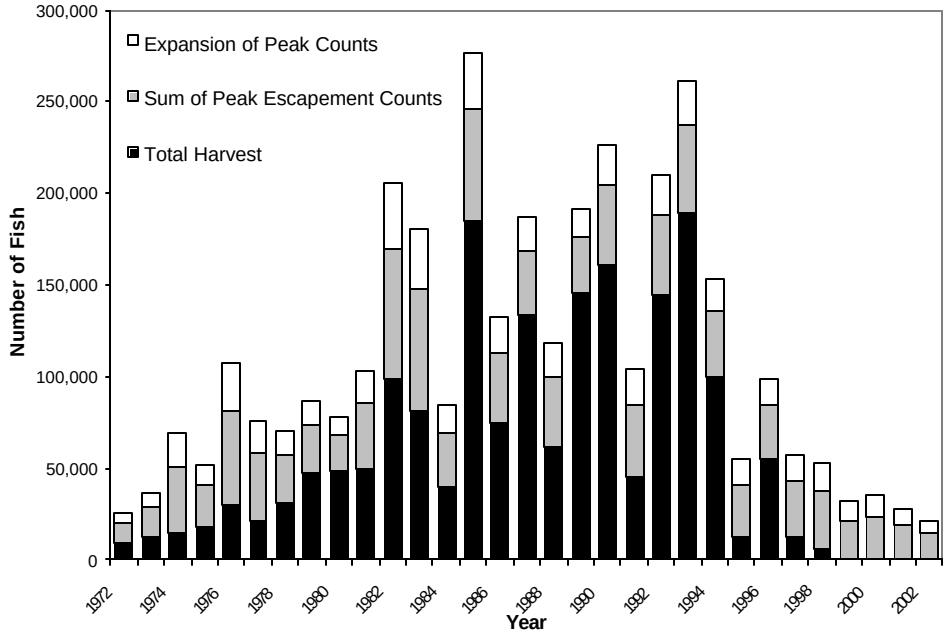
The stock assessment program consists of flying aerial surveys of both the East Alsek and Doame Rivers to count spawners, collection and tabulation of fish tickets and subsistence catch reports, and monitoring of the sport fishery through a postal questionnaire. Sampling of the commercial catch and the 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 F.1. Escapement index counts, total spawning escapement estimates, harvests, run sizes, and exploitation rates for East-Alsek-Doame River system sockeye salmon, 1972–2002. 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.

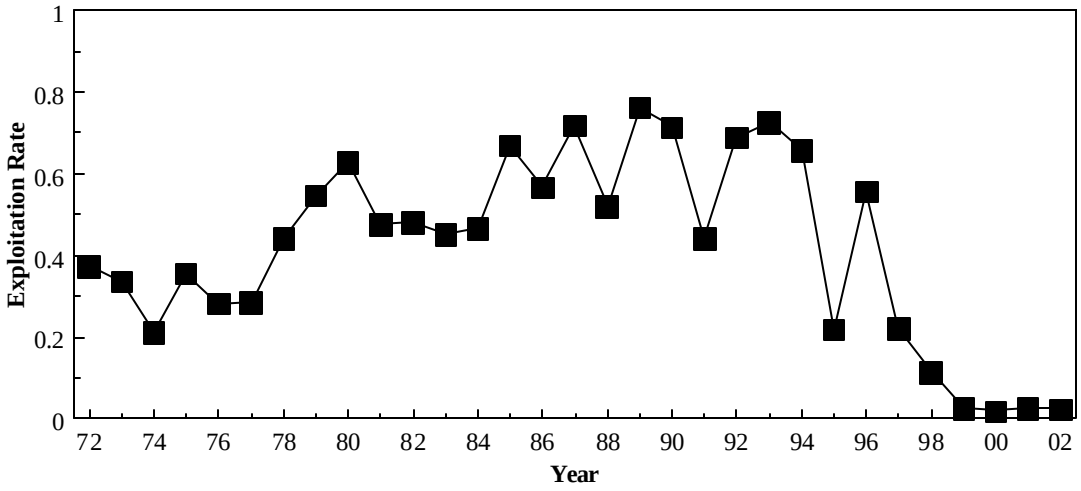
Year	East Alsek Peak Aerial Count	Doame River Peak Aerial Count	Estimated Total Escap.	Comm. Set Gillnet Harvest	Sport Harvest	Subsis. Harvest	Total Harvest	Estimated Total Runs	Estimated Exploit. Rate
1972	10,000	800	16,200	9,575			9,575	25,775	37.1%
1973	15,000	*1,333*	24,500	12,342			12,342	36,842	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 F.2. Estimated total returns (recruits) of East Alsek-Doame River system sockeye salmon, brood years 1972–2002. Sampling data for the age-5 return for brood year 1997 are not available, the recent five-year average of *3,451* was used as a proxy estimate. Estimates for the six-year old returns for brood years 1996 and 1997 are not available, proxy values of 0 were used.

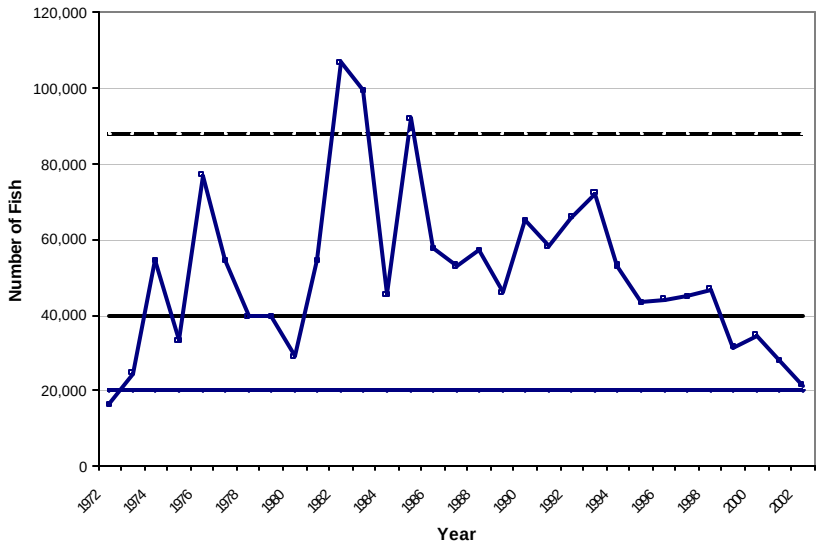
Brood Year	Parent Escapement	Age 2 Return	Age 3 Return	Age 4 Return	Age 5 Return	Age 6 Return	Estimated Total Return	Estimated Return per Spawner
1972	16,200	436	8,587	78,537	6,652	132	94,344	5.82
1973	24,500	265	18,370	55,762	6,340	182	80,919	3.30
1974	54,500	616	13,031	52,241	7,975	175	74,038	1.36
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*	



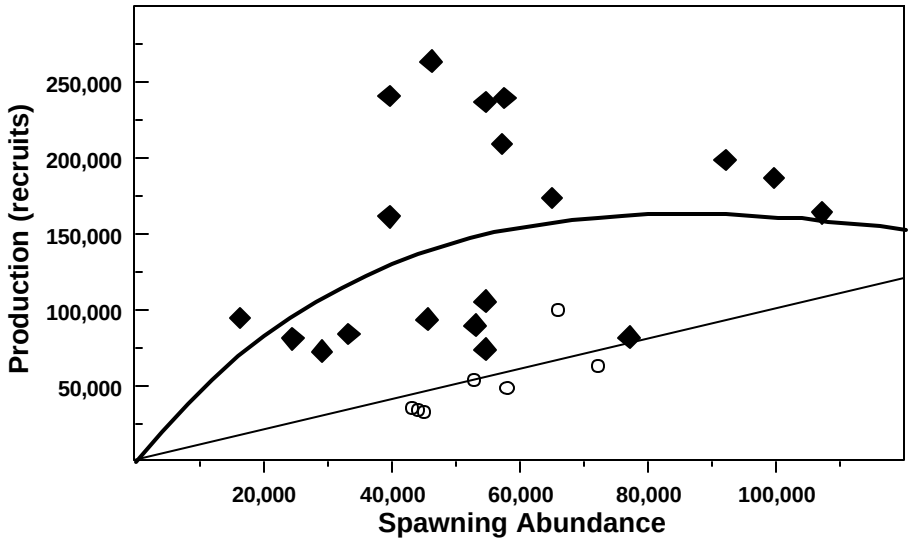
Appendix F.3. Estimated total runs of East Alsek River and Doame River sockeye salmon, 1972 to 2002.



Appendix F.4. Estimated exploitation rates for East Alsek-Doame River system sockeye salmon, 1972–2002.



Appendix F.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 26,000–57,000). 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 F.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 G. 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

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, a-parameter = 5.54, $1/\beta \approx 32{,}000$ (β-parameter = $3.14\ 10^{-5}$)

Late run, a-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

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 (NSRAA) 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.

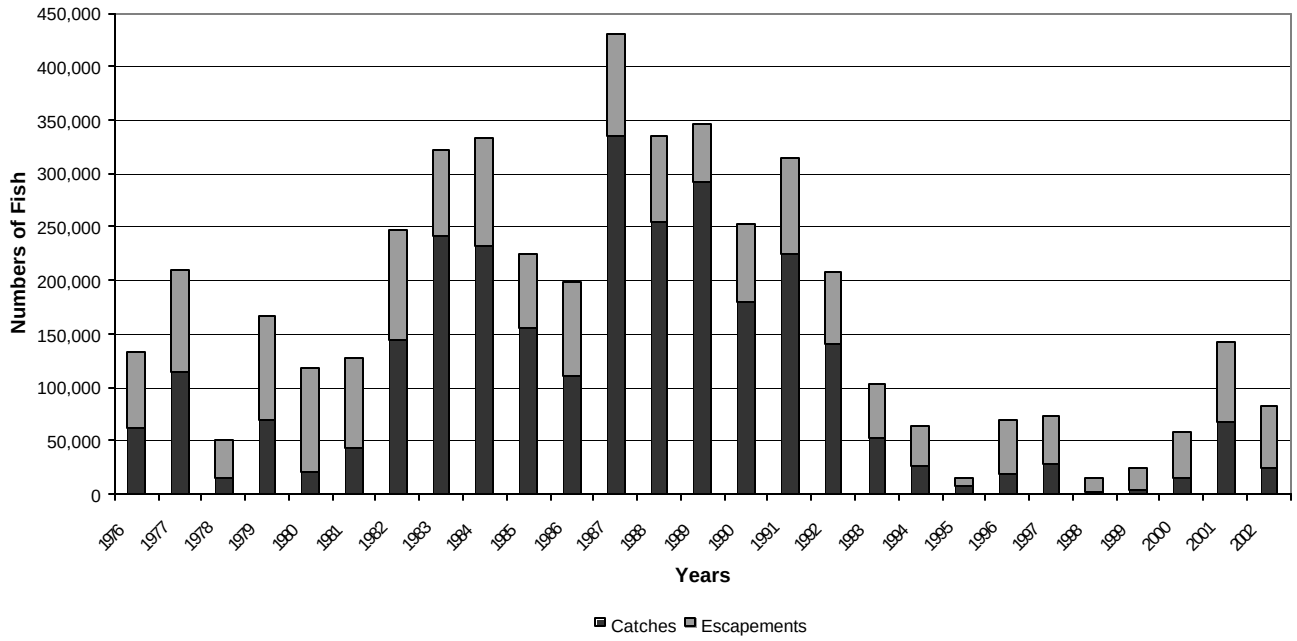
Appendix G.1. Estimated spawning escapements, commercial harvest, total run size, and exploitation rates of Chilkoot Lake sockeye salmon, 1976 to 2002.

Year	Weir Counts	Mark-Recapture Estimates [a]	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%

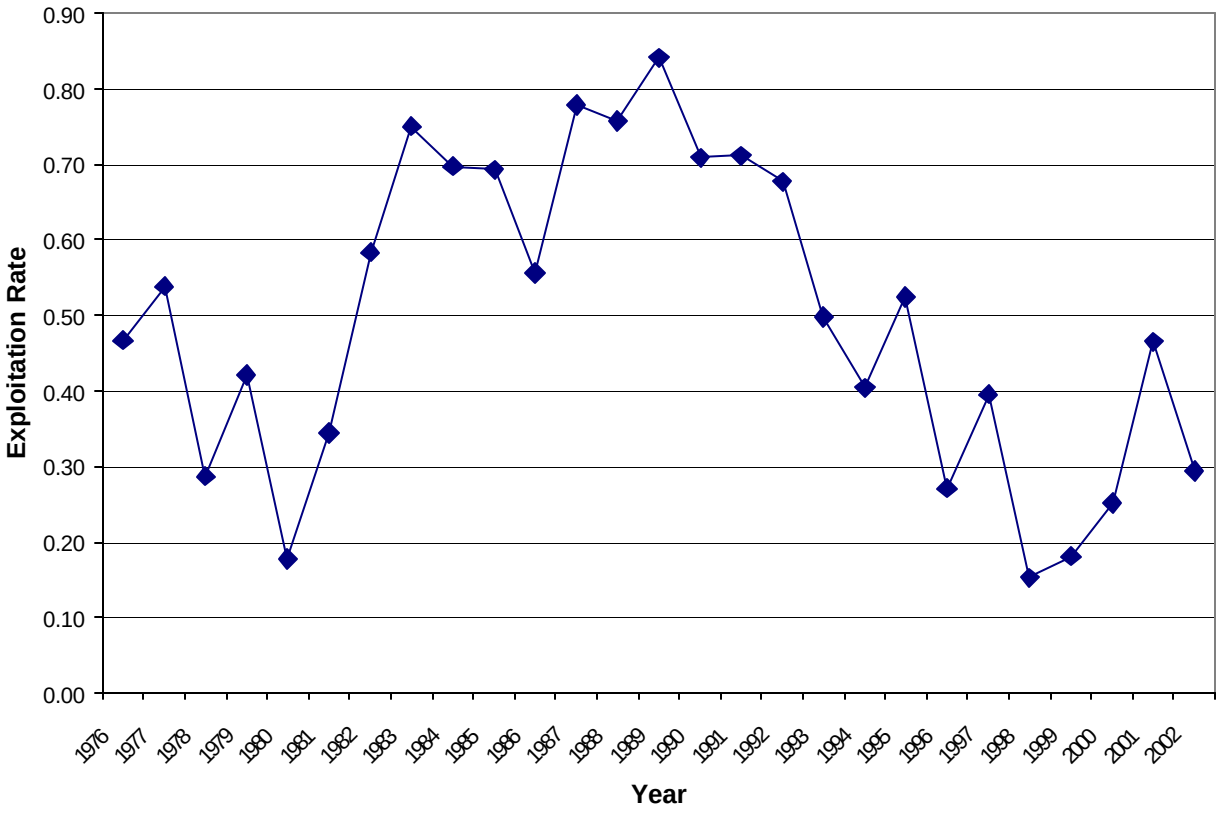
[a] Weir counts are used to represent escapement estimates.

Appendix G.2. Estimated total return of Chilkoot Lake sockeye salmon from brood years 1976 to 2002.

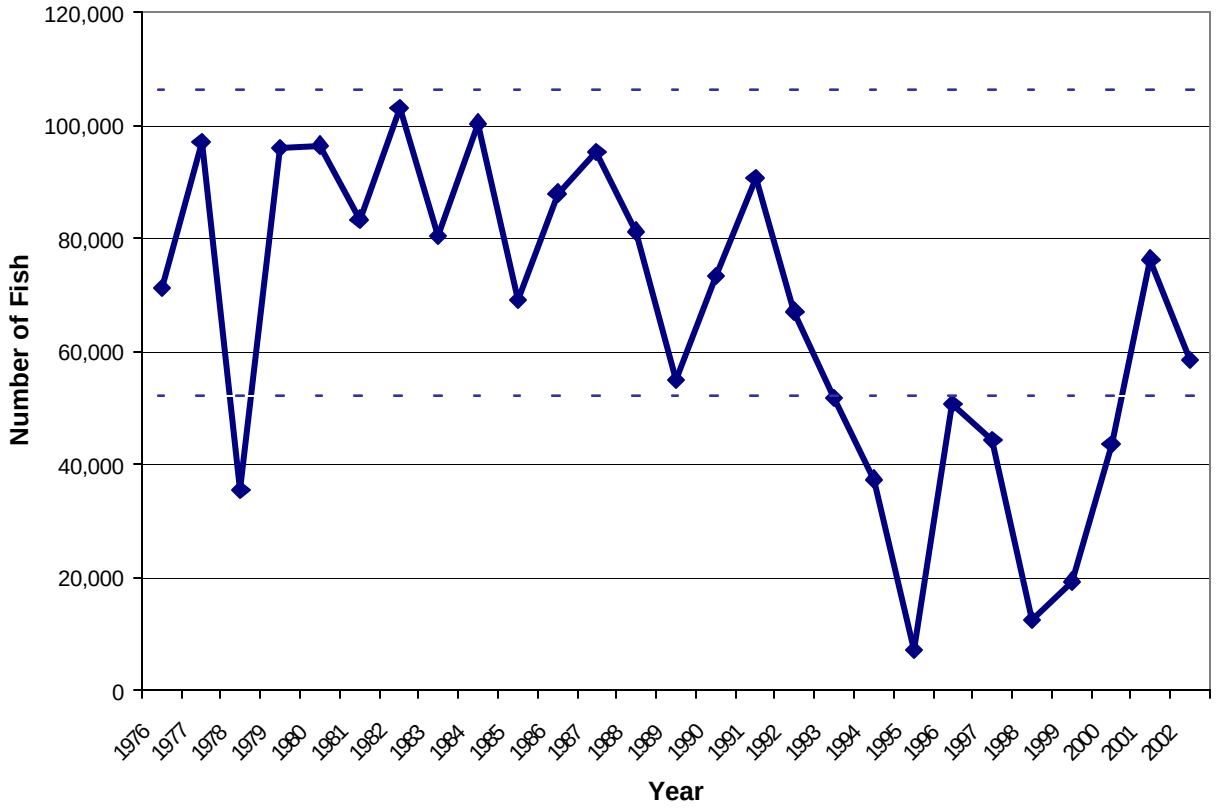
Year	Escapement	Age 3	Age 4	Age 5	Age 6	Age 7	Estimated Total Return	Estimated Return Per Spawner
1976	71,297		8,933	99,862	20,976		129,771	1.82
1977	97,051		9,556	198,529	79,724	139	287,948	2.97
1978	35,454	24	27,952	225,042	23,698	395	277,111	7.82
1979	95,946		16,911	298,328	34,788	501	350,528	3.65
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							



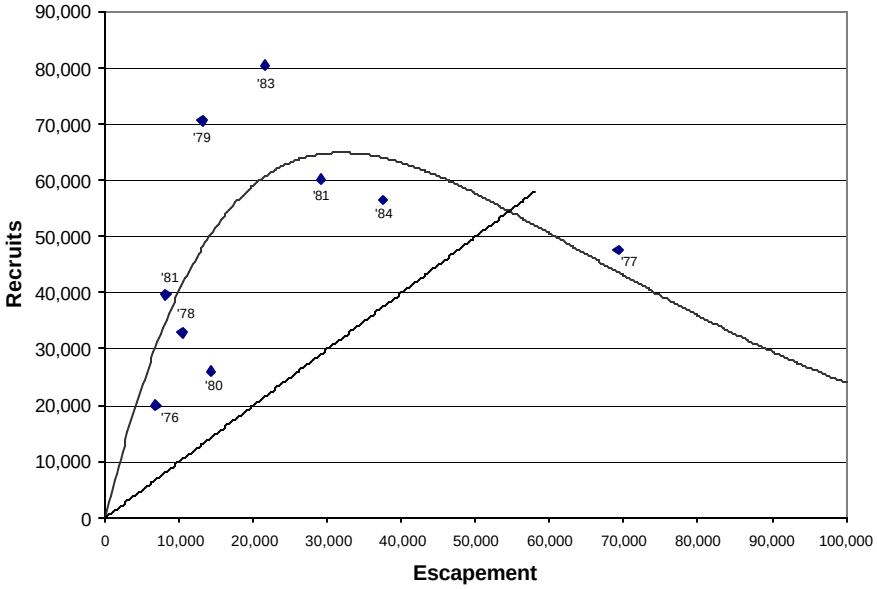
Appendix G.3. Catches and escapements of Chilkoot Lake sockeye salmon, 1976–2002.



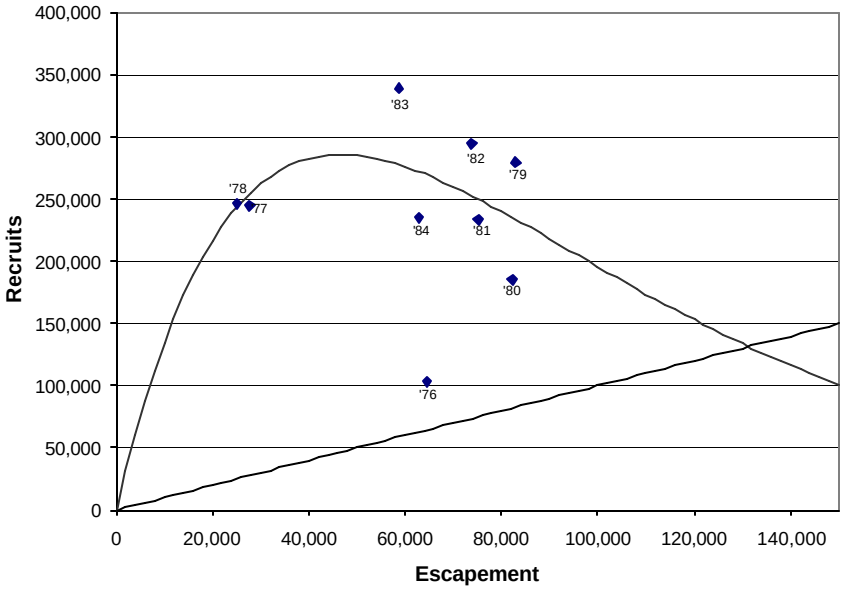
Appendix G.4. Estimated exploitation rates for Chilkoot Lake sockeye salmon, 1976–2002.



Appendix G.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 G.6. Estimated stock-recruit relationship for early-run Chilkoot Lake sockeye salmon, based on brood years 1976–1984 (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 G.7. Estimated stock-recruit relationship for late-run Chilkoot Lake sockeye salmon, based on brood years 1976–1984 (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 H. 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

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, a-parameter = 4.30, $1/ß \approx 35{,}000$ ($ß$-parameter = $2.83\ 10^{-5}$)

Late run, a-parameter = 8.05, $1/ß \approx 47{,}000$ ($ß$-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%.

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 (NSRAA) 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.

NSRAA stocked sockeye salmon fry into Chilkat Lake in 1994–1997 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 in 1998–2000 and again in 2002 pending recovery of the zooplankton populations.

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

Appendix H.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%

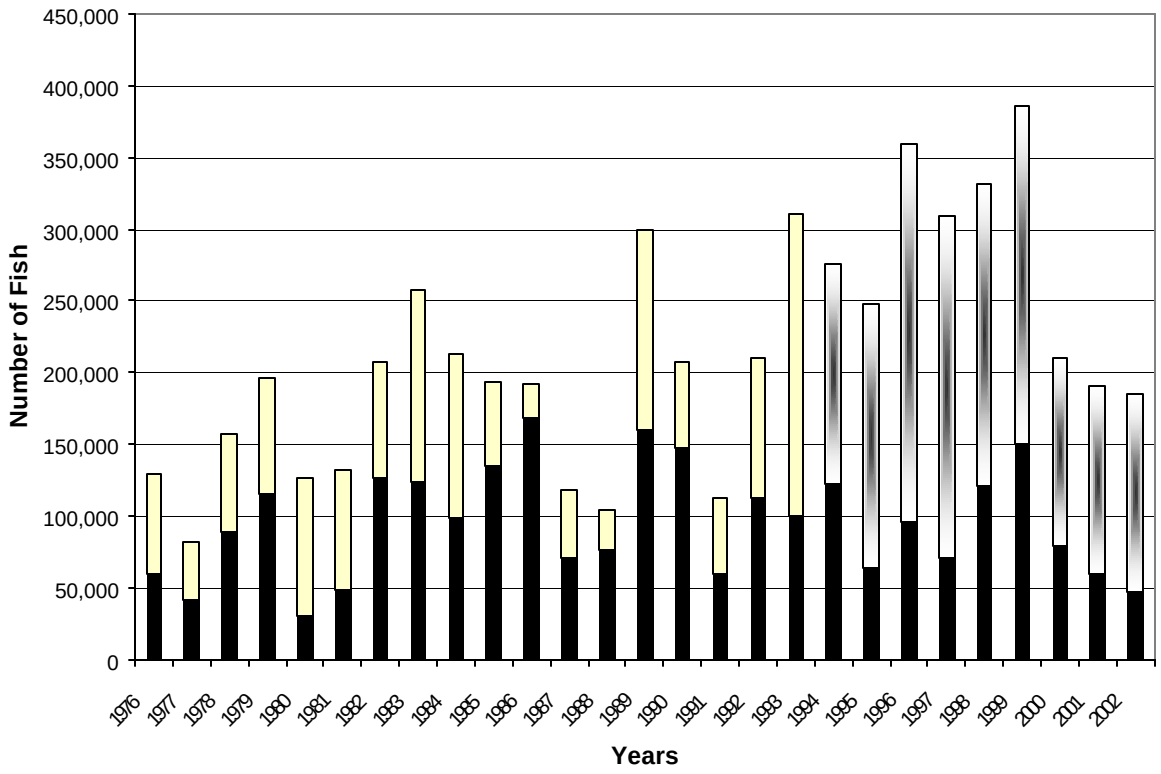
[a] *Estimate was derived from marking experiment at the weir.*

Appendix H.2. Estimated total return of Chilkat Lake sockeye salmon from brood years 1976 to 2002.

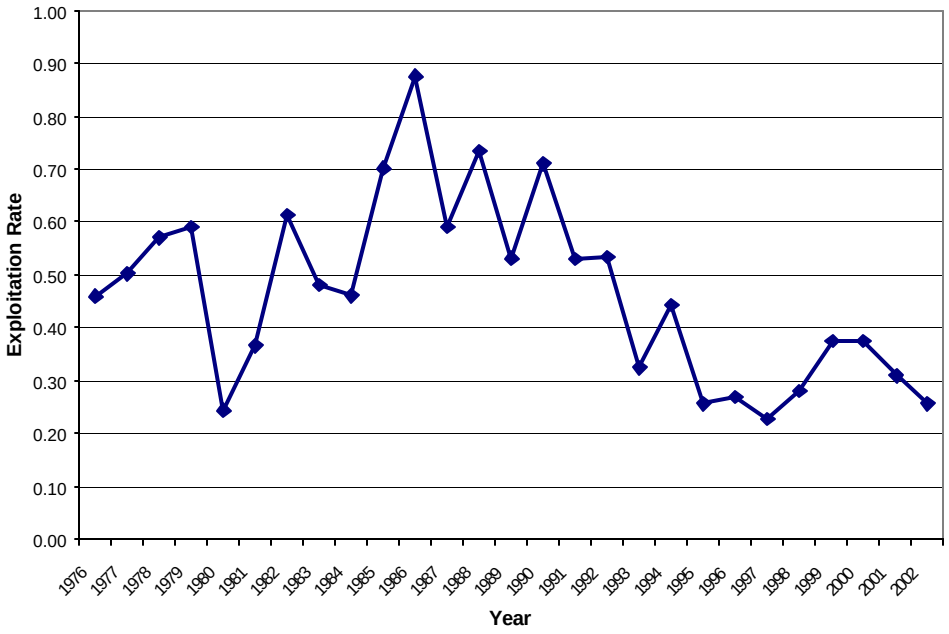
Year	Escapement	3-Year Old	4-Year Old	5-Year Old	6-Year Old	7-Year Old	8-Year Old	Estimated Total Return	Estimated Return Per Spawner
1976	69,729		3,053	72,275	98,928	203		174,459	2.50
1977	41,044		1,800	102,160	103,535	224		207,719	5.06
1978	67,528		5,053	142,192	52,042	80		199,367	2.95
1979	80,589	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 H.3. Stocking history of sockeye salmon into Chilkat Lake, estimated number of smolts produced from stocked fry, and estimated survivals, 1994 to 2002.

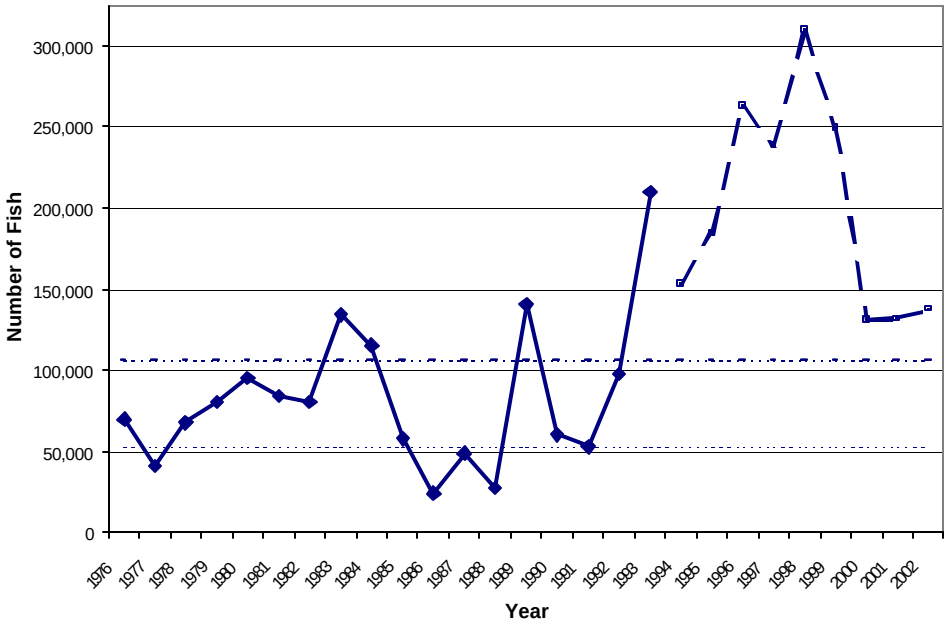
Year Stocked	Number of Fry Stocked	Smolts Produced			Total Smolts Produced	Percent Fry-to-Smolt Survival
		Age 1.	Age 2.	Age 3.		
1994	4,400,000	686,000	330,000	0	1,016,000	23.1%
1995	2,394,000	269,000	377,000	16,000	662,000	27.7%
1996	2,691,000	99,000	34,000	25,000	158,000	5.9%
1997	2,807,000	221,000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



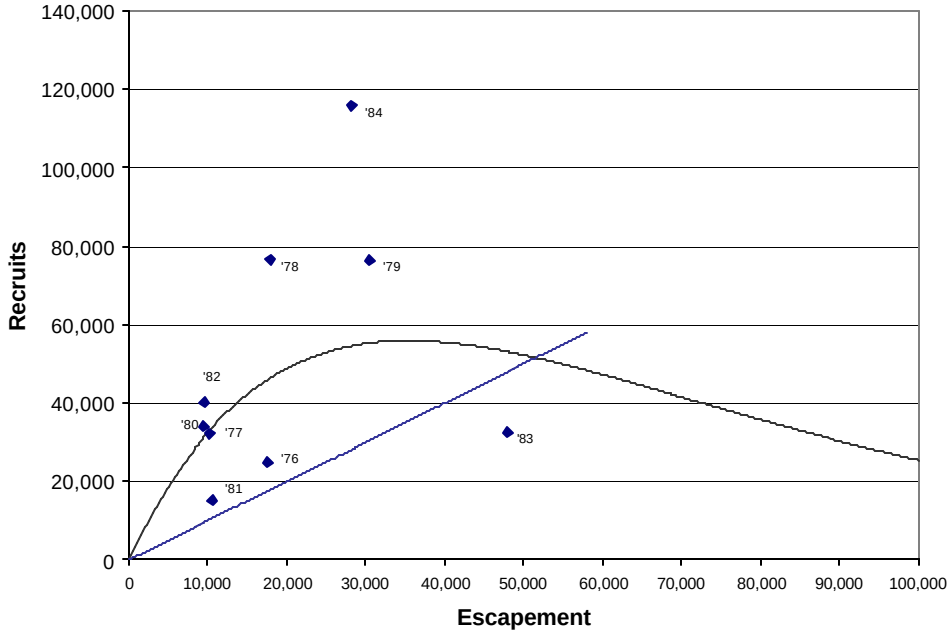
Appendix H.4. Catches and escapements of Chilkat Lake sockeye salmon, 1976–2002. Catches delineated by black bars, weir counts by lighter bars (1976–1993), mark-recapture escapement estimates denoted by center shading (1994–2002).



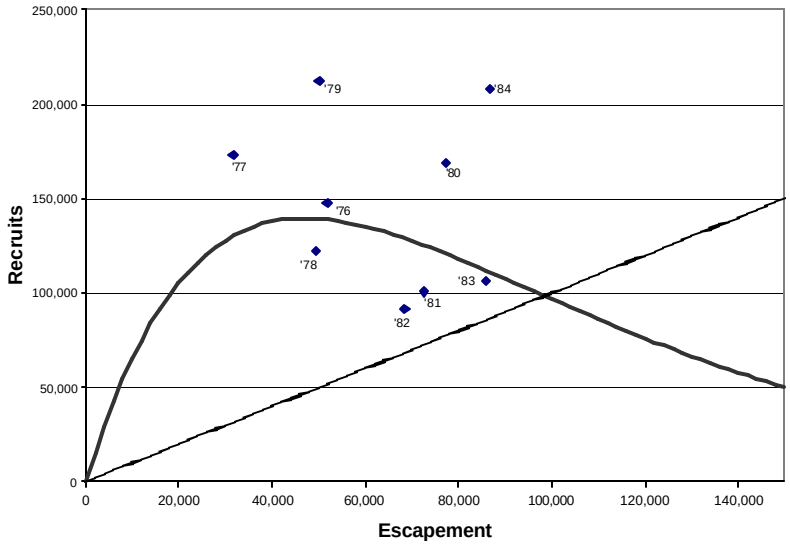
Appendix H.5. Estimated exploitation rates for Chilkat Lake sockeye salmon, 1976–2002.



Appendix H.6. Escapement estimates for Chilkat Lake sockeye salmon, 1976–2002. 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 H.7. Estimated stock-recruit relationship for early-run Chilkat Lake sockeye salmon, based on brood years 1976 to 1984 (after McPherson 1990). The upper curve represents production predicted by Ricker's model. The lower 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 H.8. Estimated stock-recruit relationship for late-run Chilkat Lake sockeye salmon, based on brood years 1976 to 1984 (after McPherson 1990). The upper curve represents production predicted by Ricker's model. The lower 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 I. 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, 1982–1997, 1999–present

Stock-Recruit Analysis Summary:

Model: Ricker

Number of years in model: 15

Ratio of highest escapement to lowest escapement: 160

Parameter estimates: a-parameter = 4.30 ("bias adjusted" value is 8.55), $1/\beta \approx 23{,}000$ (β-parameter = $4.30\ 10^{-5}$), s^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

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 1988 and 1989, but continued again from 1990 through 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 less 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 in 2000 and 2001. 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 to 25 thousand spawners still may be preferred for other reasons.

Appendix I.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	11,621			61	1,682			
1985	yes	10,669	10,991	97	n.e.		109	11,100			65	1,763			
1986	yes	9,414	9,798	86	n.e.		109	9,907	sockeye	28,220	78	2,163	fry stocking	chinook	900,000
1987	yes	12,990	14,251	199	n.e.		199	14,450	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	34,790	sockeye	38,800					
1990	yes	72,517	73,181	5,326	703		6,029	79,210	sockeye	59,520	107	3,045			
1991	yes	45,039	45,510	3,105	n.e.		3,337	48,847	sockeye	236,436[f]	97	2,844			
1992	yes	10,231	10,326	96	n.e.		96	10,422			95	2,003			
1993	yes	24,422	25,018	2,326	130		2,456	27,474			109	3,205			
1994	yes	39,216	39,710	4,120	721		4,841	44,551			80	1,682			
1995	yes	34,280	34,798	2,968	646		3,614	38,412			94	2,740			
1996	yes	18,076	19,209	3,337	n.e.		4,415	23,624							
1997	no	28,898	28,898	2,253	n.e.		3,822	32,720							
1998	no	na	52,039	4,296	1,734		6,030	58,069							
1999	yes	57,754	57,754	6,761	3,192		9,953	67,707			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	24,763			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 1984–1995; granular fertilizer suspended in bags and applied to beaches 1999–2001.
The weir count for 2002 is preliminary.

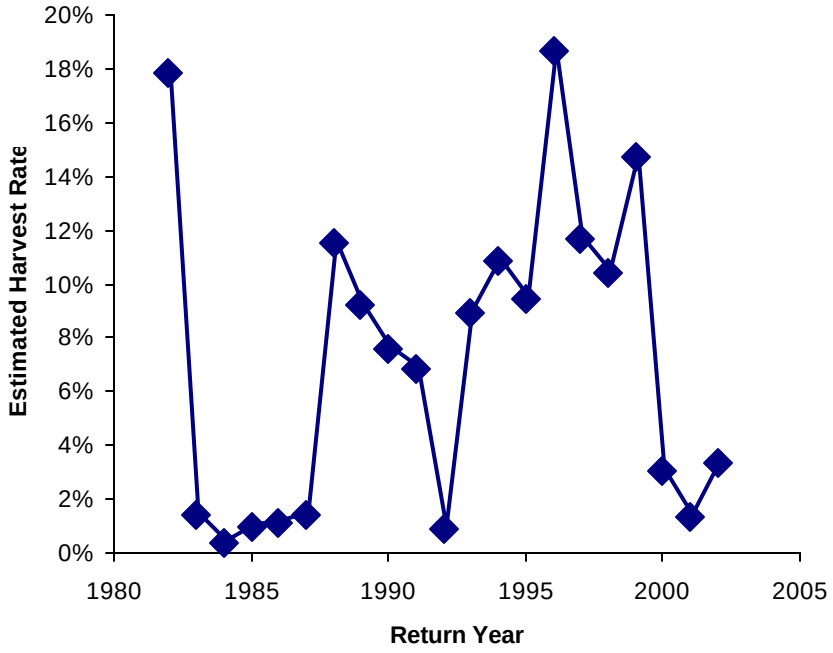
Appendix I.2. Estimated brood-year specific return of Redoubt Lake sockeye salmon. Columns denote brood years, and rows denote return year. Column totals denote estimated return for the brood year, based on the estimated age classes.

Return	Estimated	Estimated	Total	Brood Year																
Year	Escape-ment	Harvest	Run	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*

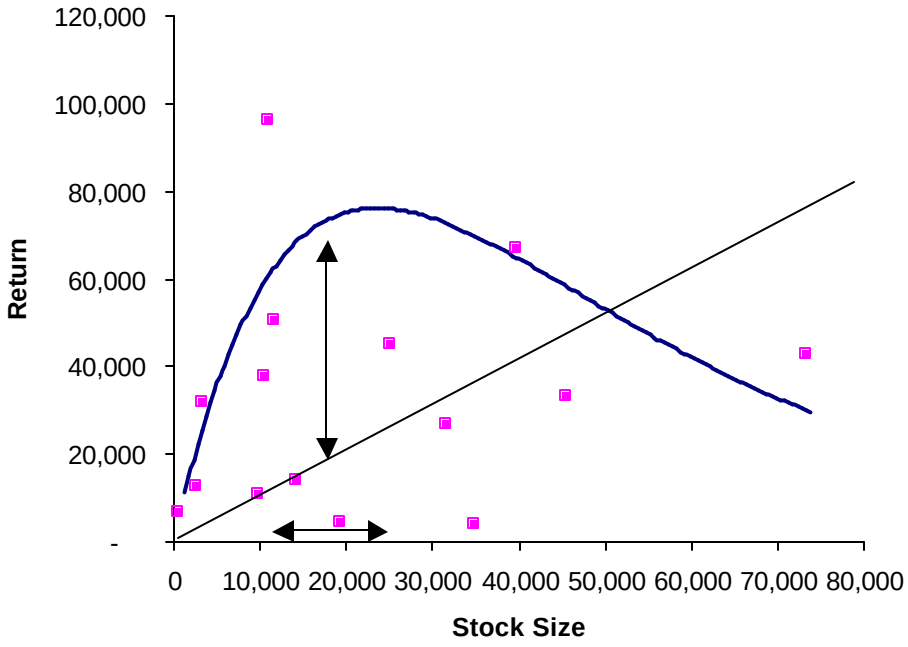
Age composition of total adult return extrapolated from scale sampling of escapement.

[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 I.3. Estimated harvest rate on Redoubt Lake sockeye stock, 1982–2002.



Appendix I.4. Estimated stock-recruit relationship for Redoubt Lake sockeye salmon, based on brood years 1982–1996. 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 J.Taku River sockeye salmon stocks.

System:	Taku River
Species:	Sockeye Salmon
Stock Units:	Kuthai Lake, Little Trapper Lake, Tatsamenie Lake, Mainstem Taku River
Management Jurisdiction:	Alaska Dept. Fish and Game (ADF&G), Dept. of Fisheries and Oceans, Canada (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 (TAC) of sockeye migrating originating in Canada; TAC 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 (TTC) of the Pacific Salmon Commission (TTC 2001). 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.

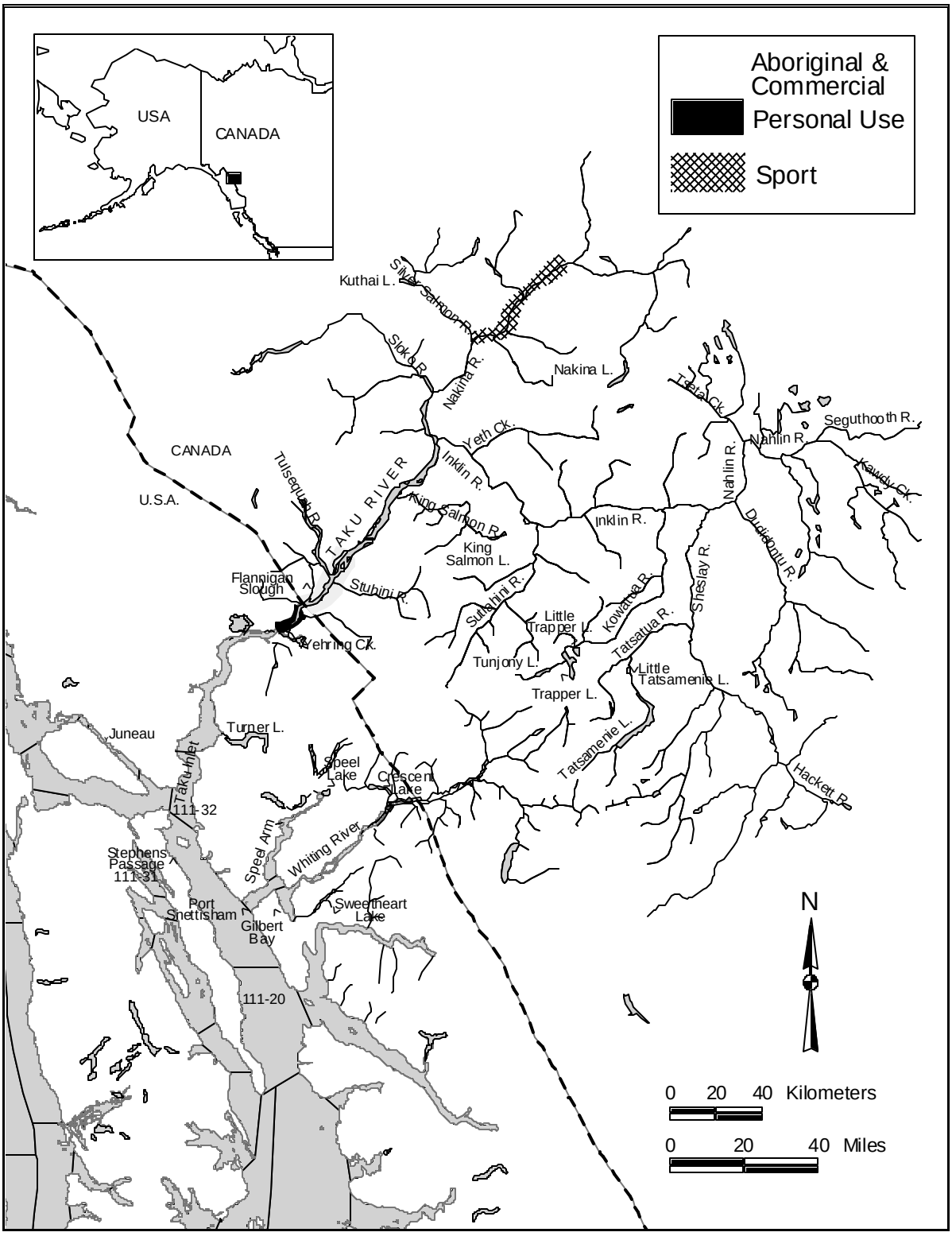
The river supports a diverse assemblage of sockeye salmon stocks returning to lakes and streams in the headwaters as well as substantial numbers that spawn in the mainstem river and side sloughs, not associated with lakes. There is a small, largely unmonitored amount of spawning that occurs in several 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 (TTC 2000). 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 (TTC 2001b). Brood stock have been collected at the Trapper and Tatsamenie Lake systems, gametes flown to the Snettisham Hatchery in Alaska where they are incubated and treated to mark their otoliths to allow the fish to be distinguished throughout their life. 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 71,000–80,000 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 (TTC 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.

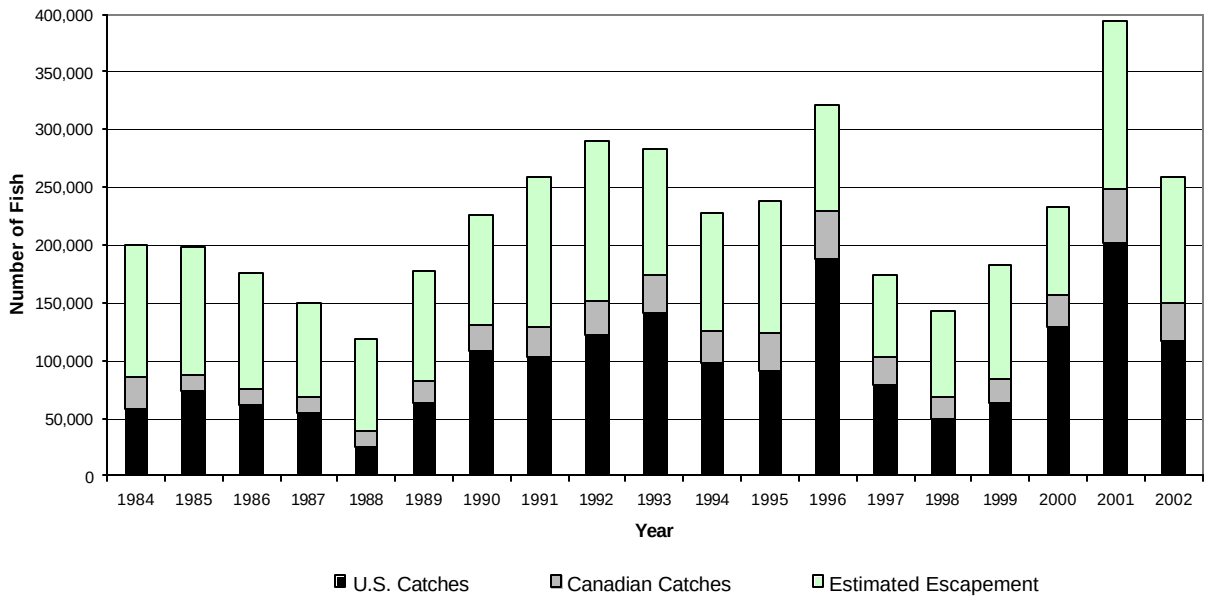


Appendix J.1. Taku River drainage and surroundings, showing location of commercial, sport, and recreational fisheries.

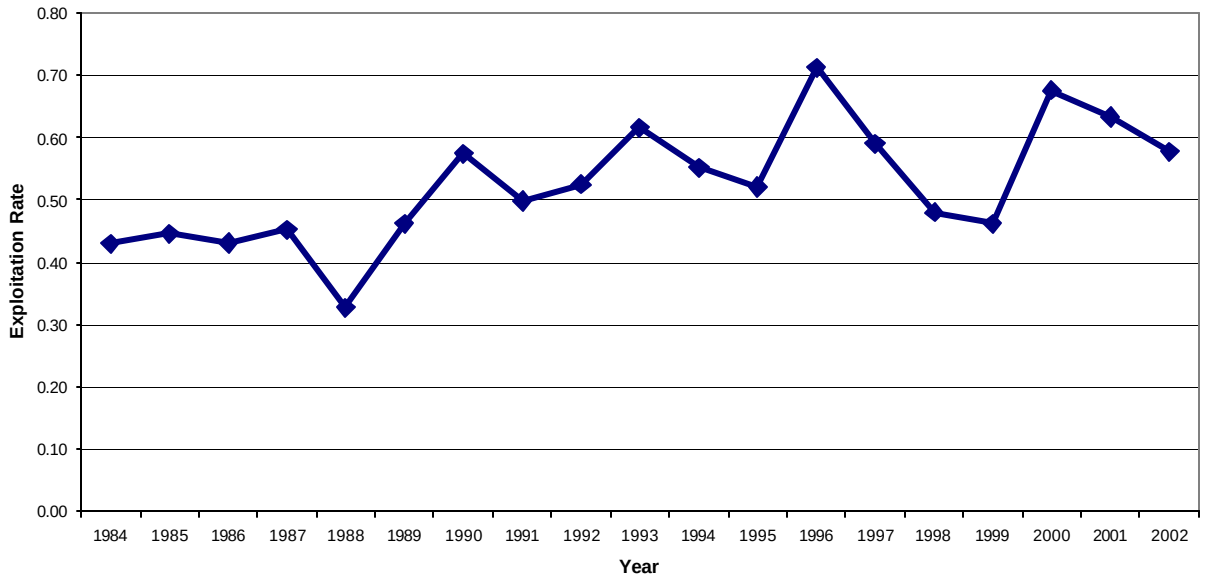
Appendix J.2. Estimated catches of Taku River sockeye salmon in the U.S. and in Canada, estimated escapements into Canadian waters, and estimated harvest rates in the combined fisheries, 1984 to 2002.

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%

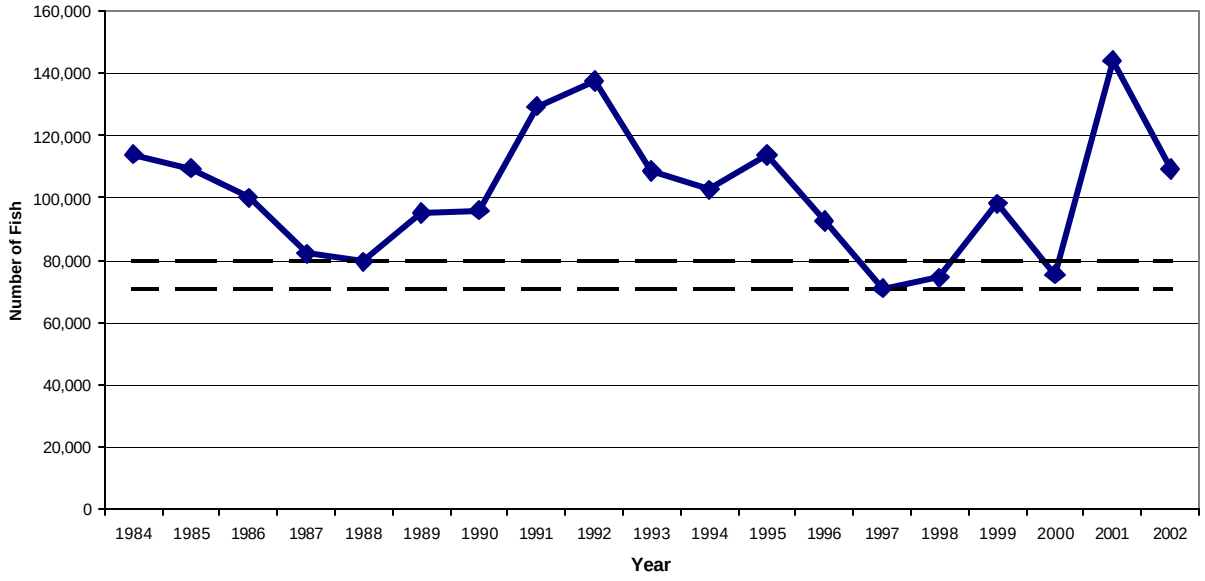
Catches and escapements for 2002 are preliminary.



Appendix J.3. Estimated catches of Taku River sockeye salmon in the U.S. and in Canada, as well as escapement into Canadian waters, 1984–2002. Escapement estimates do not include escapements below the U.S./Canada border. Catch and escapement estimates for 2002 are preliminary.



Appendix J.4. Estimated exploitation rate of Taku River sockeye salmon in U.S. plus Canadian fisheries, 1984–2002. The estimated rate for 2002 is preliminary.



Appendix J.5. Estimated escapement of Taku River sockeye salmon into Canadian waters, 1984–2002. 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 J.6. Literature cited.

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 K. Speel Lake sockeye salmon.

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., J. H. Clark. *in press.* Biological escapement goal for Speel Lake sockeye salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report.
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
Number of years in model: 13
Ratio of highest escapement to lowest escapement:
Parameter values: a-parameter = 17.22 (adjusted), $1/\beta \approx 9{,}100$, (β-parameter = .00011)
Basis of range of escapement goal: Escapement range predicted to provide for 80% or more of estimated maximum sustainable yield (MSY)

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 413.9 acres, maximum depth of 28 feet, and a mean depth of 10 feet. The Snettisham hatchery is located downstream from Speel Lake, about 6 miles to the southwest.

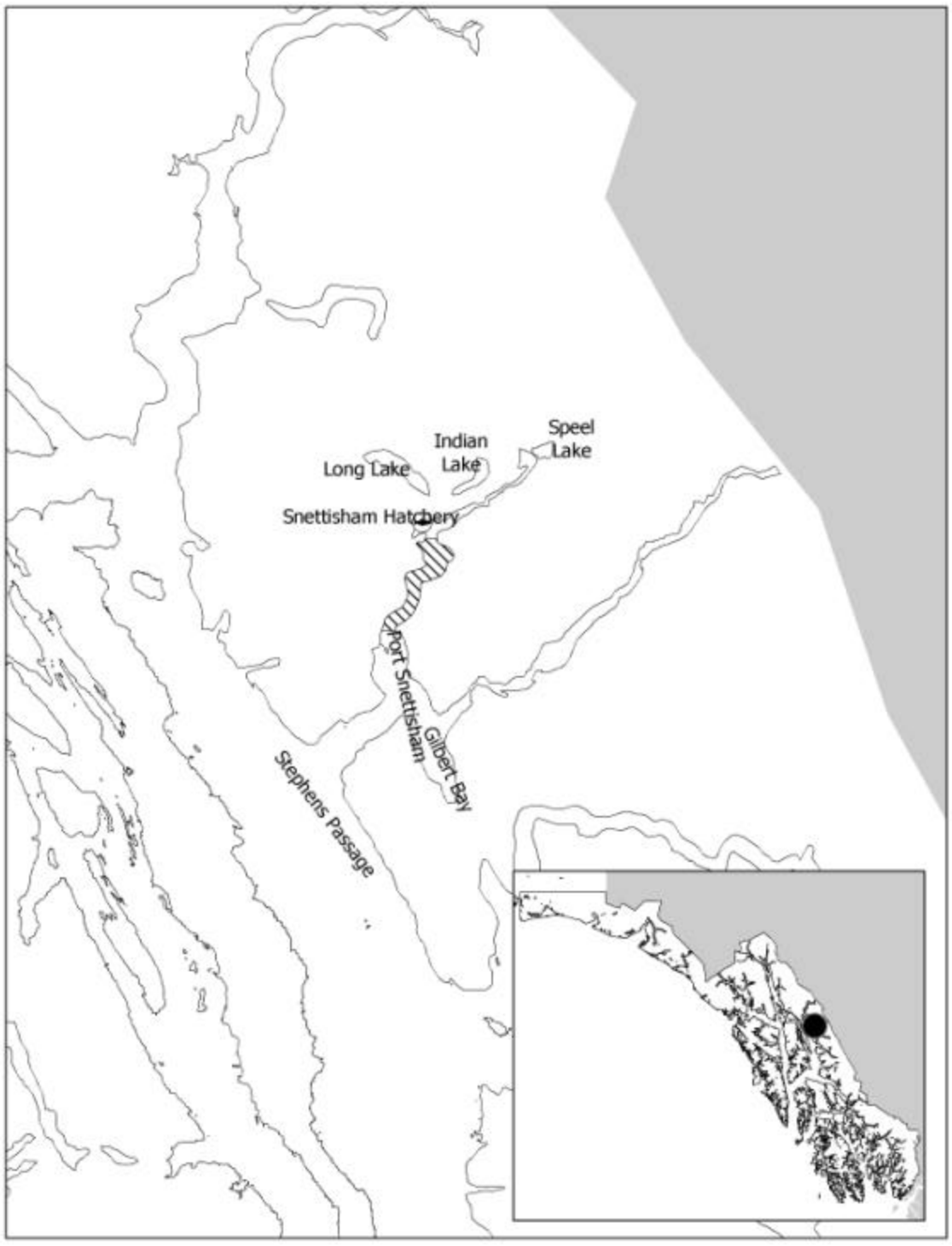
Speel Lake sockeye salmon exhibit a life cycle typical for many sockeye salmon stocks in Alaska, where most fish spend one year in freshwater before becoming smolts, and return after 2 or 3 years spent in the ocean. The date at which the adults migrate into Speel Lake is quite variable, and is dependent upon the amount of rainfall in August. The Speel River is a cold, glacially influenced river. If August rainfall has been low, and the Speel Lake outlet water flows shallow and warm, the fish will school up in the Speel River and not move past the weir site. When a heavy rainfall produces freshets, the fish will migrate en masse into the lake, and greater than 30 percent of the annual escapement may move past the weir in 1 day. The timing of these freshets varies from early August to early September, depending on annual rainfall patterns.

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

The stock identification program in place that estimates stock of origin in the mixed stock District 111 fishery is comprehensive. The number of Speel Lake sockeye salmon in the annual District 111 sockeye salmon harvest is estimated via analysis of paired samples: a tissue sample for detection of brain parasites, and fish scales for stock age structure and for linear discriminant function analysis.

An adult weir located at the outlet of Speel Lake counts the fish that pass upstream. Unfortunately, for 17 of the last 20 years, the weir ceased operation on or about August 31, prematurely truncating the upstream passage 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 algorithm produced more credible escapement estimates, but the estimates so generated have a large 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 three years.



Appendix K.1. Speel Lake and surrounding area. Striped area denotes the hatchery Special Harvest Area (SHA).

Appendix K.2. Estimated spawning escapements, commercial harvests, total returns, and exploitation rates for Speel Lake sockeye salmon, 1983 to 2002.

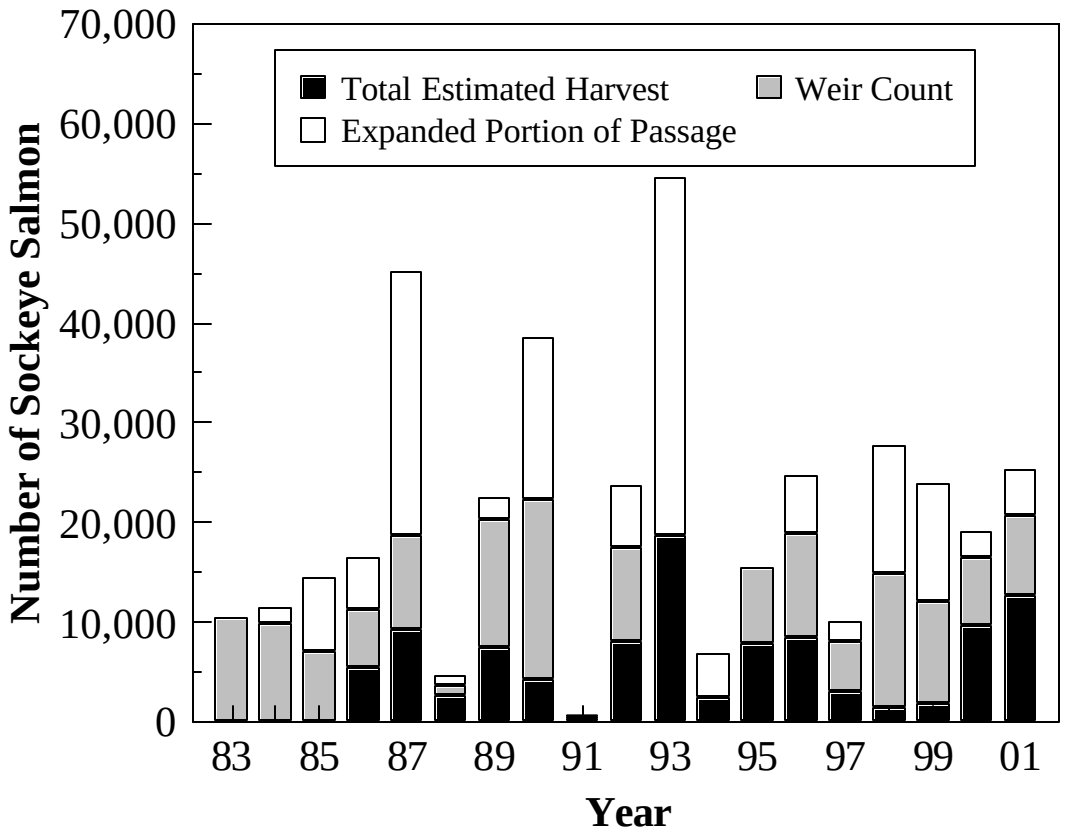
Year	Weir Counts	Upstream Passage Estimates	Brood Stock Removals	Escapement Estimates	Harvest Estimates	Total Return Estimates	Estimated Exploitation Rates
1983	10,484	10,484	0	10,484			
1984	9,764	11,424	0	11,424			
1985	7,073	14,483	0	14,483			
1986	5,857	11,062	0	11,062	5,346	16,408	33%
1987	9,353	35,927	0	35,927	9,284	45,211	21%
1988	969	1,903	259	1,644	2,637	4,540	58%
1989	12,854	15,039	2,115	12,924	7,425	22,464	33%
1990	18,095	34,463	1,197	33,266	4,143	38,606	11%
1991[a]	299	359	0	359	187	359	34%
1992	9,439	15,623	1,517	14,106	8,053	23,676	34%
1993[b]		35,865	1,042	34,823	18,641	54,506	34%
1994[b]		4,462	628	3,834	2,319	6,781	34%
1995	7,668	7,668	1,703	5,965	7,741	15,409	50%
1996	10,442	16,215	1,927	14,288	8,475	24,690	34%
1997	4,999	6,906	0	6,906	3,086	9,992	31%
1998	13,358	26,155	0	26,155	1,456	27,611	5%
1999	10,277	22,115	0	22,115	1,814	23,929	8%
2000	6,763	9,426	0	9,426	9,635	19,061	51%
2001	8,060	12,735	0	12,735	12,610	25,345	50%
2002	5,016	5,016	0	5,016			

[a] The harvest in 1991 was not directly measured, the value provided is based upon an assumed harvest rate.

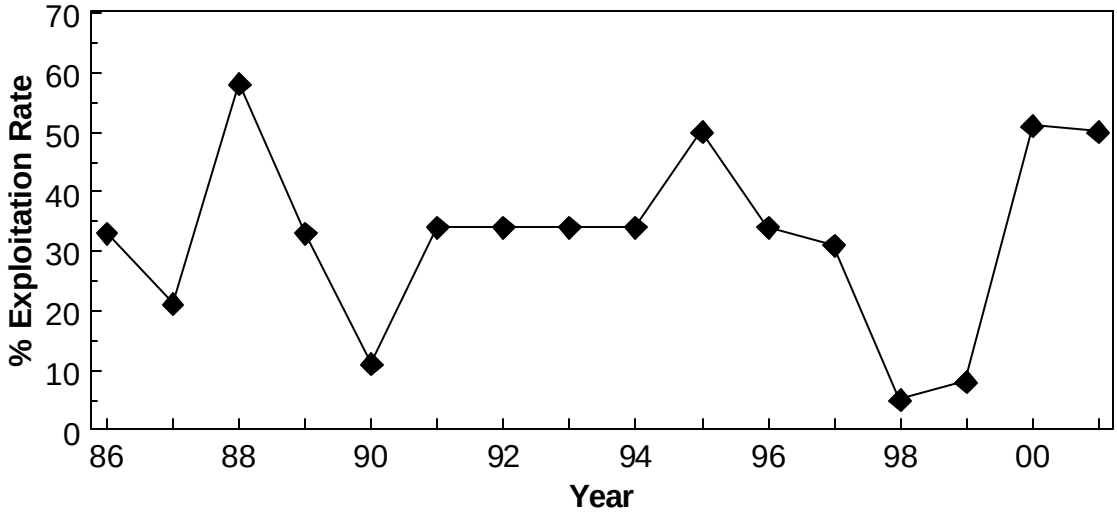
[b] The weir was not operated in 1993 and 1994, passage estimates are based on assumed harvest rates.

Appendix K.3. Estimated total return of Speel Lake sockeye salmon from brood years 1976 to 2001.

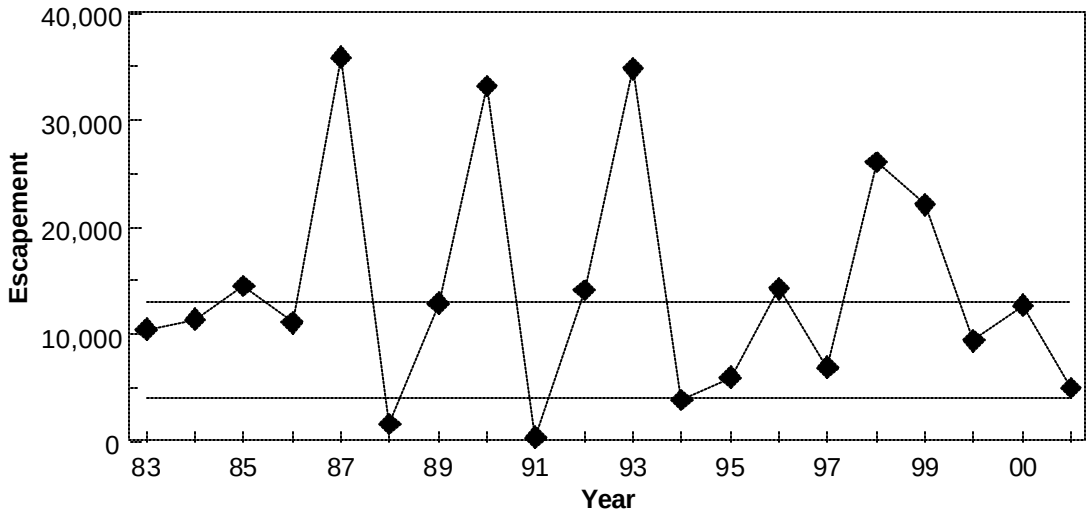
Year	Est. Age 3 Total Run	Est. Age 4 Total Run	Est. Age 5 Total Run	Est. Age 6 Total Run	Est. Total Run	Estimated Brood Year Escapement	Estimated Total Recruits	Estimated Recruits Per Spawner
1983	Speel Lake Origin Harvests Not Estimated					10,484	6,263	0.60
1984	Speel Lake Origin Harvests Not Estimated					11,424	18,725	1.64
1985	Speel Lake Origin Harvests Not Estimated					14,483	25,504	1.76
1986	28	7,921	7,896	562	16,408	11,062	17,745	1.60
1987	0	1,929	42,480	802	45,211	35,927	14,438	0.40
1988	2	1,858	2,605	75	4,540	1,644	49,406	30.05
1989	4	5,073	15,687	1,701	22,464	12,924	21,081	1.63
1990	170	16,849	20,407	1,180	38,606	33,266	8,546	0.26
1991	2	126	396	21	546	359	28,776	80.16
1992	0	11,190	11,990	496	23,676	14,106	7,494	0.53
1993	0	14,720	37,633	2,152	54,506	34,823	16,350	0.47
1994	169	1,410	4,622	580	6,781	3,834	31,131	8.12
1995	16	6,523	7,131	1,738	15,409	5,965	20,167	3.38
1996	171	2,494	22,020	5	24,690	14,288	24,877	1.71
1997	121	4,960	4,848	64	9,992	6,906		
1998	783	15,618	11,073	136	27,611	26,155		
1999	442	7,973	15,367	147	23,929	22,115		
2000	368	7,336	11,336	24	19,061	9,426		
2001	1,121	7,706	16,443	75	25,345	12,735		



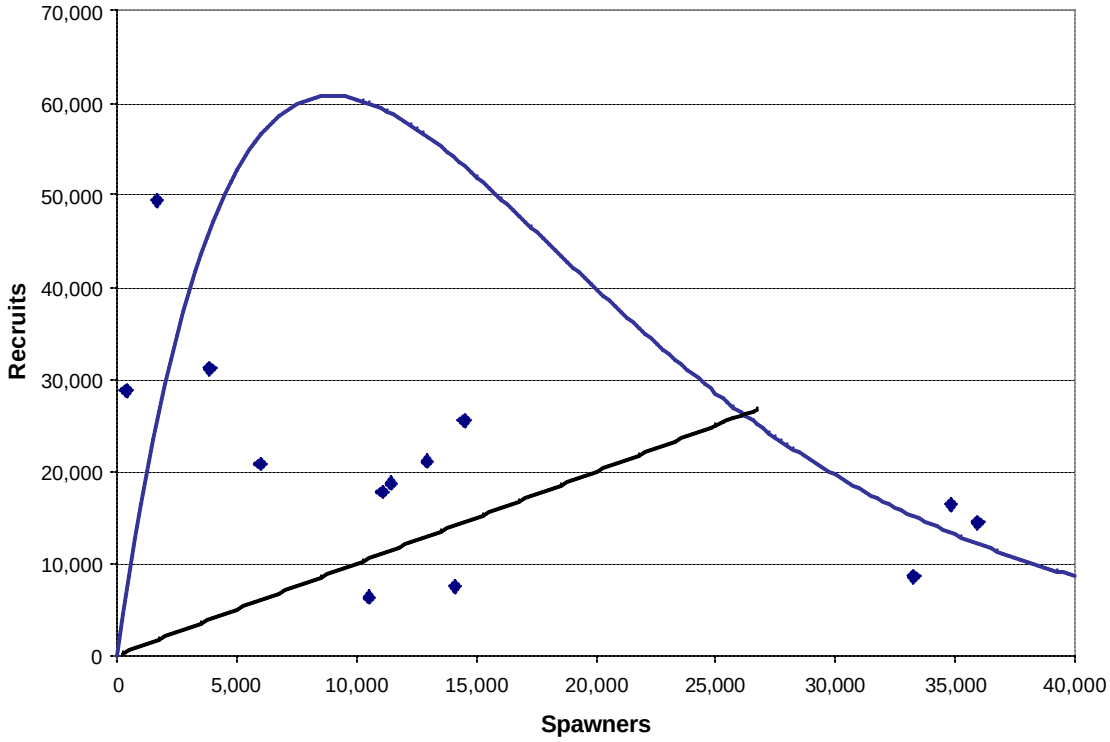
Appendix K.4. Harvests, weir counts, and expanded portions of passage for Speel Lake sockeye salmon, 1983–2001.



Appendix K.5. Estimated exploitation rates for Speel Lake sockeye salmon, 1986–2001.



Appendix K.6. Escapement estimates for Speel Lake sockeye salmon, 1983–2002. Diamonds with dotted line delineates escapement estimates and the 2 solid lines denote the upper and lower bounds of the biological escapement range.



Appendix K.7. Estimated stock-recruit relationship for Speel Lake sockeye salmon, based on brood years 1983 to 1996. The curve represents production predicted by Ricker's mode, the squares represent 1983–1996 data points, and the straight diagonal line represents replacement.

Appendix L. Tahltan Lake sockeye salmon.

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

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 L.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.

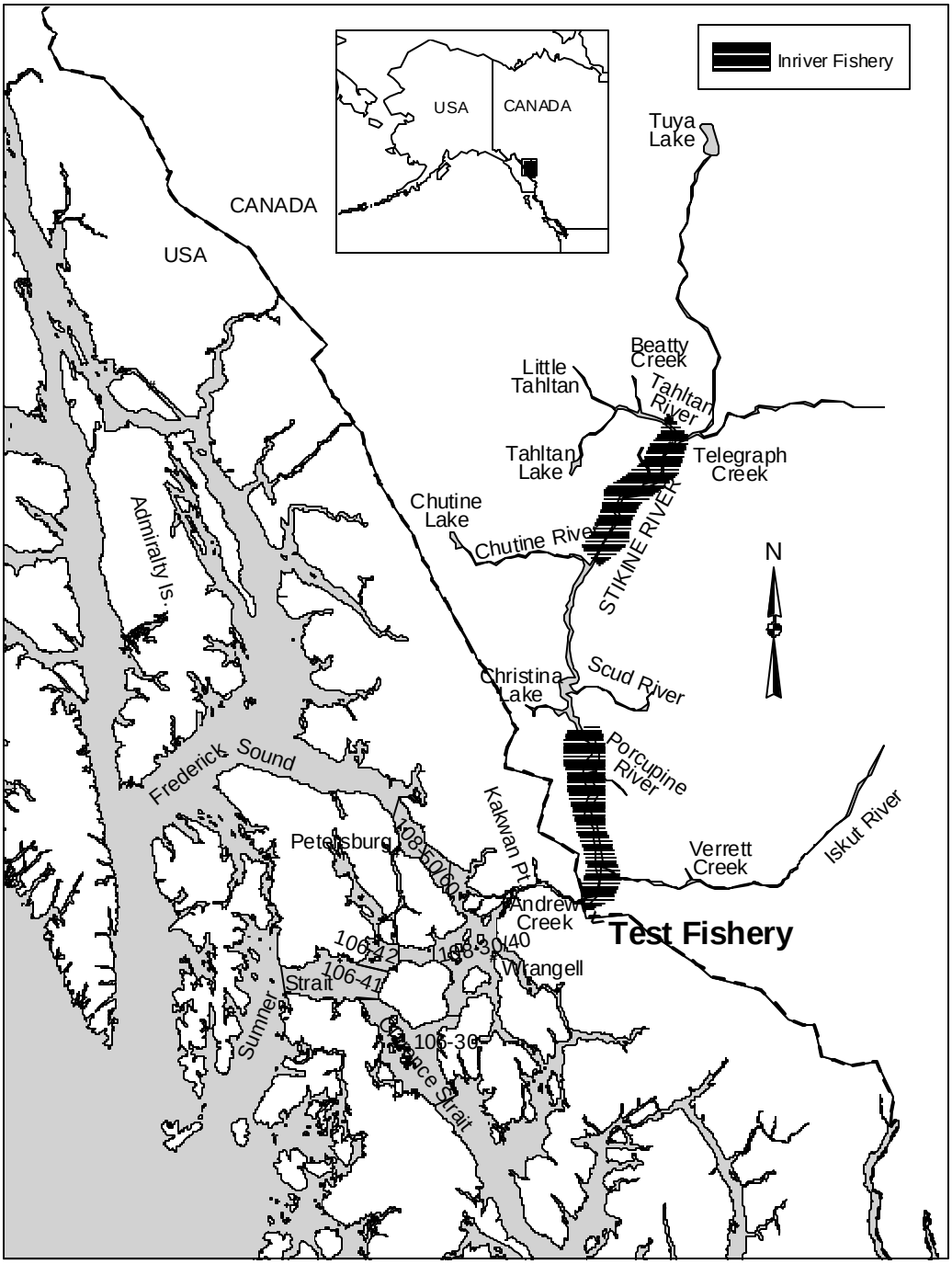
The Rock Island eddy project is currently being evaluated for accuracy of the estimate. Escapement into Tahltan Lake has been monitored annually at a weir since 1959. The weir also serves as a platform to estimate emigrating smolt in late spring.

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 – 30,000) for Tahltan Lake in 1993, based on an analysis conducted by Canadian Department of Fisheries and Oceans staff and reviewed by the Pacific Stock Assessment Review Committee (PSARC). 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 (TCTR 96-1). The analysis indicated Maximum Sustainable Catch of naturally spawning fish is achieved at escapements of 15,000–19,000 spawners. PSARC 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 1991–2000 average of 1.2 million and the 1997–2000 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. The department therefore does not recommend Tahltan Lake sockeye for consideration as a *stock of concern.*



Appendix L.1. Stikine River drainage and surroundings, showing location of commercial, subsistence, and recreational fisheries.

Appendix L.2. Estimated marine catches, inriver returns, inriver catches, escapement, total returns, and harvest rates for Tahltan Lake sockeye salmon, 1979 to 2002.

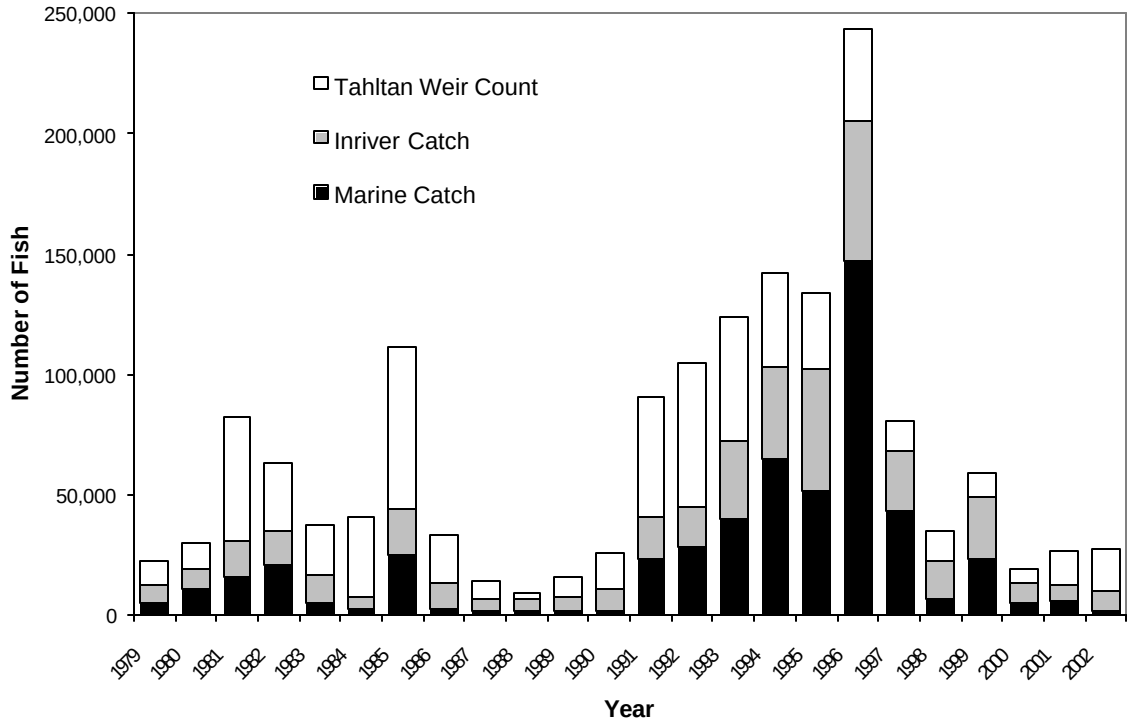
Year	Estimated Marine Catch	Est. Inriver Return	Est. Inriver Catch	Estimated Escapement	Estimated Total Return	Estimated Harv. Rate
1979	5,076	17,472	7,261	10,211	22,548	54.7%
1980	11,239	19,137	8,119	11,018	30,376	63.7%
1981	16,189	65,968	15,178	50,790	82,157	38.2%
1982	20,819	42,493	14,236	28,257	63,312	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.

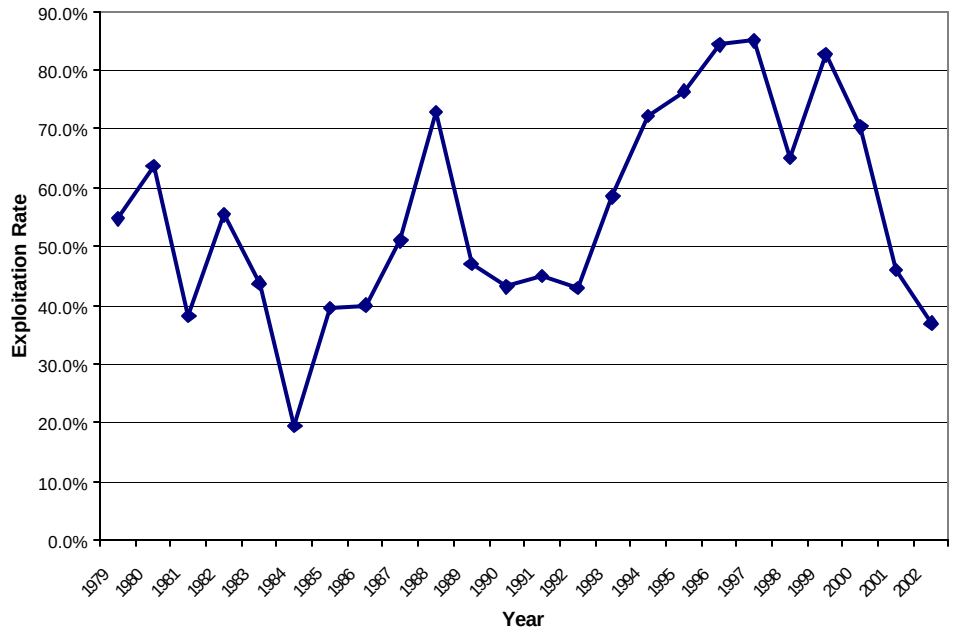
Appendix L.3. Estimated number of emigrating smolts counted at Tahltan Lake weir, 1984–2002.

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]

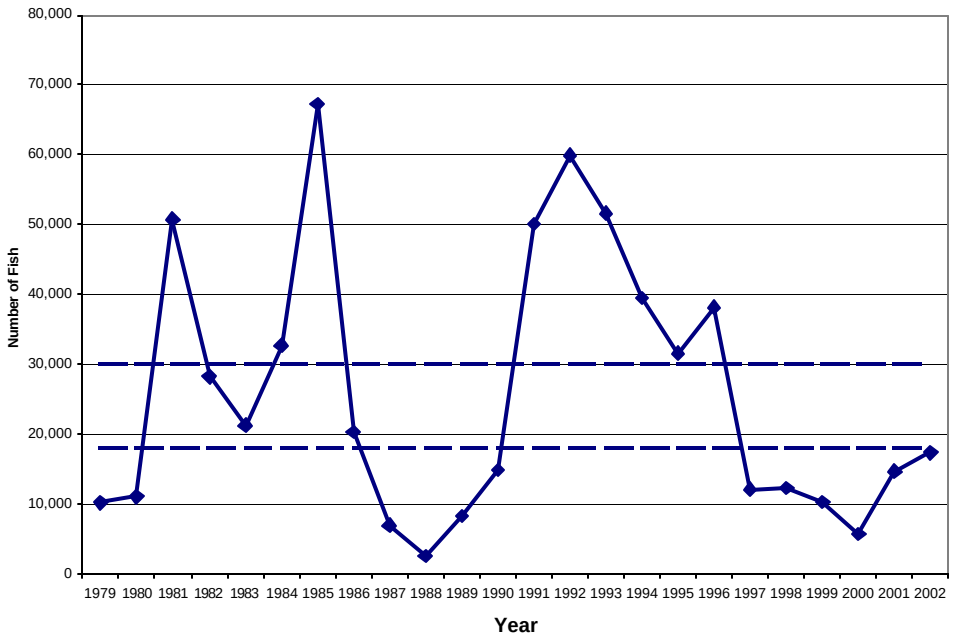
[a] wild and enhanced proportions for smolts not yet available.



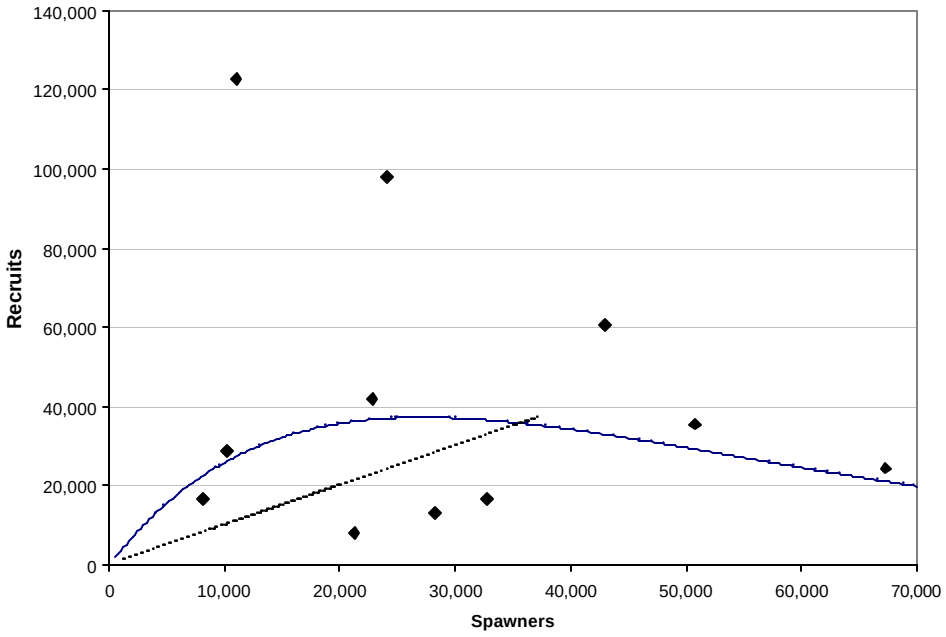
Appendix L.4. Estimated marine catches, inriver catches, and escapement of Tahltan Lake sockeye salmon, 1979–2002.



Appendix L.5. Estimated exploitation rates of Tahltan Lake sockeye salmon in U.S. and Canadian fisheries, 1979–2002.



Appendix L.6. Estimated escapement of Tahltan Lake sockeye salmon, compared with the escapement goal range, 1979–2002. Solid line is escapement estimate; dotted lines are the upper and lower bounds of escapement goal range.



Appendix L.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 1975–1985 data points, and the straight diagonal line represents replacement.

Appendix M. Mainstem Stikine sockeye salmon.

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 set goal
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 K.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. 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. The Department of Fisheries and Oceans Canada (CDFO), and the Alaska Department of Fish and Game, 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.

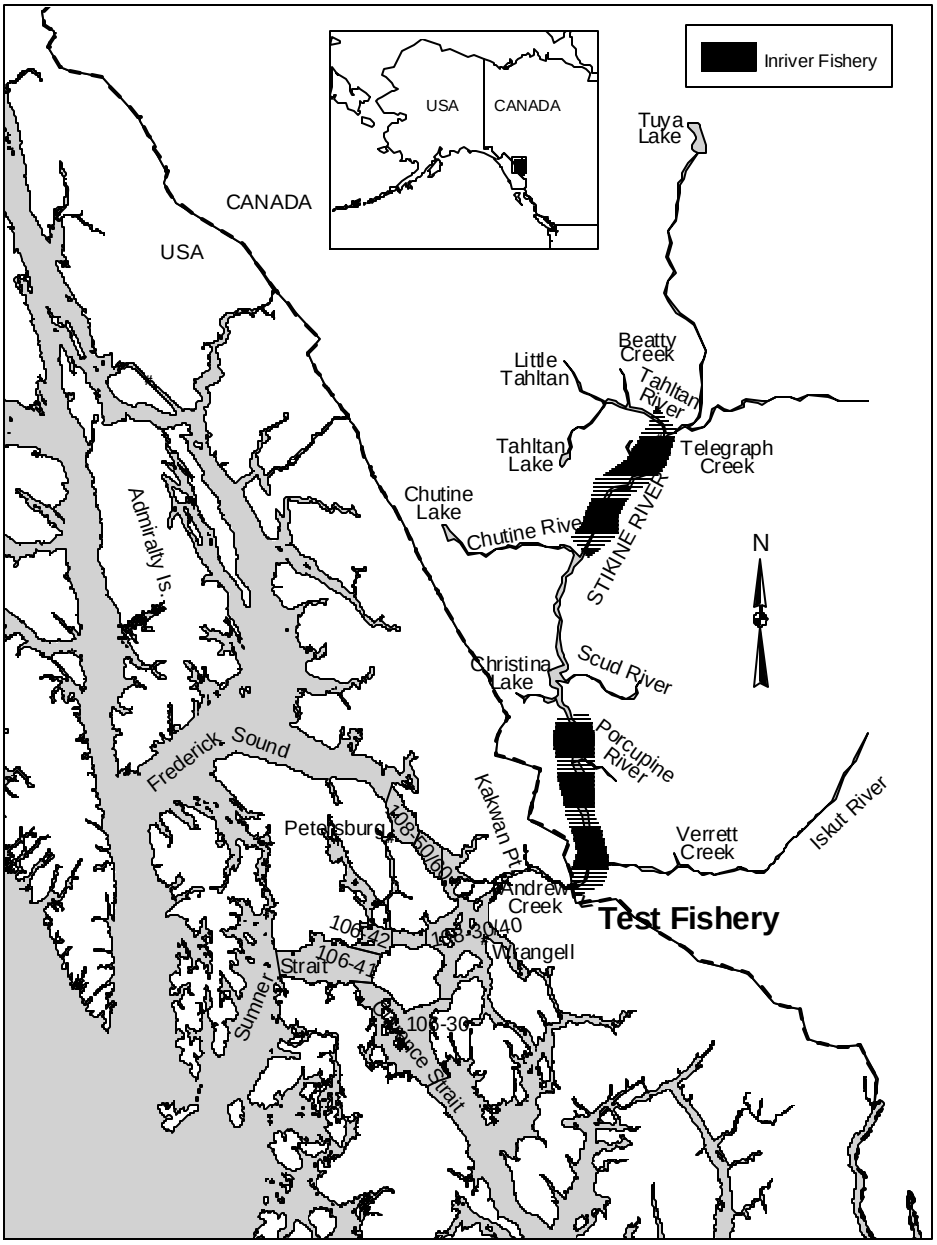
The Stikine River sockeye salmon run is managed for component stocks, one of which is mainstem Stikine. Pre-season forecasts are generated for component stocks. An inseason management model is jointly maintained by ADF&G and DFO members of the Transboundary Technical Committee to forecast run size and 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.

Basically, 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: mainstem Stikine fish. Total inriver run estimate multiplied by proportion of mainstem Stikine sockeye salmon in the run equals 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), and 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.

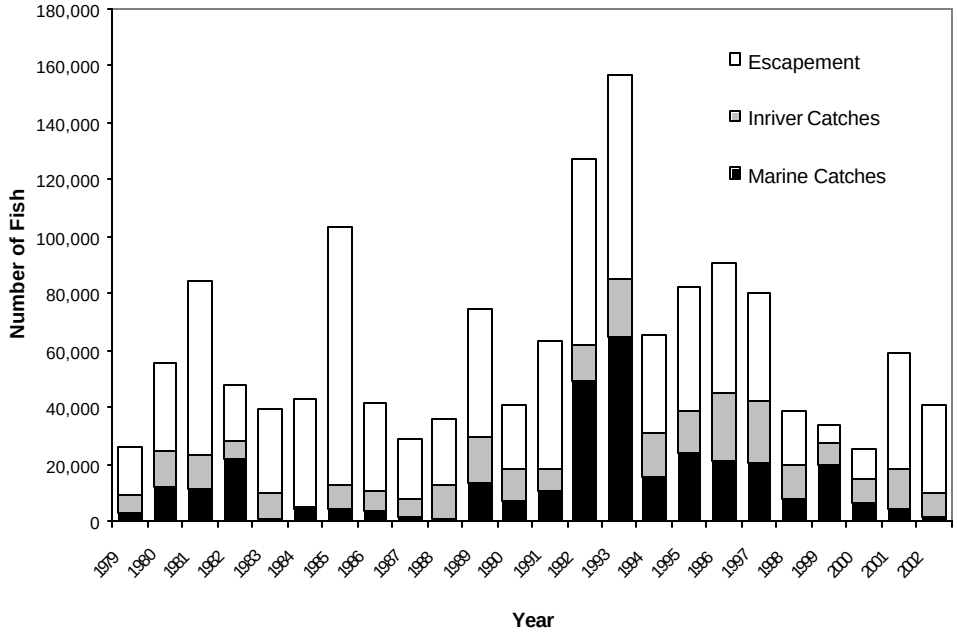


Appendix M.1. Stikine River drainage and surroundings, showing location of commercial, subsistence, and recreational fisheries.

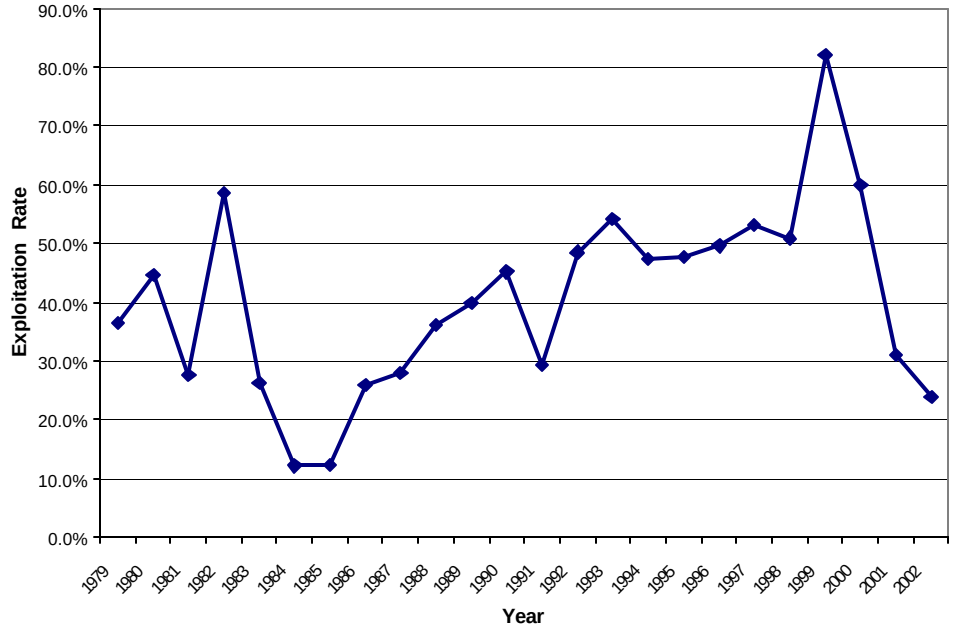
Appendix M.2. Estimated marine catches, inriver returns, inriver catches, escapement, and total returns for Stikine River mainstem sockeye salmon, 1979–2002.

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 [a]	1,906	39,278	7,892	31,387	41,187	23.8%

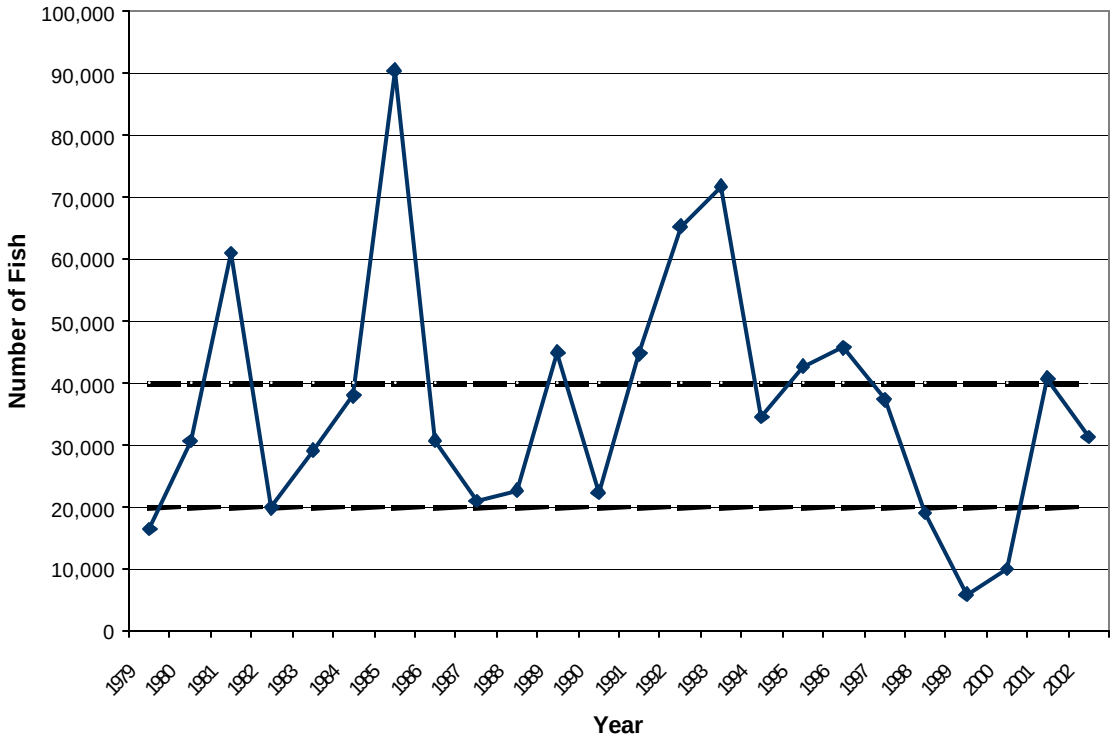
[a] 2002 data is preliminary.



Appendix M.2. Estimated catch in U.S. fisheries, in Canadian fisheries, and estimated escapement into Canadian waters, of mainstem Stikine sockeye salmon, 1979–2002. Escapement estimates do not include escapements below the U.S./Canada border.



Appendix M.3. Estimated exploitation rate of mainstem Stikine River sockeye salmon, in U.S. and Canadian fisheries, 1979–2002.



Appendix M.4. Estimated escapement of mainstem Stikine River sockeye salmon into Canadian waters, 1979–2002. 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 N. 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. *in press*. 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.
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.

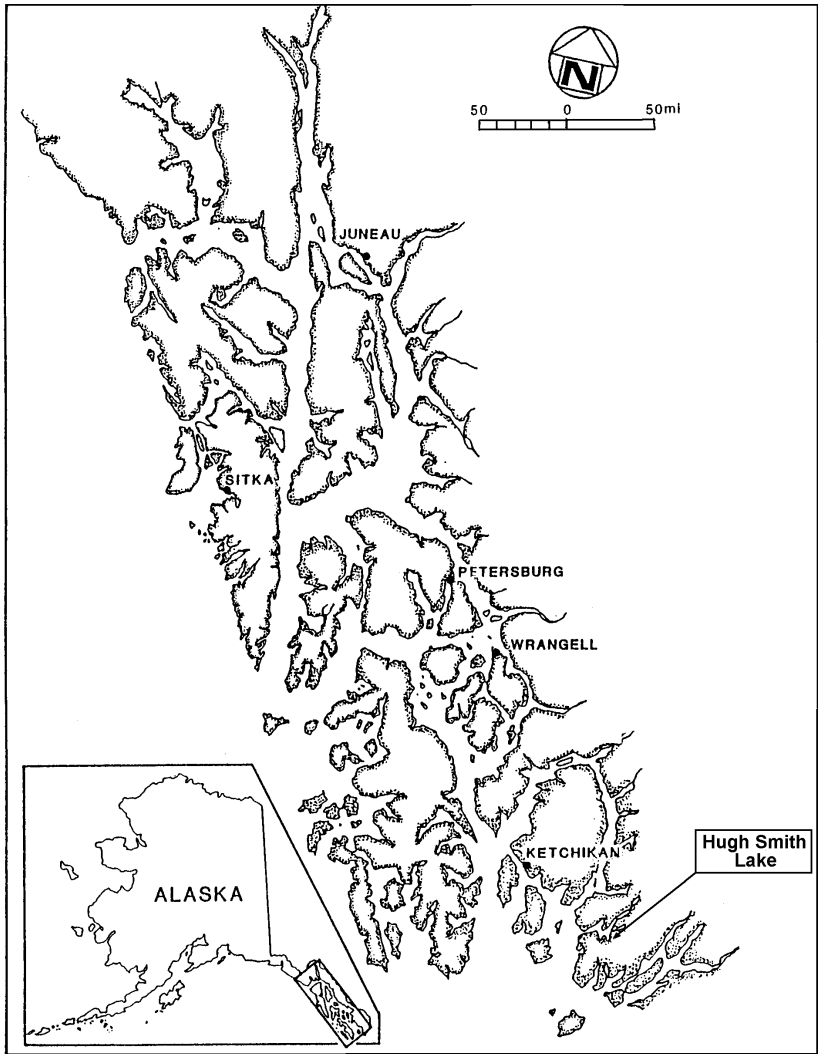
In recent times, the harvest of Hugh Smith bound sockeye salmon has been mostly incidental in other fisheries, with the coded wire tags originating from this system principally recovered in Districts 101 and 104 in Alaska, but there has been no sampling for these tags in Canadian fisheries. From smolt 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 conformation of these estimates by mark-recapture studies since 1992. The most recent escapement goal, of 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 five-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 five-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 N.1. The location of Hugh Smith Lake in Southeast Alaska.

Appendix N.2. Hugh Smith Lake sockeye salmon escapement estimates and run timing, 1967–2002.

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, 1967–1985.
[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 N.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.

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Appendix N.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 N.3. Mark-recapture escapement estimates for Hugh Smith Lake sockeye salmon, 1992–2002.

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

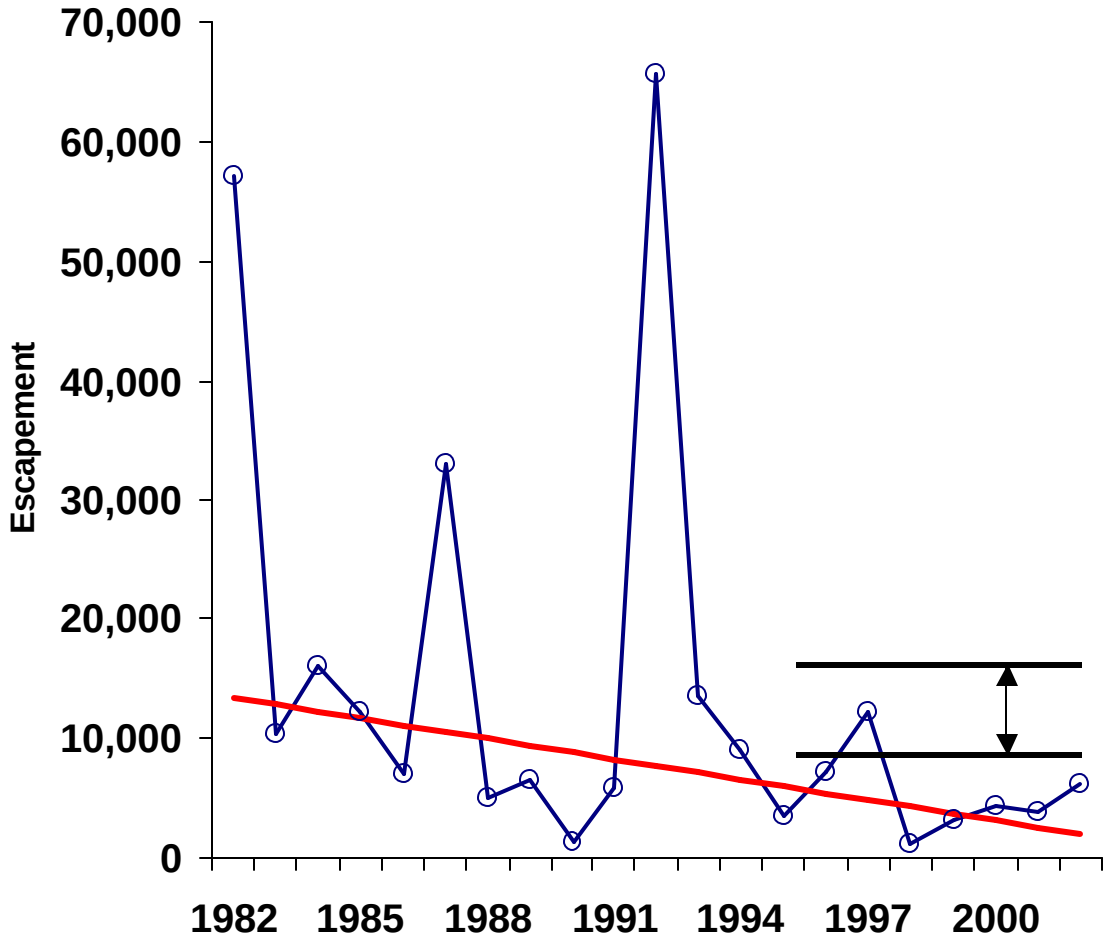
[a] The weir count used for mark-recapture calculations was the number of live fish (weir count minus weir mortalities) passed through the weir.

[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 N.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 N.5 Estimated survival of sockeye salmon smolt from Hugh Smith Lake that were coded wire tagged, 1980–1996. 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 N.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 O. McDonald Lake sockeye salmon.

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, 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.

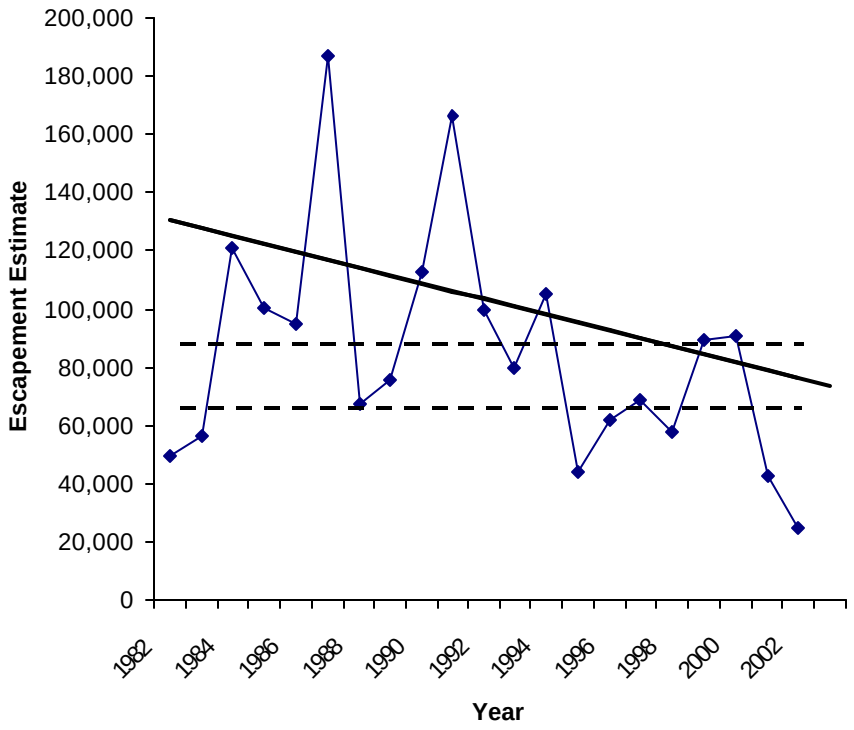
Historically, McDonald Lake sockeye salmon were harvested primarily in the District 106 drift gillnet fishery, although these fish are caught in a variety of Canadian and Alaskan fisheries. Both coded wire tag and U.S./Canada migration tagging studies indicated that McDonald Lake sockeye salmon have 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 65,000–85,000 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 O.1. Estimated total return of McDonald Lake sockeye salmon, 1982–2001. 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]			
1982–2000 average	188,770	5,033	168	733	807	90,980	286,491	195,511	66%

a/ The 2002 escapement estimate is preliminary.



Appendix O.1. Annual estimated escapement of sockeye salmon to McDonald Lake, 1982-2002. 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 O.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. 35 p.

Appendix P. Information on the 12 subsistence projects.

Appendix P.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 75–80% 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 three-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 P.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 1979–1982, 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 three-year sockeye salmon stock assessment project and a mark-recapture study estimated approximately 6,000 sockeye salmon spawned in Hetta Lake this first year.

Appendix P.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 25–60% 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 due to 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 P.4. Kanalku Lake

Kanalku Lake is located on the 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 used 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 effort was successful in the 2002 season. Preliminary data from 2002 shows a five-fold increase in the escapement estimate between 2002 (1,600 spawners) and 2001 (300 spawners).

Appendix P.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 1981–1989.

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 harvest 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 P.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 four-fold decline in the sockeye salmon catches in this area. The majority of the sockeye salmon are taken in hatchery terminal fisheries in Chatham Straight. 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 P.7. Luck Lake

Luck Lake is located on the northeast side of Prince of Wales Island and is assessable 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 of 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 P.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 five-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 five-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 P.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 Creek 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 of 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 on the spawning grounds.

Appendix P.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 from the beginning of 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 P.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 P.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 through 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 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 the 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 to be 12,000 sockeye salmon using mark-recapture methods in combination with the weir counts.