A Summary of 1982–1991 Harvests, Escapements, Migratory Patterns, and Marine Survival Rates of Coho Salmon Stocks in Southeast Alaska

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A Summary of 1982–1991 Harvests, Escapements, Migratory Patterns, and Marine Survival Rates of Coho Salmon Stocks in Southeast Alaska

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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, and survival rates. The primary purpose of the program was to index fishery harvest rates and patterns and determine factors affecting adult production. The estimated average harvest rate for the three indicator stocks by the Alaska troll fishery during the 1982–90 period was relatively stable, ranging from a low of 38.1% in 1988 to a peak of 55.0% in 1989. The average harvest rate estimate for the Alaska troll fishery by stock was 47.5% for the Berners River, 52.3% for Ford Arm Lake, and 36.4% for Hugh Smith Lake. The average for all stocks and all years was 44.9%. Harvest rates by all gear types combined varied substantially among stocks. The Berners River stock, which is taken about equally by the troll fishery and the Lynn Canal drift gillnet fishery, was harvested at an estimated average rate of 75.3% (range 61.9–92.9%). The Ford Arm Lake stock was harvested primarily by the troll fishery at an estimated average rate of 55.8% (range 43.6–69.1%). The Hugh Smith Lake stock was harvested by several fisheries at an estimated average combined rate of 66.2%; the 1982–88 average rate of 61.8% (range 52.3–66.5%) increased to 82.1% in 1989 and to 81.1% in 1990. Juvenile coho salmon tagged in the Berners River in late June of 1980 to 1989 survived to adult return, as determined by catch and escapement, at an estimated average rate of 5.3% (range 2.9–8.8%). Similarly, Ford Arm Lake juveniles tagged in July and August survived at an estimated average rate of 9.5% (range 6.0–14.4%), and smolts that migrated from Hugh Smith Lake survived at an estimated average rate of 10.7% (range 4.2–19.1%). Smolts that migrated from the Berners River in 1989 survived at an estimated rate of 19.8%. At Hugh Smith Lake, 5 years of age-.1 coho salmon escapements ranging from 903 to 2,144 produced a narrow range of estimated smolt emigrations (23,480–29,548); no relationship between escapement and smolt production was evident. Recent results continue to support earlier conclusions about the relative stability of coho production from some lake systems and the important effect of marine survival rates on adult production. Determination of spawner-recruit relationships for the Hugh Smith Lake stock and the other indicator stocks was not possible.

INTRODUCTION

The coho salmon *Oncorhynchus kisutch* is an important species to commercial, sport, and subsistence fisheries in Southeast Alaska. During 1981 to 1990, the annual commercial catch averaged 2.1 million fish, ranging from 1.1 to 3.3 million fish (ADF&G, Southeast Region catch database, Douglas). Commercial fisheries have accounted for the vast majority of the total harvest; sport and subsistence fisheries have taken only about 3%.

The majority of the coho salmon harvested in Southeast Alaska are produced in approximately 3,000 local 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 stock mixing. Effective management requires an understanding of stock migratory characteristics, status, productivity, harvest rates, and fisheries contributions.

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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 1991, wild coho salmon were marked in 24 systems throughout the main part of Southeast Alaska and 5 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. *in press*). As more of this information has become available, program emphasis has shifted to long-term research on selected *indicator stocks* that are used to represent aggregates of wild stocks. In addition to providing additional information on harvest rates and patterns, these ongoing studies are directed at providing data on population dynamics useful in evaluating escapement goals and in developing models to predict abundance. Since 1982, the indicator stocks have been Berners River and Auke Creek north of Juneau, Ford Arm Lake on the outer coast, and Hugh Smith Lake south of Ketchikan (Figure 1).

The objectives of this continuing study are to estimate harvest rates by area and gear type, smolt migrations, escapements, total adult abundance, age composition, smolt and adult production per spawner, and survival rates for the three indicator stocks. This report includes a summary and analysis of tag release and recovery data for three of the four indicator stocks under study by the Alaska Department of Fish and Game, Commercial Fisheries Division, during the period from 1 July 1986 to 30 June 1991. Studies at Auke Creek funded jointly by the ADF&G, Division of Sport Fish, and the National Marine Fisheries Service were reported by Taylor (1991) and Elliott and Sterritt (1991).

METHODS

Smolt and Presmolt Tagging

Migrating coho salmon smolts were tagged annually at Hugh Smith Lake from 1982 to 1991 and at the Berners River from 1989 to 1991. Presmolt coho salmon were also tagged at the Berners River sporadically from 1972 to 1977, from 1980 to 1981, and during 1983–1988. Presmolts were tagged at Ford Arm Lake in 1980–81, and from 1983 to 1990. The majority of surviving fish that were tagged as age-1 presmolts were expected to return as adults 2 years later, whereas those tagged as smolts were expected to return to the fisheries and spawning grounds after 1 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 to capture age-1 and older presmolts were also used at the Berners River and at Ford Arm Lake. Fifty traps were set and checked four times daily at 2-h intervals when the water temperature was warm ($\geq 11^{o}$ C). Up to 100 traps were set and checked twice daily when water temperatures were $<11^{o}$ C and fish were less active. Traps were moved frequently to maintain the highest possible catch rates. Prior to being tagged, presmolts were held in pens until a total of 1,000–4,000 were captured or for a period not exceeding 3 d. 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 used under field conditions is found in Koerner (1977).

Targets of 600 samples at Hugh Smith Lake and 850 samples at Berners River were taken for age and length; 10% of the daily 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 for fork length to the nearest millimeter.

During May and June of 1989 through 1991, minnow traps were used to capture a mixture of smolts and rearing juveniles at the Berners River. In 1989 and 1991 an effort was made to visually distinguish presmolts and smolts based on smolt morphology, which included silvery body and darkened fins. Fish displaying smolt characteristics were assigned different tag codes than were all other fish tagged, but there was a great deal of uncertainty in classifying many fish.

Tag Recovery from Fisheries

Commercial catch sampling for coho salmon with coded wire tags in Southeast Alaska was conducted

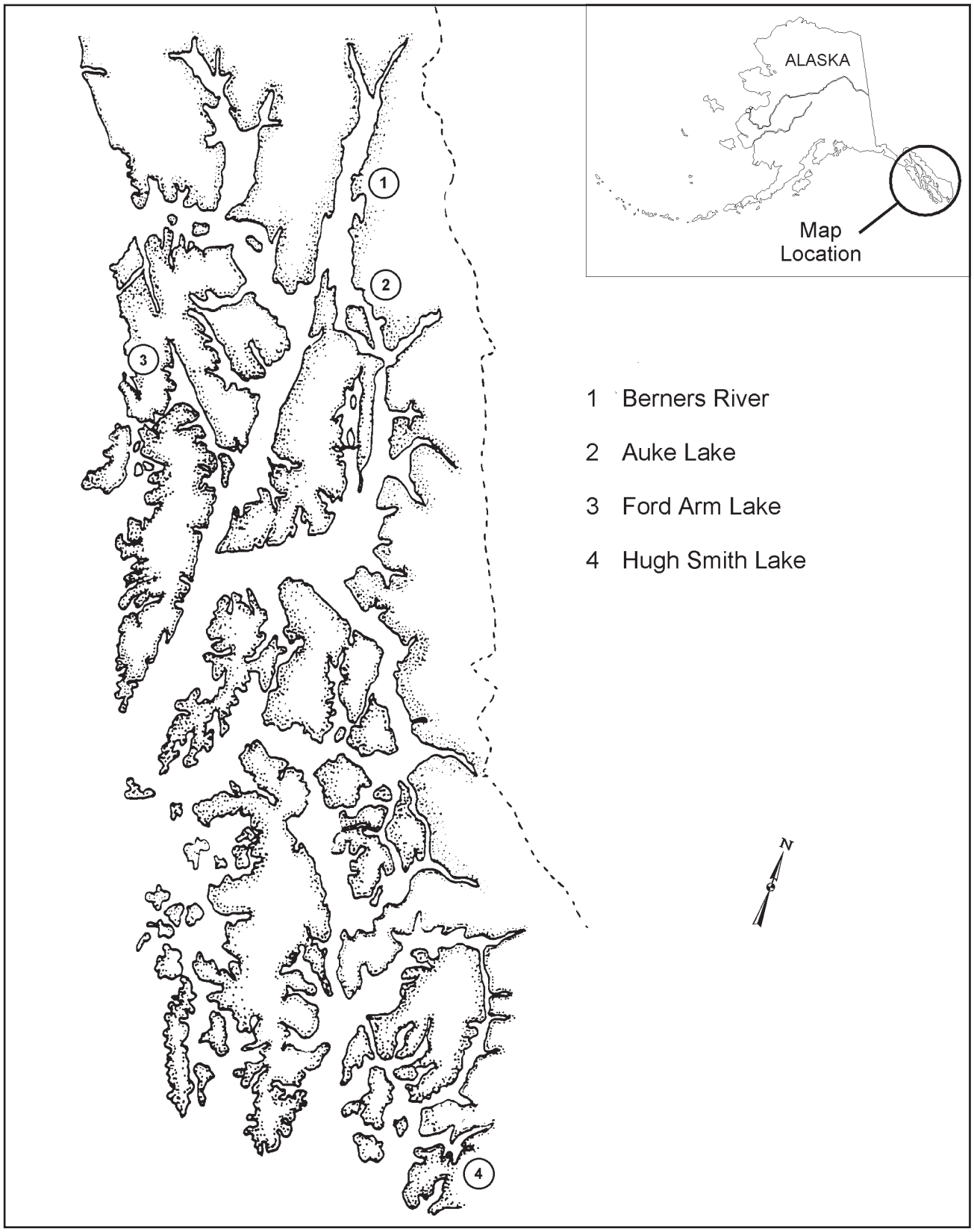

Figure 1. Locations of wild coho salmon indicator stocks in Southeast Alaska.

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-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, beginning on Sunday and ending on Saturday, were used for expanding net and trap recoveries. Troll fishery recoveries were expanded (1) for open periods by quadrant for estimating total catch, (2) by statistical week and quadrant for analyzing migratory timing, and (3) by fishing period and PMFC 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 strata; 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 (Suchanek and Bingham 1992). Tags recovered from random samples were expanded over biweekly strata that contained additional stratifications including weekends versus weekdays, mornings versus afternoons, and 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 passing 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 coded wire tags and age-length-sex data. The beach seine was deployed in pools by a three-person crew. 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 magnetic field detector to determine the presence of a tag. If the fish registered a positive signal when its head was moved quickly both ways through the detector, 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 and examined for the presence of an adipose fin. In 1982 and 1983 a sample of 20 adipose-clipped adults was sacrificed and examined for tags (Shaul et al. 1985, 1986). If any were found to have lost tags, additional samples were taken from up to 50 fish. In more recent years, if a fish had a clipped adipose fin, a magnetic field detector and the procedures described above for the Berners River were used. Males under 460 mm long at Hugh Smith Lake and males 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 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. 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 5 mm from mideye to tail fork. 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

From 1982 through 1990, the upper Berners River and tributaries were surveyed annually by foot and

helicopter during a 10-d 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. When the helicopter retumed to remove 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 conducted the Berners River surveys from 1982 to 1990. 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 to be 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 m 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 headwater and small tributaries, but most were holding in clear pools below spawning areas. The 10-d trip was typically long enough to work around unfavorable survey conditions due to high water.

Ford Arm and Hugh Smith Weirs

Metal picket weirs were operated at the outlets of Ford Arm Lake and Hugh Smith Lakes. In the early 1980s, the weirs were operated through mid- to late November. Starting with 1985, the close-out date was changed to late October when it was recognized that few if any fish entered the systems after that time. Spawning usually began below the Ford Arm weir in mid- to late October. Surveys were conducted below the weir from October 7 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. Spawning is unknown 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 occurred in some recent years due to bears opening holes in the wire mesh during high-water periods. Tagging was used to estimate the escapement in 1982, 1983, 1988, 1989, and 1990.

At Hugh Smith Lake, extreme flows threatened the weir in 1982, 1983, 1986, and 1987. At those times, pickets were pulled for periods ranging from a few days to several days, and tagging and recovery was used to estimate escapement in those years. The wooden tripod weir was replaced in 1989 with an aluminum bipod structure, which performed without problems in flood conditions during 1989 and 1990.

All healthy adult coho salmon that passed through the weirs were captured in a trap, examined for coded wire tags, and marked with a dorsal fin clip (i.e., the posterior three rays of the dorsal fin were removed with wire cutters approximately 1 cm above the fish's back). In 1982 and 1983, instead of using clips, fish were tagged with numbered Floy anchor tags (Shaul

et al. 1985, 1986). Data from those years indicated a high degree of intermixing of marked fish between tagging and recovery; therefore, a single-stratum estimate (Chapman 1951) was believed to have little bias. At Hugh Smith Lake, a single-stratum estimate resulted in relatively low bias compared with the stratified estimates (Schaefer 1951) of 6.9% in 1982 and 2.2% in 1983.

The dorsal clip was employed as the primary mark in more recent years because it is easier and less expensive to apply than numbered tags. Although not tested, loss of marks due to fin degradation from the dorsal clip did not appear to be a problem. Mark-recoveries were sampled with sport spinning gear, dip nets, and seines. At Ford Arm Lake, tag recovery was conducted in the lake beginning in mid-October. At Hugh Smith Lake, 2- to 3-d mark-recovery trips were initiated in the vicinity of the spawning streams in mid-November and continued through late January when there was an indication that some of the escapement may have passed the weir uncounted and that an alternative estimate was needed. The inlet streams, Buschman 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 that passed the weir after recovery sampling began were marked with a left opercular punch. This was used rather than a dorsal clip so that they could be distinguished, if recaptured, but excluded from the mark-recapture estimate. All fish taken during recovery were marked with a single left opercular punch and released.

If all fish passing the weir were counted, 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 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 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

$$\theta_t = \left(\frac{m_1}{S}\right)\left(\frac{t}{m_2}\right) , \qquad (1)$$

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 (θ_t):

$$E = N\theta_t \ . \qquad (2)$$

Harvest by Gear Type and Escapement

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

$$C_i = \frac{F_i}{\theta_t} , \qquad (3)$$

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:

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

Harvest Rates

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

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

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:

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

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 pass 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:

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

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

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

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 that lack 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 PMFC 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 4–6 d, the average time of capture of landed fish probably occurred 2–3 d previously.

Survival Rates

Survival rates for smolts to adults composing the run were estimated for coho salmon that migrated from Hugh Smith Lake from 1983 to 1989 and presmolts that were tagged in the Berners River between 1980 and 1981 and from 1983 to 1988 and at Ford Arm Lake between 1980 and 1981 and from 1983 to 1988.

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:

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

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 1990 and the Berners River in 1989 and 1990 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 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 and Presmolts Tagged

From 1972 to 1988, numbers of presmolt coho salmon tagged in the lower Berners River ranged from 7,826 in 1981 to 15,326 in 1984 and averaged 10,372 (Table 1). Two trough traps used in a beaver pond in May through early June 1989 caught 6,438 smolts for tagging; in two ponds these traps caught 23,598 smolts in 1990 and 21,456 smolts in 1991. Minnow traps were used in addition to trough traps to capture a mixture of smolts and presmolts: 5,660 in 1989, 2,781 in 1990, and 3,669 in 1991. Of these, 1,021 in 1989 and 1,414 in 1991 were classified as smolts. Fish captured in late June were expected to remain in fresh water for an additional 11 months before migrating to sea.

The numbers of presmolts tagged at Ford Arm Lake in July and August ranged from 3,882 in 1983 to 12,567 in 1988 and averaged 8,828 (Table 2). Most tagging trips were about 12 d. Fish were found in sufficient concentrations for tagging in three primary locations: shoreline and shallow offshore areas of the lake, the outlet stream, and a small pond near the north end of the lake.

In Hugh Smith Lake, 5,345 presmolts in 1980 and 3,737 in 1981 were captured in minnow traps and tagged. Between 1981 and 1991, a smolt weir at the outlet of Hugh Smith Lake was operated from mid-April through late May or early June. The number of

Table 1. Number of Berners River coho salmon coded wire tagged by year, type, and tag code, 1983–91.

Year	Type	Code	Number Marked
1983	Presmolt	4-22-08	1,278
		4-22-43	9,070
		Total	10,348
1984	Presmolt	4-24-34	4,499
		4-24-36	10,827
		Total	15,326
1985	Presmolt	4-24-46	10,110
1986	Presmolt	4-23-05	8,740
1987	Presmolt	4-26-56	10,349
1988	Presmolt	4-29-42	9,926
1989	Smolt (trough trap)	4-29-27	6,438
	Smolt (minnow trap)	4-29-23	1,021
	Mixed (minnow trap)	4-29-26	5,660
		Total	13,119
1990	Smolt (trough trap)	4-26-62	11,478
	Smolt (trough trap)	4-29-31	10,540
	Smolt (trough trap)	4-31-05	1,580
	Mixed (minnow trap)	4-26-61	2,781
		Total	26,379
1991	Smolt (trough trap)	4-29-44	21,456
	Smolt (minnow trap)	4-31-06	1,414
	Mixed (minnow trap)	4-31-10	3,669
		Total	26,539

Table 2. Number of presmolt coho salmon coded wire tagged at Ford Arm Lake by year and code, 1983–91.

Year	Code		Number Marked
1983	4-23-23		3,882
1984	4-23-28		2,033
	4-24-35		5,629
		Total	7,662
1985	4-24-47		7,626
1986	4-23-03		10,392
1987	4-26-57		10,138
1988	4-29-22		11,108
	4-29-18		1,459
		Total	12,567
1989	4-29-41		11,300
1990	4-33-54		10,742
1991	4-36-38		9,506

Table 3. Number of coho salmon smolts coded wire tagged at Hugh Smith Lake by year and code, 1982–91.

Year	Code		Number Tagged
1982	4-21-30		4,873
	4-21-43		700
		Total	5,573
1983	4-20-28		2,489
	4-20-29		1,289
	4-22-06		5,869
		Total	9,647
1984	4-23-06		5,227
	4-23-07		1,576
	4-23-19		9,944
		Total	16,747
1985	4-24-50		5,352
	4-24-51		3,102
	4-24-52		1,379
		Total	9,833
1986	4-24-41		5,689
1987	4-26-52		4,806
1988	4-29-24		5,202
1989	4-27-18		7,187
1990	4-27-20		10,187
	4-29-19		919
		Total	11,106
1991	4-36-02		12,068
	4-35-52		1,201
		Total	13,269

smolts marked ranged from 2,777 in 1981 to 16,747 in 1984 (Table 3).

Harvest by Gear Type and Escapement

Between 1982 and 1983 and between 1985 and 1990, the Berners River coho run estimate to lower Lynn Canal averaged 24,551 fish, ranging from 14,058 to 34,036 (Table 4). The estimated contribution to the Alaska troll fishery averaged 11,638 (range 5,926–17,153), and the Lynn Canal drift gillnet fishery averaged 6,492 (range 1,664–10,568). Estimated total contributions to the purse seine fishery averaged only 66 fish; in the marine sport fishery the average was 129 fish. The estimated total contribution to all fisheries averaged 18,325 fish (range 10,798–24,196), and the total escapement survey count averaged 6,226 (range 1,752–11,050). The troll fishery harvest estimate averaged 47.7% (range 39.6–55.1%) of the total run; this was 26.8% in the drift gillnet fishery (range 8.5–41.0%), 0.3% in the purse seine fishery, and 0.5% in the marine sport fishery. Harvest rate estimates for the Berners River are probably overestimates because escapement estimates are based on a peak survey count rather than a total weir count or mark-recapture estimate.

The estimated total run to Ford Arm Lake averaged 5,060 fish (range 3,229–6,287) during 1982, 1983, and 1985 to 1990 (Table 5). Tag recovery data indicated that the Ford Arm Lake stock was harvested by only the troll and purse seine fisheries, the estimated average harvests being 2,674 (range 1,456–3,777) and 190 (range 0–931), respectively. The estimated total fishery catch averaged 2,864 (range 1,535–4,343); the total escapement averaged 2,196 (range 1,546–3,028). The troll harvest rate on Ford Arm Lake coho salmon averaged 52.4% (range 41.3–61.5%) and the purse seine fishery 3.4% (range 0–14.8%).

The total estimated run to Hugh Smith Lake averaged 3,528 fish (range 1,530–6,096) during 1982–1990 (Table 6). The fisheries accounted for an estimated average total catch of 2,344 fish (range 1,017-3,952) and an average total harvest rate of 66.2% (range 52.3–82.1%). The harvest of Hugh Smith Lake coho salmon was distributed across a variety of fisheries. On the average, troll gear harvested an estimated 44.7% of the total run, of which 36.4% was taken in Alaska and 8.3% in British Columbia (B.C.). Purse seine gear harvested an average of 11.5% and drift gillnet gear 8.3% of the total run in Alaska fisheries; 1.1% was harvested in B.C. net fisheries. The Ketchikan marine sport fishery and Annette Island fish traps each

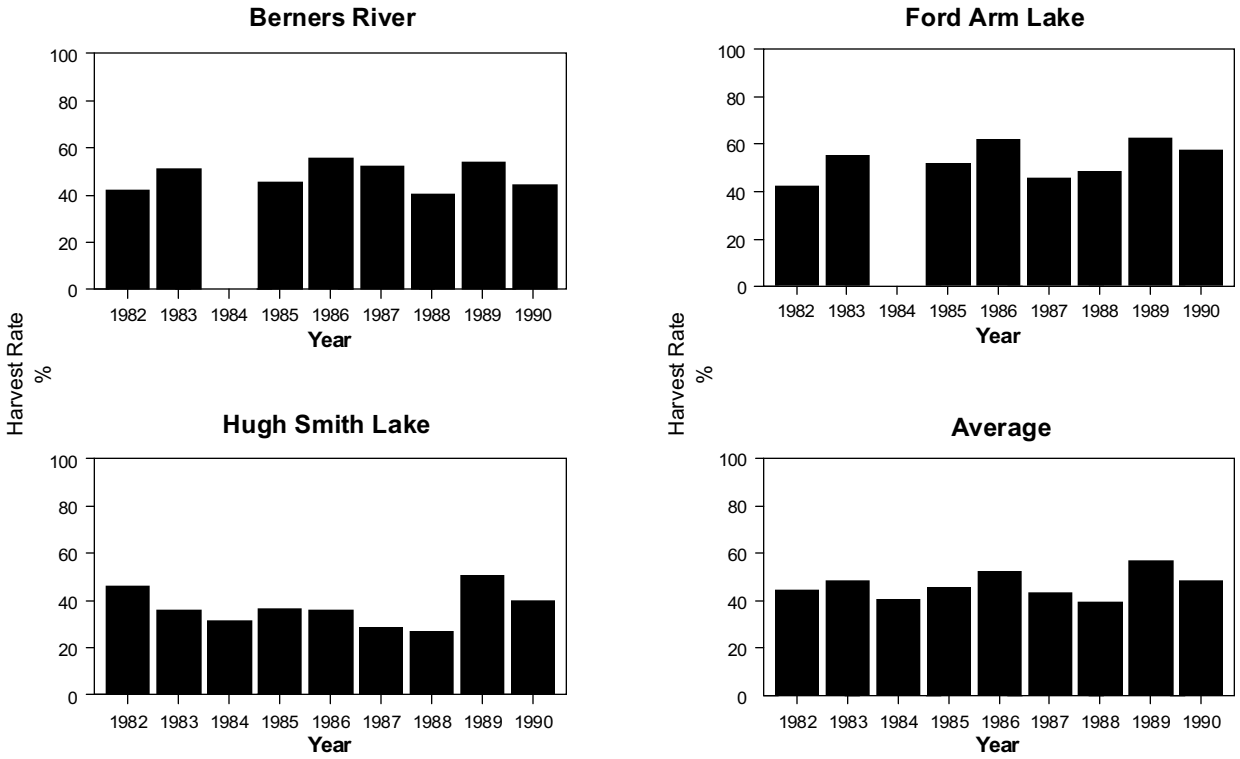

Figure 2. Alaska troll fishery harvest rates estimated for three Southeast Alaska indicator coho salmon stocks and the average of all three, 1982–1990.

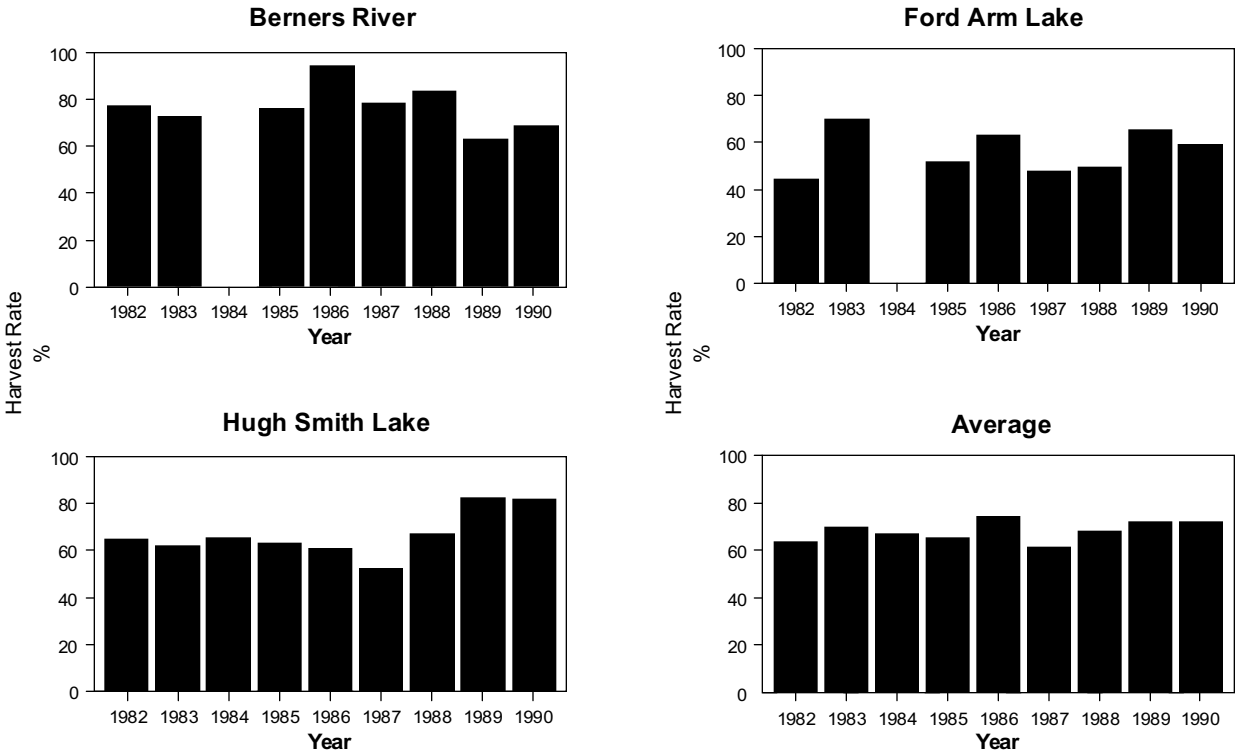

Figure 3. Harvest rates by all fisheries estimated for three Southeast Alaska indicator coho salmon stocks and the average of all three, 1982–1990.

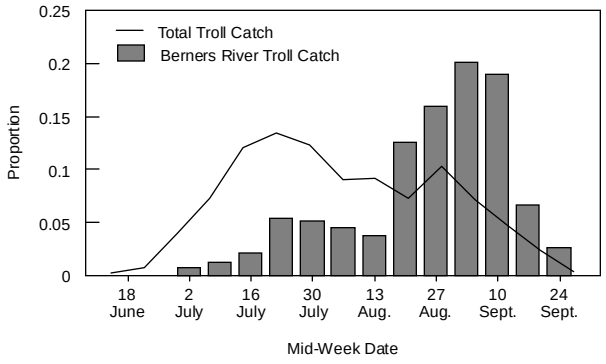

Figure 4. Weekly proportions of (1) the total coho salmon troll catch, and (2) the estimated troll catch of Berners River coho salmon, averaged for 1982, 1983, and 1985–1990.

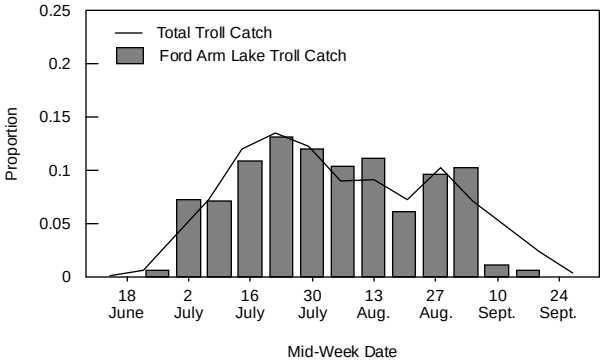

Figure 5. Weekly proportions of (1) the total coho salmon troll catch, and (2) the estimated troll catch of Ford Arm Lake coho salmon, averaged for 1982, 1983, and 1985–1990.

Table 4. Estimated harvest and percentage of run harvested by gear type, escapement, and total run of coho salmon returning to the Berners River, 1982, 1983, and 1985–1990.

Year	Fishery Sample Size[a]	Harvest: Number of fish and percent by gear type					Escapement	Total Run
		Troll	Purse Seine	Drift Gillnet	Sport	Total Catch		
1982	48	12,887 (41.6%)	0	10,568 (34.1%)	0	23,455 (75.7%)	7,505 (24.3%)	30,960 (100%)
1983	125	17,153 (50.4%)	0	6,978 (20.5%)	65 (0.2%)	24,196 (71.1%)	9,840 (28.9%)	34,036 (100%)
1985	93	10,865 (44.8%)	198 (0.8%)	7,015 (28.9%)	0	18,078 (74.5%)	6,169 (25.5%)	24,247 (100%)
1986	157	13,560 (55.1%)	0	8,928 (36.2%)	395 (1.6%)	22,883 (92.9%)	1,752 (7.1%)	24,635 (100%)
1987	53	7,448[b] (53.0%)	0	3,301 (23.5%)	48 (0.3%)	10,798 (76.8%)	3,260 (23.2%)	14,058 (100%)
1988	102	5,926 (39.6%)	181 (1.2%)	6,141 (41.0%)	0	12,248 (81.8%)	2,724 (18.2%)	14,972 (100%)
1989	58	10,515 (53.4%)	0	1,664 (8.5%)	0	12,179 (61.9%)	7,509 (38.1%)	19,688 (100%)
1990	470	14,751 (43.6%)	149 (0.4%)	7,339 (21.7%)	525 (1.6%)	22,764 (67.3%)	11,050 (32.7%)	33,814 (100%)
Average Number of Fish		11,638	66	6,492	129	18,325	6,226	24,551
Average Percent of Total		47.7	0.3	26.8	0.5	75.3	24.7	100

[a] Includes only expandable random recoveries.

[b] Estimated troll catch in 1987 includes 242 fish (1.7%) harvested in the northern British Columbia troll fishery. The estimated average number and percent harvested in the Southeast Alaska troll fishery was 11,608 (47.5%).

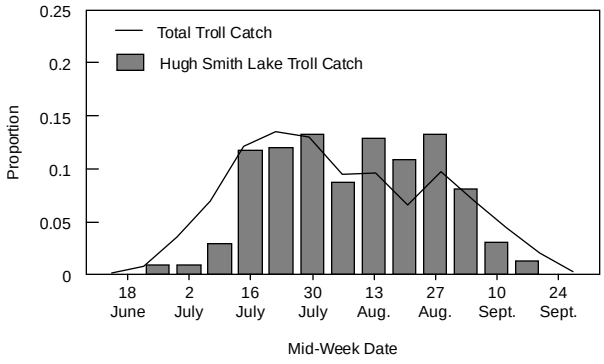

Figure 7. Weekly proportions of (1) the total coho salmon troll catch, and (2) the estimated troll catch of Hugh Smith Lake coho salmon in the Northwest, Northeast and Southwest Quadrants, averaged for 1982–1990.

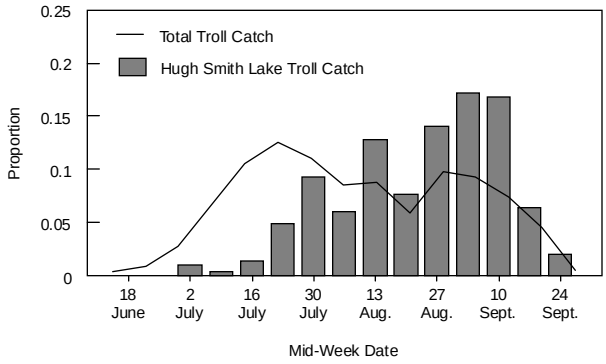

Figure 8. Weekly proportions of (1) the total coho salmon troll catch, and (2) the estimated troll catch of Hugh Smith Lake coho salmon in the Southeast Quadrant, averaged for 1982–1990.

Table 5. Estimated harvest and percentage of run harvested by gear type, escapement, and total run of coho salmon returning to Ford Arm Lake, 1982, 1983, and 1985–1990.

Year	Fishery Sample Size[a]	Harvest: No. of fish and percent			Escapement	Total Run
		Troll	Purse Seine	Total Catch		
1982	38	1,948 (41.3%)	106 (2.3%)	2,054 (43.6%)	2,662 (56.4%)	4,716 (100%)
1983	93	3,412 (54.3%)	931 (14.8%)	4,343 (69.1%)	1,944 (30.9%)	6,287 (100%)
1985	49	2,438 (51.2%)	0	2,438 (51.2%)	2,324 (48.8%)	4,762 (100%)
1986	87	2,500 (60.9%)	62 (1.5%)	2,562 (62.4%)	1,546 (37.6%)	4,108 (100%)
1987	71	1,456 (45.1%)	79 (2.4%)	1,535 (47.5%)	1,694 (52.5%)	3,229 (100%)
1988	151	2,887[b] (48.4%)	46 (0.8%)	2,933 (49.2%)	3,028 (50.8%)	5,961 (100%)
1989	221	3,777 (61.5%)	185 (3.0%)	3,962 (64.5%)	2,177 (35.5%)	6,139 (100%)
1990	174	2,979 (56.5%)	108 (2.0%)	3,087 (58.5%)	2,190 (41.5%)	5,277 (100%)
Average Number of Fish	2,674	190	2,864	2,196	5,060	
Average Percent of Total	52.4	3.4	55.8	44.2	100	

[a] Includes only expandable random recoveries.
[b] Estimated troll catch in 1988 included 30 fish (0.5%) harvested in the northern British Columbia troll fishery. The estimated average number and percent harvested in the Southeast Alaska troll fishery was 2,671 (52.3%).

Table 6. Estimated harvest and percentage of run harvested by gear type, escapement, and total run of coho salmon returning to Hugh Smith Lake, 1982–1990.

		Harvest: Number of fish and percent by gear type									
Year	Fishery Sample Size[a]	Alaska Troll	Alaska Seine	Alaska Gillnet	Alaska Trap	Alaska Sport	B.C. Troll	B.C. Net	Total Catch	Escapement	Total Run
1982	91	2,780 (45.6%)	627 (10.3%)	203 (3.3%)	0	0	264 (4.3%)	78 (1.3%)	3,952 (64.8%)	2,144 (35.2%)	6,096 (100%)
1983	189	1,373 (35.4%)	424 (10.9%)	277 (7.2%)	49 (1.3%)	0	211 (5.4%)	51 (1.3%)	2,385 (61.5%)	1,490 (38.5%)	3,875 (100%)
1984	151	1,260 (31.4%)	501 (12.5%)	470 (11.7%)	18 (0.5%)	0	325 (8.1%)	28 (0.7%)	2,602 (64.9%)	1,408 (35.1%)	4,010 (100%)
1985	212	868 (36.0%)	287 (11.9%)	137 (5.7%)	5 (0.2%)	0	199 (8.3%)	13 (0.5%)	1,509 (62.6%)	903 (37.4%)	2,412 (100%)
1986	257	1,585 (35.4%)	515 (11.5%)	315 (7.0%)	2 14 (0.1%)	234 (0.3%)	26 (5.2%)	2,691 (0.6%)	1,783 (60.1%)	4,474 (39.9%)	(100%)
1987	100	656 (28.0%)	95 (4.1%)	249 (10.6%)	0	23 (1.0%)	153 (6.5%)	50 (2.2%)	1,226 (52.3%)	1,118 (47.7%)	2,344 (100%)
1988	42	408 (26.7%)	230 (15.0%)	122 (8.0%)	0	0	234 (15.3%)	23 (1.5%)	1,017 (66.5%)	513 (33.5%)	1,530 (100%)
1989	91	1,213 (50.0%)	375 (15.5%)	237 (9.8%)	0	41 (1.7%)	105 (4.3%)	20 (0.8%)	1,991 (82.1%)	433 (17.9%)	2,415 (100%)
1990	263	1,810 (39.4%)	538 (11.7%)	504 (11.0%)	24 (0.5%)	0	794 (17.3%)	53 (1.2%)	3,723 (81.1%)	870 (18.9%)	4,593 (100%)
Average Number of Fish		1,328	399	279	11	9	280	38	2,344	1,184	3,528
Average Percent of Total		36.4	11.5	8.3	0.3	0.3	8.3	1.1	66.2	33.8	100

[a] Includes only expandable random recoveries.

harvested an average of 0.3% of the estimated total run. The sport harvest is probably an underestimate because of incomplete sampling before 1986. Overall, Alaska fisheries harvested an estimated average of 56.8% of the Hugh Smith Lake run compared to the B.C. fisheries, which averaged 9.4%. Total harvest rate estimates increased substantially from a relatively stable range of 52.3–66.5% between 1982 and 1988 to 82.1% in 1989 and 81.1% in 1990. Increased harvest rate estimates occurred in each of the three major fisheries: troll, purse seine and drift gillnet. Escapements were only 433 in 1989 and 870 in 1990, compared with the 1982–1988 average of 1,337.

Removal Rates

Removal rate estimates for the Berners River may be high because foot surveys are less likely to thoroughly account for the escapement than total weir counts or mark-recapture estimates on other systems. The Berners River stock was assumed to migrate through the troll and purse seine fisheries and then through the Juneau sport fishery before entering Lynn Canal. During 1982 and 1983 and between 1985 and 1990, the estimated combined troll and purse seine removal rate for the Berners River stock averaged 48.0% (range 40.8–55.1%; Table 8). Due to its late run timing, the Berners River run was subjected to only minor fishing pressure in purse seine and marine sport fisheries. The estimated removal rate in the Juneau marine sport fishery averaged only 1.0%. On average, the Berners River stock was estimated to incur the greatest and most variable removal rate in the Lynn Canal (District 115) drift gillnet fishery: the annual estimates averaged 51.3% and ranged from 15.5% to 83.6%.

Table 7. Estimated harvest rates by the Alaska troll fishery and all fisheries combined for coded wire tagged coho salmon indicator stocks, 1982–1990.

Year	Berners River	Ford Arm Lake	Hugh Smith Lake	Average
Alaska Troll Fishery:				
1982	41.6	41.3	45.6	42.8
1983	50.4	54.3	35.4	46.7
1984			31.4	38.8[a]
1985	44.8	51.2	36.0	44.0
1986	55.1	60.9	35.4	50.5
1987	51.3	45.1	28.0	41.5
1988	39.6	47.9	26.7	38.1
1989	53.4	61.5	50.0	55.0
1990	43.6	56.5	39.4	46.5
Average	47.5	52.3	36.4	44.9
All Fisheries:				
1982	75.7	43.6	64.8	61.4
1983	71.1	69.1	61.5	67.2
1984			64.9	64.4[a]
1985	74.5	51.2	62.6	62.8
1986	92.9	62.4	60.1	71.8
1987	76.8	47.5	52.3	58.9
1988	81.8	49.2	66.5	65.8
1989	61.9	64.5	82.1	69.5
1990	67.3	58.5	81.1	69.0
Average	75.2	55.8	66.2	65.6

[a] The average for 1984 was weighted.

Before becoming available in inside waters of southern Southeast Alaska, coho salmon returning to Hugh Smith Lake were considered to be harvested simultaneously in northern B.C. and in the outside and intermediate districts of Southeast Alaska. During 1982–1990, combined removal rate estimate for Hugh Smith Lake coho salmon in northern B.C. and the outside and intermediate areas of Southeast Alaska averaged 44.1% (range 35.6–55.1%), of which 34.6% (range 27.9–45.8%) was attributed to Alaska fisheries and 9.4% (5.1–18.5%) to northern B.C. fisheries (Table 9). The estimated removal rate in inside areas averaged 40.4% (range 24.7–63.6%); the estimated total harvest rate for all fisheries averaged 66.2% (range 52.3–82.1%).

Because of its location on the outer coast and absence of a terminal fishery, the Ford Arm Lake stock was assumed to be harvested simultaneously by all fisheries. Therefore, its removal rate estimates are the same as the overall harvest rates, which averaged 55.8% (range 43.6–69.1%).

Table 8.Estimated removal rate (percentage) by fishery and overall harvest rate for coho salmon runs to the Berners River, 1982, 1983, and 1985–1990.

Year	Removal Rates[a] Troll and Purse Seine	Marine Sport	115 Gillnet	Overall Harvest Rate
1982	41.6	0.0	58.5	75.7
1983	50.4	0.4	41.5	71.1
1985	45.6	0.0	53.2	74.5
1986	55.1	3.6	83.6	92.9
1987	53.0	0.7	50.3	76.8
1988	40.8	0.0	69.3	81.8
1989	53.4	0.0	15.5	61.9
1990	44.0	2.9	38.7	67.3
Average	48.0	1.0	51.3	75.2

[a] 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.

Table 9. Estimated removal rate (percentage) by area and overall harvest rate for coho salmon runs to Hugh Smith Lake, 1982–1990.

Year	Removal Rates[a] Outside and Intermediate	Northern B.C.	Total	Inside[b]	Overall Harvest Rate
1982	38.1	5.6	43.7	37.5	64.8
1983	28.9	6.7	35.6	40.3	61.5
1984	30.2	8.8	39.0	42.4	64.9
1985	31.8	8.8	40.6	37.0	62.6
1986	38.2	5.8	44.0	28.8	60.1
1987	27.9	8.7	36.6	24.7	52.3
1988	34.3	16.8	51.1	31.4	66.5
1989	45.8	5.1	50.9	63.6	82.1
1990	36.6	18.5	55.1	57.9	81.1
Average	34.6	9.4	44.1	40.4	66.2

[a] 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.

[b] Inside area includes Districts 101, 102, 105, 106, 107, and 108.

Distribution of Harvests

The harvest of the Berners River coho salmon stock was restricted largely to northern fishing areas of Northern Outside, Central Outside, Central Intermediate, Lynn Canal, and Stephens Passage which

Table 10. Estimated harvest distribution as a percentage of total harvest for Berners River coho salmon by area and gear type, 1982, 1983, and 1985–1990.

Area	Gear Type	1982	1983	1985	1986	1987	1988	1989	1990	Avg.
P. W. Sound	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Northern Outside	Troll	20.3	29.6	18.3	28.4	16.9	20.3	24.8	25.2	23.0
Central Outside	Troll	3.7	11.7	15.5	15.7	13.9	2.1	11.9	8.4	10.4
Southern Outside	Troll	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.1
	Seine	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.2	0.2
	Total	0.0	0.0	0.0	0.0	0.0	1.5	0.0	1.0	0.3
Central	Troll	35.6	26.9	23.3	7.7	22.9	25.9	48.8	26.9	27.3
Intermediate	Seine	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.4	0.2
	Sport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
	Total	35.6	26.9	24.5	7.7	22.9	25.9	48.8	27.5	27.5
Southern	Troll	0.0	1.0	0.0	1.5	0.0	0.0	0.0	1.2	0.5
Intermediate	Seine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
	Total	0.0	1.0	0.0	1.5	0.0	0.0	0.0	1.3	0.5
Central Inside	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Stephens Passage	Sport	0.0	0.3	0.0	2.0	0.6	0.0	0.0	2.2	0.6
	Gillnet	0.0	0.0	0.0	0.0	0.0	0.0	2.6	1.3	0.5
	Total	0.0	0.3	0.0	2.0	0.6	0.0	2.6	3.5	1.1
Lynn Canal	Troll	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
	Gillnet	40.4	30.5	41.7	44.7	42.6	50.2	11.9	32.3	36.8
	Total	40.4	30.5	41.7	44.7	42.6	50.2	11.9	32.7	36.8
British Columbia	Troll	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.4	0.4
Grand Total		100	100	100	100	100	100	100	100	100
Sample Size (Tags)		40	98	81	122	32	103	48	387	

accounted for an estimated average of 98.8% of the catch during 1982, 1983, and 1985–1990 (Table 10). Small percentages (<1% each) were taken in the Southern Outside, Southern Intermediate, and Prince William Sound Areas, and northern B.C. Overall, Lynn Canal was the most important single harvest area for the Berners River stock accounting for an estimated average of 36.8% of the total Berners River catch. The most important harvest areas in the troll and purse seine fisheries were the Northern Outside Area (23.0%) and the Central Intermediate Area (27.5%).

The Ford Arm Lake coho salmon stock was harvested primarily in the local Central Outside Area, (average 70.3% of the estimated catch), the Northern Outside Area (20.2%), and Central Intermediate Area (6.4%; Table 11). Minor harvests included the Southern Outside (2.0%), Southern Intermediate (0.4%), and Central Inside (0.6%) Areas, and northern British Columbia (0.1%).

Hugh Smith Lake coho salmon were harvested over a relatively broad area from Yakutat to northern British Columbia. From 1982 to 1990, the two most important harvest areas on average were the local Southern Inside Area, which accounted for an average of 27.8% of the catch, and the Central Outside Area, which accounted for 25.8% (Table 12). Catches were 17.8% in the Southern Outside Area, 5.4% in the Southern Intermediate Area, 13.9% in northern B.C., 4.2% in the Northern Outside Area, 1.7% in the Central Intermediate Area, and 3.4% in the Central Inside Area.

The harvest distribution of the Southeast Alaska troll catch of selected stocks (Appendix A.2) showed that nearly all of the estimated troll catch of Berners River (97.4%) and Ford Arm Lake (98.3%) coho salmon occurred in the Northwest Quadrant (Table 13). Hugh Smith Lake fish were more evenly distributed over the quadrants: Northwest 55.8%; Northeast 6.5%; Southwest 18.6%; Southeast 19.1%.

Migratory Timing

Although available to some extent during most of the season, the Berners River stock displayed charac-

Table 11. Estimated harvest distribution as a percentage of total harvest for Ford Arm Lake coho salmon by area and gear type, 1982, 1983 and 1985–1990.

Area	Gear Type	1982	1983	1985	1986	1987	1988	1989	1990	Avg.
Northern Outside	Troll	9.4	19.2	15.3	4.9	24.0	29.5	31.2	27.7	20.2
Central Outside	Troll	62.4	51.0	84.7	88.0	55.8	61.8	55.9	63.0	65.3
	Seine	0.0	23.0	0.0	0.7	6.8	0.0	5.9	3.3	5.0
	Total	62.4	74.0	84.7	88.7	62.6	61.8	61.8	66.3	70.3
Southern Outside	Troll	5.3	1.0	0.0	1.2	0.0	0.0	0.0	0.0	0.9
	Seine	5.0	0.0	0.0	1.9	0.0	1.6	0.0	0.0	1.1
	Total	10.3	1.0	0.0	3.1	0.0	1.6	0.0	0.0	2.0
Central Intermediate	Troll	13.0	5.8	0.0	1.3	13.4	5.5	6.4	5.5	6.3
	Seine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1
	Total	13.0	5.8	0.0	1.3	13.4	5.5	6.4	6.0	6.4
Southern Intermediate	Troll	0.0	0.0	0.0	2.0	0.0	0.5	0.6	0.4	0.4
Central Inside	Troll	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.6
Northern British Columbia	Troll	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.2	0.1
Grand Total		100	100	100	100	100	100	100	100	100
Sample Size (Tags)		31	71	31	65	49	132	157	134	

teristically late migratory timing in all fisheries. On average, the peak occurred in the troll fishery during late August through mid-September (Figure 4; Appendix B.1). The period of greatest harvest, i.e. >10% per week, was approximately August 17 to September 13, and the peak weekly harvest was in the beginning of September. On average, the troll harvest of all coho salmon stocks combined peaked during late July and declined substantially before the Berners River stock peaked. Some of the decline in the total troll catch of Berners River fish during early to mid-August was caused by the annual 10-d troll closures that have been in effect since 1980.

The Ford Arm Lake stock was characterized by relatively protracted timing in the troll fishery. Significant weekly catches occurred from the first week of July through the first week of September (Figure 4; Appendix B.2).

On average, during 1982–1990 Hugh Smith Lake coho salmon were available to the Alaska troll fishery from late June through the end of the season on 20 September (Figure 5; Appendix B.3). The peak typically occurred in mid- to late August. Differences existed between the timing of the Hugh Smith Lake stock in intermediate and outer coastal areas compared to the inside waters. In the Northeast, Northwest and Southwest Quadrants, migrations underwent significant harvest from mid-July through early September, having a peak contribution in late August (Figure 6; Appendix B.4). However, in the Southeast Quadrant peak harvests displayed substantially later timing compared with the total troll harvest of coho salmon (Figure 6; Appendix B.5). On average, in the Southeast Quadrant, the Hugh Smith Lake stock was most heavily harvested during the last week of August through the second week of September, whereas the total catch of all stocks peaked during the second half of July.

Survival Rates

The estimated smolt-to-adult survival rate, excluding fishing mortality, for 1982 through 1989 for the Hugh Smith Lake stock averaged 10.7% and ranged 4.2% to 19.1% (Table 14). The high degree of variability observed in smolt survival rates at Hugh Smith Lake may occur in other systems and explain much of the variability inherent in returns and catches of coho salmon in southern Southeast Alaska.

Survival rates to adult return for predominantly age-1 rearing presmolts tagged at the Berners River during late June averaged 5.3% (range 2.9% to 8.8%).

Table 12. Estimated harvest distribution as a percentage of total harvest for Hugh Smith Lake coho salmon by area and gear type, 1982–1990.

Area	Gear Type	1982	1983	1984	1985	1986	1987	1988	1989	1990	Avg.
Northern Outside	Troll	0.0	8.0	5.6	5.8	2.7	3.3	6.7	0.0	6.1	4.2
Central Outside	Troll	30.2	21.6	19.8	33.0	37.9	11.3	23.8	31.2	22.9	25.8
	Seine	0.0	0.4	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	25.8
Southern Outside	Troll	11.1	10.0	7.0	8.6	5.7	22.6	5.6	12.2	7.3	10.0
	Seine	5.2	3.0	8.7	3.0	11.5	5.6	17.1	9.5	6.2	7.8
	Total	16.3	13.0	15.7	11.6	17.1	28.2	22.7	21.7	13.5	17.8
Central Intermediate	Troll	1.4	2.2	6.9	0.0	2.7	1.2	0.0	1.0	0.0	1.7
Southern Intermediate	Troll	10.7	4.4	0.7	2.8	3.9	9.9	3.3	6.9	5.5	5.3
	Seine	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.3	0.1
	Total	10.7	4.4	1.2	2.8	3.9	9.9	3.3	6.9	5.8	5.4
Central Inside	Troll	0.3	2.9	1.2	0.7	1.1	0.0	0.0	5.6	1.2	1.4
	Seine	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Gillnet	0.0	5.5	0.6	0.3	3.2	0.0	0.0	4.2	3.1	1.9
	Total	0.3	9.0	1.8	1.0	4.3	0.0	0.0	9.8	4.3	3.4
Southern Inside	Troll	14.7	9.0	9.4	7.2	4.4	6.0	5.1	5.1	5.5	7.4
	Seine	11.7	13.6	9.2	15.8	7.9	2.0	3.9	8.8	8.0	9.0
	Gillnet	5.5	6.0	16.7	8.6	8.6	20.0	11.1	7.4	10.5	10.5
	Trap	0.0	2.0	0.7	0.4	0.1	0.0	0.0	0.0	0.6	0.4
	Sport	0.0	0.0	0.0	0.0	0.5	1.8	0.0	2.0	0.0	0.5
	Total	31.9	30.6	36.0	32.0	21.5	29.8	20.1	23.3	24.6	27.8
British Columbia	Troll	7.1	8.7	12.0	13.0	8.8	12.3	21.3	5.1	21.4	12.2
	Net	2.1	2.1	1.0	0.8	1.0	4.0	2.1	1.0	1.4	1.7
	Total	9.2	10.8	13.0	13.8	9.8	16.3	23.4	6.1	22.8	13.9
Grand Total		100	100	100	100	100	100	100	100	100	100
Sample Size (Tags)		83	175	143	196	228	99	42	92	258	

Ford Arm Lake rearing juveniles tagged during July and August experienced survival rates ranging from 6.0% to 14.4% and averaging 9.5%.

Smolts that were captured in trough traps in the Berners River in 1989 survived at an estimated rate of 19.8%. Fish from the same emigrant year that were tagged as presmolts in 1988 survived at an estimated rate of 8.8%. This indicates a 44% survival rate of the presmolts for the 11-month period from late June 1988 until late May 1989. Fish that were captured in minnow traps in spring 1989 and identified as smolts based on visual characteristics survived at an estimated rate of 20.5%, which was slightly higher than smolts taken in trough traps. Fish from the same catches that did not have strong smolt characteristics returned at a rate of 13.1% in 1990, suggesting that many of these were smolts despite their appearance.

Smolt Estimates

During 1983 to 1990 total coho smolt estimates for Hugh Smith Lake averaged 31,046 and ranged from 21,878 to 51,789. Annual estimates and confidence limits are shown in Table 15. Hugh Smith Lake smolts were predominantly (58.6%) age 2.0; 24.5% were age 3.0, and 15.1% were age 1.0 (Table 16). Age-4 and -5 smolts were present but uncommon. Estimated annual numbers of smolts migrating are shown in Table 17, while smolt production by brood year is shown in Table 18.

Table 13. Estimated harvest distribution as a percentage of the total Alaska troll harvest by quadrant for Berners River, Ford Arm Lake and Hugh Smith Lake coho salmon, 1982–1990.

Year	Northwest	Northeast	Southwest	Southeast	Number of Total	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
Avg.	97.4	2.5	0.1	0.0	100	
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
Avg.	98.3	0.3	1.0	0.4	100	
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
1984	59.7	1.3	15.1	23.8	100	67
1985	65.5	2.4	15.2	16.9	100	114
1986	73.9	5.2	9.5	11.4	100	155
1987	31.8	14.8	42.8	10.7	100	52
1988	68.2	0.0	15.6	16.3	100	22
1989	48.4	6.1	20.9	24.6	100	61
1990	55.3	8.3	15.8	20.6	100	123
Avg.	55.8	6.5	18.6	19.1	100	

The estimated number of smolts migrating from the Berners River in 1989 was 164,357 (95% CI 123,645–205,069). The age composition of migrants captured from lower river ponds was 35.6% age 1.0, 60.9% age 2.0, and 3.5% age 3.0 (n = 603).

The 1990 smolt migration from the Berners River was estimated at 141,176 fish (95% CI 126,291–156,061). The age composition of migrants captured from lower river ponds was 23.8% age 1.0, 74.3% age 2.0, 1.8% age 3.0, and 0.1% age 4.0 (n = 869).

Daily weir counts of returning adults and their age composition was reported by Wood (*in press*).

DISCUSSION

Harvest rate estimates for the three indicator stocks by the Alaska troll fishery from 1982 to 1990

Table 14. Estimated survival rates (percentage) of predominantly age-1. and older wild coho salmon presmolts and smolts from the time of tagging until entry into the coastal fisheries the following year, 1980–1989.

Year Tagged	Berners River Rearing Juveniles	Ford Arm Lake Rearing Juveniles	Hugh Smith Lake Smolts
1980	2.9	6.3	-
1981	6.7	9.6	-
1982	-	-	13.3
1983	5.9	14.4	7.4
1984	5.1	10.2	7.5
1985	3.2	6.0	19.1
1986	5.3	7.0	10.6
1987	4.3	12.7	4.2
1988	8.8	-	6.0
1989	-	-	17.3
Average	5.3	9.5	10.7

Table 15. Hugh Smith Lake coho salmon smolt counts at the weir and total smolt estimates, 1983–1990.

Year	Smolt Weir Count	Number Marked (M)	Returns Sampled (C)	Adipose Clips (R)	Smolt Estimate (N)	Variance	95% CI Lower Bound	95% CI 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

stabilized around 45% under a consistent management approach. The troll fishery, except in 1988, was conducted from early July through September 20 with only a single 10-d closure during late July or August. The average troll harvest rate fell to a low of 38% in 1988 when 13 d of regionwide closures were added to protect a very weak run and southern Southeast Alaska additionally remained closed throughout September.

Average total harvest rate estimates for the three indicator stocks from 1982 to 1990 were 56% for the outer coastal stock (Ford Arm Lake), 66% for the southern inside stock (Hugh Smith Lake), and 75% for the Lynn Canal stock (Berners River). Sustainable and optimum harvest rates for coho stocks are currently unknown. However, there is evidence that harvest rates over 75% can be excessive for some wild stocks. Coho stocks in Georgia Strait, British Columbia have undergone a long-term decline since the early 1970s that may be attributed to exploitation rates of 75–80% (CDFO 1990). Based on the current harvests of Georgia Strait stocks, as supported by simulation coho production model for the Carnation Creek stock, Canadian resource planners are recommending that the total harvest rate be reduced to 65% to 70%. Studies of ten Southeast Alaska stocks in the early 1980s (Shaul et al. 1991) indicated that, although harvest rates varied substantially by geographical area, the overall harvest rate averaged about 60%. The upward trend in catches of wild stocks in Southeast Alaska since the early 1980s suggests that this harvest rate is sustainable. Until further information on stock productivity is available, I recommend an upper limit of 70% as a guideline for stocks that are harvested entirely by mixed-stock fisheries where abundance-based management of stock groupings is unfeasible.

Recent harvest rates of >80% for the Hugh Smith Lake stock raise concern about the potential for overexploitation. Estimates for 1989 were 82% and 81% for 1990, compared to 52% to 66% (average 62%) for 1982 to 1988. Concurrently, escapements decreased to 433 fish in 1989 and 870 in 1990 from the 1982–1988 average of 1,337. If recent harvest rates are representative and continue, more conservative management of southern inside stocks may be needed as well as additional coded wire tagging and an improved escapement assessment program.

The high average harvest rate estimate (75%) for the Berners River stock is of less concern because a

Table 16. Estimated age composition percentages for Hugh Smith Lake coho salmon smolts, 1983–1990.

	Ages					
Year	1	2	3	4	5	Sample Size
1983	22.3	49.5	28.2	0.0	0.0	305
1984	12.3	52.4	34.6	0.7	0.0	269
1985	17.9	60.9	21.2	0.0	0.0	340
1986	16.0	58.5	25.5	0.0	0.0	306
1987	5.8	61.5	32.7	0.0	0.0	452
1988	16.1	71.2	12.6	0.1	0.0	702
1989	26.0	49.6	21.1	3.0	0.3	853
1990	4.7	73.3	19.8	2.0	0.2	782
1991	8.7	67.4	21.9	2.0	0.0	562
Average	14.4	60.5	24.2	0.9	0.0	

Table 17. Estimated numbers of coho salmon smolts emigrating from Hugh Smith Lake by age class, 1983–1990.

	Ages					
Year	1	2	3	4	5	Total
1983	11,546	25,640	14,603	0	0	51,789
1984	3,938	16,828	11,099	239	0	32,104
1985	4,216	14,307	4,976	0	0	23,499
1986	3,503	12,798	5,577	0	0	21,878
1987	2,083	22,276	11,859	0	0	36,218
1988	3,756	16,621	2,925	33	0	23,336
1989	6,928	13,203	5,623	789	77	26,620
1990	1,534	24,155	6,521	660	55	32,925
Average	4,688	18,228	7,898	215	16	31,046

large proportion of the harvest of Lynn Canal stocks occurs in a semi-terminal fishery where abundance of this specific stock group can be assessed and managed inseason using an historical fishery performance database. Because of greater management flexibility, escapement rather than harvest rate is a more appropriate management objective for the Berners River and similar systems, such as the Chilkat and Taku Rivers. Priorities for further assessment projects for northern inside stocks should focus on estimating escapement in the largest producing systems, especially the Chilkat and Taku Rivers.

The effect that variations in Lynn Canal removal rates can have on the Berners River escapements is apparent when comparing the 1986 and 1989 runs. Total run estimates were 24,635 in 1986 and 19,688 in 1989, and the troll fishery removal rates were close to the same at 55.1% and 53.4%. However, drift gillnet removal rates were estimated at 83.6% in 1986, which left an escapement of only 1,752. By comparison, in 1989 the gillnet fishery took only 15.5%, and the resulting escapement was 7,509.

A second major objective of the indicator stock program, in addition to estimating harvest rates, was to investigate the relationship between escapement and yield and to determine an appropriate level of exploitation for wild coho stocks. At Hugh Smith Lake, 5 years of age-.1 coho salmon escapements ranging over two fold from 903 to 2,144 produced a narrow range of estimated smolt migrations that only varied up to 23%: 23,480 to 29,548. No relationship between escapement and smolt production was evident from visual interpretation of this limited data. However, smolt production estimates from more recent low escapements of 513 spawners in 1988 and 424 spawners in 1989 may help better define the relationship between escapement and resultant production. The continued development of spawner-recruit relationships will help in understanding the implications of harvesting the Hugh Smith stock and other stocks at the high rates discussed above. Determination of spawner-recruit relationships for the Hugh Smith Lake stock and the other indicator stocks will require several more years of return estimates from a broader range of escapements.

Results of this study continue to support earlier conclusions (Shaul et al. 1991) about the relative stability of coho production from some lake systems and the important effect of marine survival rates on adult production.

Table 18. Estimated numbers of Hugh Smith Lake coho salmon smolts emigrating from specific parent escapements and brood years, 1983–1990.

		Age					
Brood Year	Parent-Year Escapement	1	2	3	4	5	Total
1981		11,546	16,828	4,976	0	0	33,351
1982	2,144	3,938	14,307	5,577	0	0	23,822
1983	1,490	4,216	12,798	11,859	33	77	28,983
1984	1,408	3,503	22,276	2,925	789	55	29,548
1985	903	2,083	16,621	5,623	660		24,988
1986	1,783	3,756	13,203	6,521			23,480
1987	1,118	6,928	24,155				
1988	513	1,534					
1989	424						
1990	870						

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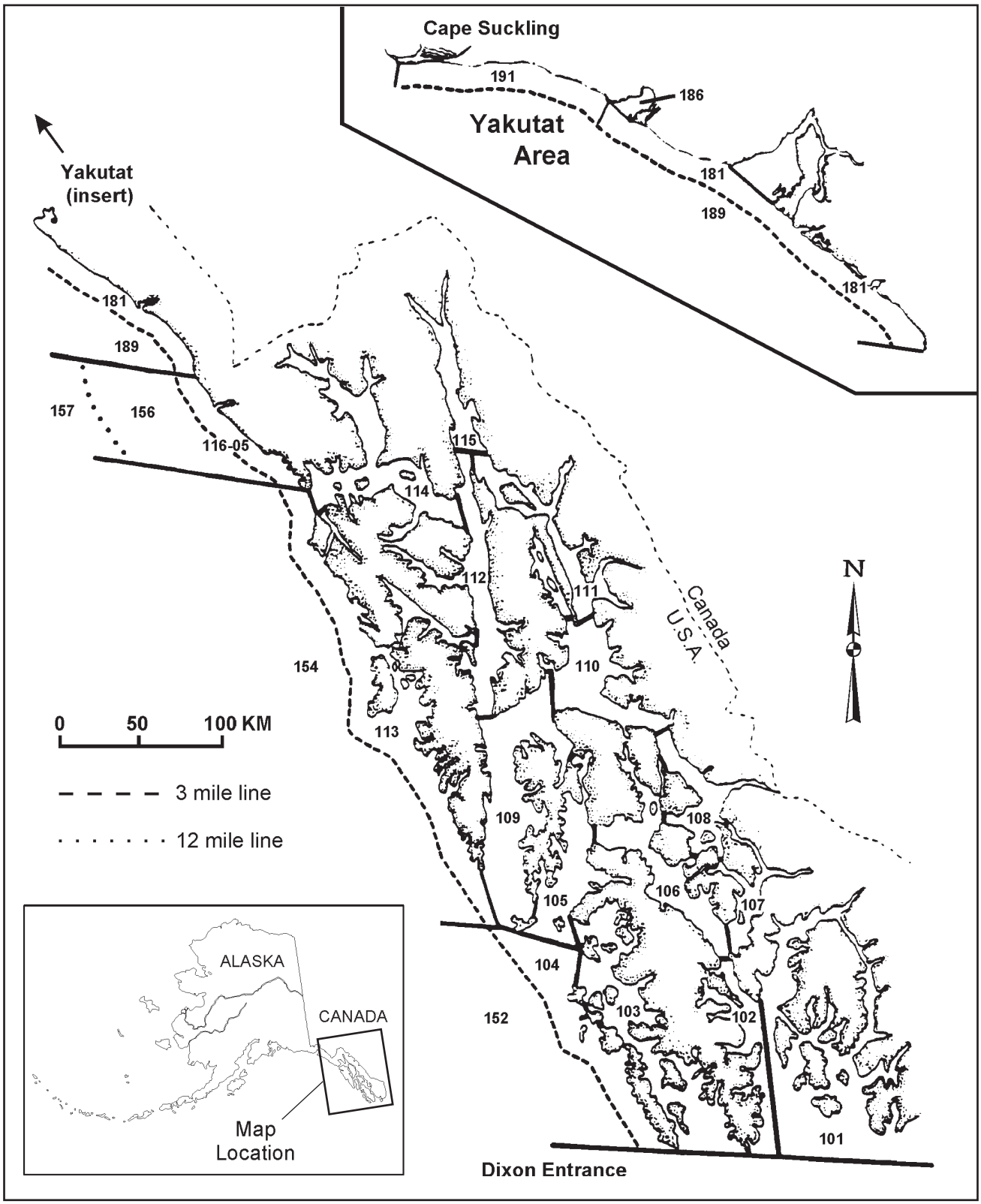
— Appendix A. Statistical Areas —



Appendix A.1. Southeast Alaska statistical fishing districts.

— *Appendix A. Statistical Areas* —

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

PMFC 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

— Appendix B. Estimated Weekly Proportions —

Appendix B.1. Estimated weekly proportions of the total troll catch of Berners River coho salmon, 1982, 1983, and 1985–1990.

Stat. Week	1982	1983	1985	1986	1987	1988	1989	1990	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	0.0000	0.0000	0.0000	0.0647	0.0000	0.0000	0.0000	0.0000	0.0081
28	0.0000	0.0193	0.0370	0.0199	0.0000	0.0000	0.0000	0.0269	0.0129
29	0.0000	0.0000	0.0000	0.1329	0.0000	0.0000	0.0000	0.0354	0.0210
30	0.0244	0.0761	0.1039	0.0791	0.1037	0.0167	0.0313	0.0173	0.0566
31	0.0486	0.0566	0.0664	0.0245	0.1108	0.0000	0.0509	0.0547	0.0516
32	0.0000	0.0832	0.0377	0.0592	0.0513	0.0000	0.0538	0.0723	0.0447
33	0.0952	0.0000	0.0000	0.0181	0.0000	0.0869	0.0484	0.0434	0.0365
34	0.3578	0.2010	0.0000	0.1107	0.2010	0.0684	0.0619	0.1346	0.1419
35	0.0985	0.1663	0.1227	0.1585	0.0323	0.1664	0.3296	0.2301	0.1631
36	0.0000	0.1655	0.3482	0.2243	0.2880	0.3805	0.1329	0.1555	0.2119
37	0.1449	0.1165	0.2380	0.1081	0.1839	0.2449	0.2342	0.1923	0.1828
38	0.0000	0.1155	0.0461	0.0000	0.0290	0.0329	0.0570	0.0375	0.0398
39	0.2306	0.0000	0.0000	0.0000	0.0000	0.0033	0.0000	0.0000	0.0292
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample Size	25	77	50	87	43	63	49	303	

Appendix B.2. Estimated weekly proportions of the total troll catch of Ford Arm Lake coho salmon, 1982, 1983, and 1985–1990.

Stat. Week	1982	1983	1985	1986	1987	1988	1989	1990	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0000	0.0106	0.0484	0.0000	0.0000	0.0000	0.0074
27	0.0000	0.0000	0.4280	0.1164	0.0613	0.0092	0.0071	0.0000	0.0777
28	0.0000	0.1662	0.0429	0.1967	0.0682	0.0278	0.0000	0.0923	0.0743
29	0.1584	0.1326	0.0205	0.1584	0.0843	0.0608	0.0520	0.1765	0.1054
30	0.0844	0.1376	0.0752	0.1347	0.1918	0.1081	0.1084	0.0737	0.1142
31	0.1006	0.1775	0.0385	0.0828	0.1094	0.0278	0.1209	0.1994	0.1071
32	0.0000	0.1025	0.0546	0.1558	0.1500	0.0000	0.1899	0.2116	0.1080
33	0.2394	0.0157	0.1003	0.0611	0.0509	0.1464	0.1044	0.1332	0.1064
34	0.1235	0.0895	0.0000	0.0000	0.1208	0.1496	0.0669	0.0000	0.0688
35	0.1020	0.0991	0.1660	0.0297	0.0955	0.0000	0.2455	0.0981	0.1045
36	0.1917	0.0567	0.0673	0.0538	0.0194	0.4212	0.0746	0.0000	0.1106
37	0.0000	0.0000	0.0000	0.0000	0.0000	0.0450	0.0156	0.0152	0.0095
38	0.0000	0.0226	0.0067	0.0000	0.0000	0.0041	0.0148	0.0000	0.0060
39	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample Size	37	83	49	85	65	148	206	156	

Appendix B.3. Estimated weekly proportions of the total troll catch of Hugh Smith Lake coho salmon, 1982–1990.

Stat. Week	1982	1983	1984	1985	1986	1987	1988	1989	1990	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0402	0.0000	0.0000	0.0276	0.0000	0.0000	0.0000	0.0075
27	0.0085	0.0000	0.0000	0.0000	0.0073	0.0183	0.0000	0.0229	0.0310	0.0098
28	0.0000	0.0415	0.0000	0.0492	0.0723	0.0000	0.0000	0.0000	0.0608	0.0249
29	0.1134	0.0867	0.0655	0.1351	0.1081	0.1910	0.0000	0.0379	0.1511	0.0988
30	0.0628	0.1481	0.0000	0.1689	0.1246	0.0430	0.0573	0.2477	0.0871	0.1044
31	0.0950	0.1010	0.2028	0.1394	0.1216	0.1554	0.0474	0.0788	0.1531	0.1216
32	0.0000	0.1224	0.1365	0.0713	0.1217	0.0924	0.0000	0.0631	0.1175	0.0805
33	0.2632	0.0154	0.1014	0.1189	0.0553	0.0000	0.2941	0.1359	0.1052	0.1210
34	0.1111	0.2405	0.0000	0.0000	0.1007	0.2527	0.1498	0.0632	0.0677	0.1095
35	0.2396	0.0745	0.0764	0.1498	0.1378	0.1152	0.1156	0.1872	0.1216	0.1353
36	0.0481	0.0626	0.1317	0.0747	0.0794	0.0863	0.3358	0.0205	0.0279	0.0963
37	0.0170	0.0686	0.1871	0.0521	0.0284	0.0181	0.0000	0.1428	0.0631	0.0641
38	0.0055	0.0348	0.0584	0.0406	0.0428	0.0000	0.0000	0.0000	0.0139	0.0218
39	0.0358	0.0039	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0044
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample Size	64	107	67	114	155	52	22	61	120	

— Appendix B. Estimated Weekly Proportions —

Appendix B.4. Estimated weekly proportions of the total troll catch of Hugh Smith Lake coho salmon in the Northwest, Northeast and Southwest Quadrants combined, 1982–1990.

Stat. Week	1982	1983	1984	1985	1986	1987	1988	1989	1990	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0534	0.0000	0.0000	0.0310	0.0000	0.0000	0.0000	0.0094
27	0.0000	0.0000	0.0000	0.0000	0.0084	0.0205	0.0000	0.0128	0.0395	0.0090
28	0.0000	0.0556	0.0000	0.0601	0.0827	0.0000	0.0000	0.0000	0.0694	0.0298
29	0.1453	0.1084	0.0871	0.1515	0.1236	0.2139	0.0000	0.0511	0.1801	0.1179
30	0.0735	0.1800	0.0000	0.2001	0.1424	0.0320	0.0705	0.2856	0.0956	0.1200
31	0.0861	0.1144	0.2695	0.1310	0.1276	0.1394	0.0583	0.0763	0.1902	0.1325
32	0.0000	0.1322	0.1814	0.0516	0.1285	0.0898	0.0000	0.0498	0.1494	0.0870
33	0.2845	0.0207	0.1348	0.1147	0.0528	0.0000	0.3070	0.1215	0.1217	0.1286
34	0.1229	0.2301	0.0000	0.0000	0.1151	0.2477	0.1449	0.0852	0.0372	0.1092
35	0.2728	0.0562	0.0000	0.1470	0.1239	0.1291	0.1423	0.2344	0.0839	0.1322
36	0.0149	0.0593	0.1263	0.0748	0.0673	0.0966	0.2770	0.0151	0.0000	0.0813
37	0.0000	0.0231	0.1062	0.0359	0.0147	0.0000	0.0000	0.0681	0.0260	0.0305
38	0.0000	0.0200	0.0413	0.0333	0.0130	0.0000	0.0000	0.0000	0.0071	0.0127
39	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample Size	44	73	44	87	128	45	18	44	96	

Appendix B.5. Estimated weekly proportions of the total troll catch of Hugh Smith Lake coho salmon in the Southeast Quadrant, 1982–1990.

Stat. Week	1982	1983	1984	1985	1986	1987	1988	1989	1990	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	0.0386	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0517	0.0000	0.0100
28	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0293	0.0033
29	0.0000	0.0227	0.0000	0.0614	0.0000	0.0000	0.0000	0.0000	0.0449	0.0143
30	0.0250	0.0542	0.0000	0.0292	0.0000	0.1350	0.0000	0.1391	0.0561	0.0487
31	0.1266	0.0613	0.0000	0.1771	0.0797	0.2883	0.0000	0.0859	0.0169	0.0929
32	0.0000	0.0934	0.0000	0.1595	0.0735	0.1139	0.0000	0.1013	0.0000	0.0602
33	0.1874	0.0000	0.0000	0.1377	0.0730	0.2940	0.2384	0.1770	0.0448	0.1280
34	0.0692	0.2711	0.0000	0.0000	0.0000	0.0000	0.1709	0.0000	0.1797	0.0768
35	0.1213	0.1284	0.3086	0.1622	0.2347	0.0000	0.0000	0.0519	0.2600	0.1408
36	0.1659	0.0723	0.1483	0.0745	0.1638	0.1688	0.5907	0.0359	0.1303	0.1723
37	0.0774	0.2026	0.4327	0.1247	0.1243	0.0000	0.0000	0.3572	0.1992	0.1687
38	0.0253	0.0784	0.1104	0.0737	0.2510	0.0000	0.0000	0.0000	0.0387	0.0642
39	0.1633	0.0156	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0199
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample Size	20	34	23	27	27	7	4	17	24	