HARVESTS, ESCAPEMENTS, MIGRATORY PATTERNS, SMOLT MIGRATIONS, AND SURVIVAL OF COHO SALMON IN SOUTHEAST ALASKA BASED ON CODED WIRE TAGGING, 1994-1996

By

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and

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Regional Information Report[1] 1J98-02

Alaska Department of Fish and Game
Division of Commercial Fisheries Management and Development
Douglas, Alaska

January 1998

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[1] The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data, this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Commercial Fisheries Management and Development Division.

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ACKNOWLEDGMENTS

The authors appreciate the efforts of the many field employees who collected the basic data essential to the development of this report: Larry Derby, Rebecca Wilson, Susan Jordan, Wayne Lonn, Molly Kemp, Nick Olmsted, Ken Koolmo, Karen Koolmo, Richard Bloomquist, Mark Olsen, Kent Taylor, and John Preus. Jerry Koerner assisted in supervision of the smolt tagging and adult weir operations at Hugh Smith Lake.

PROJECT SPONSORSHIP

This investigation was partially financed by the Anadromous Fish Conservation Act (P.L. 89-304 as amended) under Federal Aid Grant Award Nos. NA46FA0344 and NA46FA0344, Amendment 1).

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ABSTRACT

Wild juvenile coho salmon *Oncorhynchus kisutch* were coded wire tagged in three Southeast Alaska streams: Berners River, Ford Arm Lake, and Hugh Smith Lake. Returning adults were enumerated and sampled to estimate total escapement, fishery contribution, removal rates, migratory patterns, age structure, smolt migrations, and survival rates. The primary purpose of the program was to index fishery harvest rates and patterns and to determine factors affecting adult production.

The estimated 1994 total run to the Berners River and Hugh Smith Lake were the largest recorded while the Ford Arm Lake stock was second only to 1993. Very high marine survival rates combined with large smolt migrations were responsible for the large indicator stock returns and a record region catch in 1994. In 1995, survival rates for the three systems averaged 58% lower than in 1994 while total adult returns were reduced by a similar average amount (59%).

Harvest Rates were relatively high for the Berners River stock (78.4% in 1994; 82.8% in 1995) and the Ford Arm Lake stock (71.9% in 1994; 67.4% in 1995) compared with the early 1990's. Harvest rates for the Hugh Smith Lake stock remained high at 81.4% in 1994 and 73.6% in 1995, which continued a trend of higher harvest rates for this stock since 1989. An increase in average harvest rates for the Hugh Smith Lake stock from 62% in 1982-1988 to 77% in 1989-1995 resulted primarily from increases in the troll and gillnet fisheries.

Gillnet fishery openings inside Berners Bay were implemented in 1994 and 1995 for the first time in an attempt to achieve escapement objectives for the Berners River. Berners Bay openings totaling eight days on the very large 1994 run were successful in harvesting a substantial number of fish surplus to the escapement goal range. However, the potential hazards associated with this terminal fishing strategy became evident in 1995 when a very high removal rate occurred during a single two day opening when a large number of boats fished on a below-average, over-forecasted run that was highly concentrated in the bay. The result was a 1995 escapement that was just above the lower end of the goal range. We recommend that terminal fishery openings in this area be conducted only when the run is very large.

KEY WORDS: Coho salmon, coded wire tag, indicator stock, migration patterns, migratory timing harvest rate, Southeast Alaska

INTRODUCTION

The coho salmon *Oncorhynchus kisutch* is an important species to commercial, sport, and subsistence fisheries in Southeast Alaska. During 1989 to 1996, the total catch averaged 3.4 million fish and ranged from 2.3 to 5.7 million (ADF&G, integrated fishery database). On average, commercial fisheries accounted for 96.4% of the total harvest while sport, subsistence, and personal-use fisheries accounted for the remainder. The sport catch averaged 122,700 fish while subsistence and personal use accounted for only 2,200 fish.

The majority of the coho salmon harvested in Southeast Alaska are produced in over 3,000 local anadromous fish streams. Important contributions are also made by the Canadian portions of three major transboundary rivers (Stikine, Taku, and Alsek) and by streams along the British Columbia coast. Management of fisheries for coho salmon in Southeast Alaska is complicated by the scattered distribution of the resource and by mixing of stocks. Effective management requires an understanding of the stock migratory characteristics, status, productivity, harvest rates, and fishery contributions.

To better understand wild coho stock migrations and fisheries impacts, a juvenile/smolt-marking program was initiated in 1972. In these early studies, fish were marked with fluorescent pigment (Gray et al. 1978); coded wire tagging equipment was employed beginning in 1976. Through 1993, wild coho salmon were marked in 24 systems throughout the main part of Southeast Alaska and five systems near Yakutat. Earlier studies focused on characterizing the rates and time-area distributions of the harvest of stocks from different areas of the region (Shaul et al. 1991). As more of this information has become available, program emphasis has shifted to long-term research on selected indicator stocks that represent a larger group of stocks (Shaul 1994a, 1994b; Shaul and Crabtree 1996). In addition to providing additional information on harvest rates and patterns, these ongoing studies are directed at providing data useful in evaluating escapement goals (Clark et al. 1994) and developing models to predict abundance. Since 1982, the wild indicator stocks have been the Berners River and Auke Creek north of Juneau, Ford Arm Lake on the outer coast, and Hugh Smith Lake south of Ketchikan (Figure 1).

While the developing history of escapement and run reconstruction information is expected to provide a basis for management of Southeast coho stocks, there is substantial uncertainty about the validity of current aging methods using scale growth patterns. In order to validate aging methods and provide greater certainty about the accuracy of spawner-recruit data, an age verification study was initiated on the Berners River in spring 1996. Initial capture and marking of fry is documented in this report.

This report includes a summary and analysis of tag release and recovery data for Berners River, Ford Arm Lake, and Hugh Smith Lake, the three indicator stocks under study by the Alaska Department of Fish and Game (ADF&G), Commercial Fisheries Management and Development Division (CFMDD) during the period from July 1, 1994 to June 30, 1996. Studies at Auke Creek were funded jointly by the ADF&G, Division of Sport Fish, and the National Marine Fisheries Service and are reported in the ADF&G, Sport Fish, Fishery Data Series. However, some Auke Creek results are included in this report for comparison.

METHODS

Smolt and Presmolt Tagging

Migrating coho salmon smolts were tagged at Hugh Smith Lake and the Berners River from April to June. Presmolts were tagged at Ford Arm Lake in July. The majority of surviving fish that were tagged as age-1 rearing juveniles were expected to return as adults two years later, whereas those tagged as smolts were expected to return to the fisheries and spawning grounds after one year at sea.

Emigrating smolts were captured for tagging at Hugh Smith Lake with a smolt weir installed at the outlet of the lake. Smolts in the Berners River were captured at beaver dams using trough traps (design described by Elliott 1992). Wire-mesh minnow traps baited with salmon roe were used to capture age-1 and older juveniles at Ford Arm Lake. Approximately 100 traps were set and checked twice daily. Traps were moved frequently to maintain the highest possible catch rates. Prior to being tagged, juveniles were held in pens for a period not exceeding 3 days, or until a total of 1,000-4,000 were captured. Gray and Marriott (1986) describe the minnow trapping method in detail. Emigrating smolts were tagged and released daily. A description of the coded wire tagging technique under field conditions is found in Koerner (1977).

Targets of 600 samples at Hugh Smith Lake and 850 samples at the Berners River were taken for age and length: 10% of the daily smolt catch was sampled up to a daily maximum of 50 fish. Five to ten scales were taken from the preferred area: i.e., the left side of the fish approximately two rows above the lateral line where crossed by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). The scales were removed with a surgical scalpel and distributed separately across one of four quadrants on a glass microscope slide. Samples from four fish were placed on each slide, which was labeled with fish numbers and lengths. Another slide was then fastened over it with clear tape to protect the scales. All smolts that were sampled for scales were measured from snout to fork to the nearest millimeter.

Fry Tagging

Coho salmon fry were captured on the Berners River during late May and June 1996 and were tagged with half-length coded-wire tags. The objective was to mark 2,000-5,000 newly emerged fry. Subsequent recovery and age sampling of these tagged fish at the smolt and adult stages is expected to provide samples of known age with which to verify current aging techniques and to assist in developing improved aging methods.

A variety of capture devices was tested including small-mesh minnow traps (0.32 mm mesh) baited with salmon roe, small beach seines, and dipnets. These methods were deployed in suitable locations throughout the lower Berners River. An upper length limit for tagging was selected, based on the length-frequency

profile for captured fish, in order to exclude fish that were older than age .0. Tagged fry were released into the main beaver pond on the west side of the valley where they were judged to have the highest chance of being recovered as smolts as they migrated from the system.

Tag Recovery from Fisheries

Commercial catch sampling for coho salmon with coded wire tags was conducted by ADF&G sampling personnel stationed at fish processors and buying stations located throughout the region. The samplers watched for adipose clipped coho salmon during off-loading and sorting operations. Skippers of fishing vessels and tenders were interviewed to determine the districts they had fished (Appendix A.1). The heads of all adipose fin-clipped fish were sent to the ADF&G, Coded wire Tag Laboratory for tag removal and decoding. Four Quadrants (Appendix A.2) were used in expanding random recoveries from the troll fishery, whereas recoveries from net and trap fisheries were expanded by district. Statistical weeks extending from Sunday through Saturday were used for expanding net and trap recoveries. Troll fishery recoveries were expanded (1) for open periods for estimating total contribution, (2) by statistical week and quadrant for analyzing migratory timing, and (3) by fishing period and Pacific States Marine Fisheries Commission (PSMFC) area for analyzing harvest distribution. Randomly recovered tags were expanded by the inverse of the proportion of the catch that was sampled within an area, gear type, and weekly or period stratum; adjustments were made to account for lost samples (Clark and Bernard 1987). An adjustment for lost samples was made by multiplying expansions by the inverse of the proportion of heads and tags lost.

The ADF&G, Sport Fish Division conducted a creel census and survey of the Juneau and Ketchikan marine recreational fisheries (Hubartt et al. 1995 and 1996). Tags recovered from random samples were expanded over biweekly strata that contained several stratifications: (1) weekdays versus weekends and holidays, (2) mornings versus afternoons, and (3) low-use versus heavy-use docks. Tags caught in derbies were expanded separately.

Sampling of British Columbia coastal fisheries and reporting of coded wire tag recoveries was conducted by the Canada Department of Fisheries and Oceans (CDFO).

Escapement Enumeration and Sampling

The Berners River escapement was estimated from a visual survey, whereas weirs were operated at the outlets of Ford Arm and Hugh Smith Lakes. As many fish as possible were examined for adipose clips at the two weir sites and on the upper Berners River. All fish counted past at the weirs were anesthetized in a solution of MS-222 to facilitate inspection; fish sampled at the Berners River were not anesthetized. In the Berners River, fish were captured with a 13-m beach seine for sampling for coded wire tags and age-length-sex data. A three-person crew deployed the beach seine in pools. The sampling target for tags was at least 1,500 fish or 25% of the total survey count. Fish captured in the beach seine were marked with a partial dorsal clip using wire cutters. In earlier years, when an adipose clip was found, the fish was sacrificed, and the head was sent to the ADF&G tag lab for tag removal and decoding. However, a greatly increased

tagging rate beginning in 1989 led to a need to sample marked fish without killing them. Beginning in 1990, adipose-clipped fish were examined with a trough-type magnetic field detector, and later a wand-type detector to determine the presence of a tag. If the fish registered a positive signal, it was released and recorded as having a tag. If a coded-wire tag was not detected from an adipose-clipped fish, the fish was sacrificed and its head was marked with a jaw tag and sent to the tag lab for further verification.

All fish that were counted past weirs were captured in the trap, examined for the presence of an adipose fin, and sampled for coded-wire tags as above. In most years, males under 450 mm long at Hugh Smith Lake and under 500 mm at Ford Arm Lake (mideye to tail fork) were classified as jacks (age .0); larger fish were classified as adults (age .1). There was a chance of misclassifying a very small number of fish because of a small overlap between size distributions of the two ocean-age classes. The size distributions were examined during the migration and an adjustment was made in the length division between age classes if warranted. In 1993, for example, growth was exceptionally slow and the delineation was reduced to 450 mm at Ford Arm Lake and 420 mm at Hugh Smith Lake and the Berners River. Not all jacks were enumerated because some were small enough to pass between the pickets.

Age-length-sex sample targets were 500 adult fish for the Berners River and 600 fish at both the Ford Arm and Hugh Smith weirs. Each fish sampled was placed in a padded measuring trough and measured to the nearest millimeter from mideye to fork of tail. The length and sex were recorded. Four scales were taken from the left side of the fish approximately two rows above the lateral line in an area crossed by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). Scales were mounted on gum cards and impressions were made in cellulose acetate (Clutter and Whitesel 1956).

Berners River Surveys

The upper Berners River and tributaries were surveyed annually by foot and helicopter during an 8 to 10-day trip in late October. The survey area was covered on two sequential days: from camp to the headwaters on the first day and from camp downstream on the second day. All side tributaries throughout the survey area were examined for fish. An additional survey was conducted later in the trip if water conditions were high or if fish were observed moving upstream. During days when the crew was transported to and from the camp, the observer surveyed the lower river from the mouth upstream to the downstream end of the foot survey area. Typically, <10% of the total count was seen in this area. The total survey count was the sum of the peak counts for all areas counted. Care was taken to schedule surveys to minimize the chance of double counting the same fish or missing fish as they moved between sections surveyed.

The same observer who conducted the Berners River surveys in 1994 and 1995 had surveyed the system since 1982. The observer walked upstream along the bank or in the stream channel, if necessary, to avoid dense vegetation. Wearing polarized sunglasses, the observer looked ahead and counted fish individually as they darted downstream past the observer or under banks or logs. Rocks were thrown into suspected hiding areas to drive fish out to be counted. In some small tributaries with overhanging root systems, the observer probed under banks to drive hiding fish out to be counted. Pools with larger schools of over 100 fish were counted repeatedly from different angles and directions until the observer was satisfied with the count, which was typically the average of several counts. Counting larger schools was often done by tens, or by tens and hundreds for the largest observed schools of 1,500-2,000.

Although infrequent, dead fish or fresh parts (jaws or pyloric caeca) found that could be identified as individual coho salmon were included in the count. Species identification was not considered a problem because coho salmon were the only salmon species present in the area during late October, although schools of Dolly Varden were present in some areas.

Helicopter surveys of the lower river were conducted from an altitude of 30-50 meters with the sun at the observer's back. The helicopter was first held stationary off to the side of the pool, so that prop wash on the water did not obscure visibility and so that the fish remained somewhat stationary and did not stir up bottom sediment. The helicopter sometimes moved past the fish or in a circle around them if the observer needed to see the fish move to confirm that he had observed all of them.

The trip was timed so that little if any spawning had occurred before the survey count and the vast majority of the escapement had entered the system. Some fish were just beginning to enter spawning areas in the headwaters and small tributaries, but most were holding in clear pools below spawning areas. The eight to 10-day trip was typically long enough to avoid unfavorable survey conditions due to high water.

Ford Arm and Hugh Smith Weirs

Metal picket weirs were operated at the outlets of Ford Arm and Hugh Smith Lakes through late October or early November. Spawning usually began below the Ford Arm weir in mid to late October. Surveys were conducted below the weir from October 1 until the weir was removed. Subsequent cumulative weir counts were subtracted from each survey count; the greatest difference between these numbers was recorded as the number of fish remaining downstream when the weir was removed. No spawning is known to occur in the short section between the Hugh Smith weir and the estuary: a downstream survey count was made each year just prior to weir removal.

In some years, the weirs became ineffective for short periods due to flooding; coho escapement was estimated using mark-recapture data for those years (Shaul et al. 1985, 1986). For later years, water flowing over the weir was resolved at Ford Arm Lake by installing a railing with a hardware cloth extension along the top of the weir to maintain a complete barrier during flood conditions. Problems with that weir's integrity have occurred in some recent years with bears opening holes in the wire mesh during high water periods. Tagging was used to estimate the escapement in 1982, 1983, 1988 through 1992, 1994, and 1995 using a single stratum estimator.

Mark-recapture techniques have also been employed to verify weir counts at Hugh Smith Lake. Fin clips were used as primary marks in more recent years because they are easier and less expensive to apply than numbered tags. In some years, a single stratum Chapman estimate has been generated. However, beginning in 1992, a stratified mark-recovery system was employed with a dorsal clip used at the weir during the first portion of the run through September 15 followed by a left ventral clip during September 16-October 6 and a right ventral clip from October 7 until the weir was removed.

At Hugh Smith Lake, mark-recovery sampling was initiated in mid-October and, in some cases, continued until February. The inlet streams, Buschmann and Cobb Creeks, were surveyed on foot, and fish were captured for sampling using dip nets and a beach seine. Additional fish were captured off the mouths of the inlet streams using sport gear. All fish taken during recovery were marked with a single left opercular punch and released.

If no fish were found to have passed the weir uncounted, the age-.1 escapement estimate included the sum of the following: (1) total weir count including all weir mortalities and fish that were sacrificed for samples; (2) the greatest difference between a downstream survey count and the weir count after the survey was made and; (3) the sum of prespawning mortalities observed in downstream surveys. If fish were found to have passed the weir uncounted, the age .1 estimate included the sum of the following: (1) Chapman or Darroch estimate of the population above the weir when recovery sampling was initiated, (2) fish counted upstream past the weir and marked with a left opercular punch after recovery sampling was initiated, (3) mortalities that occurred at the weir (fish that died in the trap and were killed by bears and fish that were sacrificed as samples), (4) unspawned wash-ups on the weir that were assumed to be handling mortalities not included in the Chapman or Darroch estimate, (5) the greatest difference between a downstream survey count and the weir count after the survey was made, and (6) the sum of prespawning mortalities observed in downstream surveys.

The total or gross escapement was used in calculating total return, harvest rates, and presmolt or smolt to adult survival rates. The net escapement -- i.e., the gross escapement estimate minus prespawning trap mortalities, bear kills at the weir, coded wire tag samples, and unspawned carcasses that washed up on the weir -- was used to estimate brood year escapement for spawner-recruit analysis.

Analysis of Tag Recovery Data

The proportion of fish in the escapement of an indicator stock that were coded wire tagged (Θ_t) was estimated by:

$$\Theta_t = \left(\frac{m_1}{s}\right)\left(\frac{t}{m_2}\right), \tag{1}$$

where
S = number of fish in the escapement sampled for adipose clips,
m_1 = number of fish in sample (S) that had adipose clips,
m_2 = number of adipose clips in the escapement sampled for tags,
t = number of adipose-clipped fish in the escapement that were sampled for tags and were found to have tags.

The total number of coded wire tagged fish in the indicator stock escapement (E) was estimated by multiplying the stock's total estimated escapement (N) by the proportion tagged (Θt).

$$E = N\,\theta_t. \tag{2}$$

Harvest by Gear Type and Escapement

Fishery contribution estimates, or the number of indicator stock fish caught (C) in fishery i, was estimated by:

$$C_i = \frac{F_i}{6_i}, \tag{3}$$

where F_i was the estimated number of tagged fish harvested (expanded sum of random fishery recoveries) in fishery i.

The total run size for an indicator stock (X) was estimated by adding the sum of the estimated catch of the stock in all fisheries and the escapement.

$$X = \Sigma C_i + N. \tag{4}$$

Harvest Rates

The harvest rate (H) for an indicator stock in fishery i was estimated as follows:

$$H_i = \frac{F_i}{\Sigma F_i + E}, \tag{5}$$

where the denominator is the total number of tagged adult returns for that stock. The overall harvest rate for an indicator stock by all fisheries was estimated as follows:

$$\Sigma H_i = \frac{\Sigma F_i}{\Sigma F_i + E}, \tag{6}$$

Where the numerator is the total number of tagged stock i fish caught in all fisheries.

Removal Rates

The removal rate is defined as the total harvest within a specific fishery divided by the total number of fish available within that fishery, which, for this analysis was considered to be the estimated total return (catch

and escapement) minus fish harvested in preceding fisheries. Therefore, it was necessary to assume a direction of migration. In this analysis, it was assumed that returning coho salmon migrated by the most direct route(s) from the open ocean toward their system of origin and all passed through the fishing areas. Defining T_2 as the number of tagged fish available to the first fishery and F_i as the harvest of tagged fish by fishery i, the removal rate (R) by the first fishery is estimated as follows:

$$R_1 = \frac{F_1}{T_2}. \tag{7}$$

For subsequent fisheries where i>1, R_i was estimated as follows:

$$R_i = \frac{F_i}{T_2 \prod_{j=1}^{L}(1-H_j)}, \tag{8}$$

where L = i-1.

Removal rates were estimated by fishery for the Berners River stock and by area for the Hugh Smith Lake stock. Total harvest rate estimates were generated for the Ford Arm Lake stock, but removal rate estimates for individual areas and fisheries were not made because most of the catch occurred in outside districts lacking a clearly defined migration through sequential fisheries. The Ford Arm Lake stock was believed to be harvested simultaneously by all fisheries.

Distribution of Harvests

Distribution of harvests for tagged stocks was examined by fishery and gear type. The harvest distribution for tagged stocks provided an indicator of harvest distribution for untagged stocks. Expanded tag recoveries of a stock in each fishery (F_i) were divided by the sum of expanded fishery recoveries in all fisheries (ΣF_i). Tag recoveries from the Alaska troll fishery were expanded by PSMFC area (Appendix A.2) and fishing period, and recoveries from the net and trap fisheries were expanded by district and statistical week. In addition, the distribution of the Southeast Alaska troll catch of the three stocks was estimated using quadrant-period strata.

Migratory Timing

The migratory timing of the three stocks in the troll fishing districts was estimated from the distribution of the weekly harvest of tagged fish. Troll fishery tag recoveries were expanded to total catch by quadrant and week. The weekly proportion of the total troll catch of each stock was estimated for each year when data were available. Expanded weekly recoveries were divided by the sum of expanded recoveries from

throughout the season to estimate weekly proportions of total catch. These estimates were based on the dates of landing of tagged fish at fishing ports. Because the average trip length for a troll vessel is about four-six days, the average time of capture of landed fish probably occurred two-three days previously.

Survival Rates

Survival rates for smolts to adults comprising the run were estimated for coho salmon that migrated from Hugh Smith Lake from 1983 to 1994 and from the Berners River in 1989 through 1994. Survival was estimated for presmolts tagged in the Berners River and Ford Arm Lake during 1980, 1981, and 1983 to 1988. Survival of Ford Arm Lake presmolts was also estimated from 1989 through 1993.

It was assumed that all marked adults returning to a system had been tagged there as juveniles or smolts and that naturally missing adipose fins were negligible; i.e., all untagged adipose-clipped fish were assumed to have shed their tags. A sample of adipose-clipped fish (m_2) was drawn from the escapement and sampled for coded wire tags, of which t fish were found to be tagged. The survival rate, S, from the time of tagging (smolt or presmolt) to the age .1 adult stage was estimated as follows:

$$(S) = \frac{(\sum F_i + E)(\frac{m_2}{t})}{T_1}, \qquad (9)$$

where m_2 = number of adipose-clipped fish in the escapement that were examined for tags,
t = number of sampled adipose-clipped fish in the escapement that contained tags, and
T_1 = number of smolts or juveniles tagged.

Tag retention was assumed to be constant for different tagging years in a single return year. However, different tag retention rates may occur in releases from different years, and this could cause small errors in the estimates.

Smolt Migration Estimates

Smolt migration estimates from Hugh Smith Lake between 1983 and 1995 and the Berners River between 1989 and 1995 were made using a Chapman estimate (Chapman 1951). The number marked (M) was the number of smolts that were adipose-clipped and released as they migrated from the system in year i, regardless of whether or not they retained their coded wire tags. The recovery sample (C) was the sum of the number of age-.0 fish sampled for adipose clips at the weir in year i and the number of age-.1 fish sampled for adipose clips at the weir in year i+1. The number of marks recovered (R) was the number of adipose-clipped fish observed in the recovery sample.

RESULTS

Smolts, Presmolts, and Fry Tagged

Ford Arm Lake Presmolts

A total of 10,993 presmolt coho salmon captured in 1,272 minnow trap sets at Ford Arm Lake during July 6-17, 1995, were coded wire tagged (Table 1). Of those, 6,576 were 62-79 mm, 2,777 were 80-100 mm, and 1,640 were >100 mm fork length. The average catch was 8.6 coho salmon 62 mm and larger per trap.

A total of 10,093 presmolt coho salmon captured in 1,098 minnow trap sets at Ford Arm Lake during July 9-19, 1996, were coded wire tagged (Table 1). Of those, 3,631 were 62-79 mm, 4,616 were 80-100 mm, and 1,846 were >100 mm fork length. The average catch was 9.2 coho salmon 62 mm and larger per trap.

Berners River Smolts

Between May 8 and June 10, 1995, 26,141 coho smolts were captured in two trough traps operated in each of two beaver ponds on the lower Berners River. Of the total number captured, 19,210 (73.5%) came from the pond on the west side of the valley, and the remaining 6,931 came from the pond on the east side. The peak daily catch of 2,396 smolts occurred on May 25. Of the total number captured, 26,017 were coded wire tagged (Table 2). Overflowing of the dam on the west pond occurred following heavy rains during May 27-31. Ageable scales were collected from 929 smolts distributed throughout the run. Based on that sample, 32.0% of the run was estimated to be age 1.0, 67.4% age 2.0, and 0.6% age 3.0 (Table 23).

Between May 6 and June 10, 1996, 41,020 coho smolts were captured on the lower Berners River. Of the total number captured, 32,430 (79.1%) came from the pond on the west side of the valley, and the remaining 8,592 came from the slough on the east side. An incline plane trap was operated on the main slough downstream from the main pond that was trapped in prior years on the east side of the valley. This was done because extensive recent beaver activity made access to the pond very difficult. The peak daily catch of 4,182 smolts from the two sites occurred on May 23. Of the total number captured, 40,954 were coded wire tagged and released (Table 2).

Berners River Fry

A total of 5,351 coho fry were captured and tagged from May 28 to June 18, 1996. Of those, an estimated 5,308 (99.2%) retained their tags which were coded 0401020904. Minnow traps, a small beach seine, and dipnetting were all employed to capture fish for tagging. However, dipnetting proved to be most effective. Fry appeared to congregate at points where water from beaver ponds spilled over dams into the main river.

Presumably, these fry had recently emerged from the main spawning area at the headwaters and were attracted to water entering the semi-glacial lower river from prime potential rearing areas in side ponds. Beaver dams formed natural delay points where fry collected while attempting to enter ponds.

Fish captured in these attempts ranged from 28 to 76 mm fork length. However, the maximum length for tagging was restricted to insure that only age-.0 fish were marked for the age verification study. Fish selected for tagging were 42 mm or less based on the length-frequency distribution which indicated a mode at 35 mm and a long tail over 42 mm which may have contained older age classes (juvenile coho as small as 43 mm were found in a sample of 150 fish collected near the headwaters of the river on October 26, 1995). The average length of tagged fry was 36.3 mm (N = 366).

Hugh Smith Lake Smolts

In 1995, the Hugh Smith smolt weir was operated during April 26-May 28. A total of 12,585 coho smolts were captured and tagged (Table 3). Ageable scales were collected from 581 smolts distributed throughout the run. Based on that sample, 48.7% of the run was estimated to be age 1.0, 49.6% age 2.0, and 1.7% age 3.

In 1996, the Hugh Smith smolt weir was operated during April 26-May 29. A total of 24,243 coho smolts were captured of which 24,220 were tagged and released (Table 3). Ageable scales were collected from 609 smolts distributed throughout the run. Based on that sample, 76.8% of the run was estimated to be age 1.0 while 23.2% were age 2.0.

Escapement Enumeration and Sampling

Berners River Surveys, 1994

In 1994, the coho salmon escapement in the upper Berners River and tributaries was surveyed and sampled during October 20-27. The upper river was surveyed on foot during October 20 and 21 for a count of 15,820 fish. After adding another 100 fish observed in the lower river pools from the helicopter, the total survey count for the trip was 15,920 spawners. This was a record count and the third year with over 15,000 spawners. Survey conditions were good.

A total of 1,512 adult coho salmon were sampled for adipose clips of which 319 were clipped and sampled for tags. Of the marked fish, 317 had tags while two did not. Age-length samples were collected from 646 age-.1 fish. Of those, 458 scale samples were ageable: 133 (29.0%) age 1.1; 321 (70.1%) age 2.1; and 4 (0.9%) age 3.1.

Berners River Surveys, 1995

In 1995, the Berners River was surveyed and sampled during October 20-27. Visibility in the lower river was poor on the 21st and no helicopter count was made of the lower pools during the trip in. Those pools were examined under satisfactory visibility conditions on the way out on the 27th and no fish were observed. The upper system was surveyed on foot during October 20-21 for a total count of 4,945 fish. Visibility was good. A total of 1,008 adults were sampled for adipose clips of which 238 were found to be marked. All of the marked fish were sampled for coded-wire tags. Tags were detected in 236 of the adipose clipped fish while no tag was detected in two fish, which were later verified to not have a tag.

In 1995, age-length samples were collected from 653 adults. Of those, 545 scale samples were ageable: 308 (56.5%) age 1.1; 235 (43.1%) age 2.1; and 2 (0.4%) age 3.1. Of the ageable samples, 126 were from adipose clipped fish: 53 (42.1%) age 1.1 and 73 (57.9%) age 2.1. Of the unmarked adults, 255 (60.9%) were age 1.1, 162 (38.7%) were age 2.1 and 2 (0.5%) were age 3.1. Of the six jacks in the random sample, one was age 1.0 while five were age 2.0.

Ford Arm Lake Weir, 1994

In 1994, the Ford Arm Lake Weir was operated during August 10 - October 22. A total of 2,507 adults and 213 jacks were passed during the period of operation. Mark recovery sampling was initiated in the lake on October 12 at which time the mark applied at the weir was changed from a dorsal clip to an opercular punch. A total of 2,411 dorsal-clipped adults had been marked and released into the lake. Ninety-three adults were captured around the lake using sport gear and a beach seine during October 12-23. Of those, 76 were marked with a dorsal clip, one with an opercular punch, and 16 had no mark. A Chapman estimate of adults entering the lake through October 11 was 2,912. The following numbers were added to estimate the gross adult escapement to the system: 83 fish passed after October 11 (opercular punched), 213 fish counted below the weir on October 22, seven prespawning mortalities observed during surveys downstream of the weir, seven unspawned wash-ups before October 12 (assumed to be handling related), six weir migrants sampled for coded wire tags. The estimated gross escapement was 3,228 adults (95% C.I. 2,964-3,492). The net escapement of 3,208 was estimated by subtracting all mortalities that were likely to have resulted from human influence: 6 coded-wire tag samples and 14 observed unspawned wash-ups.

A total of 2,522 adults were sampled for adipose clips of which 317 were marked (314 were examined for tags). Tags were detected in 308 fish. Nineteen of the 213 jacks sampled at the weir were adipose clipped.

Based on a sample of ageable scales from 486 adult coho salmon, 17.3% were age 1.1, 79.5% were age 2.1, and 3.2% were age 3.1.

Ford Arm Lake Weir, 1995

In 1995, the Ford Arm Lake Weir was operated during August 10 - October 22. A total of 1,044 adults and 181 jacks were passed during the period of operation.

Water flows in the outlet stream were low and warm in late August and early September during the period when a record number of pink salmon entered the system. Water levels were as low as 20 centimeters while water temperatures reached 13-14°C. A total of 65,235 pinks were counted above the weir compared with the previous record of 23,406 in 1991 (many pinks pass through the weir uncounted). Downstream surveys also indicated a record number of pink salmon below the weir. This combination resulted in two or three events of severe oxygen depletion accompanied by mortality of adult salmon in the outlet stream. On August 21, approximately 7,000-8,000 distressed pink salmon were observed below the weir. The crew opened a section of the weir and counted 8,581 pinks and 4 coho through. At day's end, approximately 1,000 pinks and 4 coho were observed dead below the weir.

More serious events occurred during September 5-7. On the afternoon of the 5th, fish were moving into the trap in normal fashion when suddenly fish throughout the outlet stream began to panic and rush the weir, pinning the leaders sideways against the pickets. The weir was again opened up and 5,619 pinks and 39 coho passed through by the end of the day. Fish that passed through the weir were lethargic and most stopped moving upstream immediately above the weir. On the following morning, approximately 300 dead adult coho were observed between the weir and the first riffle.

A similar situation to the 5th was observed on the 7th when a large mass of primarily pink salmon were observed packed against the weir (no coho were observed). The crew opened five sections of the weir but did not attempt to count passing fish. They surveyed the outlet stream and counted 815 dead adult coho and 15,000 dead pink salmon distributed throughout the stream to saltwater. Dead juvenile coho (fewer than 100) were also observed.

Dorsal clips were applied to 943 adults that passed the weir before October 10 while opercular clips were applied to 26 fish that passed after during October 10-22. A total of 95 adults were captured from the lake and sampled of which 68 had dorsal clips, one had an opercular clip, and 26 had no mark. Based on these recoveries, an estimated 1,299 adults passed the weir before October 10. The following numbers were added to estimate the gross adult escapement to the system: 26 fish passed after October 9 (opercular punched), 826 prespawning mortalities observed during surveys downstream of the weir, 5 unspawned wash-ups before October 10 (assumed to be handling related), 2 weir migrants sampled for coded-wire tags. In addition, an estimate of the portion of the escapement that remained below the weir was made by subtracting the number of fish that passed the weir after October 5 from the peak survey on October 5. The result (287 fish) was added to the other numbers to estimate the gross escapement at 2,445 adults (95% C.I. 2,291-2,598). The net escapement of 1,623 was estimated by subtracting 815 observed mortalities from the catastrophic die-offs during September 5-7 plus all mortalities that were likely to have resulted from human influence: 2 coded-wire tag samples and 5 observed unspawned wash-ups.

A total of 1,051 adults were examined of which 84 were adipose clipped. Of the clipped fish, tags were detected in 82 while heads from the other two fish were sent to the tag lab. Of the two that did not register tags, a tag was found in one but not in the other fish. Therefore, an estimated 8.0% of the adult return was coded-wire tagged. Thirteen of the 194 jacks sampled at the weir and during mark-recapture sampling had adipose clips.

Based on a sample of ageable scales from 407 adult coho salmon, 50.6% were age 1.1, 48.3% were age 2.1, and 1.1% were age 3.1.

Hugh Smith Lake Weir, 1994

The Hugh Smith Lake weir was operated from mid-June through November 1. The first adult coho salmon entered the lake on August 2. A total of 1,611 adults and 139 jacks were counted during the period of operation while 68 adults were counted downstream of the weir when it was removed for the season. However, a triangular shaped hole in the weir 9-cm across was discovered on September 15. Some fish were assumed to have passed uncounted through this hole.

At the weir, all 1,611 adults were marked including 468 with a dorsal clip during August 2-September 15, 680 with a left ventral clip during September 16-October 6, and 463 with a right ventral clip during October 7-November 1.

Mark-recovery sampling was conducted in and near the inlet streams during October 13-31 during which a total of 117 adults were captured including 56 with a right ventral clip, 46 with a left ventral clip, 6 with a dorsal clip, and 9 with no mark. Since all fish that escaped uncounted were assumed to have passed the weir during the first period, a simple Chapman estimate was generated for that period using only the right ventral clips and unmarked fish. This estimate (542 fish) was added to the later count to arrive at the total escapement estimate of 1,753 (95% C.I. 1,705-1,801). Therefore, an estimated 74 fish passed unobserved through the hole and were added to the actual count of 1,679.

A total of 1,618 age-.1 adults were examined for adipose clips, of which 645 were marked. Of the marked fish, 520 were examined with the field detector; 517 registered a tag-present signal and three did not. Heads were taken from the three fish that did not register a signal of which two were processed in the tag lab and found not to have tags while the other was lost to a pine marten before shipment. Of 161 jacks sampled for marks at the weir and during recovery work, 58 had adipose clips.

Based on a sample of ageable scales from 753 adult coho salmon, 32.0% were age 1.1, 66.0% were age 2.1, and 2.0% were age 3.1. Based on a sample of 50 jacks, 8.0% were age 1.0, 84.0% were age 2.0, and 8.0% were age 3.0.

Hugh Smith Lake Weir, 1995

In 1995, the first adult coho salmon was counted on August 6. A total of 1,758 adults was counted when the weir was removed on November 3 while 23 remained downstream for a gross escapement count of 1,781 adults. In addition, 99 jacks were counted past the weir.

A total of 70 adult coho salmon were sampled for marks upstream of the weir during October 21-29 including eight sampled at the mouth of Buschmann Creek and 62 sampled in Cobb Creek. Nearly all were captured using rod and reel sport gear although three were captured by hand and one with a dip net. All of these fish had been marked at the weir indicating that essentially no adult coho salmon escaped into the system uncounted. The net spawning escapement of 1,778 adults was estimated by subtracting 1 trap mortality and two coded-wire tag samples. Of six jacks that were sampled, only two were marked, indicating that the actual escapement of jacks may have been roughly three-times the count of 99 fish.

A total of 1,758 adults were sampled for adipose clips of which 562 were marked. Of the 562 adipose clipped adults, 560 registered tags on the magnetic field detector while two did not (one was subsequently verified to have a tag while the other did not). Of the 103 jacks examined, 56 were adipose clipped while 47 were not.

Based on a sample of ageable scales from 600 adult coho salmon, 29.8% were age 1.1, 67.7% were age 2.1, and 2.5% were age 3.1.

Harvest by Gear Type and Escapement

The 1994 return to the Berners River was estimated at a record 73,728 fish followed by a 1995 return of only 28,800 fish (Table 4). The 1994 harvest was divided about equally between the troll and gillnet fisheries. However, the drift gillnet fishery accounted for an estimated 51.8% of the 1995 return while the troll fishery accounted for only 30.7%. The 1995 drift gillnet harvest rate was the highest recorded for the Berners River and appears to be largely the result of a fishery opening within Berners Bay which remained closed in the fall in recent years until 1994. Openings within the bay contributed to high total exploitation rates of 78.4% in 1994 and 82.8% in 1995. However, despite intensive fishing on a modest run, the 1995 escapement of 4,945 spawners fell within the escapement goal range of 4,000 to 9,200 fish.

The estimated 1994 total run of 11,492 fish to Ford Arm Lake on the outer coast of Chichagof Island was slightly lower than the record 1993 run of 12,693 fish (Table 6). The 1995 run estimated at 7,490 fish was above average. The 1994 escapement of 3,228 was well above the goal range of 1,300-2,900 fish. The gross 1995 escapement of 2,445 fish was in the upper part of the goal range, however, the net escapement after instream mortalities was reduced to 1,623 fish, still within the range. The troll fishery has taken a relatively stable proportion of the Ford Arm run since the early 1980s ranging from 41.3% to 61.8% (average 53.7%). However, the local seine fishery harvested an estimated 10.7% of the run in 1994 and 19.6% in 1995. These proportions exceed all years except 1983 when the seine exploitation rate was estimated at 14.7%. Partly as a consequence of this intensive seining for pink salmon, the total harvest rate was estimated at a record 71.9% in 1994 and well above average at 67.4% in 1995.

Total runs to Hugh Smith Lake of 9,450 fish in 1994 and 6,753 fish in 1995 were the two largest runs since estimates were first made in 1982 (Table 6). Escapements were the fourth and fifth highest recorded at 1,753 and 1,781, respectively, and were well above the goal range of 500-1,100 spawners. Total harvest rate estimates of 81.4% in 1994 and 73.6% in 1995 were similar to other years since 1989. Harvest rate estimates for Hugh Smith Lake have increased from an average of 61.8% (range 52.3-66.5%) during 1982-1988 to 76.8% (range 68.1-82.1%) during 1989-1995. The principal component fisheries of the 15.0% increase in the average exploitation rate were the Alaska troll and drift gillnet fisheries which increased 7.8% and 7.2%, respectively. Exploitation rates by other individual fisheries changed less than 1% between the periods and showed no net change when combined. While the exploitation rate increased with increasing abundance, the average escapement decreased by less than 5% from 1,337 spawners to 1,274, still well above goal.

Removal Rates

The combined troll and purse seine removal rate for the Berners River stock was estimated at 39.3% in 1994 and 30.8% in 1995 (Table 11). These estimates were similar to 1992 and 1993 troll and seine removal rates but were below the long-term average. The estimated removal rate in the Juneau marine sport fishery, the second fishery on its migration route, continued to be low at 2.0% in 1994 and 0.6% in 1995. Because of its late run timing, the Berners River run is typically subjected to only minor fishing pressure in purse seine and marine sport fisheries. The removal rate in the Lynn Canal (District 115) drift gillnet fishery, the last fishery entered, was relatively high in both years at 63.1% in 1994 and 74.8% in 1995. The 1995 estimate was the second highest recorded next to 1986.

Before becoming available in inside waters of southern Southeast, coho salmon returning to Hugh Smith Lake were assumed to be harvested simultaneously in northern B.C. and the outside and intermediate districts of Southeast Alaska. The combined removal rate estimate for Hugh Smith Lake coho salmon in northern B.C. and the outside and intermediate areas of Southeast Alaska was estimated at 55.5% in 1994 and 36.5% in 1995. Of that percentage 47.6% (1994) and 32.3% (1995) was attributed to Alaska fisheries while 7.9% (1994) and 4.2% (1995) was attributed to northern B.C. fisheries (Table 12). The estimated removal rate in inside areas was above average in both years at 58.2% in 1994 and 58.4% in 1995.

Distribution of Harvests

The harvest of the Berners River coho salmon stock has been restricted largely to northern fishing areas (Northern Outside, Central Outside, Central Intermediate, Lynn Canal, and Stephens Passage) which accounted for an estimated average of 98.6% of the catch during 1982-1995 (Table 13). Small percentages (<1% each) were taken in the Central Inside, Southern Outside, Southern Intermediate, Southern Inside and Prince William Sound Areas and northern British Columbia. This overall pattern did not change in 1994-1995. The transition to smolt tagging beginning in 1989 has resulted in a several fold increase in the number of returning tagged adults in the 1990s compared with prior years. This has greatly increased resolution in estimates of the harvest distribution of this stock.

In 1994 and 1995, Ford Arm Lake coho salmon displayed a similar fishery distribution compared with prior years with the exception that the central outside area accounted for a larger than average proportion of the catch owing largely to an increased purse seine catch (Table 14). In these two most recent years, over 90% of the total estimated catch occurred in the central outside area with about 6% occurring in the northern outside area.

Hugh Smith Lake coho salmon continued to be harvested over a relatively broad area from Yakutat to northern British Columbia (Table 15). In 1994 and 1995, harvest distributions were similar to previous years, except that in 1995 a record percentage (28.6%) occurred in the southern inside area gillnet fisheries at Tree Point and Annette Island. A substantial portion of the gillnet catch occurred at Tree Point which remained open in 1995 after the typical September 20 closure.

The distribution of the Southeast Alaska troll catch of selected stocks was estimated by quadrant (Appendix A.2). In 1994 and 1995, as in previous years, nearly all of the estimated troll catch of Berners River and Ford Arm Lake coho salmon occurred in the Northwest Quadrant while High Smith Lake coho were more widely distributed over the quadrants (Table 16). However, the Northwest Quadrant still accounted for a 1982-1995 average of 56.9% of the troll catch of Hugh Smith Lake coho salmon. The Southwest and Southeast Quadrants were of about equal importance at 17.9% and 19.4%, respectively.

Migratory Timing

Annual estimates of the timing of the troll harvest for the three stocks from 1982 through 1993 were reported by Shaul and Crabtree (1996). An average weekly percent of the troll harvest for all years (1982-1995) is shown in Table 17 and Figure 4. Although available to some extent during most of the season, the Berners River stock has displayed characteristically late migratory timing in all fisheries (Shaul et al. 1991). On the average, migration peaked in the troll fishery during late August through mid-September.

The Ford Arm Lake stock was characterized by an earlier and more protracted peak in the troll fishery with typically stable catch rates from early to mid-July to early September.

Hugh Smith Lake coho salmon also demonstrated protracted timing in the troll fishery, although slightly later compared with the Ford Arm Lake stock. Hugh Smith Lake coho salmon typically peak in availability from mid-July through early September.

Survival Rates

High marine survival rates contributed substantially to the all-time record 1994 Southeast Alaska coho salmon catch of 5.7 million fish. Survival rates for coho salmon that migrated to sea from Auke Creek and the Berners River in 1993 were the highest recorded at 31.9% and 28.9%, respectively (Table 18). The survival rate of 1993 Hugh Smith Lake smolts of 19.4% was second only to 1991 (21.0%). Survival of Ford Arm presmolts tagged in 1992 (most smolting in 1993) was 16.9%, which was second only to the record of 22.0% for 1991 presmolts.

Marine survival experienced by 1994 smolts (returning in 1995) was down markedly from the high levels of the previous year. Survival rates for 1994 Auke Creek and Berners River smolts were below average at 11.2% and 15.9%, respectively. The survival rate of 1995 Hugh Smith Lake smolts at 13.7% was near the 1983-1993 average. The survival rate of presmolts marked at Ford Arm in 1993 and migrating as smolts in 1994 was the second lowest recorded at 5.4%.

Smolt Abundance

The estimated 1994 coho smolt migration from Hugh Smith Lake was the second highest recorded at 49,288 fish (Table 19). This large migration was followed by the second lowest recorded migration in 1995 at 22,413 fish.

Efficiency of the Hugh Smith smolt weir was estimated at only 32% in 1994 and 56% in 1995. The reason for continued low efficiency remains a mystery as the panels are sealed at the bottom with sandbags over a vexar skirt that is folded upstream approximately a meter.

Estimated smolt migrations from the Berners River in 1994 and 1995 were 181,503 and 194,019, respectively (Table 23). These estimates are down from 326,126 smolts in 1992 and 255,431 in 1993, but are near or above 1989-1991 estimates ranging from 141,154 to 187,715.

DISCUSSION

The 1994 and 1995 coho salmon returns continued the trend toward higher abundance that began in 1989. Abundance was extremely high in 1994 with record returns to the Berners River and Hugh Smith Lake and the second highest return to Ford Arm Lake (next to 1993). The record 1994 catch appears to have been the result of excellent marine survival combined with smolt runs that were well above average. Berners River smolts that returned in 1994 survived at 28.9% compared with 15.1% for the 1993 return. Marine survival for the 1994 return to Hugh Smith Lake was estimated at 19.4% compared with 13.0% in 1993. This demonstrates the importance of marine survival as well as smolt production in determining adult abundance.

Marine survival of 1995 returns decreased substantially from the previous year while smolt production showed a mixed trend. This resulted in substantially lower adult returns. Overall, survival rates for the three systems in 1995 averaged 58% lower than in 1994 while total adult returns were reduced by a similar average amount (59%).

In 1994, Berners Bay was opened to fall gillnetting for the first time since the early 1960s. Fishery performance data, inseason coded-wire tag analysis, and preliminary smolt estimates all indicated a very large run, which prompted opening of the bay for a total of 10 days during statistical weeks 38-41. These openings appeared to be successful in substantially increasing the harvest with a total harvest rate. Despite a harvest rate of 78.4%, a record 15,920 spawners were documented in the escapement.

In 1995, preliminary smolt and CWT recovery data in mid-September again indicated that abundance was above average, although lower than in 1994. Consequently, Berners Bay was opened during week 38 for two days. During this opening, 101 boats fishing primarily inside the bay harvested an estimated 7,067 Berners River coho salmon which was just over half of the remaining run. Later analysis indicated that the total run was actually below average while the total exploitation rate was very high at 82.8%. This resulted in a low escapement of 4,945 fish. The gillnet removal rate was very high at 75%, of which about half occurred in the single two-day opening in Berners Bay. Although the 1995 opening in the bay was only a

fifth of the duration of the 1994 openings, the run was much more concentrated and vulnerable. This demonstrates the risk involved in liberalizing terminal fishing based on run size projections until a substantial proportion of the escapement goal has actually been documented in the system. Improved inseason run size assessments can improve decision making regarding terminal fishery openings, however, the degree of concentration of the run within the bay is very difficult to assess. We recommend that terminal fishery openings in the bay be conducted only when the run is very large, similar to 1992-1994 levels, or when a substantial proportion of the escapement goal has been observed in the river.

The 15% increase in average harvest rate (from 62% to 77%) on Hugh Smith Lake coho salmon between 1982-1988 and 1989-1995 will be of concern if abundance declines from recent years. The increase in harvest rate was attributed about equally between the troll and drift gillnet fisheries. Despite the higher harvest rates, the escapement to Hugh Smith lake has been within or above the goal range in all years except 1989. Recent fishing patterns that have resulted in a high mixed-stock harvest rate on Hugh Smith Lake and other nearby systems suggests the need for close monitoring of escapements in District 101 and further development of reliable inseason abundance indicators.

Ford Arm Lake coho salmon abundance was higher each year during 1992-1995 than any of the nine previously recorded runs from 1982 through 1991. Survival rates from presmolt to adult were the highest recorded for the 1992-1994 returns. However, survival of presmolts returning in 1995 was low at 5.4%, indicating that high presmolt abundance was responsible for the strong 1995 return.

Clark et al. (1994) established biological escapement goals for the four coho indicator stocks using the abundance, age, and survival data provided by these projects. The goals have been met or exceeded in most recent years, suggesting that the current status of Southeast coho stocks is healthy and will likely remain so if recent fishing patterns continue and survival rates remain near or above the historical average.

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Table 1. Number of presmolt coho salmon tagged at Ford Arm Lake by year and code, 1980-1996.

Year	Code	Number Marked
1980	042021	5,925
	042024	444
		Total 6,369
1981	042123	4,914
	042133	2,012
		Total 6,926
1983	042323	3,882
1984	042328	2,033
	042435	5,629
		Total 7,662
1985	042447	7,626
1986	042303	10,392
1987	042657	10,138
1988	042922	11,108
	042918	1,459
		Total 12,567
1989	042941	11,300
1990	043354	10,742
1991	043638	9,506
1992	043807	10,547
1993	044017	10,552
1994	044018	6,564
1995	044347	10,993
1996	044019	10,093

Table 2. Number of Berners River coho salmon tagged by year, type, and code, 1972-1996.

Year	Type	Code		Number Marked
1972	Presmolt	Fluorescent Pigment		8,066
1976	Presmolt	040215		10,817
		040308		526
			Total	11,343
1977	Presmolt	041637		380
		041729		10,758
			Total	11,138
1980	Presmolt	042015		10,145
		042030		780
			Total	10,925
1981	Presmolt	041921		7,826
1983	Presmolt	042208		1,278
		042243		9,070
			Total	10,348
1984	Presmolt	042434		4,499
		042436		10,827
			Total	15,326
1985	Presmolt	042446		10,110
1986	Presmolt	042305		8,740
1987	Presmolt	042656		10,349
1988	Presmolt	042942		9,926
1989	Smolt (trough trap)	042927		6,438
	Smolt (minnow trap)	042923		1,021
	Mixed (minnow trap)	042926		5,660
			Total	13,119
1990	Smolt (trough trap)	042662		11,478
	Smolt (trough trap)	042931		10,540
	Smolt (trough trap)	043105		1,580
	Mixed (minnow trap)	042661		2,781
			Total	26,379

-Continued-

Table 2. (page 2 of 2)

Year	Type	Code	Number Marked	
1991	Smolt (trough trap)	042944		21,456
	Smolt (minnow trap)	043106		1,414
	Mixed (minnow trap)	043110		3,669
			Total	26,539
1992	Smolt (trough trap)	043808		15,804
	Smolt (trough trap)	043730		11,149
	Smolt (trough trap)	043731		11,196
	Smolt (trough trap)	043732		11,180
	Smolt (trough trap)	043725		3,077
			Total	52,406
1993	Smolt (trough trap)	044023		23,662
	Smolt (trough trap)	044024		23,787
	Smolt (trough trap)	043554		6,574
			Total	54,023
1994	Smolt (trough trap)	043956		11,329
	Smolt (trough trap)	043957		12,020
	Smolt (trough trap)	043958		11,749
	Smolt (trough trap)	043959		7,979
			Total	43,077
1995	Smolt (trough trap)	043555		11,315
	Smolt (trough trap)	043960		11,497
	Smolt (trough trap)	043954		3,205
			Total	26,017
1996	Smolt (trough trap)	044529		23,943
	Smolt (trough trap)	043734		11,803
	Smolt (trough trap)	043735		5,208
	Emergent Fry	0401020904		5,308
			Total	46,262

Table 3. Number of Hugh Smith Lake coho salmon tagged by year, type, and code, 1980-1996.

Year	Type	Code		Number Marked
1980	Presmolt	040216		5,345
1981	Smolt	042018		2,777
	Presmolt	042020		3,737
			Total	6,514
1982	Smolt	042130		4,873
	Smolt	042143		700
			Total	5,573
1983	Smolt	042028		2,489
	Smolt	042029		1,289
	Smolt	042206		5,869
			Total	9,647
1984	Smolt	042306		5,227
	Smolt	042307		1,576
	Smolt	042319		9,944
			Total	16,747
1985	Smolt	042450		5,352
	Smolt	042451		3,102
	Smolt	042452		1,379
			Total	9,833
1986	Smolt	042441		5,689
1987	Smolt	042652		4,806
1988	Smolt	042924		5,202
1989	Smolt	042718		7,187
1990	Smolt	042720		10,187
	Smolt	042919		919
			Total	11,106
1991	Smolt	043602		12,068
	Smolt	043552		1,201
			Total	13,269
1992	Smolt	043151		5,514

-Continued-

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Year	Type	Code	Number Marked	
1993	Smolt	044016		12,485
	Smolt	043729		6,916
			Total	19,401
1992	Smolt	043151		5,514
1993	Smolt	044016		12,485
	Smolt	043729		6,916
			Total	19,401
1994	Smolt	043743		10,497
	Smolt	043744		5,443
			Total	15,940
1995	Smolt	043728		10,816
	Smolt	043724		1,769
			Total	12,585
1996	Smolt	043809		14,929
	Smolt	043724		9,291
			Total	24,220

Table 4. Estimated harvest by gear type and escapement of Berners River coho salmon, 1982-1995.

		Number of Fish							
Year	Observed Recoveries	Troll	Seine	Gillnet	Sport	Canadian Net	Total Catch	Escapement	Total Run
1982	48	12,887	0	10,568	0	0	23,455	7,505	30,960
1983	125	17,153	0	6,978	65	0	24,196	9,840	34,036
1984									
1985	93	10,865	198	7,015	0	0	18,078	6,169	24,247
1986	157	13,560	0	8,928	395	0	22,883	1,752	24,635
1987	53	7,448	0	3,301	48	0	10,797	3,260	14,057
1988	102	5,926	181	6,141	0	0	12,248	2,724	14,972
1989	58	10,515	0	1,664	0	0	12,179	7,509	19,688
1990	470	14,751	149	7,339	525	0	22,764	11,050	33,814
1991	1,025	6,417	579	16,519	117	0	23,632	11,530	35,162
1992	701	15,337	344	14,677	192	0	30,550	15,300	45,850
1993	1,496	19,353	192	14,239	140	0	33,924	15,670	49,594
1994	2,647	27,319	1,686	27,907	891	5	57,808	15,920	73,728
1995	1,384	8,847	22	14,869	117	0	23,855	4,945	28,800
Average		13,106	258	10,780	192	0	24,336	8,706	33,042

Table 5. Estimated percent harvest by gear type and escapement of Berners River coho salmon, 1982-1995.

		Number of Fish							
Year	Observed Recoveries	Troll	Seine	Gillnet	Sport	Canadian Net	Total Catch	Escapement	Total Run
1982	48	41.6	0.0	34.1	0.0	0.0	75.8	24.2	100.0
1983	125	50.4	0.0	20.5	0.2	0.0	71.1	28.9	100.0
1984									
1985	93	44.8	0.8	28.9	0.0	0.0	74.6	25.4	100.0
1986	157	55.0	0.0	36.2	1.6	0.0	92.9	7.1	100.0
1987	53	53.0	0.0	23.5	0.3	0.0	76.8	23.2	100.0
1988	102	39.6	1.2	41.0	0.0	0.0	81.8	18.2	100.0
1989	58	53.4	0.0	8.5	0.0	0.0	61.9	38.1	100.0
1990	470	43.6	0.4	21.7	1.6	0.0	67.3	32.7	100.0
1991	1,025	18.2	1.6	47.0	0.3	0.0	67.2	32.8	100.0
1992	701	33.5	0.8	32.0	0.4	0.0	66.6	33.4	100.0
1993	1,496	39.0	0.4	28.7	0.3	0.0	68.4	31.6	100.0
1994	2,648	37.1	2.3	37.9	1.2	0.0	78.4	21.6	100.0
1995	1,384	30.7	0.1	51.6	0.4	0.0	82.8	17.2	100.0
Average		41.5	0.6	31.7	0.5	0.0	74.3	25.7	100.0

Table 6. Estimated harvest by gear type and escapement of Ford Arm Lake coho salmon, 1982-1995.

Year	Observed Fishery Recoveries	Alaska Troll	Seine	Drift Gillnet	Sport	Canadian Troll	Total Catch	Escapement	Total Run
1982	38	1,948	106	0	0	0	2,054	2,662	4,716
1983	93	3,344	912	0	0	0	4,256	1,938	6,194
1984									
1985	49	2,438	0	0	0	0	2,438	2,324	4,762
1986	87	2,500	62	0	0	0	2,562	1,546	4,108
1987	71	1,456	79	0	0	0	1,535	1,694	3,229
1988	151	2,857	46	0	0	30	2,933	3,028	5,961
1989	221	3,777	185	0	0	0	3,962	2,177	6,139
1990	174	2,979	108	0	0	0	3,087	2,190	5,277
1991	193	3,208	44	10	0	0	3,262	2,761	6,023
1992	199	5,252	208	0	0	0	5,460	3,847	9,307
1993	349	7,847	443	0	201	0	8,491	4,202	12,693
1994	236	6,918	1,234	0	112	0	8,264	3,228	11,492
1995	91	3,577	1,468	0	0	0	5,045	2,445	7,490
Average		3,700	377	1	24	2	4,104	2,619	6,722

Table 7. Estimated percent harvest by gear type and escapement of Ford Arm Lake coho salmon, 1982-1995.

Year	Observed Fishery Recoveries	Alaska Troll	Seine	Drift Gillnet	Sport	Canadian Troll	Total Catch	Escapement	Total Run
1982	38	41.3	2.2	0.0	0.0	0.0	43.6	56.4	100.0
1983	93	54.0	14.7	0.0	0.0	0.0	68.7	31.3	100.0
1984									
1985	49	51.2	0.0	0.0	0.0	0.0	51.2	48.8	100.0
1986	87	60.9	1.5	0.0	0.0	0.0	62.4	37.6	100.0
1987	71	45.1	2.4	0.0	0.0	0.0	47.5	52.5	100.0
1988	151	47.9	0.8	0.0	0.0	0.5	49.2	50.8	100.0
1989	221	61.5	3.0	0.0	0.0	0.0	64.5	35.5	100.0
1990	174	56.5	2.0	0.0	0.0	0.0	58.5	41.5	100.0
1991	193	53.3	0.7	0.2	0.0	0.0	54.2	45.8	100.0
1992	199	56.4	2.2	0.0	0.0	0.0	58.7	41.3	100.0
1993	349	61.8	3.5	0.0	1.6	0.0	66.9	33.1	100.0
1994	236	60.2	10.7	0.0	1.0	0.0	71.9	28.1	100.0
1995	91	47.8	19.6	0.0	0.0	0.0	67.4	32.6	100.0
Average		53.7	4.9	0.0	0.2	0.0	58.8	41.2	100.0

Table 8. Estimated harvest by gear type, escapement, and total run of coho salmon returning to Hugh Smith Lake, 1982-1995.

Year	Fishery Sample Size	Alaska Troll	Alaska Seine	Alaska Gillnet	Alaska Trap	Alaska Sport	B.C. Troll	B.C. Net	B.C. Sport	Total Catch	Escapement	Total Return
1982	91	2,780	627	203	0	0	264	78	0	3,952	2,144	6,096
1983	189	1,373	424	277	49	0	211	51	0	2,385	1,490	3,875
1984	151	1,260	501	470	18	0	325	28	0	2,602	1,408	4,010
1985	212	868	287	137	5	0	199	13	0	1,509	903	2,412
1986	257	1,585	515	315	2	14	234	26	0	2,691	1,783	4,474
1987	100	656	95	249	0	23	153	50	0	1,226	1,118	2,344
1988	42	408	230	122	0	0	234	23	0	1,017	513	1,530
1989	91	1,213	375	237	0	41	105	20	0	1,991	433	2,424
1990	263	1,810	538	504	24	0	794	53	0	3,723	870	4,593
1991	408	2,102	195	881	0	54	630	43	0	3,905	1,826	5,731
1992	497	1,852	674	601	0	42	286	9	0	3,464	1,426	4,890
1993	162	2,259	262	677	0	0	197	43	0	3,438	830	4,268
1994	846	4,339	1,125	1,424	0	59	684	53	13	7,697	1,753	9,450
1995	433	2,030	908	1,651	0	101	241	28	13	4,972	1,781	6,753
Avg.	267	1,753	483	553	7	24	326	37	2	3,184	1,306	4,489

Table 9. Estimated percent harvest by gear type and escapement of coho salmon returning to Hugh Smith Lake, 1982-1995.

Year	Fishery Sample Size	Alaska Troll	Alaska Seine	Alaska Gillnet	Alaska Trap	Alaska Sport	B.C. Troll	B.C. Net	B.C. Sport	Total Catch	Escapement	Total Return
1982	91	45.6	10.3	3.3	0.0	0.0	4.3	1.3	0.0	64.8	35.2	100
1983	189	35.4	10.9	7.1	1.3	0.0	5.4	1.3	0.0	61.5	38.5	100
1984	151	31.4	12.5	11.7	0.4	0.0	8.1	0.7	0.0	64.9	35.1	100
1985	212	36.0	11.9	5.7	0.2	0.0	8.3	0.5	0.0	62.6	37.4	100
1986	257	35.4	11.5	7.0	0.0	0.3	5.2	0.6	0.0	60.1	39.9	100
1987	100	28.0	4.1	10.6	0.0	1.0	6.5	2.1	0.0	52.3	47.7	100
1988	42	26.7	15.0	8.0	0.0	0.0	15.3	1.5	0.0	66.5	33.5	100
1989	91	50.0	15.5	9.8	0.0	1.7	4.3	0.8	0.0	82.1	17.9	100
1990	263	39.4	11.7	11.0	0.5	0.0	17.3	1.2	0.0	81.1	18.9	100
1991	408	36.7	3.4	15.4	0.0	0.9	11.0	0.8	0.0	68.1	31.9	100
1992	497	37.9	13.8	12.3	0.0	0.9	5.8	0.2	0.0	70.8	29.2	100
1993	162	52.9	6.1	15.9	0.0	0.0	4.6	1.0	0.0	80.6	19.4	100
1994	846	45.9	11.9	15.1	0.0	0.6	7.2	0.6	0.1	81.4	18.6	100
1995	433	30.1	13.4	24.4	0.0	1.5	3.6	0.4	0.2	73.6	26.4	100
Avg.	267	38.0	10.9	11.2	0.2	0.5	7.6	0.9	0.0	69.3	30.7	100

Table 10. Overall coho salmon harvest rates by indicator stock for the Alaska troll fishery and all fisheries combined, 1982-1995.

Year	Auke Lake	Berners River	Ford Arm Lake	Hugh Smith Lake	Weighted Average
Alaska Troll Fishery:					
1982	20.1	41.6	41.3	45.6	37.2
1983	32.6	50.4	54.0	35.4	43.1
1984	32.3			31.4	38.2
1985	35.2	44.8	51.2	36.0	41.8
1986	43.0	55.0	60.9	35.4	48.6
1987	37.2	53.0	45.1	28.0	40.8
1988	25.4	39.6	47.9	26.7	34.9
1989	49.6	53.4	61.5	50.0	53.6
1990	43.1	43.6	56.5	39.4	45.7
1991	15.0	18.2	53.3	36.7	30.8
1992	31.7	33.5	56.4	37.9	39.9
1993	38.4	39.0	61.8	52.9	48.0
1994	36.9	37.1	60.2	45.9	45.0
1995	32.2	30.7	47.8	30.1	35.2
Average	33.8	41.5	53.7	38.0	41.6
All Fisheries:					
1982	40.9	75.8	43.6	64.8	56.3
1983	43.8	71.1	68.7	61.5	61.4
1984	43.4			64.9	60.8
1985	44.2	74.6	51.2	62.6	58.1
1986	53.1	92.9	62.4	60.1	67.1
1987	43.2	76.8	47.5	52.3	55.0
1988	36.5	81.8	49.2	66.5	58.5
1989	55.9	61.9	64.5	82.1	66.1
1990	52.6	67.3	58.5	81.1	64.8
1991	29.8	67.2	54.2	68.1	54.8
1992	45.0	66.6	58.7	70.8	60.3
1993	45.9	68.4	66.9	80.6	65.5
1994	56.9	78.4	71.9	81.4	72.2
1995	43.9	82.8	67.4	73.6	66.9
Average	45.4	74.3	58.8	69.3	62.0

Table 11. Estimated removal rate by fishery for the Berners River coho salmon run, 1982-1995.

Year	Troll and Purse Seine	Marine Sport	115 Gillnet	Gillnet and Sport Total	Grand Total
1982	0.416	0.000	0.585	0.585	0.757
1983	0.504	0.004	0.415	0.417	0.711
1985	0.456	0.000	0.532	0.532	0.745
1986	0.551	0.036	0.836	0.842	0.929
1987	0.530	0.007	0.503	0.507	0.768
1988	0.408	0.000	0.693	0.693	0.818
1989	0.534	0.000	0.155	0.182	0.619
1990	0.440	0.029	0.387	0.415	0.673
1991	0.199	0.004	0.587	0.591	0.672
1992	0.342	0.006	0.478	0.493	0.666
1993	0.394	0.005	0.465	0.479	0.684
1994	0.393	0.020	0.631	0.644	0.784
1995	0.308	0.006	0.748	0.752	0.828
Average	0.421	0.009	0.540	0.549	0.743

Table 12. Estimated removal rate by area for the Hugh Smith Lake coho salmon run, 1982-1995.

Year	Outside and Intermediate	Northern B.C.	Total	Inside	Grand Total
1982	0.381	0.056	0.437	0.375	0.648
1983	0.289	0.067	0.356	0.403	0.615
1985	0.302	0.088	0.390	0.424	0.649
1985	0.318	0.088	0.406	0.370	0.626
1986	0.382	0.058	0.440	0.288	0.601
1987	0.279	0.087	0.366	0.247	0.523
1988	0.343	0.168	0.511	0.314	0.665
1989	0.458	0.051	0.509	0.636	0.821
1990	0.366	0.185	0.551	0.579	0.811
1991	0.299	0.117	0.416	0.454	0.681
1992	0.388	0.060	0.448	0.471	0.708
1993	0.445	0.056	0.501	0.610	0.806
1994	0.476	0.079	0.555	0.582	0.814
1995	0.323	0.042	0.365	0.584	0.737
Average	0.361	0.086	0.447	0.453	0.693

Table 13. Estimated harvest distribution (percentage) of Berners River coho salmon in marine fisheries by area and gear type, 1982-1995.

Area	Gear Type	Year (Percent)													
		1982	1983	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Avg.
P.W. Sound	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.8	0.0	0.0	0.1
Yakutat	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
N. Outside	Troll	20.3	29.6	18.3	28.4	16.9	20.3	24.8	25.2	3.4	15.6	22.4	16.5	13.6	19.6
C. Outside	Troll	3.7	11.7	15.5	15.7	13.9	2.1	11.9	8.4	4.9	7.9	10.2	7.3	7.0	9.2
S. Outside	Troll	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.2	0.1	0.0	0.2	0.0	0.1
	Seine	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.1
	Total	0.0	0.0	0.0	0.0	0.0	1.5	0.0	1.0	0.3	0.1	0.0	0.2	0.0	0.2
C. Intermed.	Troll	35.6	26.9	23.3	7.7	22.9	25.9	48.8	26.9	18.1	24.5	20.6	17.4	14.6	24.1
	Seine	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.4	0.8	1.1	0.6	2.9	0.0	0.5
	Sport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.2	0.3	0.0	0.1
	Total	35.6	26.9	24.5	7.7	22.9	25.9	48.8	27.5	18.9	25.9	21.4	20.6	14.6	24.7
S. Intermed.	Troll	0.0	1.0	0.0	1.5	0.0	0.0	0.0	1.2	0.3	0.3	0.7	0.5	0.4	0.5
	Seine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.5	0.0	0.0	0.4	0.1	0.2
	Total	0.0	1.0	0.0	1.5	0.0	0.0	0.0	1.3	1.8	0.3	0.7	0.9	0.5	0.6
C. Inside	Troll	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.1	0.0	0.0	0.0	0.0
	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.1	0.0	0.2	0.0	0.1
S. Inside	Troll	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
	Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Lynn Canal	Troll	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
	Gillnet	40.4	30.5	41.7	44.7	42.6	50.2	11.9	32.3	69.5	47.5	43.1	51.7	63.1	43.8
	Total	40.4	30.5	41.7	44.7	42.6	50.2	11.9	32.7	69.5	47.5	43.1	51.7	63.1	43.8
Steph. Pass	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	2.6	1.3	0.5	2.2	0.5	1.3	0.7	0.7
	Sport	0.0	0.3	0.0	2.0	0.6	0.0	0.0	2.2	0.5	0.4	0.3	1.3	0.5	0.6
	Total	0.0	0.3	0.0	2.0	0.6	0.0	2.6	3.5	1.0	2.6	0.8	2.6	1.2	1.3
North B.C.	Troll	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Grand Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sample Size		40	98	81	122	32	103	48	387	1,002	583	1,201	2,036	1,095	

Table 14. Estimated harvest distribution (percentage) of Ford Arm Lake coho salmon in marine fisheries by area and gear type, 1982-1995.

Area	Gear Type	Year (Percent)													
		1982	1983	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Avg.
P.W. Sound	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
N. Outside	Troll	9.4	19.2	15.3	4.9	24.0	29.5	31.2	27.7	9.3	17.7	10.7	6.1	6.0	16.2
C. Outside	Troll	62.4	51.0	84.7	88.0	55.8	61.8	55.9	63.0	81.8	73.0	75.6	76.5	60.7	68.5
	Seine	0.0	23.0	0.0	0.7	6.8	0.0	5.9	3.3	1.4	3.5	4.9	13.6	33.3	7.4
	Sport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	1.4	0.0	0.3
	Total	62.4	74.0	84.7	88.7	62.6	61.8	61.8	66.3	83.2	76.5	83.2	91.5	94.0	76.2
S. Outside	Troll	5.3	1.0	0.0	1.2	0.0	0.0	0.0	0.0	1.6	0.3	0.2	0.0	0.0	0.7
	Seine	5.0	0.0	0.0	1.9	0.0	1.6	0.0	0.0	0.0	0.5	0.9	0.0	0.0	0.8
	Total	10.3	1.0	0.0	3.1	0.0	1.6	0.0	0.0	1.6	0.8	1.1	0.0	0.0	1.5
C. Intermed.	Troll	13.0	5.8	0.0	1.3	13.4	5.5	6.4	5.5	4.9	3.9	5.0	1.8	0.0	5.1
	Seine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
	Total	13.0	5.8	0.0	1.3	13.4	5.5	6.4	6.0	4.9	3.9	5.0	1.8	0.0	5.2
S. Intermed.	Troll	0.0	0.0	0.0	2.0	0.0	0.5	0.6	0.0	0.7	1.1	0.0	0.6	0.0	0.4
C. Inside	Troll	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
North B.C.	Troll	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Grand Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sample Size		31	71	31	65	49	132	157	134	157	162	258	208	64	

Table 15. Estimated harvest distribution (percentage) of Hugh Smith Lake coho salmon in marine fisheries by area and gear type, 1982-1995.

Area	Gear Type	Year (Percent)														
		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Avg.
P.W. Sound	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
N. Outside	Troll	0.0	8.0	5.6	5.8	2.7	3.3	6.7	0.0	6.1	2.9	2.1	4.6	3.8	5.7	4.1
C. Outside	Troll	30.2	21.6	19.8	33.0	37.9	11.3	23.8	31.2	22.9	21.6	31.3	34.9	31.5	20.2	26.5
	Seine	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	30.2	22.0	19.8	33.0	37.9	11.3	23.8	31.2	22.9	21.6	31.3	34.9	31.5	20.2	26.5
S. Outside	Troll	11.1	10.0	7.0	8.6	5.7	22.6	5.6	12.2	7.3	12.4	6.5	10.3	9.6	6.8	9.7
	Seine	5.2	3.0	8.7	3.0	11.5	5.6	17.1	9.5	6.2	4.0	11.1	2.4	9.7	9.4	7.6
	Sport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.0
	Total	16.3	13.0	15.7	11.6	17.2	28.2	22.7	21.7	13.5	16.4	17.6	12.7	19.7	16.4	17.3
C. Intermed.	Troll	1.4	2.2	6.9	0.0	2.7	1.2	0.0	1.0	0.0	1.2	0.0	0.0	0.7	0.0	1.2
S. Intermed.	Troll	10.7	4.4	0.7	2.8	3.9	9.9	3.3	6.9	5.5	5.5	3.5	8.6	7.0	4.2	5.5
	Seine	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	2.1	1.4	0.3
	Total	10.7	4.4	1.2	2.8	3.9	9.9	3.3	6.9	5.8	5.5	3.5	8.6	9.1	5.6	5.8
C. Inside	Troll	0.3	2.9	1.2	0.7	1.1	0.0	0.0	5.6	1.2	0.2	1.6	0.0	0.9	0.8	1.2
	Seine	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	1.7	0.3	0.2
	Gillnet	0.0	5.5	0.6	0.3	3.2	0.0	0.0	4.2	3.1	6.9	3.1	11.6	5.0	5.1	3.5
	Total	0.3	9.0	1.8	1.0	4.3	0.0	0.0	9.8	4.3	7.1	4.9	11.6	7.6	6.2	4.9
S. Inside	Troll	14.7	9.0	9.4	7.2	4.4	6.0	5.1	5.1	5.5	7.6	4.3	5.3	3.6	1.9	6.4
	Seine	11.7	13.6	9.2	15.8	7.9	2.0	3.9	8.8	8.0	1.2	9.9	5.7	0.9	7.8	7.6
	Gillnet	5.5	6.0	16.7	8.6	8.6	20.0	11.1	7.4	10.5	16.7	15.8	9.2	13.2	28.6	12.7
	Trap	0.0	2.0	0.7	0.4	0.1	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.3
	Sport	0.0	0.0	0.0	0.0	0.5	1.8	0.0	2.0	0.0	1.5	1.3	0.0	0.3	1.8	0.7
	Total	31.9	30.6	36.0	32.0	21.5	29.8	20.1	23.3	24.6	27.0	31.3	20.2	18.0	40.1	27.6
North B.C.	Troll	7.1	8.7	12.0	13.0	8.8	12.3	21.3	5.1	21.4	17.0	9.0	6.1	8.7	4.9	11.1
	Net	2.1	2.1	1.0	0.8	1.0	4.0	2.1	1.0	1.4	1.2	0.3	1.3	0.7	0.6	1.4
	Sport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0
	Total	9.2	10.8	13.0	13.8	9.8	16.3	23.4	6.1	22.8	18.2	9.3	7.4	9.6	5.8	12.5
Grand Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sample Size		83	175	143	196	228	99	42	92	258	335	454	151	810	410	

Table 16. Estimated distribution by quadrant of the Alaska troll catch of Berners River, Ford Arm Lake, and Hugh Smith Lake coho salmon, 1982-1995.

Year	Northwest	Northeast	Southwest	Southeast	Total	Number of Recoveries
Berners River:						
1982	100.0	0.0	0.0	0.0	100	25
1983	97.0	3.0	0.0	0.0	100	77
1985	100.0	0.0	0.0	0.0	100	50
1986	96.6	3.4	0.0	0.0	100	87
1987	96.4	3.6	0.0	0.0	100	43
1988	97.6	2.4	0.0	0.0	100	64
1989	97.4	2.6	0.0	0.0	100	49
1990	93.9	5.0	1.1	0.0	100	303
1991	94.0	4.9	0.7	0.4	100	325
1992	98.3	1.6	0.1	0.0	100	342
1993	97.7	2.3	0.0	0.0	100	754
1994	97.7	1.5	0.4	0.4	100	1,370
1995	94.9	5.0	0.1	0.0	100	473
Average	97.0	2.7	0.2	0.1	100	305
Ford Arm Lake:						
1982	91.3	0.0	5.8	2.9	100	37
1983	98.8	0.0	1.2	0.0	100	83
1985	100.0	0.0	0.0	0.0	100	49
1986	97.0	1.8	1.2	0.0	100	85
1987	100.0	0.0	0.0	0.0	100	65
1988	99.5	0.5	0.0	0.0	100	148
1989	99.5	0.5	0.0	0.0	100	206
1990	100.0	0.0	0.0	0.0	100	134
1991	98.0	0.5	1.5	0.0	100	191
1992	99.3	0.4	0.3	0.0	100	189
1993	99.8	0.0	0.2	0.0	100	337
1994	99.4	0.6	0.0	0.0	100	188
1995	100.0	0.0	0.0	0.0	100	74
Average	98.7	0.3	0.8	0.2	100	137
Hugh Smith Lake:						
1982	47.0	14.8	14.8	23.3	100	64
1983	52.1	5.6	17.6	24.6	100	107
1985	59.7	1.3	15.1	23.8	100	67
1986	65.5	2.4	15.2	16.9	100	114
1987	73.9	5.2	9.5	11.4	100	155
1988	31.8	14.8	42.8	10.7	100	52
1989	68.2	0.0	15.6	16.3	100	22
1990	48.4	6.1	20.9	24.6	100	61
1991	55.3	8.3	15.8	20.6	100	123
1992	47.6	4.9	21.7	25.8	100	210
1993	70.1	2.3	11.0	16.6	100	258
1994	59.8	5.9	15.0	19.3	100	101
1995	60.2	4.3	17.3	18.2	100	494
Average	56.9	5.8	17.9	19.4	100	141

Table 17. Average weekly percent of the total troll catch of Berners River, Ford Arm Lake, and Hugh Smith Lake coho salmon and all coho stocks, 1982-1995.

Statistical Week	Average Mid-week Date	Berners River	Ford Arm Lake	Hugh Smith Lake	Total Catch
25	June 18	0.0	0.0	0.0	0.0
26	June 25	0.0	0.5	0.5	0.2
27	July 2	0.6	7.0	0.9	0.6
28	July 9	1.0	7.2	2.6	3.5
29	July 16	2.0	9.7	9.6	6.3
30	July 23	4.9	12.5	9.8	11.4
31	July 30	5.2	11.6	11.7	12.8
32	Aug. 6	5.0	11.5	9.6	12.3
33	Aug. 13	4.0	11.2	11.4	10.2
34	Aug. 20	10.5	7.8	8.2	9.0
35	Aug. 27	17.3	10.2	14.2	6.2
36	Sept. 3	20.6	8.6	10.5	10.5
37	Sept. 10	17.8	1.5	6.8	8.5
38	Sept. 17	8.3	0.7	3.5	5.1
39	Sept. 24	2.8	0.1	0.8	2.8
40	Oct. 1	0.1	0.0	0.0	0.6
Total		100.0	100.0	100.0	100.0

Table 18. Estimated survival rates of predominantly age-1 and older wild coho salmon presmolts and smolts from the time of tagging until entry into the coastal fisheries, 1980-1994.

Year Tagged (X)	Auke Creek Smolts	Berners River		Ford Arm Lake Presmolts			Hugh Smith Lake Smolts
		Presmolts	Smolts	Year X+1	Year X+2	Total	
1979	9.5						
1980	8.9	2.9		6.0	0.3	6.3	
1981	11.6	6.7		9.5		9.5	
1982	16.8						
1983	14.9	5.9		12.3	2.0	14.3	7.7
1984	20.4	5.1		8.8	1.3	10.1	7.5
1985	16.4	3.5		4.4	1.6	6.0	19.0
1986	19.7	5.2		6.7	0.4	7.1	10.7
1987	17.3	4.3		13.3	0.5	13.8	4.2
1988	14.2	9.0		9.4	1.0	10.4	10.4
1989	20.9		20.6	10.8	0.2	11.0	17.3
1990	22.8		24.9	15.0	0.3	15.3	17.4
1991	31.7		24.4	22.0	0.0	22.0	21.0
1992	23.2		15.1	16.7	0.2	16.9	13.0
1993	31.9		28.9	5.4			19.4
1994	11.2		15.9				13.7
Average	18.2	5.3	21.6	10.8	0.7	11.9	13.4

Table 19. Hugh Smith Lake coho salmon smolt weir counts and total estimates, 1983-1995.

Year	Smolt Weir Count	Number Marked (M)	Returns Sampled (C)	Adipose Clips (R)	Smolt Estimate (N)	Variance	95% C.I. Lower Bound	95% C.I. Upper Bound
1983	27,552	9,647	1,239	230	51,789	9,182,285	45,850	57,728
1984	22,803	16,928	805	424	32,104	1,115,047	30,035	34,174
1985	11,111	9,833	692	289	23,499	1,071,050	21,470	25,527
1986	6,819	5,716	508	132	21,878	2,577,574	18,732	25,025
1987	4,965	4,819	262	34	36,218	31,360,356	25,242	47,194
1988	5,319	5,292	290	65	23,336	6,206,793	18,453	28,219
1989	7,187	7,187	736	198	26,620	2,514,993	23,512	29,728
1990	11,106	11,106	1,582	533	32,925	1,278,248	30,709	35,141
1991	13,371	13,269	1,059	602	23,326	370,762	22,133	24,519
1992	5,519	5,514	833	139	32,853	6,208,323	27,969	37,736
1993	19,422	19,401	1,694	678	48,433	1,995,432	45,664	51,201
1994	15,993	15,941	1,919	620	49,288	2,539,608	46,165	52,412
1995	12,586	12,585	836	469	22,413	450,217	21,098	23,728
Avg.	12,596	10,557	958	339	32,668	5,143,899	29,002	36,333

Table 20. Estimated freshwater age composition of age .1 Hugh Smith Lake adult coho salmon, 1983-1995.

	Age (Percent)						Sample
Year	1.1	2.1	3.1	4.1	5.1	Total	Size
1985	12.3	48.6	36.1	3.1	0.0	100.0	521
1986	10.5	54.6	30.8	4.1	0.0	100.0	438
1987	6.7	64.9	26.5	1.5	0.3	100.0	387
1988	7.7	40.4	44.3	6.0	1.6	100.0	183
1989	16.0	57.8	26.2	0.0	0.0	100.0	206
1990	18.8	60.0	21.2	0.0	0.0	100.0	462
1991	8.0	82.5	9.2	0.4	0.0	100.0	563
1992	4.4	71.4	23.6	0.6	0.0	100.0	592
1993	6.3	79.5	13.8	0.4	0.0	100.0	448
1994	32.0	66.0	2.0	0.0	0.0	100.0	753
1995	27.7	56.4	15.9	0.0	0.0	100.0	600
Avg.	13.7	62.0	22.7	1.5	0.2	100.0	

Note: The fish in the 5.1 column in 1987 were actually age 4.2.

Table 21. Estimated coho salmon adult run to Hugh Smith Lake by age class, 1983-1995.

	Age					
Year	1.1	2.1	3.1	4.1	5.1	Total
1985	296	1,171	870	74	0	2,412
1986	470	2,441	1,379	184	0	4,474
1987	157	1,522	622	36	6	2,344
1988	117	619	677	92	25	1,530
1989	388	1,400	635	0	0	2,424
1990	865	2,754	974	0	0	4,593
1991	457	4,727	526	21	0	5,731
1992	214	3,489	1,156	30	0	4,890
1993	267	3,392	591	19	0	4,268
1994	2,976	6,136	185	0	0	9,297
1995	1,874	3,816	1,072	0	0	6,763
Avg.	359	2,391	826	51	3	3,630

Table 22. Estimated coho salmon run to Hugh Smith Lake and parent escapement by brood year, 1983-1995.

Brood		Age					
Year	Escapement	1.1	2.1	3.1	4.1	5.1	Total
1982	2,144	296	2,441	622	92	0	3,452
1983	1,490	470	1,522	677	0	0	2,669
1984	1,408	157	619	635	0	0	1,411
1985	903	117	1,400	974	21	0	2,512
1986	1,783	388	2,754	526	30	0	3,698
1987	1,118	865	4,727	1,156	19	0	6,767
1988	513	457	3,489	591	0	0	4,537
1989	424	214	3,392	185	0		3,791
1990	870	267	6,136	1,072			7,475
1991	1,826	2,976	3,816				8,854
1992	1,426	1,874					
1993	830						
1994	1,679						
1995	1,781						

Table 23. Total abundance and age composition of the coho salmon smolt migration from the Berners River, 1989-1995.

	Age (Percent)							95% C.I.	
Year	1	2	3	4	Total	Sample	Total Smolts	Lower Bound	Upper Bound
1989	22.09	72.32	5.59	0.00	100	603	164,356	123,644	205,068
1990	23.77	74.30	1.82	0.11	100	869	141,154	126,272	156,036
1991	35.72	63.31	0.82	0.15	100	779	187,715	161,619	213,811
1992	19.37	78.99	1.64	0.00	100	1,528	326,126	289,217	363,031
1993	13.74	85.22	1.02	0.02	100	1,482	255,431	230,692	280,170
1994	15.60	82.02	2.38	0.00	100	1,329	181,503	161,505	201,501
1995	31.95	67.42	0.64	0.00	100	929	194,019	169,757	218,281
Average	23.18	74.80	1.99	0.04	100	1,074	207,186	180,387	233,985

Table 24. Freshwater age distribution of age-.1 adult coho salmon sampled from the Berners River, 1982-1995.

Age Sample: Return Year	Number of Fish 1.1	2.1	3.1	4.1	1.2	Total Sample
1982	95	210	26	0	0	331
1983	137	412	81	5	1	636
1984						0
1985	121	214	22	2	0	359
1986	60	198	21	0	0	279
1987	67	478	11	0	0	556
1988	241	231	3	0	0	475
1989	130	297	14	0	0	441
1990	250	211	7	0	0	468
1991	212	362	7	0	0	581
1992	301	251	6	0	0	558
1993	257	300	5	0	0	562
1994	133	321	4	0	0	458
1995	308	235	2	0	0	545

Age Sample: Return Year	Percent of Total 1.1	2.1	3.1	4.1	1.2	Total Sample
1982	28.7	63.4	7.9	0.0	0.0	100
1983	21.5	64.8	12.7	0.8	0.2	100
1984						
1985	33.7	59.6	6.1	0.6	0.0	100
1986	21.5	71.0	7.5	0.0	0.0	100
1987	12.1	86.0	2.0	0.0	0.0	100
1988	50.7	48.6	0.6	0.0	0.0	100
1989	29.5	67.3	3.2	0.0	0.0	100
1990	53.4	45.1	1.5	0.0	0.0	100
1991	36.5	62.3	1.2	0.0	0.0	100
1992	53.9	45.0	1.1	0.0	0.0	100
1993	45.7	53.4	0.9	0.0	0.0	100
1994	29.0	70.1	0.9	0.0	0.0	100
1995	56.5	43.1	0.4	0.0	0.0	100
Average	36.4	60.0	3.5	0.1	0.0	100.0

Table 25. Estimated total Berners River run of age .1 coho salmon by age class, 1982-1995.

Return	Number of Fish by Age Class					Total
Year	1.1	2.1	3.1	4.1	1.2	Sample
1982	8,886	19,642	2,432	0	0	30,960
1983	7,332	22,048	4,335	268	54	34,036
1984						
1985	8,172	14,454	1,486	135	0	24,247
1986	5,298	17,483	1,854	0	0	24,635
1987	1,694	12,086	278	0	0	14,058
1988	7,596	7,281	95	0	0	14,972
1989	5,804	13,259	625	0	0	19,688
1990	18,063	15,245	506	0	0	33,814
1991	12,829	21,906	424	0	0	35,159
1992	24,737	20,628	493	0	0	45,858
1993	22,679	26,474	441	0	0	49,594
1994	21,410	51,674	644	0	0	73,728
1995	16,299	12,396	105	0	0	28,800
Average	12,369	19,583	1,055	31	4	33,042

Table 26. Berners River coho salmon escapement and estimated total adult return by brood year, 1982-1995.

Brood		Return (Number of Fish)			
Year	Escapement	1.1	2.1	3.1	Total
1982	7,505	8,172	17,483	278	25,933
1983	9,840	5,298	12,086	95	17,478
1984	2,825	1,694	7,281	625	9,600
1985	6,169	7,596	13,259	506	21,361
1986	1,752	5,804	15,245	424	21,473
1987	3,260	18,063	21,906	493	40,462
1988	2,724	12,829	20,628	441	33,898
1989	7,509	24,737	26,474	644	51,855
1990	11,050	22,679	51,674	105	74,459
1991	11,530	21,410	12,396		33,806
1992	15,300	16,299			
1993	15,670				
1994	15,920				
1995	4,945				

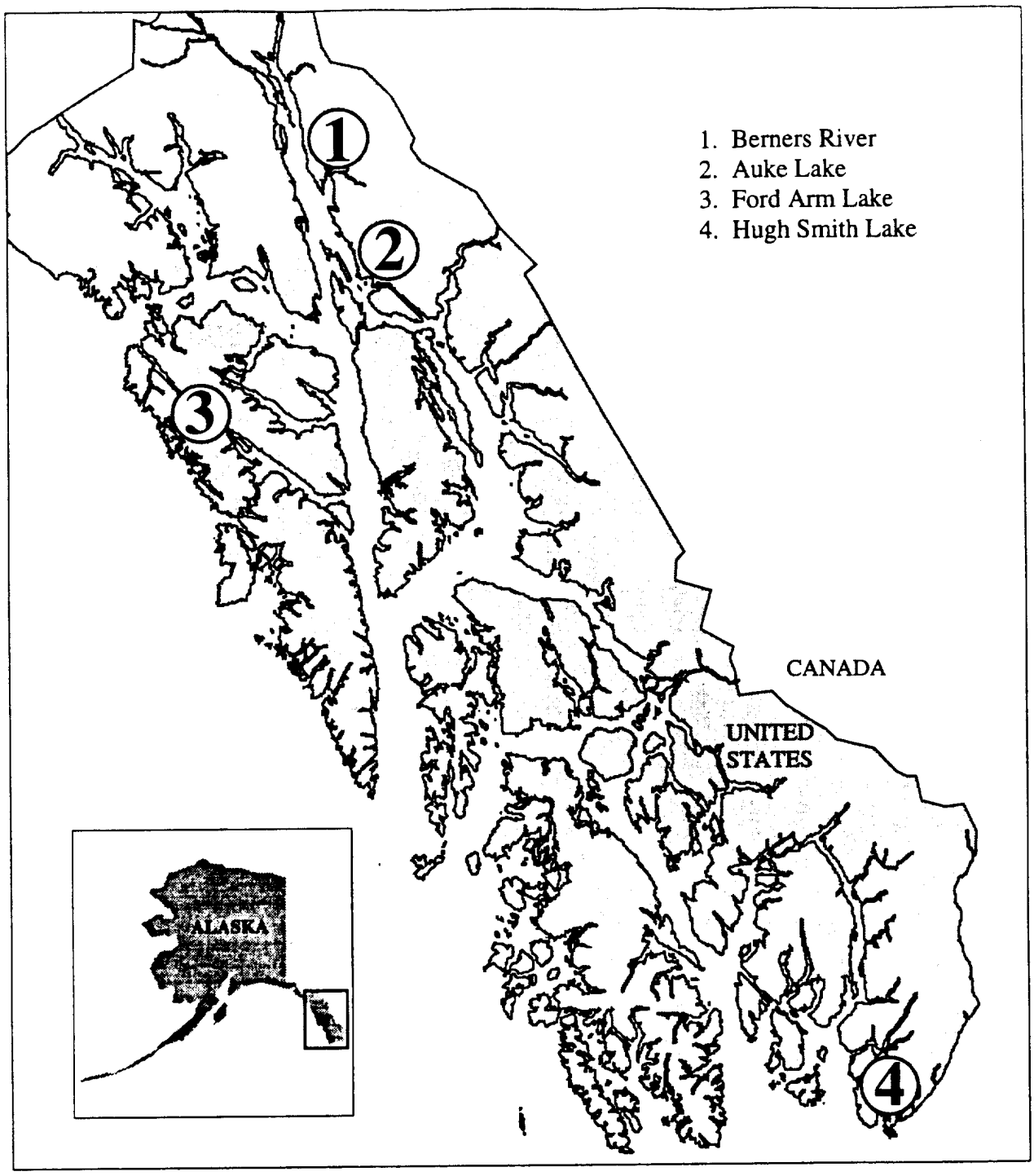


Figure 1. Locations of wild coho salmon indicator stocks in Southeast Alaska.

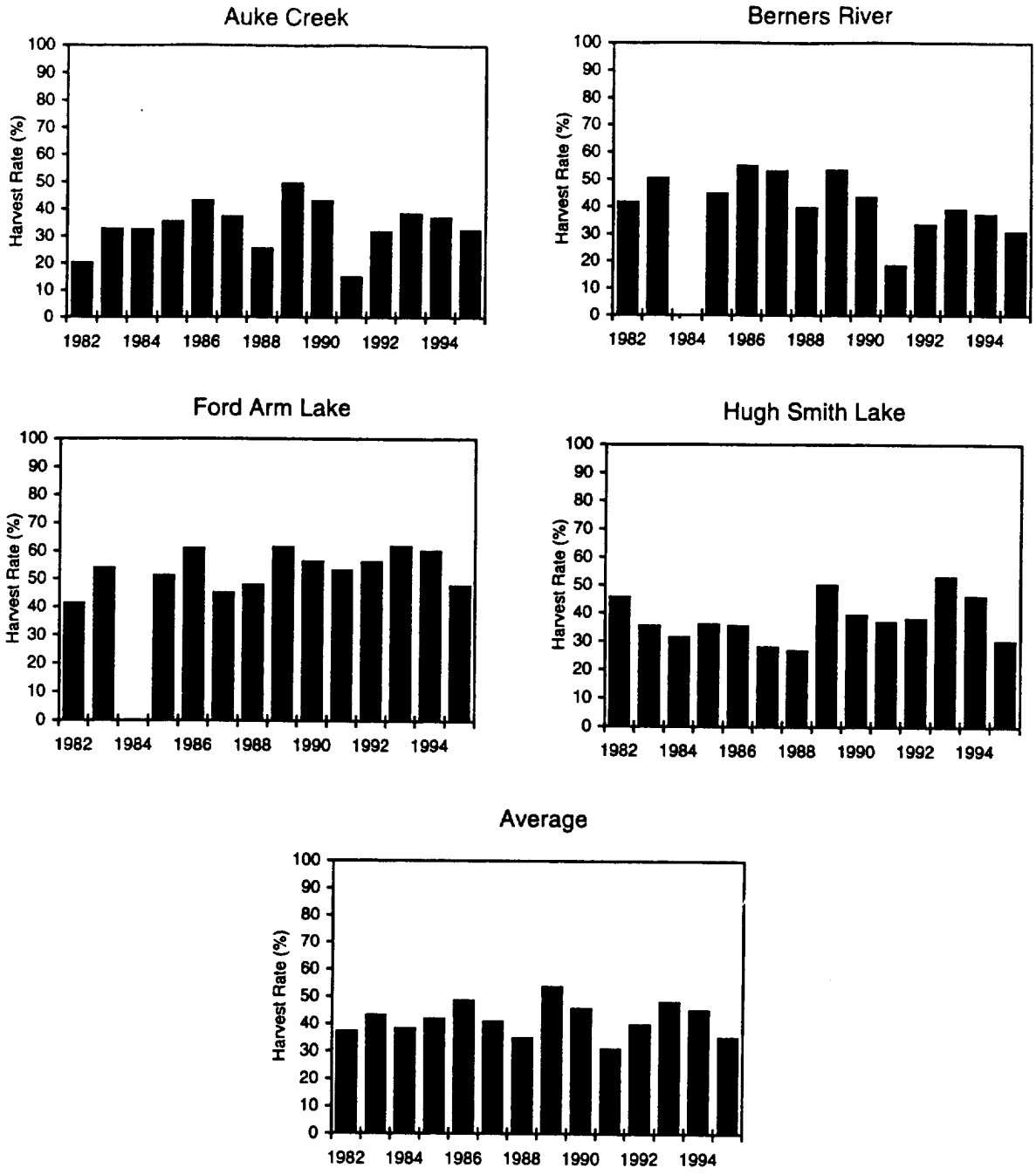


Figure 2. Estimated harvest rates by the Alaskan troll fishery for four coded-wire tagged Southeast Alaska coho stocks, 1982-1995.

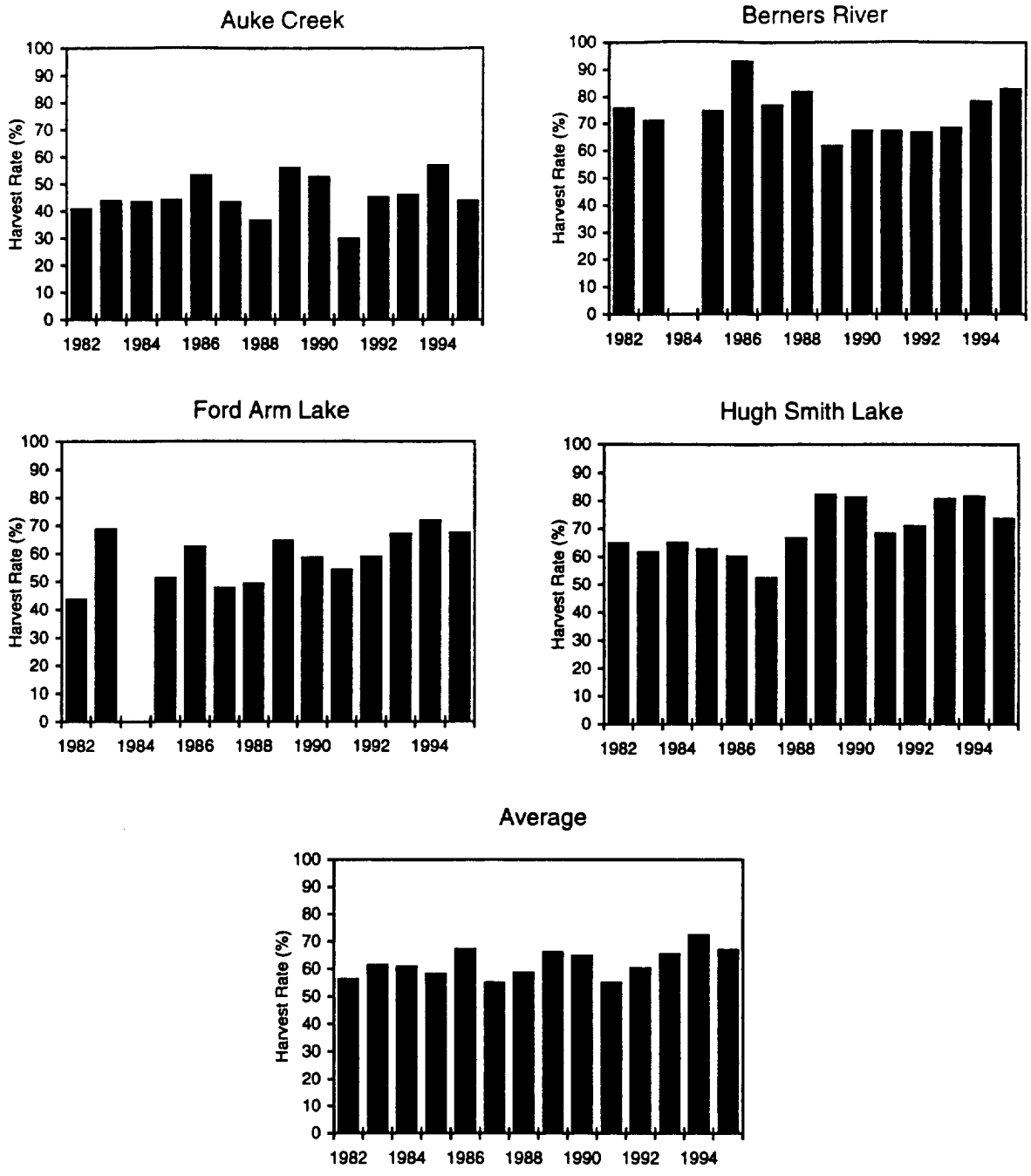


Figure 3. Estimated total harvest rates by all fisheries or four coded-wire tagged Southeast Alaska coho stocks, 1982-1995.

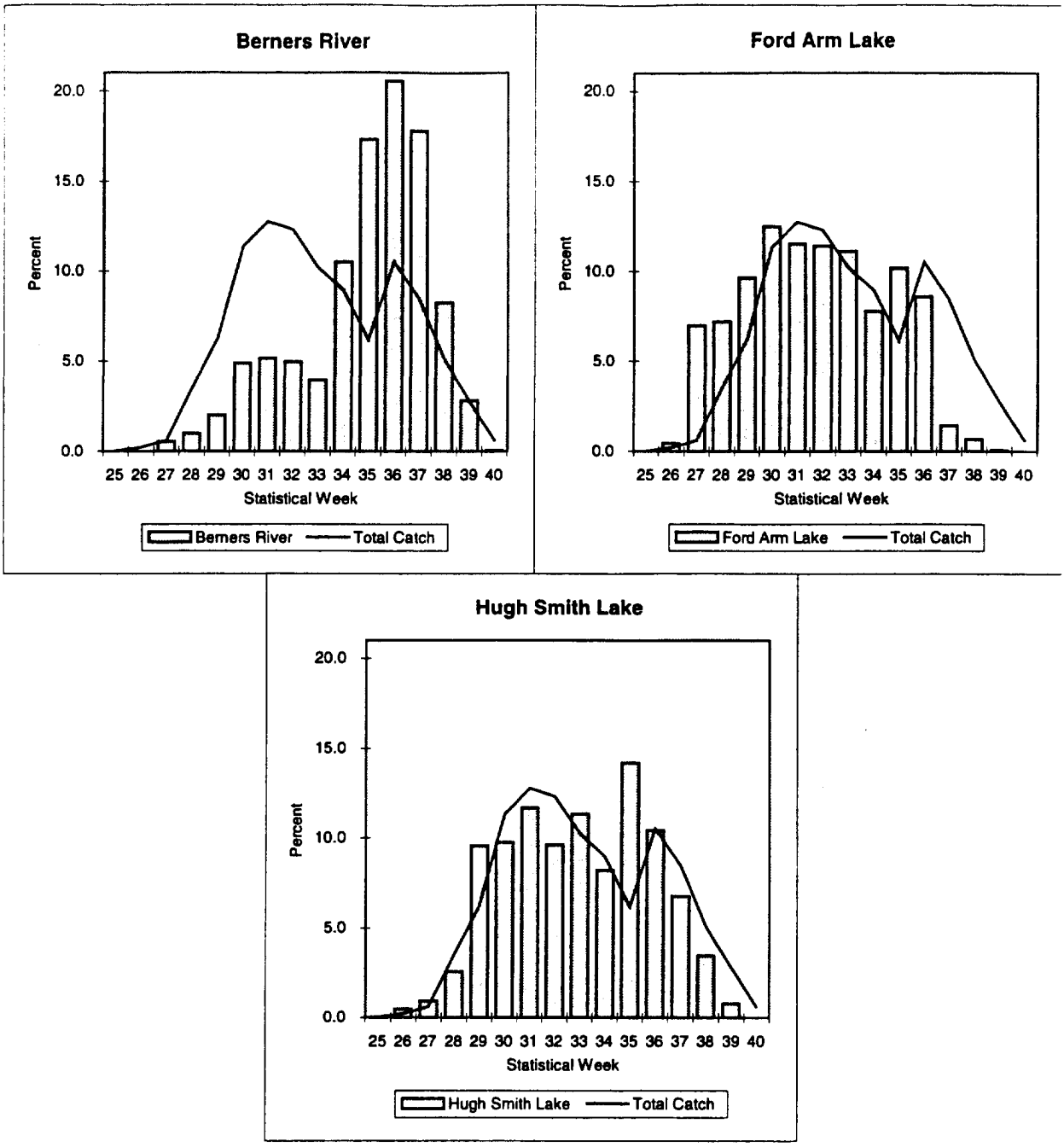
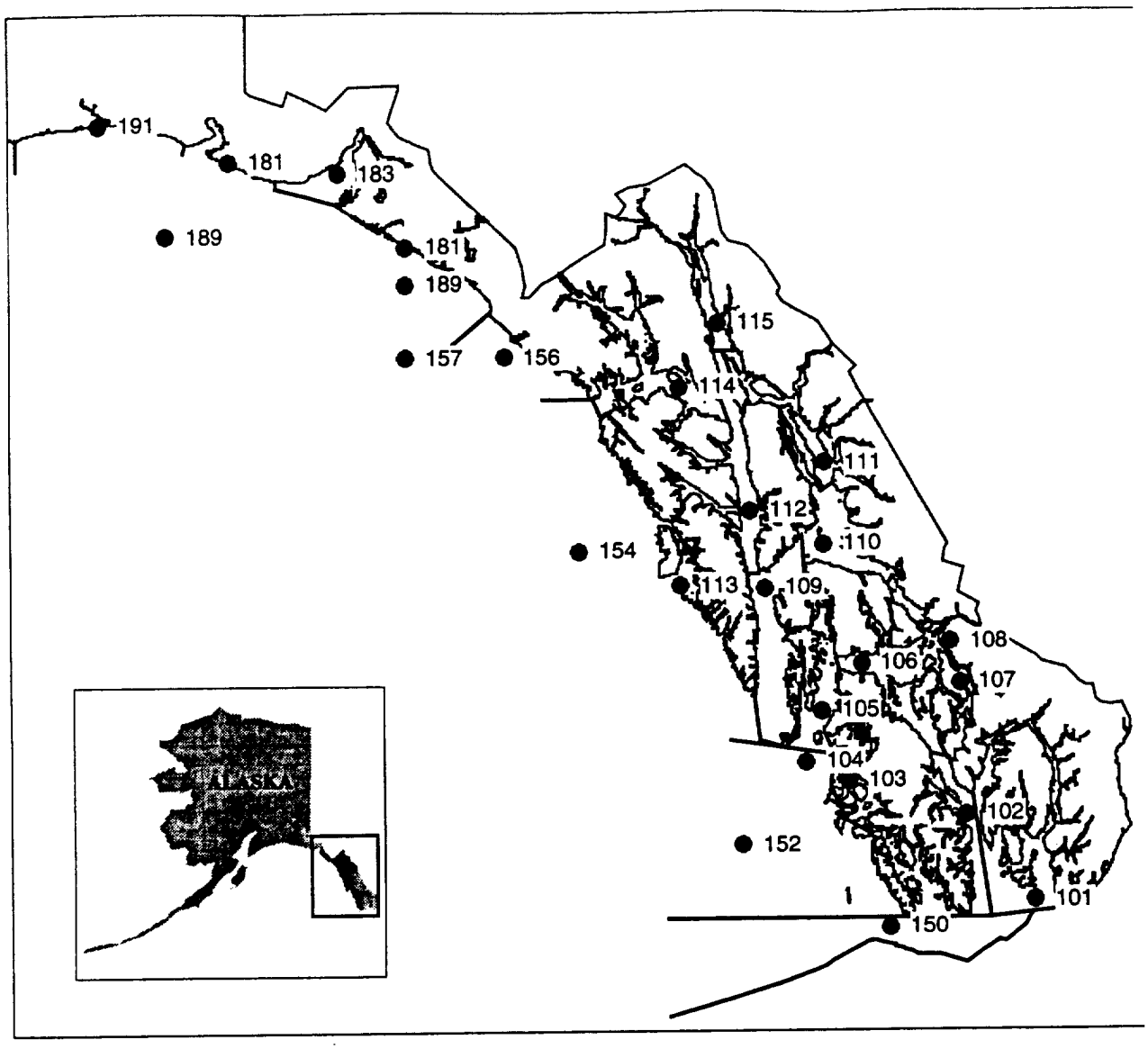


Figure 4. Average weekly percent of the total troll catch of Berners River, Ford Arm Lake, and Hugh Smith Lake coho salmon, 1982-1995.

APPENDIX



Appendix A.1. Southeast Alaska statistical fishing districts.

Appendix A.2. Statistical areas of Southeast Alaska within Pacific States Marine Fisheries Commission (PSMFC) areas and quadrants.

PSMFC Area	Abbreviation	Statistical Areas (Districts)
Northern Outside	NOUT	116, 156, 157, 181, 183, 189, 191
Central Outside	COUT	113, 154
Southern Outside	SOUT	103, 104, 152
Southern Inside	SIN	101, 102, 150
Southern Intermediate	SNTR	105, 109, 110
Central Inside	CIN	106, 107, 108
Stephens Passage	STEP	111
Central Intermediate	CNTR	112, 114
Lynn Canal	LYNN	115

Quadrant	Abbreviation	Statistical Areas (Districts)
Northwest	NW	113, 114, 116, 154, 156, 157, 181, 183, 186, 189, 191
Northeast	NE	109, 110, 111, 112, 115
Southwest	SW	103, 104, 150, 152
Southeast	SE	101, 102, 105, 106, 107, 108