MIGRATORY TIMING AND ESCAPEMENT OF TAKU RIVER SALMON STOCKS IN 1988

By

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ABSTRACT

Mark-recapture studies of Taku River salmon (*Oncorhynchus*) stocks were continued by the Alaska Department of Fish and Game and the Canadian Department of Fisheries and Oceans in 1988. The objectives of the program were to provide in-season estimates of the inriver abundance of sockeye salmon (*O. nerka*) and postseason estimates of the inriver abundance of coho (*O. kisutch*) and chum salmon (*O. keta*), and to determine the feasibility of developing mark-recapture estimates of the Taku River chinook salmon (*O. tshawytscha*) escapement. Marked to unmarked ratios of salmon harvested in Canadian inriver commercial and test gill net fisheries were used to develop estimates of the inriver abundance of sockeye, coho and chum salmon. A total of 3,292 sockeye salmon was captured in fish wheels located at Canyon Island, of which 2,873 were tagged and 958 were subsequently recovered in fisheries or on the spawning grounds. An estimated 87,028 sockeye salmon migrated upriver past Canyon Island, of which 74,055 escaped inriver fisheries. The Canadian commercial fishery exploitation rate of the inriver sockeye salmon return was 0.138. A total of 1,977 coho salmon was tagged, of which 299 were later recovered. Tagging was not conducted over the later part of the coho salmon run. However we estimated that 43,093 fish had passed Canyon Island by 18 September. Of these, 39,450 escaped through the inriver fisheries. The exploitation rate of the inriver coho salmon return by the commercial fishery was only 0.073 because fishing was stopped when the Canadian harvest quota of 3,000 fish was reached. The estimated inriver return of chum salmon through 18 September was 39,809 fish. Because tagging and recovery efforts were low and some unknown proportion of the return occurred after the project terminated, the accuracy and precision of the estimate for this species are poor. We have not developed an estimate of the chinook salmon escapement because all the necessary recovery effort information has yet to be received from Canada. Few tagged chinook salmon were found on the spawning grounds however, indicating that the return was either far larger than anticipated or previously documented, or that violations of assumptions necessary to develop unbiased estimates of return size existed in our study. Potential sources of such bias are examined.

KEY WORDS: Mark-recapture, escapement estimation, migratory timing, Taku River, transboundary river, salmon, fish wheel

INTRODUCTION

The Taku River originates in northern British Columbia and flows through Southeast Alaska, emptying into the Pacific Ocean near Juneau, Alaska (Figure 1). All five species of Pacific salmon (*Oncorhynchus* spp.) return to spawn in the drainage and are primarily exploited by Canadian inriver and Alaskan District 111 commercial gill net fisheries and Alaskan commercial troll fisheries. Relatively small numbers of fish, primarily chinook (*O. tshawytscha*) and coho (*O. kisutch*) salmon, of Taku River origin are harvested by Canadian and Alaskan sport fisheries.

Research on Taku River salmon has blossomed in this decade as a result of treaty negotiations between the United States and Canada regarding salmon interceptions. Treaty negotiations revealed the lack of basic knowledge of the population dynamics of transboundary river stocks and of the contributions of these stocks to Alaskan and Canadian fisheries. The Pacific Salmon Treaty was drafted and ratified by the two countries in 1985; it mandated that specific proportions of any surplus return of sockeye salmon (*O. nerka*) not needed to satisfy escapement requirements for the Taku River be allocated to each country's fishermen.

Research programs designed to provide data necessary to manage fisheries in accordance with treaty directives were initiated on the Taku River in 1983. Mark-recapture studies on the Taku River, jointly operated by the Alaska Department of Fish and Game (ADF&G) and the Canadian Department of Fisheries and Oceans (CDFO), have been conducted annually since 1984 to produce estimates of the Taku River escapements of sockeye, pink (*O. gorbuscha*), coho and chum salmon (*O. keta*) (Clark et al. 1986, McGregor and Clark 1987 and 1988). The studies were expanded in 1988 to determine the feasibility of developing mark-recapture estimates of the Taku River chinook salmon escapement. This report presents results from Taku River mark-recapture studies continued in 1988.

The specific objectives of the program were to:

1) provide in-season estimates of the abundance of Taku River sockeye salmon migrating past Canyon Island,

2) estimate the abundance of Taku River coho and chum salmon migrating past Canyon Island, and

3) determine the feasibility of developing mark-recapture estimates of the Taku River chinook salmon escapement.

METHODS

Study Area Description

The Taku River originates in the Stikine Plateau of northwestern British Columbia, and drains an area of approximately 16,000 square kilometers (Figure 1). The Taku is formed by the merging of two principal tributaries, the Inklin and Nakina Rivers, approximately 50 km upstream from the international border. The river flows southwest from this point though the Coast Mountain Range and empties into Taku Inlet about 30 km east of Juneau, Alaska. Approximately 95% of the Taku River watershed lies within Canada.

The Taku River is a turbid river, with much of its discharge originating in glacial fields on the eastern slopes of the Coast Range Mountains. This turbidity precludes accurate enumeration of salmon escapements by aerial or foot surveys, except for clearwater tributaries in the upper drainage. Water discharge in the summer generally increases in proportion to the amount of sunshine received in the interior (ADF&G 1955). Winter flows are minimal, ranging from approximately 20 - 40 cubic meters per second (cm/s) at the Canadian government's water survey station located on the lower Taku River near the confluence of the Taku and Tulsequah Rivers (P. Milligan, CDFO, Whitehorse, Yukon Territory, personal communication). Discharge increases in April and May and reaches a maximum average flow of 740 cm/s in June. Flow usually remains high in July and begins dropping in late August. The efficiency of fish wheels used to capture fish for tagging and the effectiveness of the Canadian commercial fishery are affected by the magnitude of river discharge. Sudden increases in discharge in the lower river result from the release of the glacially impounded waters of Tulsequah Lake (Kerr 1948). These floods usually occur once or twice a year between May and August. Maximum flows during the floods have measured from 787 - 2,489 cm/s. During the floods, water levels fluctuate dramatically and the river carries a tremendous load of debris.

Fish Wheel Operation

Migrating adult salmon were captured with two fish wheels at Canyon Island, located approximately 4 km downstream from the international border (Figure 1). Each fish wheel consists of a pontoon framework supporting an axle, paddle, and basket assembly. Two fish-catching baskets rotate about the axle due to the force of the water current against two paddles. The paddles are attached to paddle uprights set at right angles to the baskets. Crossbracing connects the baskets and paddle uprights. As the fish wheel baskets rotate and scoop up salmon, V-shaped slides attached to the rib structure of each basket direct fish to liveboxes bolted to the outer sides of the pontoons.

Each fish wheel was constructed of milled lumber and was supported by two 7.6 m long plywood pontoons. Six 200 liter (55 gallon) steel barrels, four of which were filled with polyeurethane foam, were strapped beneath each pontoon for flotation. The baskets measured 3.1 m by 3.7 m, and were covered with nylon seine mesh (5.1 x 5.1 cm openings). Liveboxes were attached on the outside of both pontoons.

The fish wheels were positioned in the vicinity of Canyon Island on opposite river banks, approximately 200 m apart. Fish wheels were secured in position by anchoring them to large trees with 0.95 cm steel cable and were held out from and parallel to the shoreline by log booms.

The fish wheels rotated at 0 - 4 r.p.m., depending on the water velocity and the number of attached paddles. When water levels subsided we attached more paddles and moved the fish wheels farther out from shore into faster water currents to maintain adequate r.p.m. to catch fish.

The fish wheels were operative from 11 May through 18 September, except during high water caused by the release of Tulsequah Lake on 1 August and 16 September.

Tagging Procedures

All uninjured salmon caught in the fish wheels were tagged, with the exception of pink salmon and individuals of other species less than 350 mm in length (mid-eye to fork of tail; MEF). Pink salmon were not tagged because the even-year Taku River run was expected to be very poor. Sockeye and coho salmon less than 350 mm in length were not tagged because the recapture of marked and catch of unmarked fish occur used to generate population estimates for these species occur in the Canadian inriver gill net fisheries, and fish in this size range are virtually unsusceptible to capture in the gill nets.

Salmon were dipnetted from a livebox into a tagging trough partially filled with river water. Spaghetti tags (Floy Tag and Manufacturing Inc., Seattle, WA) were applied to fish as follows: one person held the fish in the tagging trough while another person inserted a 15 cm applicator needle through the dorsal musculature immediately below the dorsal fin. The ends of the spaghetti tag were then knotted together with a single overhand hitch. Fish were handled with bare hands to reduce scale abrasion. During the application of spaghetti tags biological sampling was also conducted. Sex and MEF length measurements were recorded and scale samples taken from all chinook, sockeye, coho, and chum salmon. The tagging and sampling procedures took from 20 to 40 seconds per fish to complete. The fish were then immediately, and gently, released back into the river. Sex, age and length composition data of fish wheel catches are reported elsewhere in the ADF&G Technical Fishery Report Series and CDFO reports.

Fish wheel catches were sampled in the morning, afternoon, and evening. More frequent checks were made during the peak migration to minimize holding time and overcrowding of fish in the liveboxes.

The spaghetti tags we used were made of hollow PVC tubing (approximately 2.0 mm in diameter and 30 cm in length) and were consecutively numbered and labeled with project description information. Fluorescent orange tags were used to tag all species except chinook salmon. Chinook salmon were tagged with gray colored tags because, unlike other species for which abundance estimates were derived from tagged to untagged ratios in the inriver fishery on the highly glacial lower Taku River, estimates of chinook salmon abundance were to be generated from examining fish for tags in clear water spawning areas. Fluorescent orange tags are highly visible in clear water and we believed that by using less visible gray tags the potential problem of selective predation on tagged fish on the spawning grounds by bears, raptors and other predators would be minimized.

A total of 20 chinook salmon captured in fish wheels was tagged with radio transmitters by the National Marine Fisheries Service (Eiler, National Marine Fisheries Service, personal communication). Movements of these fish in the river were tracked to determine the feasibility of using this technique to determine the distribution of chinook salmon in the system.

Tag Recovery

Tags were recovered from fish harvested in inriver commercial, test and food fisheries. The fisheries occurred in Canadian portions of the Taku River within 20 kilometers of the international border. The commercial fishery operated between one to three days per week from late June through late August. Drift and set gill nets were the principal gear types used, although one fishermen operated a fish wheel to capture fish. One fisherman was contracted by CDFO to conduct the test fishery by making five standardized drifts each morning and evening that the commercial fishery was not open. The test fishery continued until 23 September, approximately 3 weeks after the commercial fishery had been closed for the season. A cash reward of $2.00 was offered by CDFO for each chinook, sockeye, coho and chum salmon tag returned with information on the date and location of recapture. Tags were collected on a regular basis by the CDFO Fisheries Patrol Officer who also monitored and compiled daily catch statistics.

Fishery catches were sampled for sex, post-orbit to hypural (POH) length measurements, and scale data by CDFO and ADF&G personnel. Paired MEF and POH length measurements were taken from commercially caught salmon and were used to develop linear regressions for converting measurements from one type to another. Sex, age, and length compositions of these catches are summarized elsewhere in the ADF&G Technical Fishery Report Series and CDFO reports.

Tag recoveries were also made by CDFO personnel at upstream migrant weirs at the outlets to Little Trapper and Little Tatsamenie Lakes, and at the Hackett River and by ADF&G at the Nahlin River. Tags were also gathered at carcass-collecting weirs by CDFO on the Nakina River and by ADF&G on Tatsatua Creek, located approximately one mile downstream from CDFO's Little Tatsamenie Lake weir. Additional tag recoveries were made at spawning locations in the upper Nahlin River, Kuthai Lake, and along the mainstem of the Taku River by ADF&G, CDFO, and the National Marine Fisheries Service (NMFS). Small numbers of tags were also recovered in the U.S. District 111 fishery.

Statistical Methods

Estimates of total population size (N) and associated variance were calculated using methods described by Chapman and Junge (1956) and Darroch (1961) and summarized by Seber (1982, p.431- 445). The estimate of population size per recovery stratum j is given by:

$$N_j = D_n S^{-1} t$$

where D is the diagonal matrix of sample size in the recovery strata, S is the matrix of tag recoveries by tagging and recovery strata, and t is the vector of the number of tags put out per tagging stratum.

The total population is then the sum of these N_j. The variance-covariance matrix of the population estimate in each period strata is given by:

$$\text{Var-Cov } [N] = D_u G^{-1} D_m D_t^{-1} G'^{-1} D_u + D_u (D_p - 1)$$

where:

U = the vector of unmarked population (equal to $D_u S^{-1} t$ where u is the vector of unmarked fish in the recovery effort and D_u is the diagonal matrix of this vector)

G = the matrix of probabilities (G_{ij}) that a fish in tagging stratum i moves to recovery stratum j

p = the vector defined by s^{-1} t and D_p is the corresponding diagonal matrix

D_m = the diagonal matrix of m_i's where $m_i = \Sigma G_{ij}/p_j - 1$ and p_j's are the inverse of the elements of vector p, and

1 = a vector of ones.

Inriver sockeye salmon return estimates were generated on an in-season basis in 1988. Mark-recapture data was forwarded to the Douglas ADF&G office within 24 hours after the weekly closure of the Canadian fishery. Data was quickly analyzed and inriver return estimates were developed. Due to the estimated three to four day travel time for fish between District 111 and Canyon Island (Clark et al. 1986) and since most tags applied at Canyon Island were not recovered until the following week in the Canadian fishery, our estimates of inriver abundance correspond with the movement of Taku River sockeye salmon through District 111 approximately two weeks earlier.

The migration of each species of salmon can be characterized by its migratory timing distribution. Fish wheel catches and CPUE reflect the timing of the different species migrating past Canyon Island. Migratory timing statistics (mean day of passage and its variance) were calculated following the procedures of Mundy (1982):

$$D = \sum_{i=1}^{d} i * P(i)$$

where i is an index of the day of migration (i = 1 is the first day of migration), d is the last day of the migration, P(i) is the proportion of the total population passing the reference site on day i as estimated from daily fish wheel CPUE, and D is the mean index day of migration which corresponds to a calendar date.

The standard error of the migration is defined as:

$$SD[D] = \left(\sum_{i=1}^{d} (D - i)^2 * P(i) \right)^{1/2}$$

RESULTS AND DISCUSSION

Fish Wheel Catches

Catches of chinook, sockeye, coho, pink and chum salmon and Dolly Varden char (*Salvelinus malma*) are summarized in Tables 1-6. Graphs of the fish wheel CPUE for each salmon species are provided in Figure 2.

The total catch of 1,436 chinook salmon in 1988 far exceeded annual fish wheel catches of this species during 1984-1987 (Table 7) because fish wheels were deployed approximately one month earlier in 1988 than in previous years. Chinook salmon catches extended from 12 May through 17 August. The catch peaked on 14 June when 59 fish were captured, but catches were fairly stable (20 to 55 fish) from 15 May through 22 June. A total of 3,292 sockeye salmon were caught between 29 May and 13 September. Peak sockeye salmon catches and CPUE occurred during the week of 10-16 July (statistical week 29), when 542 fish were caught. The pink salmon catch of 3,982 fish represents only 9% of the 1988 catch and was the lowest fish wheel catch we have recorded for this species. The fish wheels caught 2,168 coho salmon, slightly less than in 1987, but far higher than catches during 1984-1986. Catches peaked on 2-3 September, when 161 and 194 coho salmon, respectively, were caught. Chum salmon catches totaled 1,089 fish, with a peak daily catch of 111 on 3 September.

Migratory Timing

The migratory timing of sockeye and pink salmon runs, as measured by fish wheel catches, has been quite consistent during the years 1984-1988 (Table 8). The mean dates of the sockeye and pink salmon migrations in 1988 were 19 and 21 July, respectively. The consistency of migratory timing of other species is more difficult to assess because the duration of fish wheel operations has varied between years and has failed to cover the complete migration of these species. The mean date of the fish wheel catch of chinook salmon in 1988 was 8 June, roughly 3 weeks earlier than in past years, and is attributable to the early start of the program in 1988 relative to prior years. The mean dates of the coho and chum salmon returns were 24 and 31 August, respectively. Both the mean dates and associated standard errors of the migrations of these two species are biased early since the fish wheels were shut down prior to the end of the migration of each species.

Tagging and Recovery Data

A total of 7,187 salmon was tagged at Canyon Island in 1988 (Table 9). Approximately 40% (2,873) of the tags were applied to sockeye salmon, followed by 28% (1,977) to coho, 19% (1,338) to chinook, and 14% (999) to chum salmon. The numbers of fish tagged each day by species are listed in Tables 1-5.

A total of 1,412 tagged fish was recovered (Table 9). Approximately 48% (676) of these tags were recovered on the spawning grounds, 45% (634) in the Canadian commercial fishery, and 5% (69) in the Canadian test fishery. Low numbers of recoveries were made in the Canadian lower river food fishery and downstream in Taku Inlet in U.S. commercial gill net catches. Sockeye salmon represented 68% (958) of all tagged fish that were recovered.

Escapement Estimation

We derived escapement estimates for sockeye, coho and chum salmon runs. A chinook salmon escapement estimate was not generated because all pertinent data has not yet been received from CDFO.

Sockeye Salmon

Recoveries of tagged sockeye salmon in the Canadian commercial and test fisheries were used to estimate the magnitude of the inriver return of sockeye salmon. A total of 457 tags with corresponding recovery date information was returned from the 12,014 sockeye salmon taken in the Canadian commercial fishery and the 714 sockeye salmon harvested in the test fishery (Table 10a). Because estimation procedures are based on large sample theory, tagging and recovery periods were combined at the beginning and end of the season to increase the frequency of tag recoveries in tag-recapture strata. Tagging strata combined for this reason were statistical weeks 23-26 and 34-39, while grouped recovery strata were statistical weeks 26-27 and 35-39. The original stratification was thus reduced to 9 tagging and recovery strata.

For the purposes of generating population estimates, the number of fish tagged between statistical week 23 and 26 was adjusted downward from the actual total of 402 to an adjusted total of 233. This was done to reduce the potential bias caused by the late start of the inriver commercial fishery, since some fish were tagged too early in the season to be available for recapture in the fishery. The adjusted tagging total was generated by taking the ratio of the number of tags applied in tagging week 26 to the number of tags recovered from this week, and multiplying this ratio by the number of recoveries of tagged fish from tagging weeks 23-25.

Analysis of the revised data matrix revealed that the weekly abundance estimate for recovery strata 31, once the catch was subtracted, was less than zero. Obviously it is not possible for fewer fish to be present in the recovery strata than were caught. Darroch (1961) discusses the possibility of strata-specific exploitation rates being larger than 1.0 or less than 0. This is principally a result of the large degree of uncertainty associated with the weekly abundance and exploitation rates. Darroch notes that even though weekly estimates may be imprecise, large negative covariances between strata may result in a relatively accurate total abundance estimate. He suggests pooling adjacent strata to deal with this problem. Therefore we pooled data from recovery weeks 31-32 and tagging weeks 30-31.

Using these strata, we estimated that 87,028 sockeye salmon passed Canyon Island (Table 10b). The approximate 95% confidence interval associated with the estimate was +/- 18,996, and the coefficient of variation was 11.1%. The Taku River sockeye salmon run was exploited by the Canadian commercial fishery at an estimated annual rate of 0.138, compared to a 1984-1988 average of 0.155. After removal of 12,973 sockeye salmon by the Canadian commercial, test and food fisheries, the escapement totaled 74,055 fish. The Transboundary Technical Committee (1989) has set an interim escapement goal of 71,000-80,000 sockeye salmon for Canadian portions of the Taku River drainage.

The escapement estimate does not include several groups of sockeye salmon that spawn in the drainage: (1) fish that spawn in streams located downriver from Canyon Island; (2) jack sockeye salmon (fish smaller than approximately 350 mm MEF that have spent only 1 year at sea), and; (3) a small percentage of the run that passed Canyon Island prior to the beginning of the inriver fisheries. With regards to the first group, the number of sockeye salmon spawning downstream from Canyon Island is unknown but presumed small. A total of 309 sockeye salmon was passed through the Yehring Creek weir (Elliott et al 1989), however this was only a partial count since the weir was installed after some fish had already entered the creek. Small numbers of sockeye salmon were also observed on the U.S. side of the border in Fish Creek (Figure 1). The contribution of jacks can represent a sizeable portion of the Taku River run, as in 1988 when they comprised 6.8% of the total fish wheel catch of sockeye salmon (McGregor and Jones in prep). However because this size class is not susceptible to the gill nets used as recapture gear and is of almost no commercial importance, we have omitted this group from the population estimate. Lastly, as mentioned above, by reducing the number of tags applied during tagging weeks 23-25 we did not account for a small segment of the run that passed Canyon Island during late May and early June. We believe that had we not done this, the estimated escapement for the first recapture strata would have been highly inflated.

Coho Salmon

Recoveries of tagged coho salmon in the Canadian commercial and test fisheries were used to estimate the inriver return of coho salmon. Tagged coho salmon recovered from the fisheries totaled 156 fish (Table 11).

Early season coho salmon tag and recovery data were pooled to form one strata, as was the case for sockeye salmon; no other pooling of strata was required. Tagging and recovery strata totaled 10 each (Table 11). The number of coho salmon passing Canyon Island by 18 September, the last day of tagging, was 43,093 fish, similar to the 1987 estimate of 43,569 that had passed by as of 23 September of that year. The approximate 95% confidence interval around the 1988 estimate was +/- 14,036 fish, and the coefficient of variation was 16.4%. A total of 3,643 coho salmon was harvested in the Canadian commercial, test and food fisheries, thereby reducing the escapement estimate to 39,450 fish.

Our estimate of escapement based on tag and recapture data does not cover the entire coho salmon run. We terminated operation of the fish wheels on 18 September by which time the catches had declined to a low level. Recapture efforts were suspended on 23 September when the inriver test fishery terminated. Some unknown proportion of the run migrated upriver after this time, although we believe the run was almost over due to the low fish wheel, inriver test gill net, and U.S. District 111 gill net catches experienced in late September. The escapement of coho salmon to streams located downriver from Canyon Island is unknown and is not included in our estimate. A total of 1,423 coho salmon was counted through an adult counting weir operated by ADF&G, Sportfish Division, on Yehring Creek (Elliott et al 1989), however adults were not enumerated in other known spawning areas in lower river portions of the Taku River. As for sockeye salmon, the coho salmon escapement estimate does not include fish smaller than 350 mm MEF.

Chum Salmon

Recoveries of chum salmon in the Canadian commercial and test fisheries were used to estimate the magnitude of the inriver return of this species. Tagging and recapture efforts were limited for chum salmon: 999 fish were tagged and 966 were taken in the two fisheries (35 of which were tagged; Table 12a). Data were grouped into five tagging and recovery strata. The estimated inriver run estimate past Canyon Island was 39,809 chum salmon (Table 12b). The associated 95% confidence interval was extremely broad (+/- 51,086) due to the limited tagging and recapture totals. The coefficient of variation of the estimate was 65.5%.

An unknown proportion of the chum salmon run returned after the mark-recapture program was terminated. As for the coho salmon return, we think the run was almost complete by the termination of the project due to low fish wheel, inriver gill net, and U.S. District 111 gill net catches in late September. In future years the mark-recapture program needs to be modified if reliable estimates of the chum salmon escapement are to be generated. The duration of the tagging program needs to be extended later into the fall and the test fishery must be prolonged and increased in magnitude to recover more tagged fish.

Chinook Salmon

We have been unable to develop an estimate of the chinook salmon escapement because we have not yet received all relevant recapture data from CDFO. All tags that were recovered by CDFO have been received, but finalized data on the number of fish examined by size class for tags at the Nakina River carcass weir has not. However, trends in available data permit a partial assessment of the feasibility of developing mark-recapture estimates for chinook salmon.

To generate a chinook salmon escapement estimate using the statistical methods of Chapman and Junge and Darroch, it is necessary that either: (1) every fish migrating past the tagging site has an equal probability of being tagged or (2) every fish examined on the spawning grounds has an equal probability of being examined for the presence of a tag (Bernard 1987). Due to the tremendous expense involved in sampling extremely remote spawning grounds, satisfying the second condition is impractical. Therefore it is necessary to develop a method of capturing salmon for tagging throughout the migration.

To effectively operate, fish wheels need to be located in fast flowing, turbid water. Water discharge from the Taku River is typically very low during April, but average discharge increases through the end of June as the winter snowpack melts. In conducting chinook salmon research on the Taku River during the 1950's, ADF&G operated fish wheels at Canyon Island as early as 12 May and gill nets as early as 30 April. We needed to know whether early spring water flows were sufficient to rotate our fish wheels, which are much larger than the fish wheels operated by ADF&G in the 1950's.

In 1988 we began building our fish wheels on the Taku River on 1 May. The wheels were deployed on 11 May, and fished effectively from their first day of operation. Water flows present at least one week prior to 11 May were similar to late-season flows when the fish wheels were catching coho and chum salmon. We conclude that for water levels similar to those observed in 1988, it is possible to operate this capture gear throughout the chinook salmon return.

ADF&G demonstrated that the fish wheels they used in the 1950's were size-selective, catching higher proportions of smaller and younger fish than were present on the upper drainage spawning grounds (Meehan 1961). We obtained similar results in 1988. Higher proportions of age .1 and .2 chinook salmon were present in the fish wheel catches than in samples collected from the Tatsamenie Lake system and the Nahlin River (Figure 3). The size selectivity of the fish wheel violates the condition of equal probability of tagging for all fish. When such a situation is encountered, Ricker (1975) suggests dividing tagging and recovery data into size groups and estimating the abundance of each group independently. We anticipated that fish wheel size-selectivity would occur and we recorded length measurements of all fish tagged and all fish examined for tags during the spawning ground recovery effort so that we could segregate data by size group.

Fish length is closely correlated with ocean age groups of Taku River chinook salmon. Three ocean age groups can, with few exceptions, be distinguished by fish length. One-ocean fish (age .1) are typically less than 440 mm in length (MEF), while 2-ocean fish range from 440-660 mm, and 3-,4-,and 5-ocean fish are larger than 660 mm (Figure 4). We have organized our chinook salmon tagging and recovery data into these three size (age) groups (Table 12).

We recovered 109 of the 1,338 chinook salmon tagged at Canyon Island (Table 7). Approximately equal numbers of tags were recovered in Canadian inriver fisheries and the escapement, despite the fact that the documented harvest totaled only 841 fish while over 6,000 fish were examined on the spawning grounds.

The ratios of untagged to tagged chinook salmon observed on the spawning grounds varied considerably by size class but all were extremely low, ranging from 813:1 for fish >660 mm, to 84:1 for fish between 440-660 mm, and 69:1 for fish <440 mm (Table 13). The selectivity of the fish wheels for small fish undoubtedly contributed to the disproportionately higher ratio of tagged small fish in the escapements. The low numbers of chinook salmon tags recovered, given the large number of fish examined for tags, could indicate either a population of chinook salmon far larger than anticipated or previously documented or that violations of assumptions necessary to develop unbiased estimates of population size existed in our study. Further examination of available data was undertaken to attempt to assess whether necessary assumptions were violated.

In 1988 we did not tag throughout the entire chinook salmon migration, violating the assumption that all fish entering the river had an equal chance of being tagged. When we arrived on the Taku River on 1 May we found an unattended gill net being illegally fished in front of our camp. Two chinook salmon were in the net. While we have no method to assess how many fish migrated upriver prior to 11 May when the fish wheels became operational, it is very likely that later migrating stocks were tagged at a higher rate than earlier migrating stocks. Indeed, one of the latest migrating stocks in the drainage (Tatsamenie Lake system) exhibited a higher ratio of tagged fish (1 in 114) than earlier migrating stocks such as the Nahlin (1 in 149) and Nakina Rivers (1 in 153; Table 13).

Another important assumption inherent in obtaining a valid population estimate is that the tagging process did not increase the mortality rate of tagged fish over that experienced by untagged fish. Information documenting mortality rates due to our spaghetti tagging is not available, however some data suggests that chinook salmon do not respond to the tagging process as well as other species. Tagged chinook salmon later recaptured in the fish wheels had, on average, dropped downriver after tagging for a substantially longer period (11.7 days; Figure 5, Table 14) than coho (3.9 days), sockeye (3.1 days) or chum salmon (1.7 days). The drop-back rate of the twenty chinook salmon tagged with radio transmitters by NMFS in 1988 was higher and the duration of time spent downriver from the tagging site was longer than observed for sockeye salmon radio-tagged in prior years (J. Eiler, NMFS, personal communication). Due to the presence of large numbers of predators (seals, sea lions, etc.) in the lower river, predation may have been greater on tagged fish than untagged fish, although only 2 of the 20 chinook salmon tagged with radio transmitters died prior to reaching either the spawning grounds or the Canadian inriver fishery (J. Eiler, NMFS, personal communication).

To examine the effects of the stress induced during the time chinook salmon remain confined in the fish wheel liveboxes prior to tagging and release, we compared the tag recoveries of chinook salmon captured at night to those caught during the day. Fish caught at night are generally confined in the liveboxes for longer time periods than those fish captured during the daytime because evening and morning sampling periods are generally separated by 8-12 hours, compared to approximately 4-6 hours elapsed time between daytime sampling periods. If holding fish in the liveboxes for longer periods of time induced stress and caused mortality of fish, we hypothesized that a lower recovery rate of fish caught in the fish wheels at night would be seen than for fish captured during the day. However, tag recovery rates for chinook salmon caught at night were actually higher (.092) than for fish caught during the day (.072; Table 15).

Tag loss is another potential source of error that could occur as a result of the breakage and shedding of tags or by the incomplete return of tags by fishermen. Fish that have lost spaghetti tags are identifiable by the presence of tagging needle entrance and exit holes located beneath the posterior portion of the dorsal fin on each side of the fish. Fish that had lost tags were found during recovery efforts on the Nahlin, Nakina, and Hackett Rivers and the Tatsamenie Lake system (Table 13). It is possible that the fish identified as having lost tags in the Tatsamenie system had actually had their tags removed by CDFO personnel when they were dipnetted from a fish trap in the upstream counting weir prior to examination by ADF&G personnel further downstream at the carcass weir. This would not have occurred, however, at the other locations. A total of 8 fish that had lost tags were found in the upper Taku River drainage, approximately 15% of the 55 total chinook salmon spawning ground tag recoveries. Some tag loss is likely a result of aggressive courtship behavior among spawning adults. Such behavior would tend to increase the probability of tag loss as a function of the time elapsed since tagging. Some tag loss may have resulted from the spaghetti tags used to tag chinook salmon in 1988. The tags were from a tag lot that we had not used before. The tags were noticeably less pliable than other tags we have used. Samples of the tags were taken to Floy Tag Company in early 1989 for examination. Company personnel reported that the tags did indeed appear to be brittle and subject to breakage.

The failure rate of Canadian fishermen to return tags is unknown. Commercial fishermen on the lower river were offered a $2 reward for returning tags, and each fisherman was interviewed daily during fishery openings by a Canadian Fisheries Patrol Officer. Because of this, together with the much higher ratio of tagged to untagged fish in the fishery than on the spawning grounds, it is unlikely that commercial fishermen failed to return a substantial number of tags. The extent of removal and non-reporting of tagged chinook salmon by upriver sport fishermen is unknown but may have been substantial. Sport fishing lodges are operated on the

Nakina River and the Tatsamenie Lake system. The harvest of chinook salmon at these camps is not monitored by Canada. Sport fishermen voluntarily returned to ADF&G 4 tags from chinook salmon caught in the Nakina River. The fishermen had not been briefed about the tagging program but nevertheless sent the tags to the address inscribed on the spaghetti tags. Since only 24 tags were found during random examination of over 4,000 chinook salmon from the Nakina River, sport fishermen were either targeting on tagged fish or they caught a very large number of fish. CDFO personnel do not believe that substantial sport fishing catches were made (P. Milligan, CDFO, personal communication).

We did not have access to all the data necessary to fully analyze the 1988 chinook salmon mark-recapture program prior to planning for continuing studies in 1989. As reviewed above, available data suggests that several assumptions necessary for developing an unbiased estimate of population size may have been violated in 1988. We therefore proposed a modified program to be undertaken in 1989 by ADF&G, NMFS and CDFO. This program includes: (1) starting tagging operations in late April to insure that the entire run is tagged; (2) tagging a large number of fish (450) with radio tags to reveal the effects of capturing and tagging procedures on chinook salmon and provide detailed spawner distribution information for the Taku River drainage; (3) using a different lot of spaghetti tags that is not defective, and; (4) expanding spawning ground recovery efforts to additional areas.

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Table 1. Catches, numbers tagged, and CPUE (catch per fish wheel hour) of chinook salmon in fish wheels at Canyon Island, 1988.

	Daily Chinook Catch	Cumul. Chinook Catch	Daily Chinook Tagged	Cumul. Chinook Tagged	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
11-May	0	0	0	0	0.000	0.000	0.000
12-May	7	7	6	6	0.179	0.005	0.005
13-May	3	10	2	8	0.070	0.002	0.008
14-May	9	19	8	16	0.202	0.006	0.014
15-May	27	46	26	42	0.630	0.019	0.033
16-May	40	86	32	74	0.904	0.027	0.060
17-May	24	110	21	95	0.524	0.016	0.076
18-May	17	127	15	110	0.369	0.011	0.087
19-May	38	165	34	144	0.816	0.025	0.112
20-May	32	197	23	167	0.686	0.021	0.133
21-May	31	228	27	194	0.661	0.020	0.153
22-May	22	250	18	212	0.471	0.014	0.167
23-May	35	285	32	244	0.753	0.023	0.190
24-May	29	314	27	271	0.633	0.019	0.209
25-May	32	346	28	299	0.707	0.021	0.230
26-May	35	381	34	333	0.766	0.023	0.254
27-May	33	414	32	365	0.715	0.022	0.275
28-May	19	433	19	384	0.408	0.012	0.288
29-May	24	457	23	407	0.524	0.016	0.303
30-May	49	506	47	454	1.167	0.035	0.339
31-May	40	546	40	494	0.875	0.027	0.365
01-Jun	40	586	35	529	0.869	0.026	0.392
02-Jun	37	623	36	565	0.833	0.025	0.417
03-Jun	26	649	26	591	0.656	0.020	0.437
04-Jun	17	666	17	608	0.366	0.011	0.448
05-Jun	16	682	16	624	0.341	0.010	0.458
06-Jun	24	706	24	648	0.511	0.015	0.474
07-Jun	56	762	53	701	1.256	0.038	0.512
08-Jun	28	790	27	728	0.762	0.023	0.535
09-Jun	16	806	15	743	0.713	0.022	0.556
10-Jun	2	808	2	745	0.090	0.003	0.559
11-Jun	11	819	11	756	0.396	0.012	0.571
12-Jun	30	849	28	784	0.681	0.021	0.592
13-Jun	53	902	51	835	1.217	0.037	0.629
14-Jun	59	961	57	892	1.305	0.040	0.668
15-Jun	50	1011	48	940	1.099	0.033	0.701
16-Jun	37	1048	34	974	0.819	0.025	0.726
17-Jun	26	1074	24	998	0.565	0.017	0.743
18-Jun	45	1119	44	1042	1.029	0.031	0.775
19-Jun	23	1142	22	1064	0.495	0.015	0.790
20-Jun	33	1175	30	1094	0.722	0.022	0.811

- Continued -

Table 1. (page 2 of 3)

	Daily Chinook Catch	Cumul. Chinook Catch	Daily Chinook Tagged	Cumul. Chinook Tagged	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
21-Jun	31	1206	31	1125	0.692	0.021	0.832
22-Jun	41	1247	39	1164	0.887	0.027	0.859
23-Jun	11	1258	10	1174	0.246	0.007	0.867
24-Jun	14	1272	14	1188	0.312	0.009	0.876
25-Jun	14	1286	13	1201	0.301	0.009	0.885
26-Jun	17	1303	14	1215	0.533	0.016	0.901
27-Jun	9	1312	7	1222	0.398	0.012	0.914
28-Jun	10	1322	10	1232	0.284	0.009	0.922
29-Jun	13	1335	11	1243	0.284	0.009	0.931
30-Jun	12	1347	11	1254	0.257	0.008	0.939
01-Jul	6	1353	4	1258	0.129	0.004	0.942
02-Jul	4	1357	4	1262	0.087	0.003	0.945
03-Jul	9	1366	9	1271	0.197	0.006	0.951
04-Jul	10	1376	10	1281	0.221	0.007	0.958
05-Jul	7	1383	6	1287	0.162	0.005	0.963
06-Jul	6	1389	6	1293	0.130	0.004	0.967
07-Jul	5	1394	5	1298	0.108	0.003	0.970
08-Jul	8	1402	8	1306	0.176	0.005	0.975
09-Jul	0	1402	0	1306	0.000	0.000	0.975
10-Jul	5	1407	5	1311	0.111	0.003	0.979
11-Jul	3	1410	3	1314	0.067	0.002	0.981
12-Jul	3	1413	3	1317	0.068	0.002	0.983
13-Jul	3	1416	3	1320	0.068	0.002	0.985
14-Jul	5	1421	5	1325	0.165	0.005	0.990
15-Jul	1	1422	1	1326	0.023	0.001	0.990
16-Jul	3	1425	3	1329	0.066	0.002	0.992
17-Jul	5	1430	5	1334	0.115	0.003	0.996
18-Jul	1	1431	1	1335	0.024	0.001	0.997
19-Jul	1	1432	1	1336	0.025	0.001	0.997
20-Jul	1	1433	1	1337	0.023	0.001	0.998
21-Jul	0	1433	0	1337	0.000	0.000	0.998
22-Jul	0	1433	0	1337	0.000	0.000	0.998
23-Jul	1	1434	1	1338	0.022	0.001	0.999
24-Jul	0	1434	0	1338	0.000	0.000	0.999
25-Jul	0	1434	0	1338	0.000	0.000	0.999
26-Jul	0	1434	0	1338	0.000	0.000	0.999
27-Jul	0	1434	0	1338	0.000	0.000	0.999
28-Jul	0	1434	0	1338	0.000	0.000	0.999
29-Jul	0	1434	0	1338	0.000	0.000	0.999
30-Jul	0	1434	0	1338	0.000	0.000	0.999
31-Jul	0	1434	0	1338	0.000	0.000	0.999
01-Aug	0	1434	0	1338	0.000	0.000	0.999

- Continued -

Table 1. (page 3 of 3)

	Daily Chinook Catch	Cumul. Chinook Catch	Daily Chinook Tagged	Cumul. Chinook Tagged	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
02-Aug	0	1434	0	1338	0.000	0.000	0.999
03-Aug	0	1434	0	1338	0.000	0.000	0.999
04-Aug	0	1434	0	1338	0.000	0.000	0.999
05-Aug	1	1435	0	1338	0.022	0.001	0.999
06-Aug	0	1435	0	1338	0.000	0.000	0.999
07-Aug	0	1435	0	1338	0.000	0.000	0.999
08-Aug	0	1435	0	1338	0.000	0.000	0.999
09-Aug	0	1435	0	1338	0.000	0.000	0.999
10-Aug	0	1435	0	1338	0.000	0.000	0.999
11-Aug	0	1435	0	1338	0.000	0.000	0.999
12-Aug	0	1435	0	1338	0.000	0.000	0.999
13-Aug	0	1435	0	1338	0.000	0.000	0.999
14-Aug	0	1435	0	1338	0.000	0.000	0.999
15-Aug	0	1435	0	1338	0.000	0.000	0.999
16-Aug	0	1435	0	1338	0.000	0.000	0.999
17-Aug	1	1436	0	1338	0.022	0.001	1.000

Table 2. Catches, numbers tagged, and CPUE (catch per fish wheel hour) of sockeye salmon in fish wheels at Canyon Island, 1988.

	Daily Sockeye Catch	Cumul. Sockeye Catch	Daily Sockeye Tagged	Cumul. Sockeye Tagged	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
29-May	1	1	0	0	0.022	0.000	0.000
30-May	0	1	0	0	0.000	0.000	0.000
31-May	0	1	0	0	0.000	0.000	0.000
01-Jun	0	1	0	0	0.000	0.000	0.000
02-Jun	1	2	1	1	0.023	0.000	0.001
03-Jun	0	2	0	1	0.000	0.000	0.001
04-Jun	2	4	2	3	0.043	0.001	0.001
05-Jun	0	4	0	3	0.000	0.000	0.001
06-Jun	4	8	4	7	0.085	0.001	0.002
07-Jun	7	15	7	14	0.157	0.002	0.004
08-Jun	2	17	2	16	0.054	0.001	0.005
09-Jun	0	17	0	16	0.000	0.000	0.005
10-Jun	0	17	0	16	0.000	0.000	0.005
11-Jun	2	19	2	18	0.072	0.001	0.006
12-Jun	13	32	12	30	0.295	0.004	0.010
13-Jun	26	58	25	55	0.597	0.008	0.017
14-Jun	31	89	31	86	0.686	0.009	0.026
15-Jun	24	113	22	108	0.527	0.007	0.033
16-Jun	41	154	38	146	0.907	0.012	0.044
17-Jun	31	185	31	177	0.674	0.009	0.053
18-Jun	41	226	41	218	0.937	0.012	0.065
19-Jun	27	253	27	245	0.581	0.007	0.072
20-Jun	27	280	24	269	0.591	0.008	0.080
21-Jun	21	301	20	289	0.469	0.006	0.086
22-Jun	19	320	18	307	0.411	0.005	0.091
23-Jun	28	348	23	330	0.626	0.008	0.099
24-Jun	33	381	33	363	0.736	0.009	0.109
25-Jun	42	423	39	402	0.902	0.012	0.120
26-Jun	23	446	21	423	0.721	0.009	0.129
27-Jun	41	487	39	462	1.814	0.023	0.152
28-Jun	41	528	36	498	1.166	0.015	0.167
29-Jun	62	590	56	554	1.353	0.017	0.185
30-Jun	36	626	35	589	0.771	0.010	0.195
01-Jul	27	653	24	613	0.580	0.007	0.202
02-Jul	34	687	28	641	0.739	0.009	0.211
03-Jul	55	742	51	692	1.202	0.015	0.227
04-Jul	73	815	67	759	1.610	0.021	0.247
05-Jul	43	858	43	802	0.998	0.013	0.260
06-Jul	54	912	52	854	1.168	0.015	0.275
07-Jul	31	943	31	885	0.668	0.009	0.284
08-Jul	68	1011	62	947	1.497	0.019	0.303

- Continued -

Table 2. (Page 2 of 3)

	Daily Sockeye Catch	Cumul. Sockeye Catch	Daily Sockeye Tagged	Cumul. Sockeye Tagged	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
09-Jul	48	1059	45	992	1.051	0.013	0.316
10-Jul	91	1150	90	1082	2.015	0.026	0.342
11-Jul	78	1228	73	1155	1.733	0.022	0.364
12-Jul	88	1316	86	1241	1.992	0.025	0.389
13-Jul	81	1397	76	1317	1.824	0.023	0.413
14-Jul	46	1443	44	1361	1.520	0.019	0.432
15-Jul	69	1512	66	1427	1.574	0.020	0.452
16-Jul	89	1601	80	1507	1.971	0.025	0.477
17-Jul	71	1672	69	1576	1.629	0.021	0.498
18-Jul	74	1746	66	1642	1.776	0.023	0.521
19-Jul	70	1816	65	1707	1.725	0.022	0.543
20-Jul	85	1901	75	1782	1.940	0.025	0.568
21-Jul	33	1934	31	1813	0.731	0.009	0.577
22-Jul	22	1956	18	1831	0.474	0.006	0.583
23-Jul	44	2000	42	1873	0.962	0.012	0.596
24-Jul	46	2046	45	1918	0.991	0.013	0.608
25-Jul	63	2109	58	1976	1.372	0.018	0.626
26-Jul	74	2183	66	2042	1.635	0.021	0.647
27-Jul	59	2242	54	2096	1.297	0.017	0.663
28-Jul	37	2279	32	2128	0.801	0.010	0.673
29-Jul	35	2314	34	2162	0.758	0.010	0.683
30-Jul	37	2351	34	2196	0.779	0.010	0.693
31-Jul	35	2386	25	2221	1.261	0.016	0.709
01-Aug	0	2386	0	2221	0.000	0.000	0.709
02-Aug	2	2388	0	2221	0.182	0.002	0.712
03-Aug	44	2432	37	2258	1.970	0.025	0.737
04-Aug	86	2518	77	2335	1.915	0.024	0.761
05-Aug	61	2579	48	2383	1.358	0.017	0.779
06-Aug	60	2639	41	2424	1.351	0.017	0.796
07-Aug	39	2678	31	2455	0.862	0.011	0.807
08-Aug	51	2729	42	2497	1.259	0.016	0.823
09-Aug	62	2791	49	2546	1.355	0.017	0.840
10-Aug	53	2844	41	2587	1.152	0.015	0.855
11-Aug	58	2902	41	2628	1.279	0.016	0.871
12-Aug	45	2947	35	2663	0.975	0.012	0.884
13-Aug	29	2976	24	2687	1.126	0.014	0.898
14-Aug	25	3001	19	2706	1.376	0.018	0.916
15-Aug	48	3049	33	2739	1.059	0.014	0.929
16-Aug	38	3087	30	2769	0.843	0.011	0.940
17-Aug	26	3113	17	2786	0.578	0.007	0.947
18-Aug	13	3126	6	2792	0.322	0.004	0.952
19-Aug	12	3138	5	2797	0.268	0.003	0.955

- Continued -

Table 2. (Page 3 of 3)

	Daily Sockeye Catch	Cumul. Sockeye Catch	Daily Sockeye Tagged	Cumul. Sockeye Tagged	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
20-Aug	12	3150	6	2803	0.264	0.003	0.958
21-Aug	10	3160	5	2808	0.218	0.003	0.961
22-Aug	12	3172	2	2810	0.259	0.003	0.964
23-Aug	22	3194	15	2825	0.493	0.006	0.971
24-Aug	12	3206	5	2830	0.259	0.003	0.974
25-Aug	4	3210	0	2830	0.086	0.001	0.975
26-Aug	6	3216	3	2833	0.130	0.002	0.977
27-Aug	7	3223	4	2837	0.164	0.002	0.979
28-Aug	8	3231	4	2841	0.227	0.003	0.982
29-Aug	8	3239	4	2845	0.175	0.002	0.984
30-Aug	11	3250	6	2851	0.244	0.003	0.987
31-Aug	1	3251	1	2852	0.022	0.000	0.987
01-Sep	4	3255	4	2856	0.095	0.001	0.989
02-Sep	0	3255	0	2856	0.000	0.000	0.989
03-Sep	4	3259	3	2859	0.097	0.001	0.990
04-Sep	9	3268	2	2861	0.221	0.003	0.993
05-Sep	7	3275	1	2862	0.162	0.002	0.995
06-Sep	4	3279	2	2864	0.090	0.001	0.996
07-Sep	1	3280	0	2864	0.025	0.000	0.996
08-Sep	3	3283	1	2865	0.065	0.001	0.997
09-Sep	0	3283	0	2865	0.000	0.000	0.997
10-Sep	0	3283	0	2865	0.000	0.000	0.997
11-Sep	2	3285	2	2867	0.075	0.001	0.998
12-Sep	5	3290	4	2871	0.109	0.001	0.999
13-Sep	2	3292	2	2873	0.045	0.001	1.000
14-Sep	0	3292	0	2873	0.000	0.000	1.000
15-Sep	0	3292	0	2873	0.000	0.000	1.000
16-Sep	0	3292	0	2873	0.000	0.000	1.000
17-Sep	0	3292	0	2873	0.000	0.000	1.000
18-Sep	0	3292	0	2873	0.000	0.000	1.000

Table 3. Catches, numbers tagged, and CPUE (catch per fish wheel hour) of coho salmon in fish wheels at Canyon Island, 1988.

	Daily Coho Catch	Cumul. Coho Catch	Daily Coho Tagged	Cumul. Coho Tagged	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
02-Jul	1	1	1	1	0.022	0.000	0.000
03-Jul	0	1	0	1	0.000	0.000	0.000
04-Jul	0	1	0	1	0.000	0.000	0.000
05-Jul	2	3	2	3	0.046	0.001	0.001
06-Jul	1	4	1	4	0.022	0.000	0.002
07-Jul	0	4	0	4	0.000	0.000	0.002
08-Jul	1	5	0	4	0.022	0.000	0.002
09-Jul	2	7	2	6	0.044	0.001	0.003
10-Jul	1	8	1	7	0.022	0.000	0.003
11-Jul	5	13	5	12	0.111	0.002	0.005
12-Jul	10	23	10	22	0.226	0.004	0.010
13-Jul	5	28	5	27	0.113	0.002	0.012
14-Jul	4	32	4	31	0.132	0.002	0.014
15-Jul	4	36	4	35	0.091	0.002	0.016
16-Jul	8	44	7	42	0.177	0.003	0.019
17-Jul	10	54	10	52	0.229	0.004	0.024
18-Jul	9	63	9	61	0.216	0.004	0.028
19-Jul	6	69	6	67	0.148	0.003	0.031
20-Jul	17	86	17	84	0.388	0.007	0.038
21-Jul	18	104	18	102	0.399	0.007	0.045
22-Jul	16	120	16	118	0.345	0.006	0.052
23-Jul	15	135	15	133	0.328	0.006	0.058
24-Jul	7	142	7	140	0.151	0.003	0.061
25-Jul	9	151	9	149	0.196	0.004	0.064
26-Jul	12	163	12	161	0.265	0.005	0.069
27-Jul	16	179	15	176	0.352	0.007	0.076
28-Jul	18	197	18	194	0.390	0.007	0.083
29-Jul	5	202	5	199	0.108	0.002	0.085
30-Jul	9	211	9	208	0.189	0.004	0.089
31-Jul	2	213	1	209	0.072	0.001	0.090
01-Aug	0	213	0	209	0.000	0.000	0.090
02-Aug	1	214	1	210	0.091	0.002	0.092
03-Aug	4	218	4	214	0.179	0.003	0.095
04-Aug	30	248	30	244	0.668	0.013	0.108
05-Aug	35	283	33	277	0.779	0.015	0.123
06-Aug	39	322	39	316	0.878	0.017	0.139
07-Aug	42	364	39	355	0.928	0.017	0.157
08-Aug	30	394	27	382	0.741	0.014	0.171
09-Aug	32	426	31	413	0.699	0.013	0.184
10-Aug	30	456	27	440	0.652	0.012	0.196
11-Aug	29	485	29	469	0.640	0.012	0.208

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Table 3. (Page 2 of 2)

	Daily Coho Catch	Cumul. Coho Catch	Daily Coho Tagged	Cumul. Coho Tagged	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
12-Aug	21	506	19	488	0.455	0.009	0.217
13-Aug	10	516	10	498	0.388	0.007	0.224
14-Aug	48	564	48	546	2.642	0.050	0.274
15-Aug	43	607	40	586	0.949	0.018	0.291
16-Aug	35	642	34	620	0.776	0.015	0.306
17-Aug	58	700	58	678	1.289	0.024	0.330
18-Aug	52	752	45	723	1.286	0.024	0.355
19-Aug	77	829	68	791	1.721	0.032	0.387
20-Aug	68	897	62	853	1.497	0.028	0.415
21-Aug	42	939	36	889	0.915	0.017	0.432
22-Aug	27	966	22	911	0.582	0.011	0.443
23-Aug	29	995	28	939	0.651	0.012	0.455
24-Aug	28	1023	26	965	0.603	0.011	0.467
25-Aug	31	1054	23	988	0.667	0.013	0.479
26-Aug	21	1075	19	1007	0.453	0.009	0.488
27-Aug	30	1105	28	1035	0.705	0.013	0.501
28-Aug	14	1119	13	1048	0.397	0.007	0.509
29-Aug	44	1163	42	1090	0.963	0.018	0.527
30-Aug	46	1209	45	1135	1.022	0.019	0.546
31-Aug	39	1248	33	1168	0.857	0.016	0.562
01-Sep	70	1318	66	1234	1.670	0.031	0.594
02-Sep	161	1479	140	1374	3.795	0.071	0.665
03-Sep	194	1673	173	1547	4.684	0.088	0.753
04-Sep	63	1736	48	1595	1.548	0.029	0.782
05-Sep	94	1830	82	1677	2.171	0.041	0.823
06-Sep	72	1902	66	1743	1.624	0.031	0.854
07-Sep	33	1935	32	1775	0.825	0.016	0.869
08-Sep	33	1968	29	1804	0.715	0.013	0.883
09-Sep	14	1982	12	1816	0.342	0.006	0.889
10-Sep	5	1987	5	1821	0.333	0.006	0.895
11-Sep	9	1996	7	1828	0.339	0.006	0.902
12-Sep	46	2042	38	1866	1.003	0.019	0.920
13-Sep	62	2104	59	1925	1.390	0.026	0.947
14-Sep	42	2146	40	1965	1.260	0.024	0.970
15-Sep	2	2148	2	1967	0.216	0.004	0.974
16-Sep	0	2148	0	1967	0.000	0.000	0.974
17-Sep	11	2159	10	1977	0.541	0.010	0.985
18-Sep	9	2168	0	1977	0.818	0.015	1.000

Table 4. Catches and CPUE (catch per fish wheel hour) of pink salmon in fish wheels at Canyon Island, 1988.

	Daily Pink Catch	Cumul. Pink Catch	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
26-Jun	1	1	0.031	0.000	0.000
27-Jun	1	2	0.044	0.000	0.001
28-Jun	0	2	0.000	0.000	0.001
29-Jun	5	7	0.109	0.001	0.002
30-Jun	5	12	0.107	0.001	0.003
01-Jul	7	19	0.150	0.002	0.005
02-Jul	9	28	0.196	0.002	0.007
03-Jul	13	41	0.284	0.003	0.010
04-Jul	7	48	0.154	0.002	0.012
05-Jul	12	60	0.278	0.003	0.015
06-Jul	24	84	0.519	0.006	0.021
07-Jul	48	132	1.034	0.011	0.032
08-Jul	127	259	2.796	0.031	0.063
09-Jul	106	365	2.320	0.025	0.088
10-Jul	127	492	2.812	0.031	0.119
11-Jul	168	660	3.733	0.041	0.160
12-Jul	181	841	4.098	0.045	0.205
13-Jul	97	938	2.184	0.024	0.229
14-Jul	77	1015	2.545	0.028	0.256
15-Jul	196	1211	4.471	0.049	0.306
16-Jul	201	1412	4.451	0.049	0.354
17-Jul	186	1598	4.268	0.047	0.401
18-Jul	237	1835	5.689	0.062	0.463
19-Jul	189	2024	4.657	0.051	0.515
20-Jul	119	2143	2.716	0.030	0.544
21-Jul	338	2481	7.484	0.082	0.626
22-Jul	203	2684	4.374	0.048	0.674
23-Jul	215	2899	4.700	0.052	0.726
24-Jul	147	3046	3.167	0.035	0.761
25-Jul	51	3097	1.111	0.012	0.773
26-Jul	59	3156	1.304	0.014	0.787
27-Jul	101	3257	2.221	0.024	0.811
28-Jul	102	3359	2.208	0.024	0.836
29-Jul	60	3419	1.300	0.014	0.850
30-Jul	47	3466	0.989	0.011	0.861
31-Jul	17	3483	0.613	0.007	0.867
01-Aug	0	3483	0.000	0.000	0.867
02-Aug	3	3486	0.273	0.003	0.870
03-Aug	14	3500	0.627	0.007	0.877
04-Aug	67	3567	1.492	0.016	0.894

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Table 4. (Page 2 of 2)

	Daily Pink Catch	Cumul. Pink Catch	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
05-Aug	110	3677	2.449	0.027	0.920
06-Aug	80	3757	1.801	0.020	0.940
07-Aug	50	3807	1.105	0.012	0.952
08-Aug	26	3833	0.642	0.007	0.959
09-Aug	22	3855	0.481	0.005	0.965
10-Aug	22	3877	0.478	0.005	0.970
11-Aug	15	3892	0.331	0.004	0.974
12-Aug	15	3907	0.325	0.004	0.977
13-Aug	4	3911	0.155	0.002	0.979
14-Aug	10	3921	0.550	0.006	0.985
15-Aug	6	3927	0.132	0.001	0.986
16-Aug	8	3935	0.177	0.002	0.988
17-Aug	9	3944	0.200	0.002	0.990
18-Aug	3	3947	0.074	0.001	0.991
19-Aug	4	3951	0.089	0.001	0.992
20-Aug	6	3957	0.132	0.001	0.994
21-Aug	0	3957	0.000	0.000	0.994
22-Aug	0	3957	0.000	0.000	0.994
23-Aug	5	3962	0.112	0.001	0.995
24-Aug	2	3964	0.043	0.000	0.995
25-Aug	1	3965	0.022	0.000	0.996
26-Aug	1	3966	0.022	0.000	0.996
27-Aug	2	3968	0.047	0.001	0.996
28-Aug	1	3969	0.028	0.000	0.997
29-Aug	2	3971	0.044	0.000	0.997
30-Aug	0	3971	0.000	0.000	0.997
31-Aug	0	3971	0.000	0.000	0.997
01-Sep	0	3971	0.000	0.000	0.997
02-Sep	1	3972	0.024	0.000	0.997
03-Sep	1	3973	0.024	0.000	0.998
04-Sep	2	3975	0.049	0.001	0.998
05-Sep	2	3977	0.046	0.001	0.999
06-Sep	3	3980	0.068	0.001	0.999
07-Sep	0	3980	0.000	0.000	0.999
08-Sep	1	3981	0.022	0.000	1.000
09-Sep	0	3981	0.000	0.000	1.000
10-Sep	0	3981	0.000	0.000	1.000
11-Sep	0	3981	0.000	0.000	1.000
12-Sep	0	3981	0.000	0.000	1.000
13-Sep	0	3981	0.000	0.000	1.000
14-Sep	1	3982	0.030	0.000	1.000
15-Sep	0	3982	0.000	0.000	1.000
16-Sep	0	3982	0.000	0.000	1.000

Table 5. Catches, numbers tagged, and CPUE (catch per fish wheel hour) of chum salmon in fish wheels at Canyon Island, 1988.

	Daily Chum Catch	Cumul. Chum Catch	Daily Chum Tagged	Cumul. Chum Tagged	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
22-Jun	1	1	0	0	0.022	0.001	0.001
23-Jun	0	1	0	0	0.000	0.000	0.001
24-Jun	0	1	0	0	0.000	0.000	0.001
25-Jun	0	1	0	0	0.000	0.000	0.001
26-Jun	3	4	1	1	0.094	0.004	0.004
27-Jun	0	4	0	1	0.000	0.000	0.004
28-Jun	0	4	0	1	0.000	0.000	0.004
29-Jun	1	5	1	2	0.022	0.001	0.005
30-Jun	1	6	1	3	0.021	0.001	0.006
01-Jul	0	6	0	3	0.000	0.000	0.006
02-Jul	0	6	0	3	0.000	0.000	0.006
03-Jul	1	7	1	4	0.022	0.001	0.007
04-Jul	0	7	0	4	0.000	0.000	0.007
05-Jul	0	7	0	4	0.000	0.000	0.007
06-Jul	1	8	1	5	0.022	0.001	0.008
07-Jul	0	8	0	5	0.000	0.000	0.008
08-Jul	0	8	0	5	0.000	0.000	0.008
09-Jul	0	8	0	5	0.000	0.000	0.008
10-Jul	1	9	1	6	0.022	0.001	0.008
11-Jul	2	11	2	8	0.044	0.002	0.010
12-Jul	1	12	1	9	0.023	0.001	0.011
13-Jul	2	14	2	11	0.045	0.002	0.013
14-Jul	0	14	0	11	0.000	0.000	0.013
15-Jul	2	16	1	12	0.046	0.002	0.014
16-Jul	2	18	2	14	0.044	0.002	0.016
17-Jul	1	19	1	15	0.023	0.001	0.017
18-Jul	2	21	2	17	0.048	0.002	0.019
19-Jul	0	21	0	17	0.000	0.000	0.019
20-Jul	2	23	2	19	0.046	0.002	0.020
21-Jul	2	25	2	21	0.044	0.002	0.022
22-Jul	3	28	3	24	0.065	0.002	0.024
23-Jul	0	28	0	24	0.000	0.000	0.024
24-Jul	0	28	0	24	0.000	0.000	0.024
25-Jul	0	28	0	24	0.000	0.000	0.024
26-Jul	1	29	1	25	0.022	0.001	0.025
27-Jul	1	30	1	26	0.022	0.001	0.026
28-Jul	1	31	1	27	0.022	0.001	0.027
29-Jul	2	33	2	29	0.043	0.002	0.028
30-Jul	1	34	1	30	0.021	0.001	0.029
31-Jul	0	34	0	30	0.000	0.000	0.029
01-Aug	0	34	0	30	0.000	0.000	0.029

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Table 5. (Page 2 of 3)

	Daily Chum Catch	Cumul. Chum Catch	Daily Chum Tagged	Cumul. Chum Tagged	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
02-Aug	0	34	0	30	0.000	0.000	0.029
03-Aug	0	34	0	30	0.000	0.000	0.029
04-Aug	2	36	2	32	0.045	0.002	0.031
05-Aug	7	43	7	39	0.156	0.006	0.037
06-Aug	4	47	3	42	0.090	0.003	0.040
07-Aug	6	53	6	48	0.133	0.005	0.045
08-Aug	1	54	1	49	0.025	0.001	0.046
09-Aug	4	58	4	53	0.087	0.003	0.049
10-Aug	10	68	10	63	0.217	0.008	0.057
11-Aug	6	74	5	68	0.132	0.005	0.062
12-Aug	5	79	5	73	0.108	0.004	0.066
13-Aug	0	79	0	73	0.000	0.000	0.066
14-Aug	3	82	2	75	0.165	0.006	0.072
15-Aug	10	92	10	85	0.221	0.008	0.081
16-Aug	18	110	18	103	0.399	0.015	0.096
17-Aug	23	133	20	123	0.511	0.019	0.115
18-Aug	20	153	17	140	0.495	0.018	0.133
19-Aug	20	173	17	157	0.447	0.017	0.150
20-Aug	11	184	11	168	0.242	0.009	0.159
21-Aug	8	192	7	175	0.174	0.007	0.165
22-Aug	13	205	12	187	0.280	0.010	0.176
23-Aug	13	218	12	199	0.292	0.011	0.187
24-Aug	14	232	14	213	0.302	0.011	0.198
25-Aug	15	247	14	227	0.323	0.012	0.210
26-Aug	16	263	16	243	0.345	0.013	0.223
27-Aug	18	281	13	256	0.423	0.016	0.239
28-Aug	12	293	12	268	0.340	0.013	0.251
29-Aug	19	312	19	287	0.416	0.016	0.267
30-Aug	43	355	42	329	0.956	0.036	0.303
31-Aug	26	381	25	354	0.571	0.021	0.324
01-Sep	54	435	52	406	1.288	0.048	0.372
02-Sep	46	481	40	446	1.084	0.040	0.412
03-Sep	111	592	101	547	2.680	0.100	0.512
04-Sep	74	666	69	616	1.818	0.068	0.580
05-Sep	83	749	74	690	1.917	0.072	0.652
06-Sep	77	826	67	757	1.737	0.065	0.717
07-Sep	97	923	92	849	2.425	0.091	0.807
08-Sep	38	961	36	885	0.823	0.031	0.838
09-Sep	23	984	22	907	0.562	0.021	0.859
10-Sep	2	986	2	909	0.133	0.005	0.864
11-Sep	12	998	11	920	0.451	0.017	0.881

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Table 5. (Page 3 of 3)

	Daily Chum Catch	Cumul. Chum Catch	Daily Chum Tagged	Cumul. Chum Tagged	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
12-Sep	26	1024	25	945	0.567	0.021	0.902
13-Sep	17	1041	14	959	0.381	0.014	0.916
14-Sep	27	1068	25	984	0.786	0.029	0.946
15-Sep	3	1071	3	987	0.324	0.012	0.958
16-Sep	0	1071	0	987	0.000	0.000	0.958
17-Sep	12	1083	12	999	0.590	0.022	0.980
18-Sep	6	1089	0	999	0.545	0.020	1.000

Table 6. Catches and CPUE (catch per fish wheel hour) of Dolly Varden in fish wheels at Canyon Island, 1988.

	Daily Catch	Cumul. Catch	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
11-May	0	0	0.000	0.000	0.000
12-May	0	0	0.000	0.000	0.000
13-May	0	0	0.000	0.000	0.000
14-May	1	1	0.022	0.001	0.001
15-May	1	2	0.023	0.001	0.003
16-May	2	4	0.045	0.003	0.005
17-May	0	4	0.000	0.000	0.005
18-May	1	5	0.022	0.001	0.007
19-May	0	5	0.000	0.000	0.007
20-May	0	5	0.000	0.000	0.007
21-May	0	5	0.000	0.000	0.007
22-May	1	6	0.021	0.001	0.008
23-May	3	9	0.065	0.004	0.012
24-May	1	10	0.022	0.001	0.013
25-May	1	11	0.022	0.001	0.014
26-May	2	13	0.044	0.003	0.017
27-May	3	16	0.065	0.004	0.021
28-May	0	16	0.000	0.000	0.021
29-May	0	16	0.000	0.000	0.021
30-May	1	17	0.024	0.001	0.022
31-May	2	19	0.044	0.003	0.024
01-Jun	0	19	0.000	0.000	0.024
02-Jun	0	19	0.000	0.000	0.024
03-Jun	0	19	0.000	0.000	0.024
04-Jun	0	19	0.000	0.000	0.024
05-Jun	1	20	0.021	0.001	0.026
06-Jun	2	22	0.043	0.002	0.028
07-Jun	0	22	0.000	0.000	0.028
08-Jun	2	24	0.054	0.003	0.031
09-Jun	0	24	0.000	0.000	0.031
10-Jun	0	24	0.000	0.000	0.031
11-Jun	4	28	0.144	0.008	0.040
12-Jun	3	31	0.068	0.004	0.044
13-Jun	3	34	0.069	0.004	0.048
14-Jun	3	37	0.066	0.004	0.052
15-Jun	0	37	0.000	0.000	0.052
16-Jun	1	38	0.022	0.001	0.053
17-Jun	1	39	0.022	0.001	0.054
18-Jun	6	45	0.137	0.008	0.062
19-Jun	0	45	0.000	0.000	0.062

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Table 6. (Page 2 of 4)

	Daily Catch	Cumul. Catch	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
20-Jun	3	48	0.066	0.004	0.066
21-Jun	6	54	0.134	0.008	0.074
22-Jun	10	64	0.216	0.013	0.086
23-Jun	2	66	0.045	0.003	0.089
24-Jun	0	66	0.000	0.000	0.089
25-Jun	0	66	0.000	0.000	0.089
26-Jun	1	67	0.031	0.002	0.091
27-Jun	0	67	0.000	0.000	0.091
28-Jun	1	68	0.028	0.002	0.093
29-Jun	4	72	0.087	0.005	0.098
30-Jun	4	76	0.086	0.005	0.103
01-Jul	5	81	0.107	0.006	0.109
02-Jul	11	92	0.239	0.014	0.123
03-Jul	8	100	0.175	0.010	0.133
04-Jul	7	107	0.154	0.009	0.142
05-Jul	7	114	0.162	0.009	0.152
06-Jul	11	125	0.238	0.014	0.166
07-Jul	17	142	0.366	0.021	0.187
08-Jul	32	174	0.705	0.041	0.228
09-Jul	25	199	0.547	0.032	0.260
10-Jul	27	226	0.598	0.035	0.295
11-Jul	20	246	0.444	0.026	0.321
12-Jul	14	260	0.317	0.019	0.339
13-Jul	7	267	0.158	0.009	0.349
14-Jul	8	275	0.264	0.015	0.364
15-Jul	8	283	0.182	0.011	0.375
16-Jul	2	285	0.044	0.003	0.377
17-Jul	12	297	0.275	0.016	0.393
18-Jul	22	319	0.528	0.031	0.424
19-Jul	19	338	0.468	0.027	0.451
20-Jul	9	347	0.205	0.012	0.463
21-Jul	11	358	0.244	0.014	0.478
22-Jul	3	361	0.065	0.004	0.481
23-Jul	17	378	0.372	0.022	0.503
24-Jul	9	387	0.194	0.011	0.514
25-Jul	10	397	0.218	0.013	0.527
26-Jul	3	400	0.066	0.004	0.531
27-Jul	4	404	0.088	0.005	0.536
28-Jul	5	409	0.108	0.006	0.542
29-Jul	3	412	0.065	0.004	0.546
30-Jul	5	417	0.105	0.006	0.552
31-Jul	2	419	0.072	0.004	0.557

- Continued -

Table 6. (Page 3 of 4)

	Daily Catch	Cumul. Catch	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
01-Aug	0	419	0.000	0.000	0.557
02-Aug	7	426	0.636	0.037	0.594
03-Aug	14	440	0.627	0.037	0.630
04-Aug	14	454	0.312	0.018	0.649
05-Aug	18	472	0.401	0.023	0.672
06-Aug	11	483	0.248	0.014	0.686
07-Aug	17	500	0.376	0.022	0.708
08-Aug	6	506	0.148	0.009	0.717
09-Aug	4	510	0.087	0.005	0.722
10-Aug	15	525	0.326	0.019	0.741
11-Aug	9	534	0.199	0.012	0.753
12-Aug	5	539	0.108	0.006	0.759
13-Aug	1	540	0.039	0.002	0.761
14-Aug	11	551	0.605	0.035	0.797
15-Aug	22	573	0.485	0.028	0.825
16-Aug	19	592	0.421	0.025	0.850
17-Aug	9	601	0.200	0.012	0.861
18-Aug	6	607	0.148	0.009	0.870
19-Aug	4	611	0.089	0.005	0.875
20-Aug	5	616	0.110	0.006	0.882
21-Aug	1	617	0.022	0.001	0.883
22-Aug	4	621	0.086	0.005	0.888
23-Aug	5	626	0.112	0.007	0.894
24-Aug	3	629	0.065	0.004	0.898
25-Aug	3	632	0.065	0.004	0.902
26-Aug	3	635	0.065	0.004	0.906
27-Aug	8	643	0.188	0.011	0.917
28-Aug	1	644	0.028	0.002	0.918
29-Aug	5	649	0.109	0.006	0.925
30-Aug	1	650	0.022	0.001	0.926
31-Aug	1	651	0.022	0.001	0.927
01-Sep	1	652	0.024	0.001	0.929
02-Sep	2	654	0.047	0.003	0.931
03-Sep	0	654	0.000	0.000	0.931
04-Sep	0	654	0.000	0.000	0.931
05-Sep	0	654	0.000	0.000	0.931
06-Sep	13	667	0.293	0.017	0.949
07-Sep	4	671	0.100	0.006	0.954
08-Sep	9	680	0.195	0.011	0.966
09-Sep	4	684	0.098	0.006	0.972
10-Sep	2	686	0.133	0.008	0.979
11-Sep	3	689	0.113	0.007	0.986

- Continued -

Table 6. (Page 4 of 4)

	Daily Catch	Cumul. Catch	Daily Cpue	Daily Proport. Cpue	Cumul. Proport. Cpue
12-Sep	8	697	0.174	0.010	0.996
13-Sep	3	700	0.067	0.004	1.000
14-Sep	0	700	0.000	0.000	1.000
15-Sep	0	700	0.000	0.000	1.000
16-Sep	0	700	0.000	0.000	1.000
17-Sep	0	700	0.000	0.000	1.000
18-Sep	0	700	0.000	0.000	1.000

Table 7. Total fish wheel catches of salmon, by species, 1984-1988.

	Year				
Species	1984	1985	1986	1987	1988
Chinook	138	184	571	285	1,436
Sockeye	2,334	3,601	5,808	4,307	3,292
Coho	889	1,207	758	2,240	2,168
Pink	20,845	27,670	7,256	42,786	3,982
Chum	316	1,376	80	1,533	1,089

Table 8. Migratory timing statistics of the various salmon species past the Canyon Island fish wheels, 1984-1988.[a]

Species	Statistic	Year				
		1984[b]	1985	1986	1987	1988
Chinook	Mean Date	28 June	26 June	28 June	27 June	8 June
	Standard Error[c]	8.0	8.6	9.2	7.7	14.9
Sockeye	Mean Date	23 July	24 July	16 July	24 July	19 July
	Standard Error	17.6	18.1	14.2	15.8	19.5
Coho	Mean Date	11 Aug.	18 Aug.	3 Aug.	23 Aug.	24 Aug.
	Standard Error	12.3	16.3	10.3	18.4	15.6
Pink	Mean Date	19 July	19 July	27 July	19 July	21 July
	Standard Error	9.3	8.5	5.5	9.3	9.6
Chum	Mean Date	14 Aug.	8 Sept.	7 Aug.	9 Sept.	31 Aug.
	Standard Error	12.8	11.8	11.3	10.5	12.5

[a] Based on daily fish wheel catch-per-unit-effort.
[b] Based on daily fish wheel catches.
[c] Units are days.

Table 9. Summary by species of the tags applied at Canyon Island and tag recoveries, 1988.

Species	Number of Fish Tagged	Recovery Location: Canadian Commercial Catch	Canadian Testfish Catch	Canadian Foodfish Catch	District 111 Catch	Escapement	Total
Chinook	1,338	44	6	2	2	55	109
Sockeye	2,873	428	30	12	1	487	958
Coho	1,977	135	21	4	9	130	299
Chum	999	27	12	2	1	4	46
Total	7,187	634	69	20	13	676	1,412

Table 10a. Tagging and recovery data from the 1988 Taku River sockeye salmon mark-recapture program. Data are number of sockeye salmon tagged at Canyon Island and recovered in Canadian commercial and test fisheries by statistical week.

Statistical Week of Tagging	Statistical Week of Recovery										Total	Total Tagged
	26-27	28	29	30	31	32	33	34	35	36-39		
23-26	14	2	1								17	233
27	10	7	1								18	239
28		13	44	4		1					62	351
29			41	72	1	4					118	515
30			1	61	31	3	1	1			98	366
31					37	23	3	1			64	323
32						1	16	5	5		27	228
33							9	14	9	1	33	263
34								8	4	0	12	116
35-39									2	6	8	70
Total	24	22	88	137	69	32	29	29	20	7	457	2704
Canadian Catch	1903	846	2750	2234	1827	947	900	844	334	143	12728	

Table 10b. Tagging and recovery data from the 1988 Taku River sockeye salmon mark-recapture program by grouped tagging and recovery time strata, the population estimate in each recovery strata, 95% confidence intervals for the strata estimates, Canadian commercial fishery exploitation rates, and the estimated escapement in each recovery strata.

Statistical Week of Tagging	Statistical Week of Recovery								Total	Total Tagged
	26-27	28	29	30	31-32	33	34	35-39		
23-26	14	2	1						17	233
27	10	7	1						18	239
28		13	44	4	1				62	351
29			41	72	5				118	515
30-31			1	61	94	4	2		162	689
32					1	16	5	5	27	228
33						9	14	10	33	263
34-39							8	12	20	186
Total	24	22	88	137	101	29	29	27	457	2704
Population Estimate	27683	10861	10072	10744	10299	7884	3356	6129	87028	
95% Confidence Int.										
Lower	9138	-9665	-11594	-102	1227	2052	-12135	-1801	68032	
Upper	46229	31387	31738	21590	19370	13716	18847	14059	106024	
Canadian Commercial Catch	1758	721	2645	2164	2608	864	803	451	12014	
Commercial Fishery Exploitation Rate	.064	.066	.263	.201	.253	.110	.239	.074	.138	
Test Fishery Catch	145	125	105	70	166	36	41	26	714	
Escapement Estimate	25780	10015	7322	8510	7525	6984	2512	5652	74055 *	

* Total escapement reduced by 245 fish harvested in the Canadian inriver food fishery.

Table 11. Tagging and recovery data from the 1988 Taku River coho salmon mark-recapture program. Data are number of coho salmon tagged at Canyon Island and recovered in Canadian commercial and test fisheries by statistical week, the population estimate in each recovery strata, 95% confidence intervals for the strata estimates, Canadian commercial fishery exploitation rates, and the estimated escapement in each recovery strata.

Statistical Week of Tagging	Statistical Week of Recovery											
	29-30	31	32	33	34	35	36	37	38	39	Total	Total Tagged
26-29	10		1								11	42
30	2	19	2								23	91
31		5	6	1							12	75
32				19	4	1					24	108
33				4	15						19	182
34					6	23	3				32	355
35						4	22				26	182
36							2	3	1		6	512
37								2			2	274
38										1	1	156
Total	12	24	9	24	25	28	27	5	1	1	156	1977[a]
Canadian Catch	166	303	170	471	649	722	933	83	17	29	3545	
Population Estimate	548	1060	1526	1257	7412	8366	5583	11371	1446	4524	43093	
95% Confidence Int.												
Lower	141	412	191	-192	3619	4451	2572	-4140	-11309	-4161	29057	
Upper	955	1708	2860	2707	11206	12281	8594	26882	14200	13209	57130	
Canadian Commercial Catch	154	272	148	437	567	637	908	0	0	0	3123	
Commercial Fishery Exploitation Rate	.281	.257	.097	.348	.077	.076	.163	0	0	0	.073	
Test Fishery Catch	12	31	22	36	82	85	25	83	17	29	422	
Escapement Estimate	382	757	1356	784	6763	7644	4650	11288	1429	4495	39450[b]	

[a] Tagging totals in appropriate strata were reduced to reflect removal of tagged fish by District 111 fishery.
[b] Total escapement was reduced by 98 fish harvested in the Canadian inriver food fishery.

Table 12a. Tagging and recovery data from the 1988 Taku River chum salmon mark-recapture program. Data are number of chum salmon tagged at Canyon Island and recovered in Canadian commercial and test fisheries by statistical week.

Statistical Week of Tagging	Statistical Week of Recovery											
	27-30	31	32	33	34	35	36	37	38	39	Total	Total Tagged
27-29											0	14
30	1	1									2	10
31											0	6
32				1							1	12
33											0	31
34					2	1					3	95
35						6	1				7	88
36							5	13			18	291
37								1	2		3	362
38-39										1	1	90
Total	1	1	0	1	2	7	6	14	2	1	35	999
Canadian Catch	10	9	12	33	97	158	487	82	18	60	966	

Table 12b. Tagging and recovery data from the 1988 Taku River chum salmon mark-recapture program by grouped tagging and recovery time strata, the population estimate in each recovery strata, 95% confidence intervals for the strata estimates, Canadian commercial fishery exploitation rates, and the estimated escapement in each recovery strata.

Statistical Week of Tagging	Statistical Week of Recovery						
	27-34	35	36	37	38-39	Total	Total Tagged
27-33	5					5	73
34	1	6				7	95
35		1	5			6	88
36			13	1		14	291
37-39				2	1	3	452
Total	6	7	18	3	1	35	999
Population Estimate	2351	2117	7266	7957	20118	39809	
95% Confidence Int.							
Lower	393	331	576	-14931	-42101	-11278	
Upper	4308	3903	13957	30846	82337	90895	
Canadian Commercial Catch	134	124	475	0	0	733	
Commercial Fishery Exploitation Rate	.057	.059	.065	0	0	.018	
Test Fishery Catch	27	34	12	82	78	233	
Escapement Estimate	2190	1959	6779	7875	20040	38843	

Table 13. Mark-recapture data by size class for chinook salmon, 1988. Random tag recoveries were those found during sampling for tagged:untagged ratios, select tag recoveries were those found without sampling for tagged:untagged ratios, and lost tags were determined by the presence of secondary marks left by the tagging process.

Sample Source	Sample Size	Size Class <440	440-660	>660	Unknown
Chinook Tagged	1,338	357	630	333	14
Fishery Recoveries					
Canada	53	6	30	17	
U.S.	2	0	1	1	
Spawning Ground Data Used For Mark-Recapture Ratios:					
Nahlin River					
Fish Examined	740	26	166	548	
Random Tag Recoveries	5	0	5	0	
Untagged:Tagged Ratio	148:1	-	33:1	-	
Lost Tags	1	0	0	1	
Nakina River					
Fish Examined[a]	3,336	429	1,510	1,397	
Random Tag Recoveries	22	7	13	2	
Untagged:Tagged Ratio	152:1	61:1	116:1	699:1	
Select Tag Recoveries	4	3	1	0	
Lost Tags	2	1	1	0	
Tatsamenie					
Fish Examined	1,013	169	349	495	
Random Tag Recoveries	9	2	6	1	
Untagged:Tagged Ratio	113:1	85:1	58:1	495:1	
Select Tag Recoveries	8	0	6	2	
Lost Tags[b]	3	1	2	0	
Subtotal					
Fish Examined	5,089	624	2,025	2,440	
Random Tag Recoveries	36	9	24	3	
Untagged:Tagged Ratio	141:1	69:1	84:1	813:1	
Select Tag Recoveries	12	3	7	2	
Lost Tags	6	2	3	1	
Additional Spawning Ground Data:					
Hackett River					
Select Tag Recoveries	6	1	5	0	
Lost Tags	2	0	0	0	1
Little Trapper Lake					
Select Tag Recoveries	1	0	1	0	

[a] Preliminary totals, not including approximately 1,000 fish sampled by CDFO.
[b] Some of these tags may have been removed by CDFO at their upstream weir.

Table 14. Recapture of spaghetti-tagged fish in fish wheels at Canyon Island in 1988.

Species	Numbers Tagged	Numbers Recaptured	Percent Recaptured	Mean Days at Large	Range	Median
Chinook	1,338	39	2.91	11.7	0-35	9
Coho	1,977	72	3.64	3.9	0-15	3
Sockeye	2,873	103	3.59	3.1	0-24	2
Chum	999	38	3.80	1.7	0-8	1

Table 15. Comparison of tag recoveries of chinook salmon caught at night (holding time in liveboxes from 0-12 hours) and during the day (reduced holding time).

Recovery Location		Numbers Recovered	Numbers Tagged	Recovery Rate
Canadian Fishery				
	Night	25		
	Day	27		
Escapement				
Tatsamenie	Night	5		
	Day	12		
Nahlin	Night	5		
	Day	0		
Nakina	Night	13		
	Day	13		
Hackett	Night	1		
	Day	5		
L. Trapper	Night	1		
	Day	0		
Escapement Subtotal	Night	25		
	Day	30		
Total	Night	50	545	.092
	Day	57	793	.072

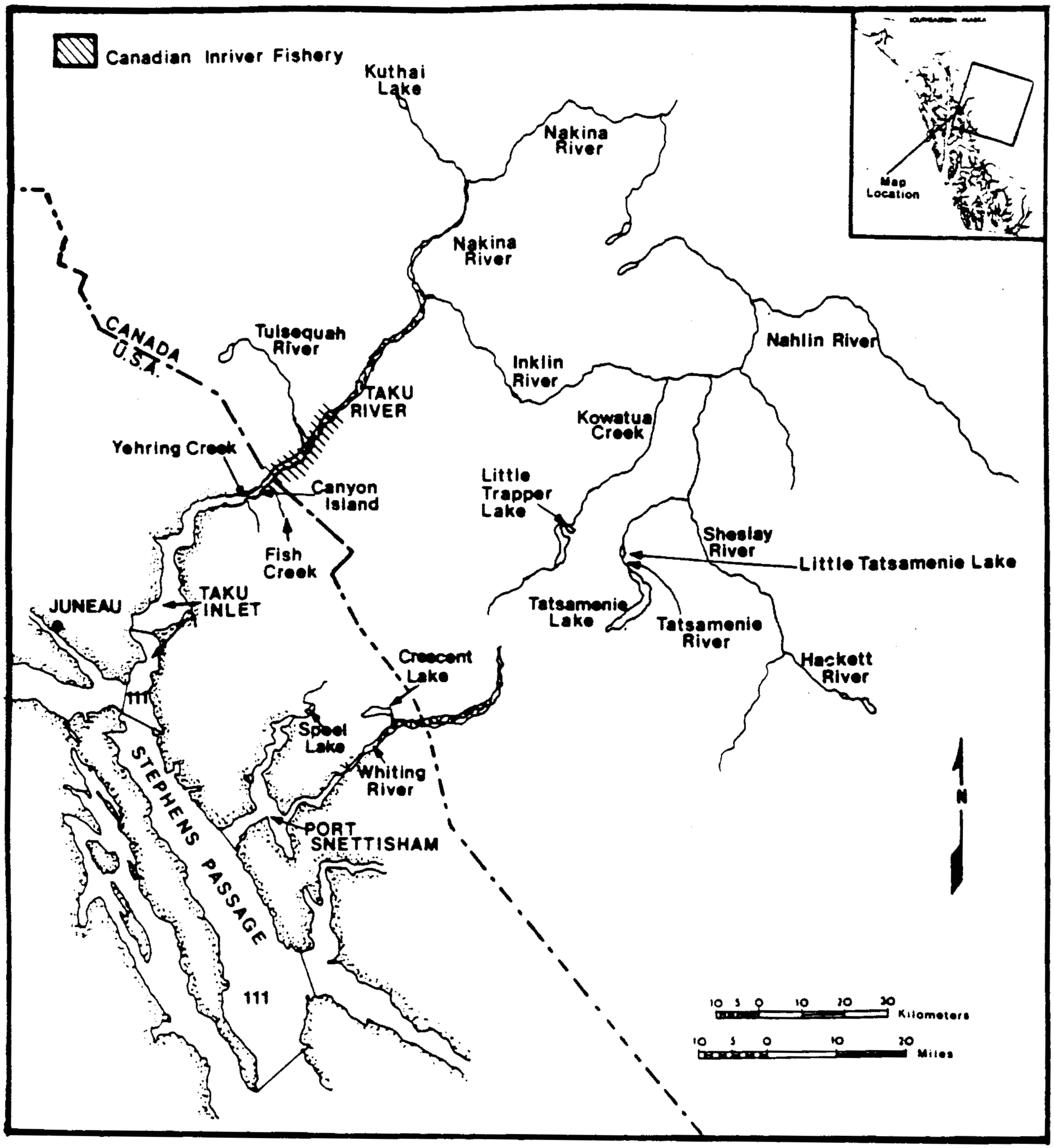

Figure 1. Taku River and Port Snettisham drainages.

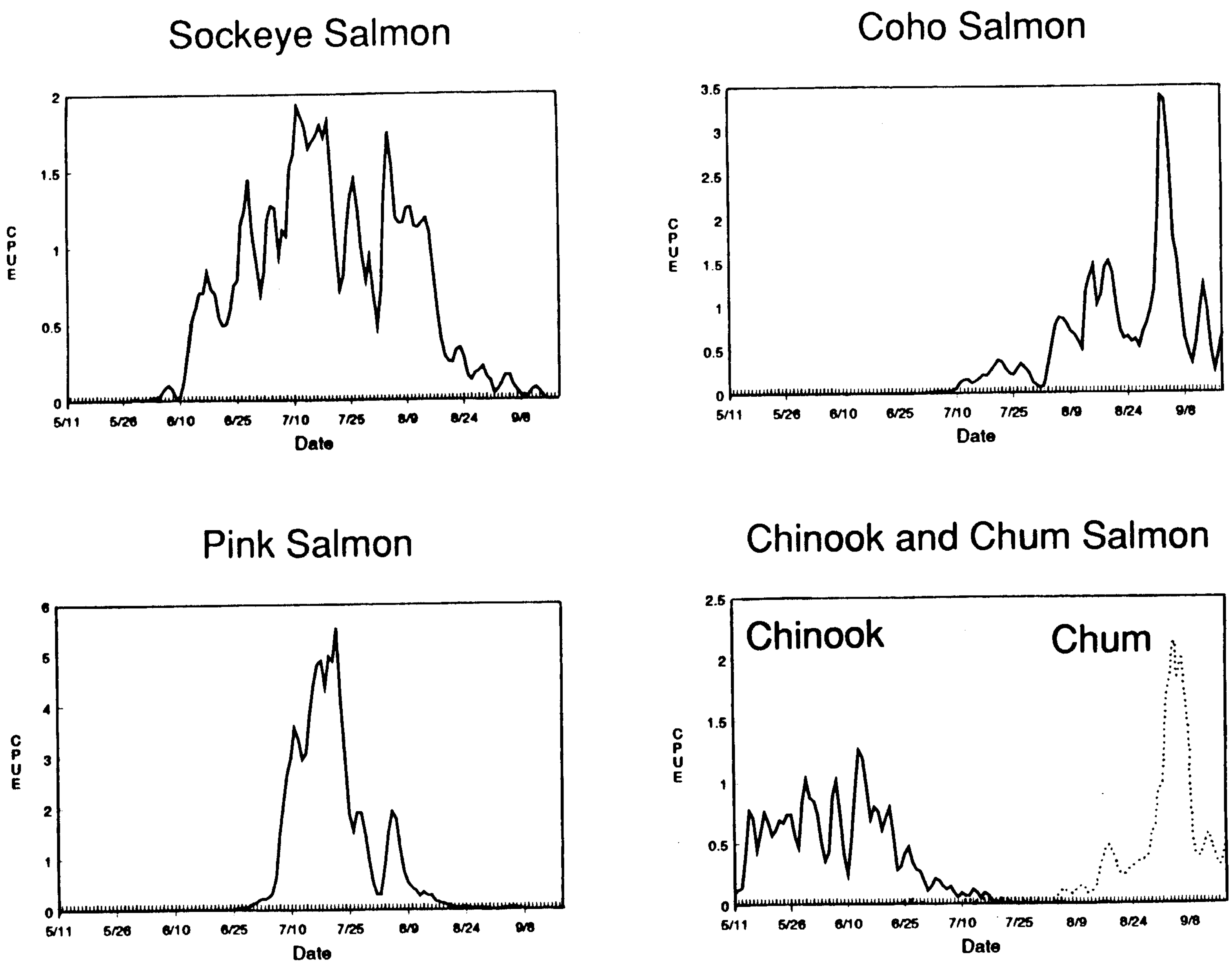

Figure 2. Fish wheel CPUE (catch per fish wheel hour) for the various salmon species captured in 1988.

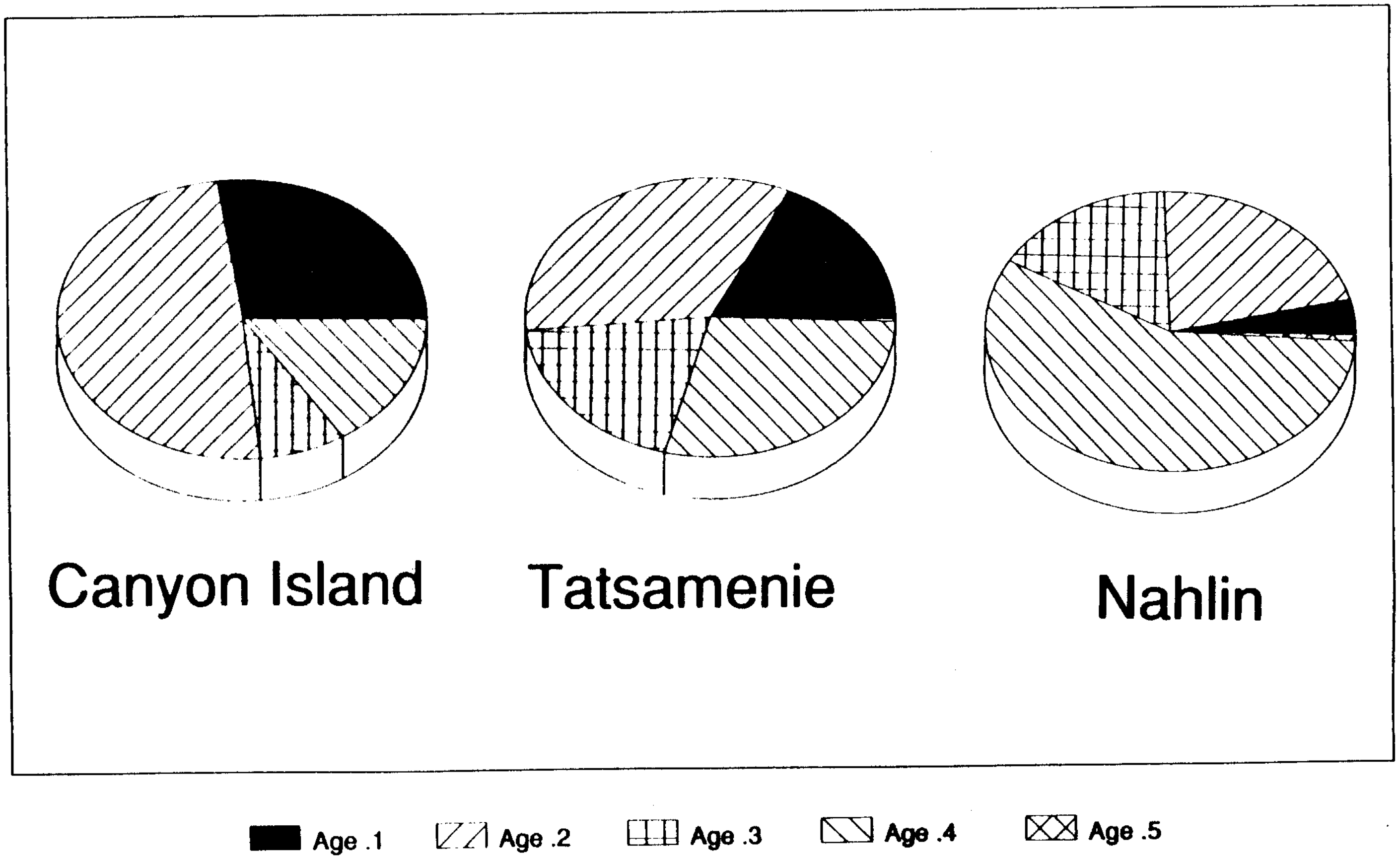

Figure 3. Age composition of chinook salmon sampled from escapements to the Tatsamenie Lake system and the Nahlin River, and from Canyon Island fish wheel catches, 1988.

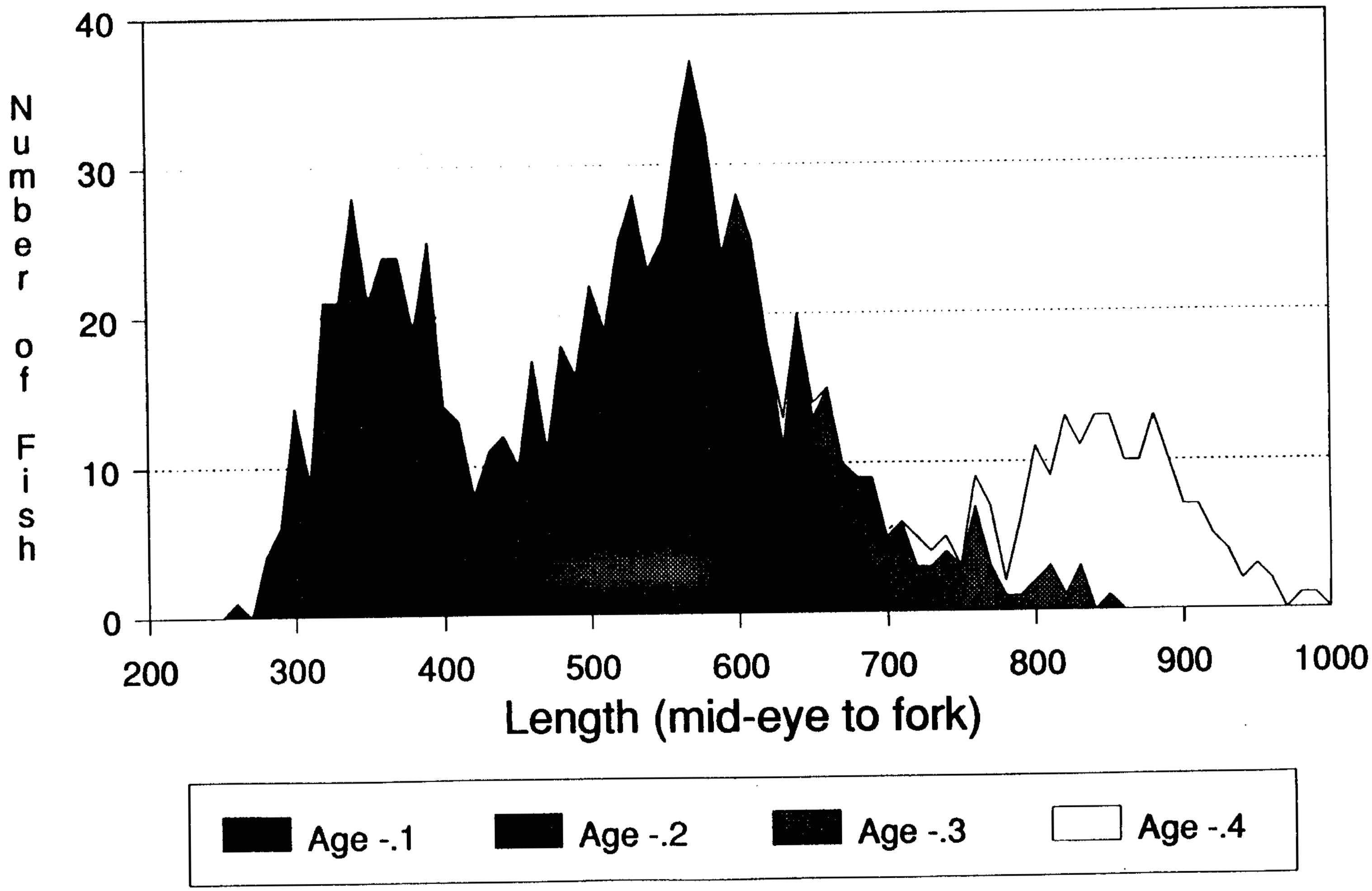

Figure 4. Length composition by age for chinook salmon caught in fish wheels at Canyon Island, 1988.

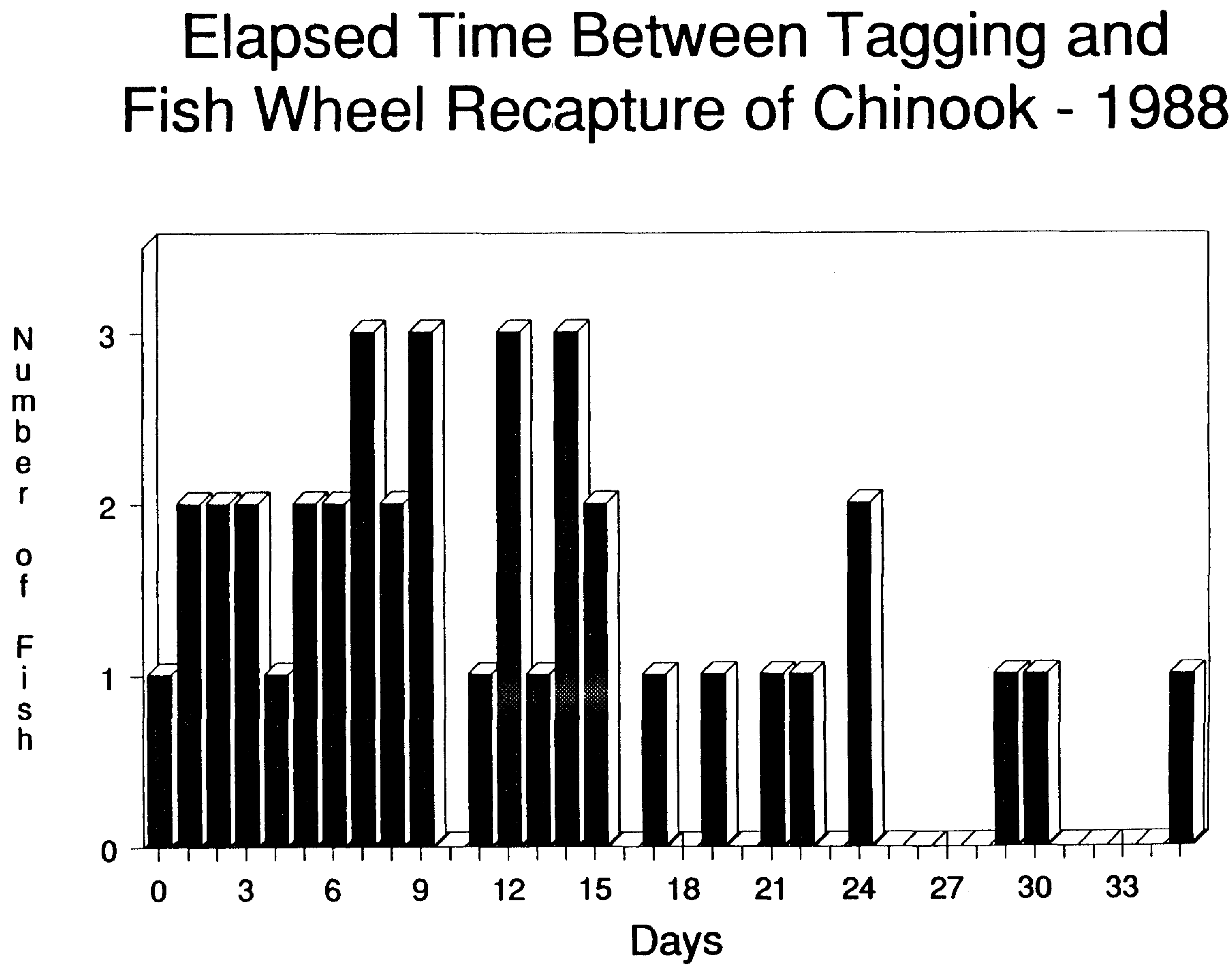

Figure 5. Frequency distribution of the elapsed time between tagging and fish wheel recapture of tagged chinook salmon, 1988.

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