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The Effects of Time and Size at Release on Returns at Maturity of Chinook Salmon from Quinsam River Hatchery, B.C., 1982 and 1983 Releases

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1996

Canadian Technical Report of Fisheries and Aquatic Sciences No. 2105

Fisheries and Oceans Pêches et Océans

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Canadian Technical Report of Fisheries and Aquatic Sciences

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Canadian Technical Report of
Fisheries and Aquatic Sciences 2105

1996

THE EFFECTS OF TIME AND SIZE AT RELEASE ON RETURNS AT MATURITY OF CHINOOK SALMON FROM QUINSAM RIVER HATCHERY, B.C., 1982 AND 1983 RELEASES

by

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Cat. No. Fs 97 - 6 / 2105 E ISSN 0706 - 6457

Correct citation for this publication:

Morley, R.B., A.Y. Fedorenko, H.T. Bilton and S.J. Lehmann. 1996. The effects of time and size at release on returns at maturity of chinook salmon from Quinsam River Hatchery, B.C., 1982 and 1983 releases. Can. Tech. Rep. Fish. Aquat. Sci. 2105: 88 p.

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Juvenile chinook were released from the Quinsam River Hatchery on Vancouver Island on four different dates (May 5, May 26, June 16 and July 7) in both 1982 and 1983. Fish from each release group were graded into small, medium and large size categories, and each group differentially coded-wire tagged. Returns to catch and escapement were examined for the effects of time and size at release on survival, growth, age at maturity and catch distribution.

The study showed that highest survivals resulted from earlier (May) releases of larger (6-10 g) juveniles. Compared to later releases, May releases also showed the strongest release size effects, with larger juveniles returning at higher rates. (These survival trends may well be specific to the 1982 and 1983 releases of Quinsam hatchery chinook, reflecting the genetic make-up of these broods, as well as the freshwater, estuarial and marine conditions). Effects of release time and size were generally minor on the adult age and size composition in the escapement. These effects were also minor on the marine catch distribution. Of the total catch of Quinsam chinook, over 80% were taken in Alaska and North-Central B.C. waters.

RÉSUMÉ

Morley, R.B., A.Y. Fedorenko, H.T. Bilton and S.J. Lehmann. 1996. The effects of time and size at release on returns at maturity of chinook salmon from Quinsam River Hatchery, B.C., 1982 and 1983 releases. Can. Tech. Rep. Fish. Aquat. Sci. 2105: 88 p.

Des saumons quinnats juvéniles ont été relâchés de la pisciculture de la revière Quinsam dans l'île de Vancouver à quatre dates (les 5 et 26 mai, le 16 juin et le 7 juillet) en 1982 et à nouveau en 1983. Les poissons de chaque groupe libéré ont été classés en catégories «petit», «moyen» et «gros», et les individus de chaque groupe ont été marqués au moyen d'une micromarque magnétisée codée pour les trois catégories. Les micromarques retournées provenant des prises et des saumons de remonte ont été examinées afin de déterminer l'incidence du moment de la libération et de la taille à la libération sur la survie, la croissance et l'âge à la maturité ainsi que sur la distribution des prises.

L'étude a démontré qu'on peut s'attendre aux taux de survie les plus élevés chez les juvéniles plus gros (de 6 à 10 grammes) qui ont été libérés plus tôt (en mai). Comparativement aux groupes ayant été libéré plus tard, les poissons libérés en mai illustraient les effects les plus forts de la libération par rapport à la taille, en ce sens qu'on notait un taux de retour plus élevé pour les plus gros spécimens. (Les tendances susmentionnées sont propres aux libérations de 1982 et 1983 pour les saumons quinnats de la pisciculture de la rivière Quinsam, ce qui atteste la constitution génétique de ces stocks ainsi que les conditions des eaux douces, estuariennes et marines caractéristiques de ces années.) Le moment de la libération et la taille des poissons avaient généralement peu d'incidence sur la taille des adultes et leur répartition selon l'âge au moment de l'échappée. Ces effets étaient aussi mineurs pour ce qui est de la distrubution des prises en mer. Sur l'ensemble des prises de saumons quinnats issus de la rivière Quinsam, plus de 80 % ont été capturés dans les eaux de l'Alaska ainsi que dans les eaux du centre et du nord de la Colombie-Britannique.

INTRODUCTION

Efforts to increase British Columbia salmonid stocks have included the development of new and improved strategies for increasing hatchery production. One such strategy is the use of optimal time and size at release to maximize the yield. Results obtained at Canadian and U.S. facilities on the Pacific Coast have shown that, generally, survival of juvenile chinook and coho salmon can be improved by increasing the size at release (Fagerlund et al. 1987, Bilton 1984, Reisenbichler 1982, Hager and Noble 1976, Johnson 1970, Wallis 1968). Other studies have shown that both time and size at release may influence the survival of chinook and coho salmon, and may also influence the size and age of returning coho salmon (Morley et al. 1988, Dudiak et al. 1987, Unwin 1985, Bilton et al. 1984b, Bilton et al. 1982, Bilton 1980, 1978, Hopley and Mathews MS 1975). That is, by releasing juveniles at optimum time and size, substantial increases in returns of adults could be expected (Bilton et al. 1982).

As part of the Federal-Provincial Salmonid Enhancement Program (SEP), an experiment was conducted on chinook salmon at the Quinsam River Hatchery to assess the simultaneous effects of time and size at release on subsequent survival, growth, age at maturity, and catch distribution of this stock. The goal was to determine the optimal release conditions at that location. Juveniles of three size groups were released from the hatchery on each of four different dates in 1982 and again in 1983. The study was conducted over two brood years to examine for annual (i.e., brood-year) variability in the effects of time and size at release. This report presents the study results.

The experimental broods (1981 and 1982) were released in 1982 and 1983, respectively. In this report, size categories of juveniles are abbreviated in tables and appendices as follows: S - small, M - medium, L - large, T - total sizes. Fish age represents the period elapsed between the brood year and the year of recovery. All figures, tables and appendices are given at the end of text.

METHODS

The experimental design for each of the 1982 and 1983 release years and detailed information up to the release of juveniles were published previously by Bilton et al. (1983, 1984a), and are summarized below.

LOCATION, DONOR STOCK AND REARING

The study was conducted at the Quinsam River Hatchery located on Quinsam River, a tributary to Campbell River on the east coast of Vancouver Island (Fig. 1). This facility uses groundwater during winter months. The study utilized part of the production stock of Quinsam hatchery chinook from 1981 and 1982 broods. Experimental fish were reared in standard Burrow's ponds separately from the production group and treated as production fish using production densities, normal hatchery water supply, a diet of Oregon moist pellets (OMP), and a routine hatchery feeding schedule.

EXPERIMENTAL DESIGN

In each of 1982 and 1983, three size groups of juveniles were released on each of four different dates, for a total of 12 different groups each year. Each size group was to be replicated three times, giving 36 groups in total for each year (the design is shown below). It should be noted that the replicates for each time-size release group were not true replicates since individual CWT groups did not come from separate rearing containers. Size groups were achieved at marking by grading the fish in each pond into small, medium and large length categories.

SIZE CATEGORY	RELEASE DATE IN 1982 AND 1983 AND APPROXIMATE NUMBER OF FISH			
	May 5	May 26	June 16	July 7
Small	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000 *
Total	**30,000**	**30,000**	**30,000**	**30,000**
Medium	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000 *
Total	**30,000**	**30,000**	**30,000**	**30,000**
Large	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000
	10,000	10,000	10,000	10,000 *
Total	**30,000**	**30,000**	**30,000**	**30,000**
GRAND TOTAL	**90,000**	**90,000**	**90,000**	**90,000**

* In the 1982 release year, the third replicate was not available for the July 7 group; this last release utilized a portion of fish from the production pond because of insufficient fish in the experimental ponds.

TAGGING AND RELEASE

Each group was tagged distinctively using coded-wire nose tags (CWTs), and all tagged fish were marked externally by removal of the adipose fin. Marking was conducted approximately from mid-April to mid-June in 1982 and from mid-April to mid-May in 1983. Prior to each tagging session, length-frequency curves were derived from a sample of 1,000 fish taken from each experimental pond. The 5% from each tail of the distribution curve were rejected to remove extreme sizes and the remaining 90% were divided into three equal portions classified as small, medium or large. Because the fish grew rapidly during this period, the limits delineating each size category had to be moved upwards several millimeters every two to three days throughout all four tagging sessions each year (a session lasted 10-12 days).

On the day of each release, samples of fish were removed randomly from the release pond, killed and subsequently examined for tag retention, length, weight, sex, body composition and disease. An additional live sample was removed from each size category just prior to release and tested for seawater adaptability. Each release from the pond to the river began in late afternoon or early evening. Fish were released on May 5, May 26, June 16 and July 7 in each of 1982 and 1983.

The initial release numbers were from Bilton et al. (1983, 1984a). These numbers were subsequently adjusted downwards by 4 to 70 fish per CWT group to correct for beach-seine captures ("estuary kills") made in the Campbell River estuary and adjacent waters during a study on habitat evaluation conducted in that area during 1982 and 1983 (Kotyk et al. 1984, Gordon et al. 1983).

Evaluation of juveniles at release for health, seawater adaptability, body composition and sex ratios was given by Bilton et al. (1983, 1984a) and is summarized in the Results section.

RECOVERY OF ADULTS

Escapement

Annual escapement estimates for Quinsam chinook consisted of the hatchery component (those fish trapped at the counting fence located immediately upstream of the hatchery) and the river component (those fish spawning naturally in the Campbell / Quinsam River system below the fence). Trapped hatchery fish were destined for use as broodstock, for surplus sales, or passed above the fence for upstream spawning.

Hatchery escapement data were obtained from hatchery sampling records and included complete counts of all chinook trapped at the fence. The river component for 1983 (the first year of expected recoveries - jacks only) was based on a dead-pitch sample for CWT marks and a Fishery Officer estimate of the spawning population. From 1984 onward, the estimated river population was based on intensive spawning-ground surveys using the Petersen mark recovery method applied to carcasses. These surveys were part of the joint Canada/U.S. key-stream program in which selected streams, such as the Campbell / Quinsam River system, were intensively surveyed to obtain stock exploitation rates; the data are documented in the annual key-stream escapement reports. In some years, these reports contained errors and biases in data treatment and, consequently, escapements were recalculated using data from the hatchery and dead-pitch records. The finalized escapement data presented here were extracted from the Department of Fisheries and Oceans - Salmonid Enhancement Program (SEP) database.

Nearly all returns to the hatchery fence were checked for adipose marks, and all marks recovered at the fence were sexed and aged (based on CWT decoding), and measured for postorbital-hypural length (POHL) to the nearest 1 mm. These fish were also subsampled for weight to the nearest 0.01 kg. By comparison, only a portion of the river spawners were checked for adipose marks each year. The river mark recoveries were sampled for length (POHL) and sex. Most heads of adipose-clipped fish from both the hatchery and dead-pitch recoveries were removed for subsequent dissection and CWT decoding. The observed decoded CWTs were expanded by the appropriate sampling rates in order to provide the total estimated escapement for each tagged group.

Fishery

Estimates of the numbers of tagged chinook taken in the commercial (net and troll) fisheries were obtained through the Coastwide Mark Recovery Program (MRP). Commercial catches were sampled at a target intensity of 20%. The numbers of observed tags were adjusted by the actual sampling intensity by week and catch region to provide the estimated recoveries for

each tag group (Kuhn 1988). Estimates of tagged chinook taken in the sport fishery were based on voluntary returns by anglers of heads from marked chinook (i.e., fish with a missing adipose fin). A monthly "awareness factor" was calculated using results from the Strait of Georgia creel surveys (Argue et al. 1977), to estimate the proportion of marked fish caught that were recognized and reported by anglers. The awareness factor was used to adjust the observed recoveries in the sport catch to provide the catch estimates for each tag group. There were no native catches of Quinsam chinook.

Estimates of numbers of marked chinook recovered in the U.S. fisheries (Alaska and Washington / Oregon) were obtained from the U.S. agencies which use procedures similar to those outlined above for British Columbia.

DATA COMPILATION AND RELIABILITY

Total returns by age for each CWT group were determined from escapement counts to the hatchery and the river system, as well as from catch numbers estimated for the commercial and sport fisheries. Survival rates were calculated as percent returns (all ages combined) for each of the catch and escapement components, in relation to numbers of juveniles released.

Reliability of the above mark recovery estimates was considered highest for the escapement to the hatchery, as all chinook trapped at the fence were counted. The river escapement component, based primarily on spawning ground surveys, was considered less reliable, as were the commercial catch estimates where the sampling effort was aimed at 20%. The least reliable were the sport catch estimates.

ANALYTICAL METHODS

Effects of time and size at release on survival were examined by plotting survival (catch plus escapement) against juvenile size at release for each of the four releases within a year. Results were examined visually for major trends, and simple tests applied to check for significant linear size effects within each release. Response surface analysis (RSA) was also conducted on the data. This analysis allows the examination of the relationship between the dependent variable (survival) and both independent variables (time and size at release) simultaneously (Schnute and McKinnel 1984). (See Discussion section on problems regarding the use of this analysis on the study data).

Length and age composition of returning adults was based on escapement recoveries for the entire river system (i.e., hatchery returns plus river recoveries) in order to increase sample size. Adult weight and sex composition were based only on hatchery recoveries. Note that the three "replicates" for each release size group were generally pooled for data analysis in order to increase sample size.

Standardized biomass (kg) was calculated for 100 returns from each release date (May 5, May 26, June 16, July 7); size categories for each release date were combined to increase sample size for weights. Calculations were based on age composition in catch plus escapement, and mean adult weight by age in hatchery returns. Consequently, biomass was likely overestimated since those fish taken early in the fishery would not have reached the final weight observed at the hatchery.

A chi-square test was used to examine the effects of release time and size on the age and sex composition in the escapement. This test was applied to the actual (observed) marks recovered at the hatchery fence since all these fish were sexed and aged; river recoveries were excluded from the analysis since only a portion of river spawners were sampled for marks. Note that in the analysis of age composition, several age classes were combined to increase sample size. A paired-sample t-test was used to compare the mean age in the catch and escapement for the different time-size releases in each brood year.

A 2-WAY ANOVA was used to examine the effects of both size at release and age at return on the adult length in the escapement. Males and females were analyzed separately; samples with fewer than 3 fish were excluded from the analysis. Adult weight data were not analyzed due to small sample sizes.

RESULTS

JUVENILES

Information on the status of juveniles at release was extracted from Bilton et al. (1983, 1984a). In general, juveniles were in very good condition at release, with virtually no pathogens detected. Seawater adaptability was good for all groups, except for the May 5, 1982 small sized release and all of the May 26, 1982 releases which had somewhat elevated blood sodium levels. Body composition of juveniles (data available only for 1983 releases) was affected by both time and size at release. In particular, later releases generally showed a lower body moisture and fat content, and a higher body ash and protein content. Also, for a given release time group, larger juveniles showed a higher lipid content than smaller juveniles (Appendix 3). Sex ratios of juveniles were skewed significantly ($p<0.05$) in favour of males for each of the 1982 release time groups, but size effects were generally not apparent for these groups. By comparison, sex ratios for the 1983 release time groups did not deviate significantly from the 50:50 ratio. However, there was a strong size effect, with the proportion of males progressively increasing with increasing release size.

ADULT SURVIVAL

Estimated survivals to catch and escapement are detailed for each CWT group in Appendices 1 and 2. An estimated total 5,301 and 4,228 chinook were recovered from the 1982 and 1983 releases, respectively, and of these, an estimated 3,767 and 2,929 chinook, respectively, were recovered in the catch. Survivals to catch (C) and escapement (E) are summarized by release date (sizes combined) in Figure 2. Total survivals for the 1982 and 1983 releases were 1.69% and 1.18%, respectively (see below).

% SURVIVAL OF QUINSAM CHINOOK

Release Date	Catch	Escapement	C + E
	1982	RELEASES	
May 5	0.89	0.40	1.29
May 26	1.55	0.62	2.17
June 16	1.28	0.49	1.77
July 7	0.95	0.41	1.36
Total *	1.20	0.49	1.69
	1983	RELEASES	
May 5	1.02	0.48	1.51
May 26	0.97	0.37	1.35
June 16	0.73	0.36	1.10
July 7	0.53	0.23	0.76
Total *	0.82	0.36	1.18

* Total Survival = (Total Returns / Total Released) x 100.

Survival rates (catch plus escapement) were plotted against time and size at release for each year (Fig. 3). Linear and quadratic equations used to fit the data are given in Appendix 4.

Effects of Size at Release

1) There was a significant ($p<0.05$) linear relationship between survival rate and size at release for May and June releases in 1983 (Appendix 4). The other releases showed a curvilinear relationship (line of best fit) between survival rate and size at release. Survival data for May 26, 1982 release were extremely variable compared to all other releases (Fig. 3); reasons for this are not apparent.

2) For both years, earlier releases showed increased survival with increasing size at release (except for May 26, 1982 group, Fig. 3). This relationship became less marked over time, and was not apparent in the final (July) releases.

Effects of Time of Release

3) For both years (particularly 1983), survival of fish of similar size increased for earlier releases. This can be seen by comparing survivals of similar sized fish from adjacent release dates (as indicated by intersections of vertical dotted lines with regression lines, Fig. 3; some minor extrapolation (see dashed lines) of regression lines for May releases was required where size ranges did not overlap). For example in 1983 releases, the survival rate of 7.5 g juveniles was about 2.2% for May 5 release, compared to only 1.2% for May 26 release; 10.5 g juveniles survived at a rate of 1.5% for May 26 release, compared to only 0.9% for June 16 release. This trend was considerably less certain in the first two releases in 1982 (May 5, May 26), largely due to the relatively high variability in survival data for these releases. In addition, the very small size of juveniles in May 5, 1982 release prevented direct comparisons with similar sized juveniles in May 26, 1982 release. However, the trend was again obvious in comparisons between later releases that year.

4) Although our data clearly showed that survival of similar sized juveniles increased dramatically for earlier releases (Fig. 3), the results for both release years suggest that juveniles released at 4.5 g size would have survived at a similar rate whether released on May 5 or May 26 (by extrapolation, Fig. 3). If these extrapolations are accepted as reasonable, this suggests that no survival advantage would be expected from earlier compared to later releases during May of small sized juveniles (approximately 5 g or less).

In summary, while the two brood years showed different total survivals, the effects of time and size at release remained quite consistent from year to year. That is, survivals were highest for early releases of larger juveniles, with an optimum combination of time and size at release (if any) possibly outside the data window (i.e., earlier and larger than the tested range). Within the tested range, highest survivals were for May releases of 6-10 g juveniles. The study strongly indicated that if juveniles have not reached approximately 5 g by May 5, higher survival could be achieved by continuing to rear them to a larger size and releasing them at a later date. Note, however, that an excessive delay would not be advantageous due to declines in survival associated with later releases (June and July, Fig. 3).

Response Surface Analysis

Although attempts were made to conduct response surface analysis on the data to determine an optimum combination of time and size at release, this technique was judged to be inappropriate, mainly due to limitations in the data set resulting from growth of experimental fish over the period of releases. This is addressed more thoroughly in the Discussion section on Assessment of Experimental Data.

Body Composition of Juveniles

For each release date in 1983, the larger juveniles generally showed a higher lipid content and had a higher marine survival (Appendix 3). An exception was the July 7 release where all size groups showed similarly low survival rates.

AGE COMPOSITION

Age composition in the catch and escapement is summarized in Figure 4 (Table 1) and detailed for each CWT group in Appendices 5 and 6. Recoveries included ages 1 to 7, and were dominated in near-equal proportions by ages 4 and 5; these two ages together contributed 69% and 68% to the recoveries from 1982 and 1983 releases, respectively. Age 1 and age 7 components were negligible and were observed only in the escapement.

Age composition differed for males and females recovered at the hatchery fence, with males returning at a younger age (Table 3). Mean age in the catch was significantly lower than in the escapement.

TESTING FOR SIGNIFICANCE IN MEAN AGE OF CATCH AND ESCAPEMENT *

	No. Groups	Mean Age Catch	Escapement	Significance
1982 Release	12	3.91	4.61	t = 19.62, d.f. 11, p<.001
1983 Release	12	3.87	4.45	t = 15.00, d.f. 11, p<.001

* Mean age = Mean of means per time-size release. Age data per time-size release from Appendices 5 and 6.

Time of release showed no apparent effects on age composition in the catch, escapement, or total return. That is, the age structure was similar for May, June and July releases (sizes combined per release group), with ages 4 and 5 clearly dominating the total returns. A chi-square analysis was conducted separately on males and females from each release year using the observed recoveries at the hatchery fence. No significant association (at 5% level) was found between time of release and age composition in the escapement. An exception was for females from 1982 releases (X^2=15.64, d.f. 6, $p<0.05$) where most of the heterogeneity was due to the May 5 group.

Size at release also showed no clear effects on age composition of total returns (Appendices 5, 6). A chi-square analysis conducted on the hatchery recoveries for those data sets with sufficient sample sizes, also showed no significant association (at 5% level) between size at release and age composition of males or females. An exception was for females from May 5, 1983 release ((X^2=6.84, d.f. 2, $p<0.05$), where larger sized juveniles tended to return as younger females.

ADULT SIZE IN ESCAPEMENT

Mean lengths (POHL) and weights of chinook in the escapement are presented for each release by age and sex in Appendices 7 and 8. Table 2 summarizes the mean adult sizes by release time group. Mean lengths and weights ranged from 328-474 mm and 0.7-2.7 kg for age 2 fish, to 852-881 mm and 14.2-17.0 kg for age 6 fish. Males from most release time groups tended to be smaller than females in both length and weight, for a given age (Appendices 7, 8).

Mean adult lengths and weights in the escapement were plotted by release date and size for each age (Figs. 5, 6). (Note that some samples for ages 3, 5 and 6 contained fewer than 5 fish). Time of release showed little effect on adult size at return, with mean adult size per age similar for all release dates (see also Table 2). However size at release, especially for May 5 groups, appeared to have a positive effect on adult length and weight, with larger juveniles returning as larger adults (Figs. 5, 6). This finding, however, was generally not statistically significant when the adult males and females from a given release date were tested separately (2-WAY ANOVA; due to limited sample sizes only the length data were tested). While the effects of age at return were predictably significant ($p<0.005$), with older fish returning at a greater length, the effects of release size were generally not significant at 5% level. An exception were three groups (males from July 7, 1982 and June 16, 1983 releases, and females from May 5, 1983 release) where significant ($p<0.05$) and positive release size effects on adult length were observed.

BIOMASS OF RETURNS

Standardized biomass was calculated for 100 chinook returns from each release date (sizes combined per release date). The results are shown below.

Release Date	Biomass (kg) per 100 adults	
	1982 Releases	1983 Releases
May 5	1,088	989
May 26	1,007	927
June 16	1,030	976
July 7	1,028	935

All groups from each release year showed similar biomass returns per 100 adults. This supports the above findings that time of release had little effect on age composition and adult size. The consistently lower total biomass observed for the 1983 compared to 1982 releases is attributed mainly to the lower average weight of age 4 adults from 1983 releases (Fig. 6).

SEX RATIO IN ESCAPEMENT

Sex composition of hatchery recoveries is shown by age and release date in Table 3. Males predominated over females (58.1% and 54.7% for 1982 and 1983 releases, respectively). All but one time group (May 26, 1983) showed this trend, especially at younger ages where males constituted all of age 2, nearly all of age 3 and the majority of age 4 fish; females predominated in ages 5 and 6.

Time of release showed no discernible effects on the sex ratio in hatchery recoveries (all ages combined, Table 3). A chi-square analysis on each brood also showed no significant association (at 5% level) between time of release and sex ratio in hatchery returns. (The chi-square analysis was based on the actual observed recoveries at the hatchery fence; these numbers were the same or slightly lower than the estimated recoveries in Table 3). Likewise, size at release showed no clear effects on the sex ratio in hatchery returns. An exception was the July 7, 1983 release where a significant heterogeneity in sex ratios was observed for different size groups (X^2=6.54, d.f. 2, $p<0.05$).

EXPLOITATION RATE

Exploitation rates (catch as percent of total return) are summarized for each release in Figure 7 and detailed in Appendices 1 and 2. Mean exploitation rates were similar for each release time group (range 69-72% for 1982 releases, 67-72% for 1983 releases), with an overall mean rate of approximately 70%. There were no obvious release time or size effects.

CATCH DISTRIBUTION

Catch Distribution by Area

Catch distribution by major fishing area is summarized in Figure 8a and detailed for each release in Appendix 9. Five major catch areas were distinguished.

Catch Area	Description (Fig. 9)
Alaska	All Alaska waters.
North-Central	North and Cental B.C.*
Inside	Johnstone and Georgia straits
Outside	WCVI ** and Juan de Fuca Strait
WA/OR	Washington and Oregon

* Includes Johnstone Strait troll.
** WCVI - West Coast of Vancouver Island.

The two release years showed a similar catch distribution, with the majority of the catch taken in Alaska (41-46% of total catch) and North-Central B.C. (39-43% of total). Catches in the inside waters contributed only 14-16% to the total, while the outside catches (including WA/OR) were negligible (<1%). Time and size at release generally showed little effect on the catch distribution by area (Fig. 8a, Appendix 9).

Catch Distribution by Gear Type

Catch distribution by gear type is summarized in Figure 8b and detailed in Appendix 10 (note that the U.S. catch component - primarily Alaska, represents all gears combined). For both release years, most of the B.C. catch was taken by net gear (30-31%), followed by troll gear (14-16%) and lastly by sport gear (9-12%). There were no obvious release time or size effects on the Canadian catch distribution by gear, with the net component dominating in all but one instance (May 5, 1982 small sized release, Appendix 10).

Catch Distribution by Age

The proportions of the Quinsam chinook catch taken in Alaska are shown by age for each release in Appendix 11. The majority (51-76% by release date) of the age 4 catch was taken in Alaska. The B.C. catch included nearly all of age 2 fish (>95%) and generally 60% or more of the age 3 and 5 fish. Catches of age 6 fish were too low for comparison. Neither time nor size at release showed any discernible effects on catch distribution by age.

DISCUSSION

ASSESSMENT OF EXPERIMENTAL DATA

Several potential sources of error may influence the study results. One concern is grading of juveniles to obtain different size categories. This may lead to selection of hereditary factors involved in the expression of growth rate and rate of return (Bilton et al. 1982), with larger fish representing faster growing individuals in the population (Mathews and Ishida 1989). Consequently, all subsequent effects on adult returns (e.g., survival, age composition, adult size) may also reflect differential growth rates. Because of this concern, temperature control or feeding ration should be used where possible to achieve size differences in future studies.

Analysis and interpretation of survival results were confounded by the nature of the data set. Since size differences were achieved by grading, with no special measures taken to control

growth, there was a gradual increase in mean fish size between releases, with only marginal overlaps of size ranges between adjacent release dates. The experimental design was therefore unbalanced, with no observations for juveniles of the same size over all release dates.

The above limitations precluded use of the response surface analysis (RSA). Although it was possible to conduct RSA on the data, the actual data field comprised only a very small asymmetrical area of the response surface generated, the remainder of the surface being based on extrapolation. Examination of these extrapolated areas indicated that results were often unrealistic and the RSA approach was therefore considered inappropriate. Analysis of covariance, based on linear regressions of survival rate against juvenile size, was also considered but not used because of differences in slopes of the regression lines, lack of linearity in some cases, and again, the asymmetry of the data set and requirement for extrapolations.

Because of the above problems and other concerns, including inequality of variances of survival rate over time and size, and differences in reliability of data from various sources, it was decided that attempts at elaborate statistical analyses of survival rates were not warranted. Instead, only simple regression methods were used, and the data examined subjectively for obvious trends.

In some analyses (e.g., response surface analysis, multivariate analysis) on the effects of time and size at release on survival, the choice of the data used (e.g., catch plus escapement or escapement only), may affect inferences made (K. Hyatt, pers. comm.). In our analyses, the choice of the data used (catch plus escapement, Fig. 3) was supported by the observation that our survival graphs showed similar trends when each of the catch and escapement were examined separately and in combination (Fig. 2).

Another concern was the uncertainty in mark recoveries in the commercial and sport fisheries where factors, such as partial catch sampling, size selectivity by gear, and the use of an awareness factor to estimate sport catches, may add unknown errors to the recovery data.

Marine catch distribution of the various release groups reflected both the actual fish distribution (which reflects many combined effects - time and size at release, genetic variation among groups, environmental conditions, etc.), and the regional intensity and effectiveness of the fishing fleet over the marine life-span (ages 2-6) of each brood. To remove the year-to-year variability in fishing pattern and intensity of the fishing fleet, data from the same catch year should be compared (e.g., only age 4 fish from a given brood). This was not done when plotting the catch distribution graphs (Fig. 8) as sample sizes of catch recoveries would be reduced significantly.

In using the river dead-pitch recoveries to augment sample sizes for adult age and length, it was recognized that these data may be biased due to the tendency to miss smaller sized fish and recover more females than males during a dead-pitch (Andrews et al. 1988). However, it was assumed that any biases in the calculation of age, length or sex compositions (the latter based on hatchery recoveries alone) would be similar for the different experimental groups, allowing for relative comparison among groups.

Our analysis of adult length and weight data was based on relatively small sample sizes (Appendices 7, 8), which required pooling of sexes when plotting the data. This complicated the

comparison among groups since the returning females were generally larger than males at a given age (Appendices 7, 8). In addition, the sex ratio differed among ages (e.g., all age 2 and nearly all age 3 fish were males, while most age 6 fish were females).

FACTORS AFFECTING SURVIVAL OF JUVENILE CHINOOK

Numerous factors affect survival of juvenile salmon, including time and size at release, incidence and severity of disease, seawater adaptability, fish diet, food supply, competition, predation, and estuarial and marine conditions. Some of these factors are discussed below with reference to our study.

Time and Size of Release

Time of release may affect survival by affecting one or more of the major mortality factors (i.e., predation, starvation, disease and inability to adapt to seawater) (Mathews and Ishida 1989, Bilton et al. 1982). The critical period for marine survival of salmon likely occurs early in the marine life since smaller fish are more susceptible to predation, and likely more severely affected by disease and food deprivation than larger fish (Scarnecchia 1981, Peterman 1978).

In our study, both time and size at release affected survival. Within the tested data range, maximum adult returns were predicted for May releases of larger (6-10 g) juveniles (Fig. 3). This conclusion was supported by historical survival data for Quinsam hatchery chinook (production and study releases from 1974-1986 broods), with highest returns generally observed for early May to mid-June releases at 5-10 g (Appendix 14).

McAllister and Brown (unpubl.) regressed the relative survival on time and size at release for Quinsam chinook for 1982-1985 production releases. The results suggested that for early releases, survival increased as initial size increased. Likewise, survival increased with release size for the Capilano chinook released in late May (Fagerlund et al. 1987) and for the Big Qualicum chinook released in early and mid-June (Bilton (1984). Reisenbichler (1982) reported that survival for different Washington and California chinook stocks increased (at a decreasing rate) as size at release increased from less than 2 g to about 50 g. The relationship curves for release size versus survival differed between broods and between geographical regions (Washington and California) but had a similar general shape, and could be useful in predicting the relative survival of juvenile chinook released at different sizes.

Unwin (1985) examined survival trends for 30 chinook releases of a New Zealand stock (1977-1981 broods) and found that release times and sizes influenced returns significantly, both individually and in combination. He noted that, as more return data from additional broods become available, survival contours for different release times and sizes would become better defined, providing a solid management tool for hatchery releases. He cautioned, however, that each hatchery (and certainly each river) should be treated separately.

Fish Diet and Rearing Conditions

Effects of different diets on survival were not tested in this study. However, a well balanced hatchery diet could optimize smolt survival as indicated by nutritional studies on hatchery produced salmonids where diet affected fish growth, development and marine survival

(Shrimpton, Bernier and Randall 1994, Higgs et al. 1992, Ogata and Murai 1989). It is noteworthy that in our study, the larger juveniles from May to June releases showed a higher body lipid content and a higher marine survival than the smaller juveniles (Appendix 3). Studies on chinook at the Capilano Hatchery (Fagerlund et al. 1987) and Robertson Creek Hatchery (Higgs et al. 1992) also showed that larger juveniles generally had a higher lipid content and a higher marine survival than smaller juveniles.

Effects of different rearing conditions on survival were not tested in this study. However, unfavourable rearing conditions, including temperature regime, water quality and rearing density, may result in increased stress on juveniles (Shrimpton, Bernier and Randall 1994). Rearing stress may, in turn, impair the smolting process and affect post-release survival (Zaugg 1989). Increased rearing densities of chinook salmon (Martin and Wertheimer 1989, Fagerlund et al. 1987) and coho salmon (Fagerlund et al. 1983) have resulted in lower adult return rates.

Inter- and Intraspecific Competition

Chinook survival may be affected by inter- and intraspecific competition during the early rearing stages. The Campbell / Quinsam River system, into which the Quinsam hatchery juveniles are released, supports five species of salmon (chinook, coho, pink, chum and steelhead trout). In addition, in both 1982 and 1983, the Quinsam Hatchery released over 5 million chinook, pink and coho juveniles. While the migration and/or release times of juveniles are staggered for each species, some competitive interaction may be expected, especially in years of high juvenile production. Fagerlund et al. (1987) observed that at high release numbers from hatcheries, competition for food in the marine environment may increase, resulting in reduced ocean survival.

Appendix 12 summarizes some of the study findings by Levings et al. (1986) and McAllister and Brown (unpubl.). Their results suggest that the relatively higher survival observed for the 1982 compared to 1983 releases (1.69% vs 1.18%) cannot be explained by annual differences in the level of inter- and intraspecific competition. It may be that the carrying capacity of the Campbell River estuary and adjacent marine waters was not exceeded in either year.

Estuarial Residency Time

Estuarial residency time may also affect survival. Macdonald et al. (1988) observed that an extended residency time in the estuary may be advantageous to the survival of juvenile chinook. Beach-seine data indicated that the apparent mean residency time for our study releases in the Campbell River estuary was approximately 31 days, with some variation between the different groups and release years (Levings et al. 1986). Juveniles from May releases were present in the estuary and adjacent waters for a longer period than juveniles from June and July releases (Levings et al. 1986). The larger sized May releases also showed highest survivals (except for the May 5, 1982 group, Fig. 3).

The May 5, 1982 group had the smallest release size (2.2-3.9 g) of all our experimental groups, and this may have contributed to the low survival for this group. This release also showed the longest estuarial residency time compared to the other groups, possibly related to cooler (by about $2^{\circ}C$) estuarial surface temperatures in the spring of 1982 compared to the spring of 1983 (Levings et al. 1986).

Marine Environment

Marine environment is considered one of the major factors affecting survival of salmon. Increasing evidence suggests that upwelling and ocean conditions may greatly influence survival of juvenile salmon (Ewing et al. 1985), while global trends in salmon catches suggest that climate and marine environment may play an important role in salmon production (Beamish and Bouillon 1993).

Sea-surface temperatures may affect juvenile growth, competitive success, vulnerability to predators and other factors. Available water temperature data suggested that the 1983 releases generally encountered warmer water temperatures in the Campbell River estuary and the Strait of Georgia than the 1982 releases, and warmer than normal sea-surface temperatures as they migrated northward into the Queen Charlotte Strait (Appendix 13). This warming may be attributed in part to the El Nino event which lasted from the fall of 1982 through 1983 (Appendix 13). While the effects of the El Nino event on Quinsam chinook were probably minor, nevertheless, the 1983 releases showed generally lower survival rates compared to the 1982 releases (Fig. 3).

Variability in Survival Between Sites, and Between and Within Brood Years per Site

Historical data for Quinsam chinook (production and experimental releases) showed great variation in survival within brood years (e.g., 0.95-1.81% for 1984 brood) and between broods (0.24 vs 2.94% for 1985 vs 1976 broods, respectively) (Appendix 14). Also releases within the optimal "window" (early May to mid-June releases of 5-10 g juveniles) yielded both very high survivals (2.9% for 1976 brood) and low survivals (0.65% for 1979 brood) (Appendix 14.). Clearly, brood-year effects appear to be a major force influencing the survival of Quinsam chinook.

Zaugg (1989) and Vreeland (1986) noted that survival rates of chinook from 24 hatcheries in the Columbia River Basin varied widely (0.01- 2.2%) over four brood years, and between years for individual facilities (up to 5-to-10-fold variation). Likewise, Dudiak et al. (1987) observed extreme variability in survivals of an Alaska chinook stock (0.3- 5.7%). The latter authors noted that all chinook groups in poor condition at release, also showed poor survival.

Green and Macdonald (1987) observed that for a given hatchery, a large inherent variability in survival exists between and within brood years. Their analysis of Robertson Creek chinook from 1972-1977 releases showed that many factors (e.g., treatment at hatchery, release time and size) may affect survival, but that variation between brood years overshadows all other factors. Nevertheless, our experimental results showed that optimal hatchery treatments were quite similar for the two broods studied (May releases of larger juveniles, Fig. 3). Therefore, while the maximum potential survival is probably influenced by factors outside the hatchery, even in years of unfavourable marine conditions, a better survival rate may be achieved by ensuring optimal hatchery environment and treatments.

Bilton et al. (1982) cautioned that the recognition of sources of variation between sites and between broods at a site, is vital for correct interpretation of the effects of time and size at release on survival. Numerous factors may lead to variability in survival between sites and within a site (Zaugg 1989, Dudiak et al. 1987, Green and Macdonald 1987, Bilton et al. 1984b, Bilton et al. 1982). Between-site variation in survival may be due to site-specific factors, such as hatchery rearing conditions (temperature regime, water quality, etc.), genetic differences between stocks,

endemic diseases, freshwater migration route and estuarial conditions. Factors that may contribute to both between- and within-site variability in survival include rearing density, rearing stress, saltwater adaptability prior to release, time and size at release, fish health at release, freshwater migration environment, as well as annual variation in the nearshore and coastal environment (e.g., sea-surface temperatures and coastal plankton blooms) which would lead to year-to-year variability in food supply, competition and predation. As a result, conditions that may yield good survival rates at one hatchery may not apply to another site (Zaugg 1989).

Bilton et al. (1984b) reported that coho salmon on Vancouver Island showed site-specific differences in the effects of time and size at release. In particular, the relatively low returns of Quinsam hatchery coho, compared to other Strait of Georgia hatcheries, suggested that site-specific factors (e.g., genetic differences between stocks, juvenile migration routes, smolt quality, and estuary type), may be limiting the Quinsam hatchery production, at least for coho salmon. Morley et al. (1988) observed that because of this site-specificity, time and size at release studies on coho salmon should be conducted at each site. It is likely that chinook also exhibit site-specific responses to time and size at release.

Value of Controlled Studies on the Effects of Time and Size at Release

It is apparent that many different factors may influence survival. However, the present study on Quinsam chinook indicates that, given reasonably healthy fish and accepting brood-year variability in survival, the effects of time and size at release are relatively consistent from year to year. This was also evident in earlier studies on Quinsam coho (Morley et al. 1988).

It may be possible to identify a fairly broad "window" for time and size at release by simple examination of all survival data for a facility. For example, historical data for Quinsam chinook suggested a release window from early May to mid-June at 5-10 g. However, the use of this general approach (i.e., simply releasing anywhere within this broad window) could mean missing an opportunity to dramatically increase survivals, since our study indicated very strong effects of both time and size within this window. Thus, while sources of annual variability may not be fully understood or controllable, knowledge of the effects of time and size at release provides an opportunity to maximize survival to the limits imposed by brood-year variability.

Recommendations for Optimizing Release Times and Sizes for Quinsam Hatchery Chinook

Release times and sizes tested in this study approximate those which can be achieved under production conditions at Quinsam Hatchery (unless extraordinary measures are taken, such as temperature or ration control). Thus, although no model was developed to predict optimum survival, or survival for any combination of time and size at release, the results obtained here should be of value in planning rearing and release strategies for Quinsam chinook.

The survival of Quinsam hatchery chinook appears to be greatly influenced by brood-year effects. Due to the complexity of these effects, different broods could exhibit different optimal release times and sizes, and some broods may show poor survivals even if released within the optimum "window". Consequently, the survival trends observed in Figure 3 may well be specific to the 1982 and 1983 releases, reflecting the genetic make-up of these broods, as well as the freshwater, estuarial and marine conditions.

An additional concern is that, while the Quinsam studies on both chinook and coho suggest that release time-size effects are quite consistent from year to year, the number of study years have been few, and the degree of effects may change with time. Consequently, a narrow release time-size "window" is not recommended for a site. Instead, a more general optimal release strategy should be developed, based on study results and historical survival data for that location. It is further recommended that controlled time-size release studies, perhaps much simplified, be repeated periodically at a site to monitor for possible long-term changes in optimum time-size release conditions. Since these conditions may be site-specific, test results for one location may not be applicable to other sites.

Based on the study results, we recommend the following release guidelines to improve the survival of Quinsam chinook freshwater releases (Appendix 15 summarizes the current production strategy and recommendations):

1. Conduct early releases (May) of larger juveniles (6-9 g).

2. Avoid releasing small juveniles (<5 g) at any time.

3. Avoid delaying releases beyond mid-June.

4. Determine the survival advantage (if any) of releasing larger juveniles in late April compared to May.

5. Periodically repeat controlled time-size release studies.

ADULT AGE

In our study, no obvious or consistent release time effects were observed on the age composition at return. The effects of size at release were less conclusive due to small sample sizes. Martin and Wertheimer (1989) found that for an Alaska chinook stock, large (30 g) yearling smolts produced adults with a younger age composition compared to small (10 g) smolts, while Bilton (1984) observed that within a release size range of 4-13 g, larger Big Qualicum chinook juveniles produced more age 2 fish. Likewise, studies on coho salmon (Bilton et al. 1982, Hagar and Noble 1976) showed that larger smolts produced adults with a younger age distribution.

ADULT SIZE

Time of release showed no obvious effects on adult size at return. Size at release appeared to have a positive effect for May releases but this trend was generally not confirmed statistically. Larger sample sizes are required to clarify the effects of release size, with males and females analyzed separately since pooling of sexes masks the data trends.

Fagerlund et al. (1987) compared the return sizes for small (~6.5 g) versus large (~9 g) Capilano chinook juveniles. Within this limited size range, they observed no release size effects on the size of age 2 and age 3 returns, but a positive release size effect on the size of age 4 returns. Martin and Wertheimer (1989) reported that for an Alaska chinook stock, larger chinook smolts (30 g vs 10 g) returned as larger adults.

SEX RATIO IN ESCAPEMENT

For the 1982 releases, the predominance of males over females in the escapement may be partly explained by the significantly higher proportion of males at release (Bilton et al. 1983). This explanation may not be applied to the 1983 releases where juveniles from each release date showed a 50:50 sex ratio (Bilton et al. 1984a).

In our study, males predominated in the younger age group (ages 2-4). Similar observations were made for the Big Qualicum chinook (Bilton 1984) and the Robertson Creek chinook (Green and Macdonald 1987).

CATCH DISTRIBUTION BY AREA

Quinsam chinook in this study were captured primarily in Alaska and North-Central B.C. waters. Recoveries in Washington / Oregon waters were observed only for May releases and were considered insignificant. Recovery data for other Quinsam chinook broods also showed negligible recoveries in these areas. Effects of release time on catch distribution by area could not be analyzed statistically since the standard chi-square test, typically used for this analysis, was not appropriate (Appendix 16, B. Pyper, pers. comm.). However, catch distribution showed no obvious release time or size effects.

Other studies on coho salmon from Quinsam Hatchery (Bilton et al. 1984b) and from Washington and Oregon hatcheries (Mathews and Ishida 1989) showed that earlier releases tended to have a more extended marine range, based on catch distribution. Green and Macdonald (1987) observed that earlier releases of Robertson Creek chinook showed increasing recaptures in Alaska and decreasing recaptures in B.C. However, these authors noted that time and size effects were slight compared to brood-year effects, and suggested that the manipulation of release dates and sizes to increase the B.C. catch component may not be worthwhile.

CATCH DISTRIBUTION BY AGE

Our study showed that mean age in the catch was lower than in the escapement. Likewise, Bilton (1984) observed for Big Qualicum chinook a selection by fisheries for younger aged fish.

In this study, the majority of age 4 chinook catch was taken in Alaska waters, probably reflecting size restrictions in the Alaska fishery and variable migration patterns of different ages; age 2, 3 and 5 fish were caught primarily in B.C. waters. This trend has significant economic implications since age 4 chinook dominated the total catch. Green and Macdonald (1987) analyzed returns from 1972-1977 releases of Robertson Creek chinook, and also found an interaction between age at recapture and place of recapture: the B.C. fishery tended to exploit younger (age 3) fish, while the Alaska fishery tended to exploit older (age 4 and 5) fish.

SUMMARY

1. Juvenile chinook from Quinsam Hatchery were released on four different dates (May 5, May 26, June 16 and July 7) in each of 1982 and 1983, to determine the effects of time and size at release on subsequent survival, growth, distribution and age at maturity.

2. Total survivals for 1982 and 1983 releases were 1.69% and 1.18%, respectively. Highest survivals resulted from earlier releases (May) of larger (6-10 g) juveniles.

3. Both time and size at release affected survival. Fish of similar size survived better in earlier releases (May to July period). Earlier (May) releases also showed greatest size at release effects, with larger juveniles returning at higher rates; size effects were negligible for latest (July) releases. There was a strong indication that if juveniles had not reached approximately 5 g by May 5, higher returns could be expected by delaying releases beyond that date to achieve a larger release size.

4. Historical survival data for Quinsam hatchery chinook indicated that highest survivals generally resulted for releases from early May to mid-June at 5-10 g (supporting summary points 2 and 3 above).

5. While there was considerable brood-year variability in total survival of Quinsam chinook, the effects of time and size at release appeared to be relatively consistent from year to year.

6. Ages 4 and 5 dominated the Quinsam chinook returns, together contributing 69% and 68% to recoveries from 1982 and 1983 releases, respectively. Time and size at release generally showed little effect on age composition of returns.

7. Adult size in the escapement showed no obvious release time effects. Larger samples are required to clarify release size effects by sex on the size of returning adults.

8. Males predominated in the escapement (58.1% and 54.7% for 1982 and 1983 releases, respectively), and predominated in the younger age groups (ages 2-4). There were no clear effects of release time or size on the sex ratio in hatchery escapement.

9. Exploitation rate was approximately 70% for the combined groups, and generally showed no obvious effects of release time or size.

10. The two brood releases showed a similar catch distribution by area. The total catch was dominated by the Alaska (41-46% of total catch) and North-Central B.C. (39-43% of total) catch components. The inside catch (Johnstone and Georgia straits) contributed only 14-16% to the total. Time and size at release showed no obvious effects on catch distribution by area or gear type.

11. Catch distribution by age showed that the majority of age 4 fish were taken in Alaska waters, while nearly all of age 2 fish, and the majority of age 3 and 5 fish were taken in B.C. waters.

12. It is recommended that for maximum survival of juvenile chinook, releases of high quality juveniles be made within the optimum time-size release "window". Where sufficient historical survival data are available for a site, it may be possible to identify a fairly broad "window" for time and size at release. However, the results reported here indicate that more controlled studies can provide a better defined optimum strategy regarding time and size at release.

13. Specific release guidelines, based on the study results, were developed for Quinsam hatchery chinook (p. 16). It is recommended that time-size release studies, perhaps much simplified, be repeated periodically at a given site, to monitor for possible long-term changes in optimum release time and size conditions.

ACKNOWLEDGEMENTS

The authors wish to thank Howard Freeland for supplying ocean temperature records; Howard Stiff and Kim Hyatt for carrying out the response surface analysis; Brian Pyper and Greg Steer for assisting with statistical analyses; Joan Bateman for extracting appropriate data files; and Marcia Vanwely for assisting with literature search. We are also grateful to Brian Anderson, Carol Cross, Kim Hyatt and Ted Perry for reviewing the manuscript.

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FIGURES

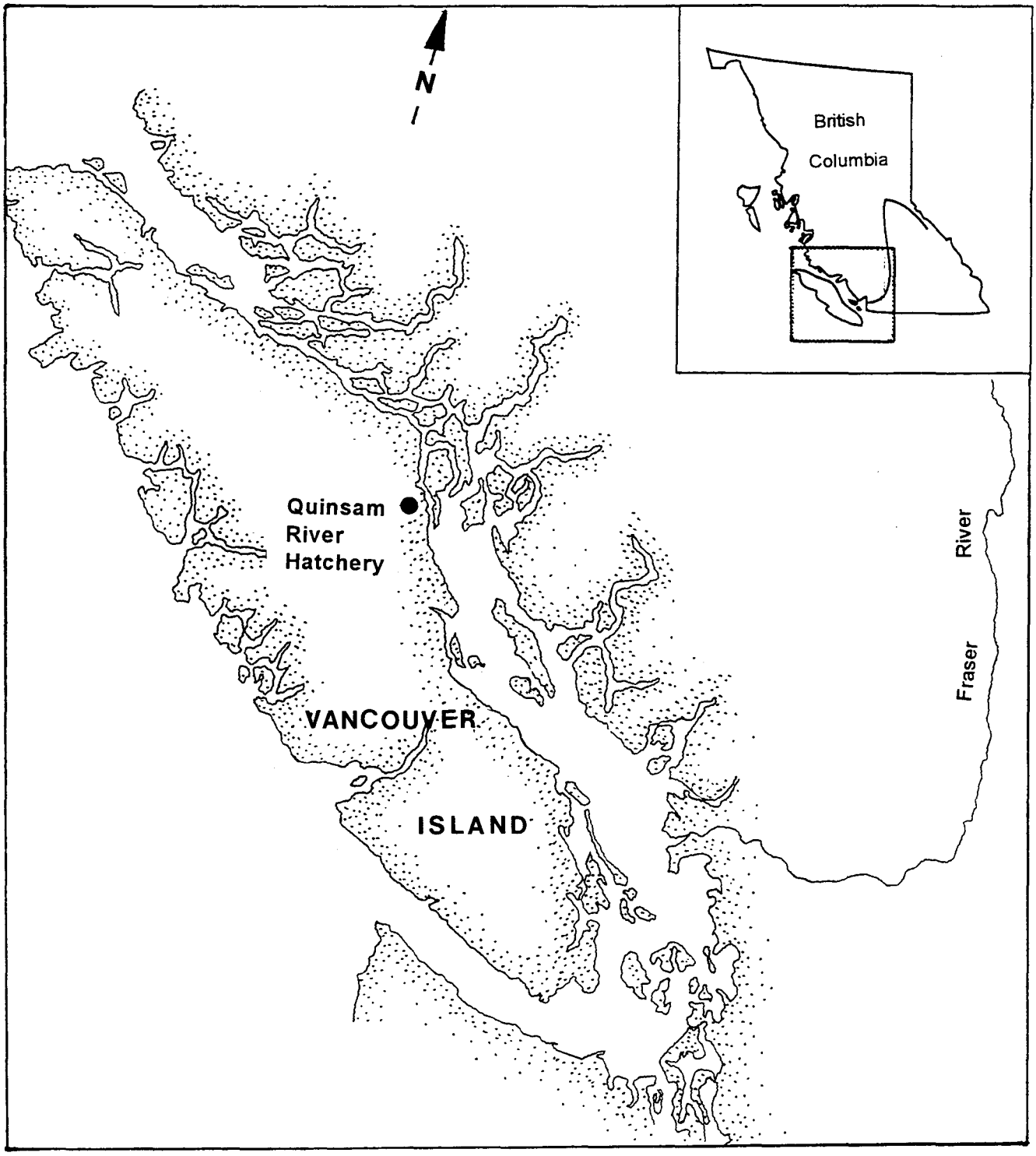


Fig. 1. Location of Quinsam River Hatchery on Vancouver Island.

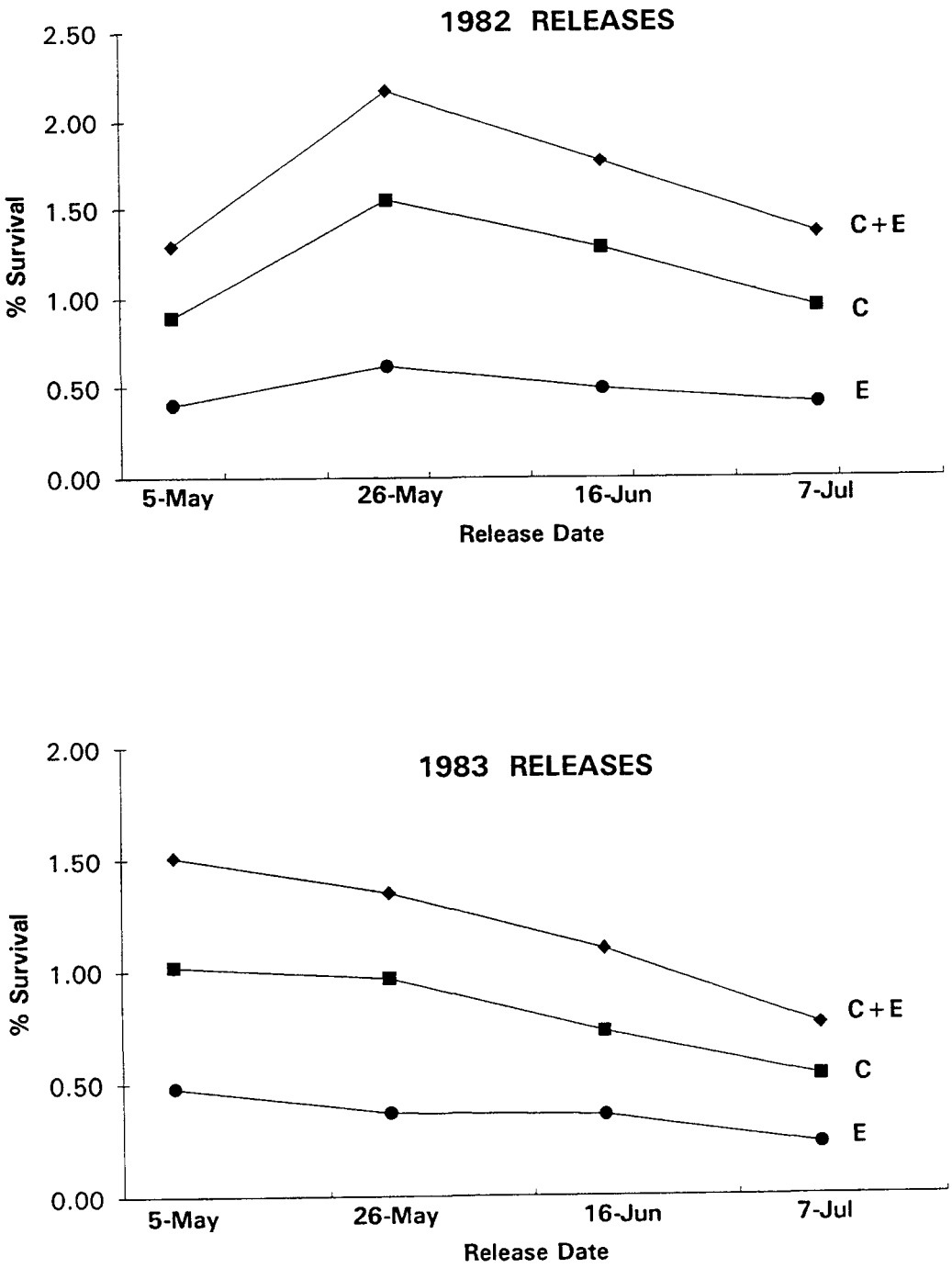


Fig. 2. Survival of Quinsam chinook in the catch (C) and escapement (E) be release date, 1982 and 1983 releases.

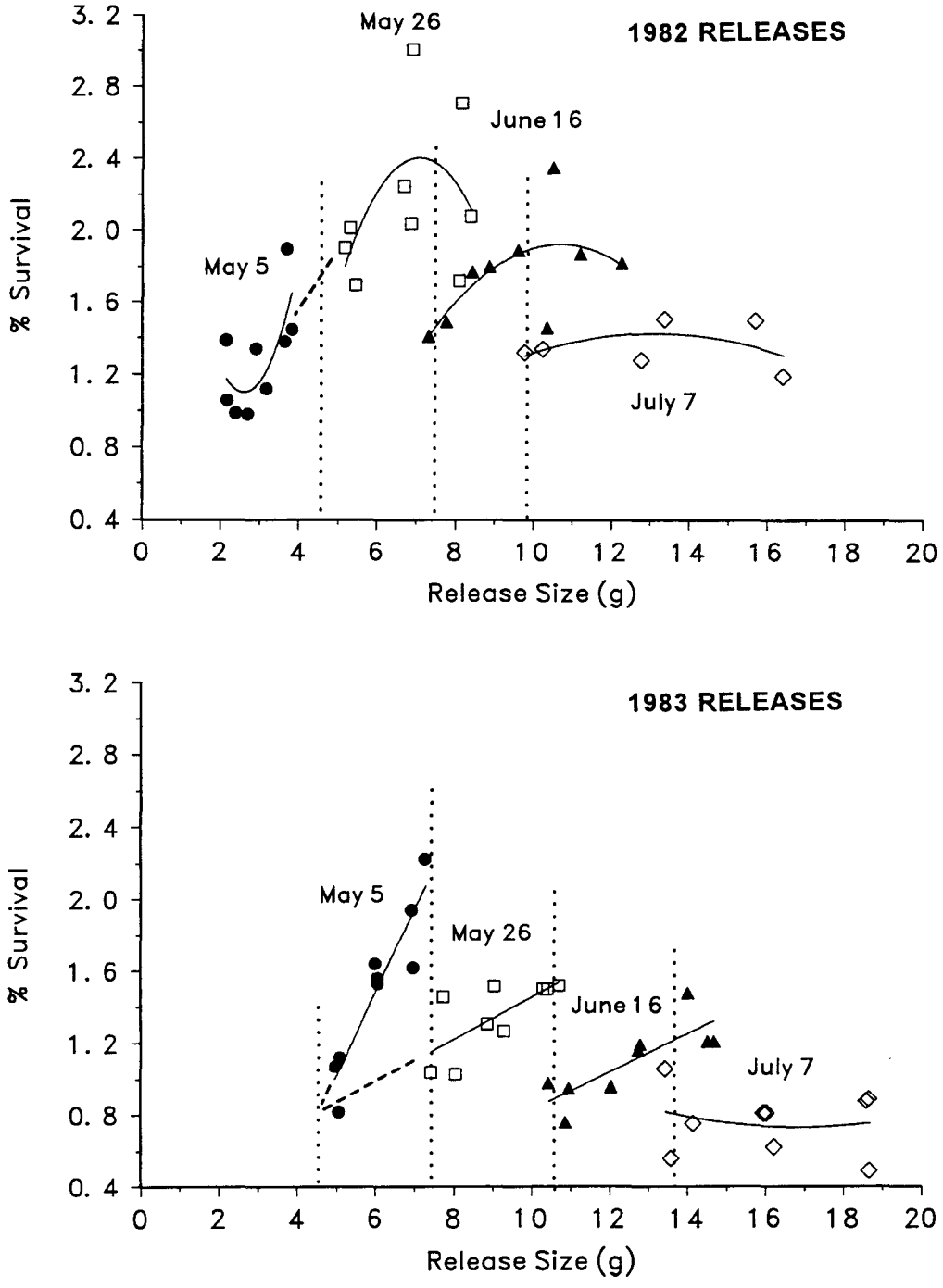


Fig. 3. Survival of Quinsam chinook (catch plus escapement) by release date and size, 1982 and 1983 releases. (Vertical dotted lines denote fish of similar size in adjacent release dates; dashed lines extrapolated between May 5 and May 26 releases allow for comparison of survival at 4.5 g for the two dates).

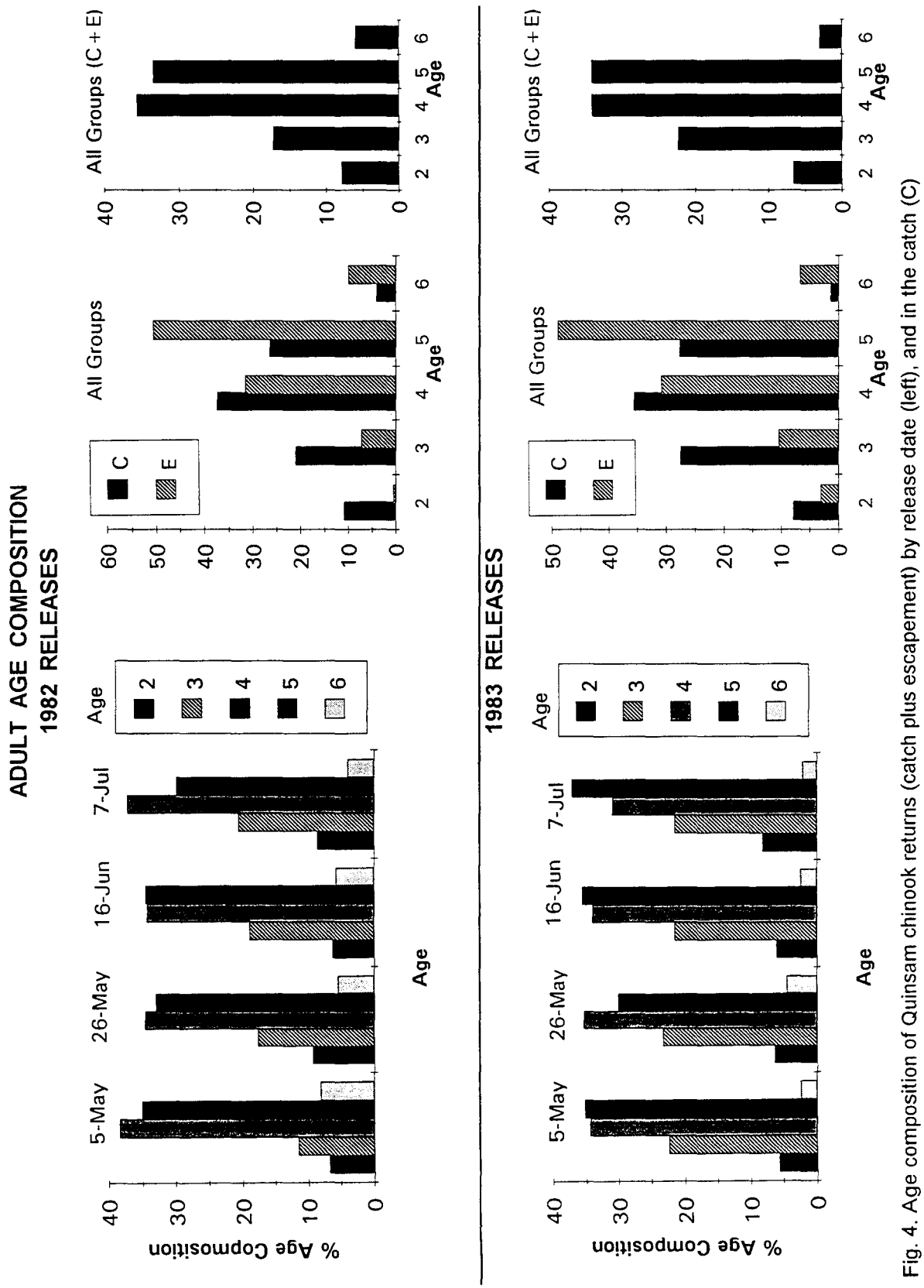


Fig. 4. Age composition of Quinsam chinook returns (catch plus escapement) by release date (left), and in the catch (C) and escapement (E) for all groups (right), 1982 and 1983 releases.

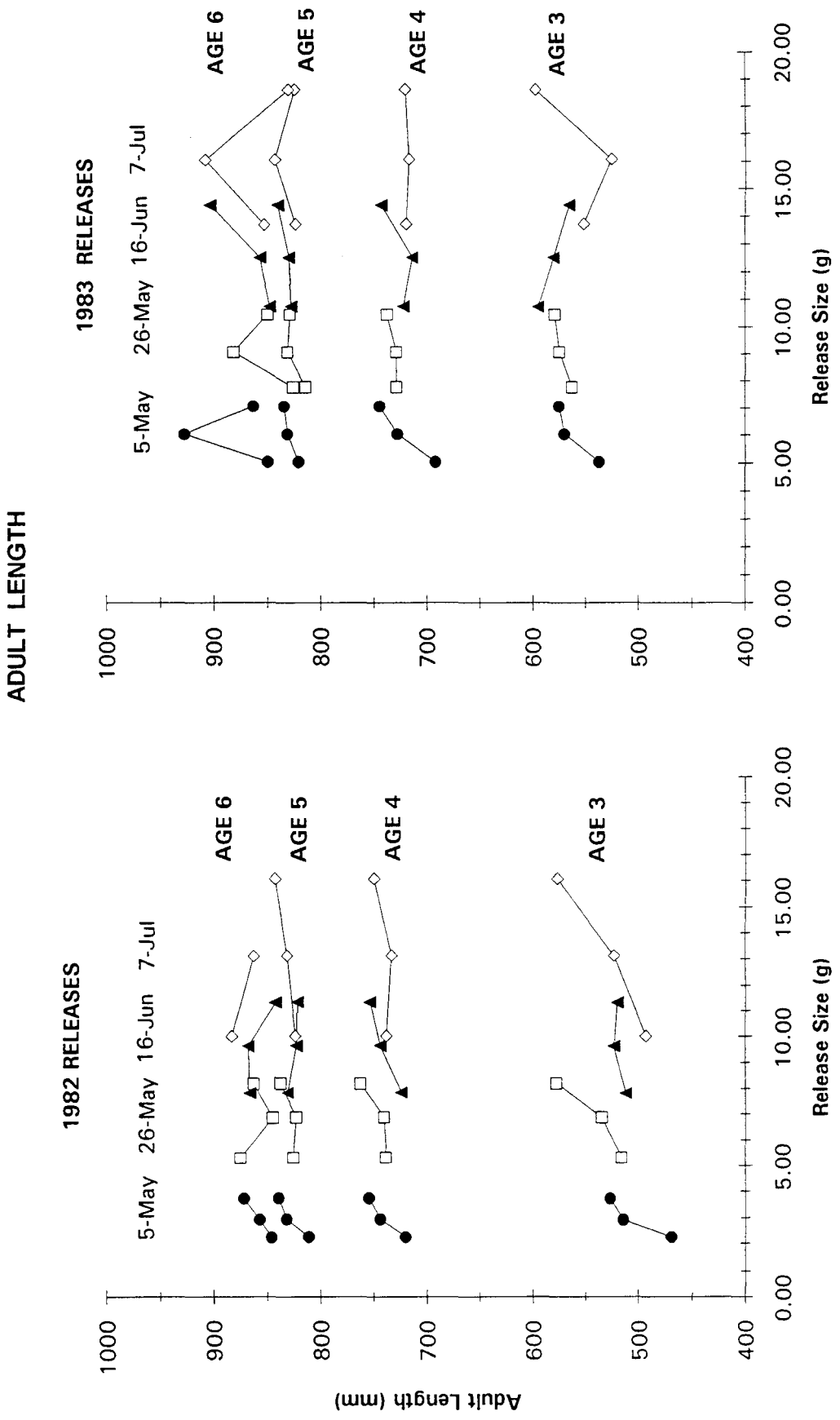


Fig. 5. Mean lengths (POHL) by age in the escapement of Quinsam chinook by release date and size, 1982 and 1983 releases (sexes combined per age group; sample sizes for age 3 and age 6 fish may be less than 5).

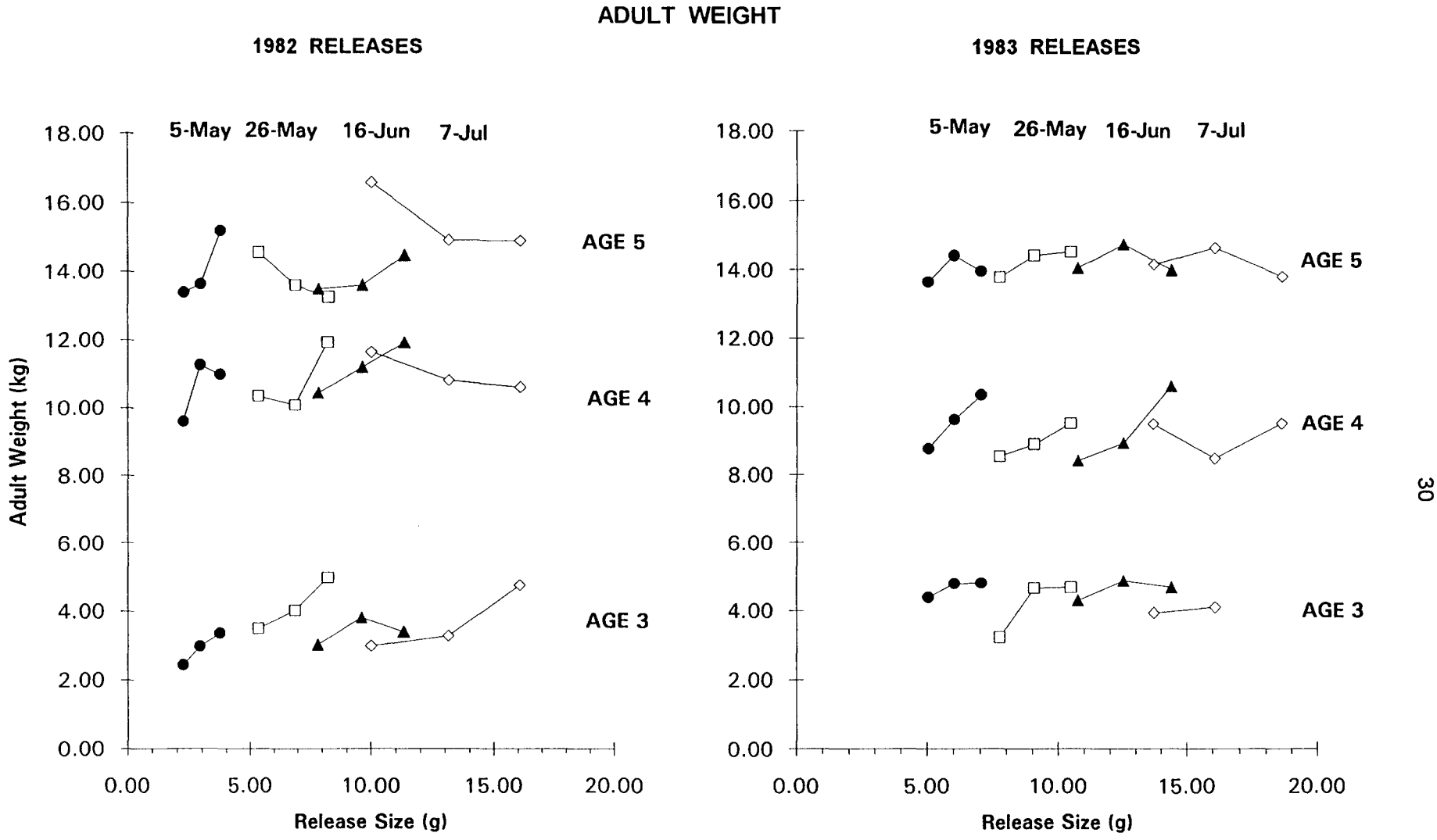


Fig. 6. Mean weights by age in the escapement of Quinsam chinook by release date and size, 1982 and 1983 releases (sexes combined per age group; sample sizes for age 3 and age 5 fish may be less than 5).

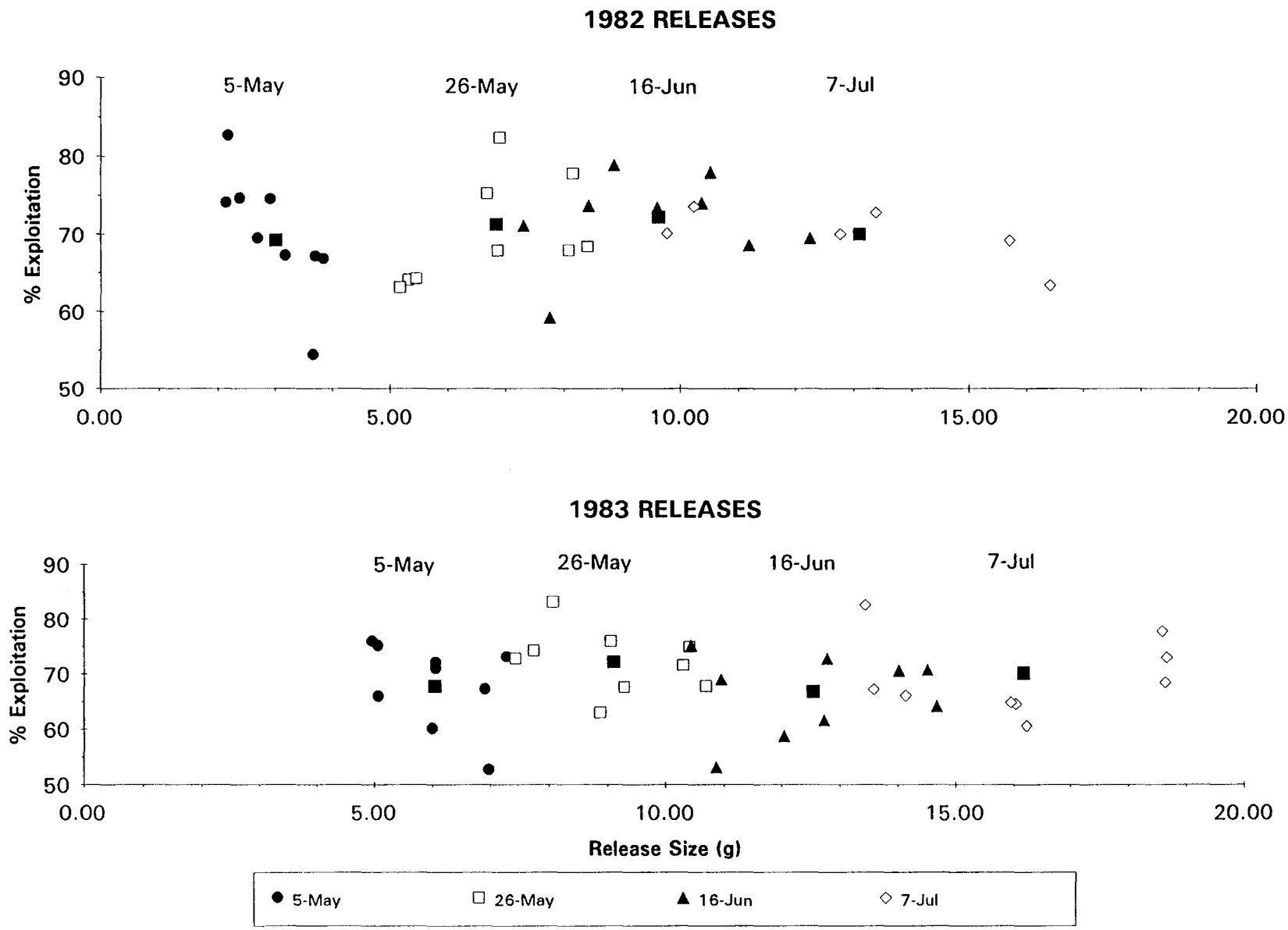


Fig. 7. Exploitation rates for Quinsam chinook by release date and size, 1982 and 1983 releases (solid boxes indicate mean rate per release date).

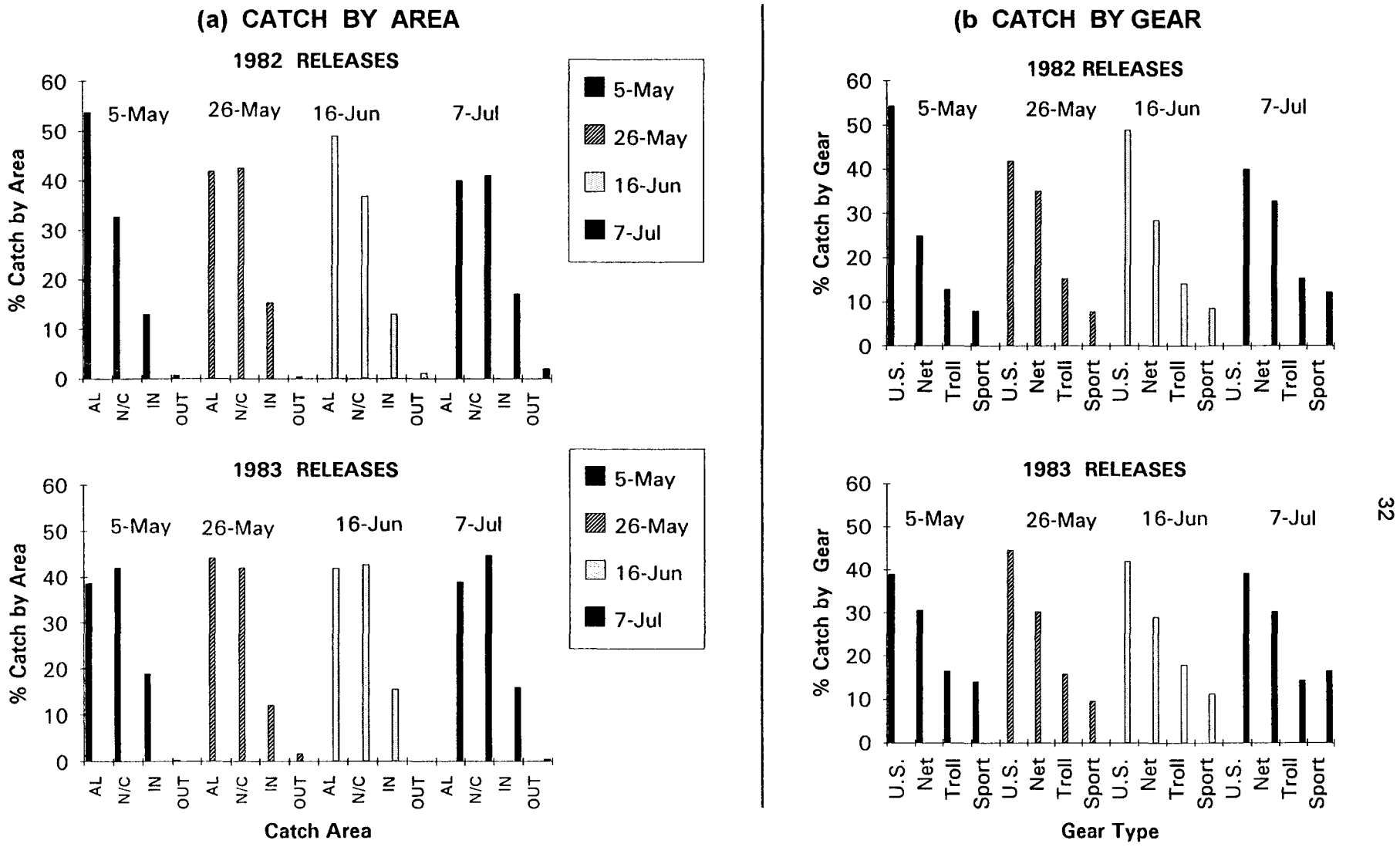


Fig. 8. Catch distribution by area (a) and gear (b) of Quinsam chinook by release date, 1982 and 1983 releases.

Area codes: AL - Alaska, N/C - North/Central, IN - Inside, OUT - Outside (includes west coast Vancouver Island, Juan de Fuca Strait and Washington / Oregon).

Gear codes: U.S. - all gears, Net - B.C. net, Troll - B.C. troll, Sport - B.C. sport.

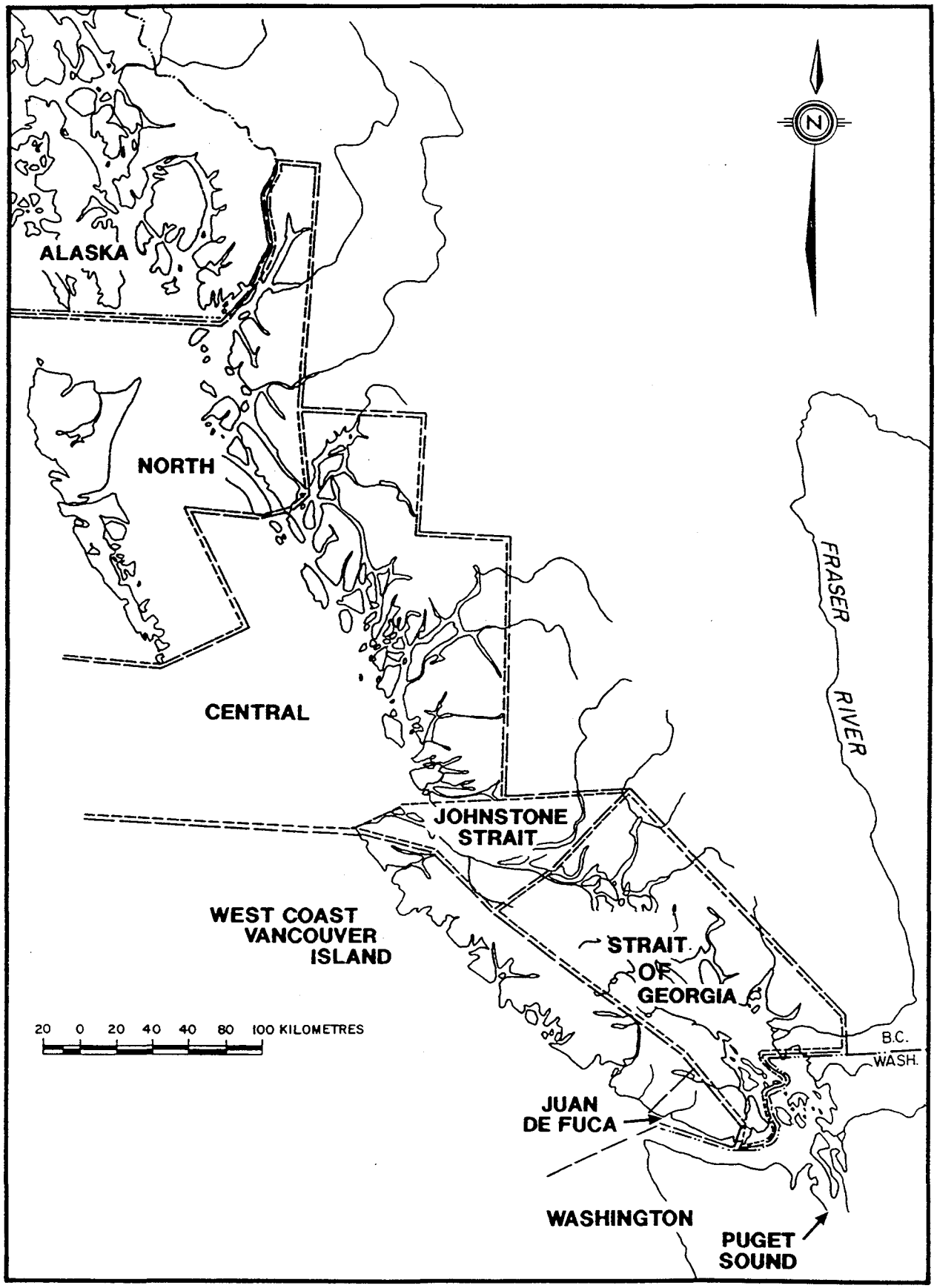


Fig. 9. Map of major catch areas.

TABLES

Table 1. Age composition of Quinsam chinook in the catch (C) and escapement (E), and mean age at recovery by release date, 1982 and 1983 releases. *

Age	May 5			May 26			June 16			July 7			ALL RELEASES		
	C	E	C+E	C	E	C+E	C	E	C+E	C	E	C+E	C	E	C+E
1982 RELEASES															
2	9.8	0.0	6.8	12.7	0.9	9.3	8.7	0.2	6.3	12.0	0.5	8.6	10.8	0.5	7.8
3	13.3	6.4	11.5	20.9	9.1	17.6	23.8	5.9	18.9	26.6	6.4	20.6	21.0	7.3	17.2
4	45.2	23.0	38.4	35.7	32.1	34.6	34.9	33.2	34.3	36.4	39.0	37.2	37.5	31.6	35.7
5	25.3	57.3	35.1	26.8	47.9	33.0	28.5	50.3	34.5	22.8	46.3	29.9	26.5	50.7	33.5
6	5.8	11.8	7.8	3.8	9.3	5.3	4.3	8.7	5.6	2.4	6.0	3.6	4.1	9.2	5.7
7	0.0	0.9	0.3	0.0	0.5	0.2	0.0	0.7	0.2	0.0	1.4	0.4	0.0	0.8	0.2
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mean Age	4.02	4.75	4.26	3.88	4.56	4.07	3.96	4.60	4.15	3.78	4.53	4.02	3.92	4.63	4.13
1983 RELEASES															
1	0	0	0	0	0	0	0	0	0	0	0.5	0.1	0	0.1	0
2	7.0	2.8	5.7	7.2	3.9	6.4	7.9	2.5	6.1	10.3	2.9	8.1	7.8	3.0	6.4
3	27.1	12.4	22.4	28.2	10.1	23.3	26.6	10.8	21.5	28.2	5.8	21.5	27.5	10.4	22.3
4	35.7	32.0	34.4	37.4	30.1	35.4	36.0	30.9	34.0	31.4	29.1	30.9	35.6	30.9	34.1
5	29.5	46.8	35.2	23.3	48.2	30.1	29.2	49.1	35.6	29.9	52.9	37.1	27.7	49.0	34.2
6	0.8	6.0	2.4	3.5	7.1	4.5	0.3	6.8	2.4	0.0	6.8	2.1	1.4	6.7	3.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mean Age	3.90	4.41	4.07	3.86	4.42	4.02	3.87	4.47	4.05	3.80	4.46	4.02	3.87	4.46	4.05

* Data from Append. 5 and 6.

Table 2. Mean lengths (POHL) and weights by age (sexes combined) in the escapement of Quinsam chinook by release date, 1982 and 1983 releases (n = sample size).

1982 RELEASES

Release	Mean	POSTORBITAL-HYPURAL LENGTH (mm) **										WEIGHT (KG) ***									
		Age 2		Age 3		Age 4		Age 5		Age 6		Age 2		Age 3		Age 4		Age 5		Age 6	
Date	Rel. Wt.*	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)
5-May	3.01 g	-	-	510	(15)	745	(57)	832	(128)	859	(31)	-	-	3.08	(11)	10.83	(30)	14.17	(31)	16.03	(8)
26-May	6.84 g	328	(4)	547	(36)	748	(138)	828	(168)	863	(38)	1.00	(4)	4.20	(29)	10.92	(76)	13.91	(34)	15.71	(10)
16-Jun	9.64 g	474	(1)	520	(17)	742	(111)	826	(145)	856	(29)	2.70	(1)	3.42	(11)	11.19	(60)	13.81	(41)	15.18	(6)
7-Jul	13.10 g	412	(1)	532	(13)	742	(66)	835	(66)	875	(12)	1.70	(1)	3.80	(12)	10.92	(38)	15.42	(16)	16.95	(7)

1983 RELEASES

Release	Mean	POSTORBITAL-HYPURAL LENGTH (mm) **										WEIGHT (KG) ***									
		Age 2		Age 3		Age 4		Age 5		Age 6		Age 2		Age 3		Age 4		Age 5		Age 6	
Date	Rel. Wt.*	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)	mm	(n)
5-May	6.05 g	370	(11)	567	(47)	733	(107)	829	(181)	881	(11)	1.32	(10)	4.72	(34)	9.97	(58)	14.06	(95)	15.56	(4)
26-May	9.10 g	367	(11)	575	(32)	734	(80)	824	(152)	852	(17)	1.10	(9)	4.51	(18)	9.13	(48)	14.22	(81)	14.20	(11)
16-Jun	12.56 g	359	(7)	575	(34)	729	(74)	832	(140)	864	(10)	0.93	(6)	4.71	(24)	9.52	(33)	14.25	(68)	15.80	(3)
7-Jul	16.17 g	395	(3)	545	(10)	719	(45)	832	(96)	867	(6)	0.72	(2)	4.08	(6)	9.14	(20)	14.20	(43)	15.35	(1)

* Mean juvenile weights from Appendix 7.

** Postorbital-hypural lengths for escapement recoveries in the total Campbell / Quinsam River system (Append. 7).

*** Weights for escapement recoveries at the hatchery fence only (Append. 8).

Table 3. Sex ratio by age in the escapement (to hatchery fence) of Quinsam chinook by release date, 1982 and 1983 releases.*

Release Date	Juveniles Mean Wt. (g)**	AGE 2 Males No	(%)	AGE 2 Females No	(%)	AGE 3 Males No.	(%)	AGE 3 Females No.	(%)	AGE 4 Males No.	(%)	AGE 4 Females No	(%)	AGE 5 Males No	%	AGE 5 Females No.	(%)	AGE 6 Males No.	%	AGE 6 Females No.	(%)	ALL AGES Males No.	%	ALL AGES Females No.	(%)
1982 RELEASES																									
May 5	3.01	0	-	0	-	11	**100**	0	**0**	32	**86.5**	5	**13.5**	5	**15.6**	27	**84.4**	2	**25.0**	6	**75.0**	50	**56.8**	38	**43.2**
May 26	6.84	5	**100**	0	**0**	31	**100**	0	**0**	67	**69.1**	30	**30.9**	11	**28.9**	27	**71.1**	2	**20.0**	8	**80.0**	116	**64.1**	65	**35.9**
June 16	9.64	1	**100**	0	**0**	12	**100**	0	**0**	52	**66.7**	26	**33.3**	6	**14.6**	35	**85.4**	1	**16.7**	5	**83.3**	72	**52.2**	66	**47.8**
July 7	13.10	1	**100**	0	**0**	12	**100**	0	**0**	30	**65.2**	16	**34.8**	3	**18.8**	13	**81.3**	0	**0**	7	**100**	46	**56.1**	36	**43.9**
Total		7	**100**	0	**0**	66	**100**	0	**0**	181	**70.2**	77	**29.8**	25	**19.7**	102	**80.3**	5	**16.1**	26	**83.9**	284	**58.1**	205	**41.9**
1983 RELEASES																									
May 5	6.05	10	**100**	0	**0**	42	**95.5**	2	**4.5**	40	**61.5**	25	**38.5**	32	**33.3**	64	**66.7**	0	**0**	4	**100**	124	**56.6**	95	**43.4**
May 26	9.10	9	**100**	0	**0**	31	**100**	0	**0**	28	**52.8**	25	**47.2**	20	**24.1**	63	**75.9**	0	**0**	11	**100**	88	**47.1**	99	**52.9**
June 16	12.56	6	**100**	0	**0**	33	**97.1**	1	**2.9**	28	**75.7**	9	**24.3**	24	**34.8**	45	**65.2**	0	**0**	3	**100**	91	**61.1**	58	**38.9**
July 7 +	16.17	3	**100**	0	**0**	10	**100**	0	**0**	15	**68.2**	7	**31.8**	15	**34.9**	28	**65.1**	1	**100**	0	**0**	44	**55.7**	35	**44.3**
Total		28	**100**	0	**0**	116	**97.5**	3	**2.5**	111	**62.7**	66	**37.3**	91	**31.3**	200	**68.7**	1	**5.3**	18	**94.7**	347	**54.7**	287	**45.3**

* Numbers are estimated marks by sex (i.e., observed numbers adjusted for sampling rate, lost pins, etc.).

** Mean juvenile weights from Appendix 7. All size groups combined per release date.

+ Age 2 males from July 7, 1983 release include one age 1 male.

APPENDICES

Appendix 1a. Estimated returns of Quinsam chinook by age in the catch (C) and escapement (E) for releases on May 5, 1982.

1st RELEASE - MAY 5, 1982

Tag code	Juveniles Size	Mean Wt. (g	No. * released	Age 2 C	Age 2 E	Age 2 C+E	Age 3 C	Age 3 E	Age 3 C+E	Age 4 C	Age 4 E	Age 4 C+E	Age 5 C	Age 5 E	Age 5 C+E	Age 6 C	Age 6 E	Age 6 C+E	Age 7 C	Age 7 E	Age 7 C+E	ALL AGES C No.	C % Surv.	E No.	E % Surv.	C + E No.	C + E % Surv.	Catch as % of total return
8-21-19	S	2.16	6,693	6	0	6	2	1	3	52	8	61	5	12	17	4	2	6	0	0	0	69	1.03	24	0.36	93	1.39	74.2
8-21-20	S	2.39	9,161	0	0	0	20	0	20	31	2	33	10	15	25	6	5	12	0	0	0	68	0.74	23	0.25	91	0.99	74.7
8-21-21	S	2.18	8,739	12	0	12	1	3	4	42	3	45	18	5	23	4	5	9	0	0	0	77	0.88	16	0.18	93	1.06	82.8
	T	2.25	24,593	18	0	18	23	4	27	125	13	139	33	32	65	14	12	27	0	0	0	214	0.87	63	0.26	277	1.13	77.3
8-21-22	M	2.70	9,705	11	0	11	9	1	10	30	3	33	13	25	38	2.1	0	2	0	0	0	66	0.68	29	0.30	95	0.98	69.5
8-21-23	M	2.92	10,006	10	0	10	6	3	10	44	10	54	28	15	43	10	4	14	0	3	3	100	1.00	35	0.35	134	1.34	74.6
8-21-24	M	3.18	10,050	13	0	13	10	3	14	32	10	42	18	17	35	3	7	10	0	0	0	76	0.76	37	0.37	113	1.12	67.3
	T	2.94	29,761	34	0	34	25	7	34	106	23	129	59	57	116	15	11	26	0	3	3	242	0.81	101	0.34	342	1.15	70.8
8-21-25	L	3.71	9,475	10	0	10	26	1	27	41	14	55	36	38	74	8	6	15	0	0	0	121	1.28	59	0.62	180	1.90	67.2
8-21-26	L	3.67	9,692	8	0	8	13	8	21	29	12	40	21	33	53	3	8	11	0	0	0	73	0.75	61	0.63	134	1.38	54.5
8-21-27	L	3.85	9,583	3	0	3	12	1	14	35	14	49	39	29	68	3	2	5	0	0	0	93	0.97	46	0.48	139	1.45	66.9
	T	3.74	28,750	21	0	21	51	10	62	105	40	144	96	100	195	14	16	31	0	0	0	287	1.00	166	0.58	453	1.58	63.4
Grand Total		3.01	83,104	73	0	73	99	21	123	336	76	412	188	189	376	43	39	84	0	3	3	743	0.89	330	0.40	1,072	1.29	69.3

* No. released corrected for tag loss and "estuary kills".

Appendix 1b. Estimated returns of Quinsam chinook by age in the catch (C) and escapement (E) for releases on May 26, 1982.

2nd RELEASE - MAY 26, 1982

	Juveniles			Age 2			Age 3			Age 4			Age 5			Age 6			Age 7			ALL AGES C		ALL AGES E		ALL AGES C + E		Catch as
Tag code	Size	Mean Wt. (g)	No. * released	C	E	C+E	C	E	C+E	C	E	C+E	C	E	C+E	C	E	C+E	C	E	C+E	No.	% Surv.	No.	% Surv.	No.	% Surv.	% of total return
8-21-28	S	5.32	9,403	17	2	19	13	4	17	47	18	65	38	36	74	8	7	15	0	0	0	122	1.30	68	0.72	190	2.02	64.2
8-21-29	S	5.18	9,553	8	0	8	18	2	20	54	26	80	27	34	61	9	5	14	0	0	0	115	1.20	67	0.70	182	1.91	63.2
8-21-30	S	5.46	9,041	24	0	24	8	6	15	30	11	41	29	30	59	8	8	15	0	0	0	99	1.10	55	0.61	154	1.70	64.3
	T	5.32	27,997	49	2	51	39	12	52	131	55	186	94	100	194	25	20	44	0	0	0	336	1.20	190	0.68	526	1.88	63.9
8-21-31	M	6.91	10,156	31	0	31	114	5	119	68	13	81	28	30	58	10	6	16	0	0	0	252	2.48	54	0.53	306	3.01	82.4
8-21-32	M	6.88	10,266	13	2	15	24	7	31	56	23	79	42	32	75	6	2	8	0	0	0	142	1.38	67	0.65	209	2.04	67.9
8-21-33	M	6.70	9,730	21	0	21	32	3	35	41	17	57	71	27	99	0	7	7	0	0	0	165	1.70	54	0.55	219	2.25	75.3
	T	6.83	30,152	65	2	67	170	15	185	165	53	217	141	89	232	16	15	31	0	0	0	559	1.85	175	0.58	734	2.43	76.2
8-21-34	L	8.41	10,188	8	0	8	22	11	33	48	26	74	66	27	93	0	3	3	0	0	0	145	1.42	67	0.66	212	2.08	68.4
8-21-35	L	8.09	10,364	27	1	28	18	8	26	48	19	67	20	23	43	7	7	14	0	0	0	121	1.17	57	0.55	178	1.72	68.0
8-21-36	L	8.17	10,144	25	0	25	38	4	42	99	24	122	48	25	73	4	6	10	0	3	3	214	2.11	62	0.61	275	2.71	77.8
	T	8.22	30,696	60	1	61	78	23	101	195	69	263	134	75	209	11	16	27	0	3	3	480	1.56	186	0.61	665	2.17	72.2
Grand Total		6.84	88,845	174	5	179	287	50	338	491	177	666	369	264	635	52	51	102	0	3	3	1,375	1.55	551	0.62	1,925	2.17	71.4

* No. released corrected for tag loss and "estuary kills".

Appendix 1c. Estimated returns of Quinsam chinook by age in the catch (C) and escapement (E) for releases on June 16, 1982.

3rd RELEASE - JUNE 16, 1982

Tag code	Juveniles Size	Mean Wt. (g)	No. * released	Age 2 C	Age 2 E	Age 2 C+E	Age 3 C	Age 3 E	Age 3 C+E	Age 4 C	Age 4 E	Age 4 C+E	Age 5 C	Age 5 E	Age 5 C+E	Age 6 C	Age 6 E	Age 6 C+E	Age 7 C	Age 7 E	Age 7 C+E	ALL AGES C No.	C % Surv.	E No.	E % Surv.	C + E No.	C + E % Surv.	Catch as % of total return
8-21-37	S	8.43	9,434	11	0	11	32	2	34	49	11	60	31	24	55	0	6	6	0	0	0	123	1.30	43	0.46	167	1.77	73.7
8-21-38	S	7.76	9,720	13	0	13	11	4	15	31	17	48	24	33	57	8	4	12	0	0	0	86	0.88	59	0.61	145	1.49	59.3
8-21-39	S	7.32	9,356	7	0	7	31	1	32	24	12	36	26	20	46	5	4	10	0	0	0	94	1.00	38	0.41	132	1.41	71.2
	T	7.84	28,510	31	0	31	74	7	81	104	40	144	81	77	158	13	14	28	0	0	0	303	1.06	140	0.49	444	1.56	68.2
8-21-40	M	10.36	10,003	6	1	7	37	4	41	35	16	51	27	16	43	3	1	4	0	0	0	108	1.08	38	0.38	146	1.46	74.0
8-21-41	M	9.61	10,389	7	0	7	24	3	27	56	18	74	49	29	78	9	2	10	0	0	0	144	1.39	52	0.50	196	1.89	73.5
8-21-42	M	8.87	9,705	22	0	22	41	2	43	39	11	50	33	20	53	4	3	7	0	0	0	138	1.42	37	0.38	175	1.80	78.9
	T	9.62	30,097	35	1	36	102	9	111	130	45	175	109	65	174	16	6	21	0	0	0	390	1.30	127	0.42	517	1.72	75.4
8-21-43	L	11.19	10,575	11	0	11	21	3	24	68	29	97	30	24	54	6	6	13	0	0	0	136	1.29	62	0.59	198	1.87	68.7
8-21-44	L	12.26	10,092	5	0	5	25	5	31	55	17	71	32	25	57	11	6	17	0	3	3	128	1.27	56	0.55	184	1.82	69.6
8-21-45	L	10.52	10,038	17	0	17	49	2	52	41	14	55	73	29	102	3	6	10	0	0	0	184	1.83	52	0.52	236	2.35	78.0
	T	11.32	30,705	33	0	33	95	10	107	164	60	223	135	78	213	20	18	40	0	3	3	448	1.46	170	0.55	618	2.01	72.5
Grand Total		9.64	89,312	0 99	1	100	271	26	299	398	145	542	325	220	545	49	38	89	0	3	3	1,141	1.28	437	0.49	1,579	1.77	72.3

* No. released corrected for tag loss and "estuary kills".

Appendix 1d. Estimated returns of Quinsam chinook by age in the catch (C) and escapement (E) for releases on July 7, 1982.

4th RELEASE - JULY 7, 1982

	Juveniles			Age 2			Age 3			Age 4			Age 5			Age 6			Age 7			ALL AGES C		ALL AGES E		ALL AGES C + E		Catch as
Tag code	Size	Mean Wt. (g)	No. * released	C	E	C+E	C	E	C+E	C	E	C+E	C	E	C+E	C	E	C+E	C	E	C+	No.	% Surv.	No.	% Surv.	No.	% Surv.	% of total return
8-21-46	S	10.23	9,004	10	0	10	10	3	13	36	11	47	30	12	42	4	5	9	0	0	0	89	0.99	32	0.36	121	1.34	73.6
8-21-47	S	9.78	9,186	4	0	4	36	3	39	28	12	40	13	19	32	4	2	6	0	0	0	85	0.93	36	0.39	121	1.32	70.2
	T	10.00	18,190	14	0	14	46	6	52	64	23	87	43	31	74	8	7	15	0	0	0	174	0.96	68	0.37	242	1.33	71.9
8-21-49	M	13.38	9,510	7	0	7	31	2	33	39	12	51	23	17	40	4	5	10	0	3	3	105	1.10	39	0.41	144	1.51	72.9
8-21-50	M	12.78	6,815	11	0	11	11	1	12	18	15	33	22	9	31	0	1	1	0	0	0	61	0.90	26	0.38	87	1.28	70.1
	T	13.13	16,325	18	0	18	42	3	45	57	27	84	45	26	71	4	6	11	0	3	3	166	1.02	65	0.40	231	1.42	71.9
8-21-52	L	16.42	9,646	10	0	10	22	3	25	35	13	48	6	27	33	0	0	0	0	0	0	73	0.76	43	0.45	115	1.19	63.5
8-21-53	L	15.71	9,158	19	1	20	25	2	27	29	22	51	22	17	39	0	0	0	0	0	0	95	1.04	42	0.46	137	1.50	69.3
	T	16.07	18,804	29	1	30	47	5	52	64	35	99	28	44	72	0	0	0	0	0	0	168	0.89	85	0.45	252	1.34	66.7
Grand Total		13.10	53,319	0 61	1	62	135	14	149	185	85	270	116	101	217	12	13	26	0	3	3	508	0.95	218	0.41	725	1.36	70.1

* No. released corrected for tag loss and "estuary kills".

Appendix 2a. Estimated returns of Quinsam chinook by age in the catch (C) and escapement (E) for releases on May 5, 1983.

1st RELEASE - MAY 5, 1983

	Juveniles			Age 2			Age 3			Age 4			Age 5			Age 6			ALL AGES C		ALL AGES E		ALL AGES C + E		Catch as
Tag code	Size	Mean t. (g	No. * released	C	E	C+E	C	E	C+E	C	E	C+E	C	E	C+E	C	E	C+E	No.	% Surv.	No.	% Surv.	No.	% Surv.	% of total return
8-20-46	S	5.08	9,763	6	1	7	16	2	19	21	8	29	29	21	51	0	4	4	72	0.74	37	0.38	109	1.12	66.1
8-20-47	S	5.07	9,846	3	0	3	10	4	14	25	6	30	22	9	32	1	0	1	61	0.62	19	0.19	81	0.82	75.3
8-20-48	S	4.97	10,159	7	1	8	13	3	16	43	7	50	17	12	29	4	3	7	83	0.82	26	0.26	109	1.07	76.1
	T	5.04	29,768	16	2	18	39	9	49	89	21	109	68	42	112	5	7	12	216	0.73	82	0.28	299	1.00	72.2
8-20-49	M	6.01	10,637	5	1	6	31	7	38	29	19	48	40	31	71	0	11	11	105	0.99	69	0.65	174	1.64	60.3
8-20-50	M	6.06	9,803	9	0	9	30	3	33	33	10	43	36	31	67	0	0	0	109	1.11	43	0.44	153	1.56	71.2
8-20-51	M	6.06	9,880	7	1	8	21	3	24	35	7	42	46	31	77	0	0	0	109	1.10	42	0.43	151	1.53	72.2
	T	6.04	30,320	21	2	23	82	13	95	97	36	133	122	93	215	0	11	11	323	1.07	154	0.51	478	1.58	67.6
8-20-52	L	7.28	10,221	18	3	21	52	12	64	49	24	73	47	19	66	2	3	5	167	1.63	61	0.60	228	2.23	73.2
8-20-53	L	6.92	9,794	5	4	10	44	7	50	57	28	85	22	23	45	0	0	0	128	1.31	62	0.63	190	1.94	67.4
8-20-54	L	6.98	9,812	4	1	5	32	13	45	36	30	66	12	26	39	0	5	5	84	0.86	75	0.76	159	1.62	52.8
	T	7.06	29,827	27	8	36	128	32	159	142	82	224	81	68	150	2	8	10	379	1.27	198	0.66	577	1.93	65.7
Grand Total		6.05	89,915	64	12	77	249	54	303	328	139	466	271	203	477	7	26	33	918	1.02	434	0.48	1,354	1.51	67.8

* No. released corrected for tag loss and "estuary kills".

Appendix 2b. Estimated returns of Quinsam chinook by age in the catch (C) and escapement (E) for releases on May 26, 1983.

2nd RELEASE - MAY 26, 1983

Tag code	Juveniles Size	Mean Wt. (g	No. * released	Age 2 C	Age 2 E	Age 2 C+E	Age 3 C	Age 3 E	Age 3 C+E	Age 4 C	Age 4 E	Age 4 C+E	Age 5 C	Age 5 E	Age 5 C+E	Age 6 C	Age 6 E	Age 6 C+E	ALL AGES C No.	C % Surv.	E No.	E % Surv.	C + E No.	C + E % Surv.	Catch as % of total return
8-20-55	S	8.07	10,494	5	0	5	17	1	18	36	4	40	21	11	32	11	2	13	90	0.86	18	0.17	108	1.03	83.3
8-20-56	S	7.75	9,855	4	1	5	21	1	22	51	10	61	22	23	44	9	2	11	107	1.09	37	0.38	144	1.46	74.3
8-20-57	S	7.44	9,935	5	2	7	12	3	15	35	5	39	21	17	38	2	1	3	75	0.75	28	0.28	103	1.04	72.8
	T	7.76	30,284	14	3	17	50	5	55	122	19	140	64	51	114	22	5	27	272	0.90	83	0.27	355	1.17	76.6
8-20-58	M	9.30	10,014	14	1	15	14	3	17	40	10	50	17	24	41	0	3	3	86	0.86	41	0.41	127	1.27	67.7
8-20-59	M	9.06	9,870	6	3	9	58	3	61	20	8	28	27	18	45	2	4	6	114	1.16	36	0.36	150	1.52	76.0
8-20-60	M	8.88	9,932	0	2	2	25	8	34	29	17	46	26	20	46	2	0	2	82	0.83	48	0.48	130	1.31	63.1
	T	9.08	29,816	20	6	26	97	14	112	89	35	124	70	62	132	4	7	11	282	0.95	125	0.42	407	1.37	69.3
8-20-61	L	10.71	9,831	9	0	9	42	4	46	41	22	63	9	20	29	0	2	2	101	1.03	48	0.49	149	1.52	67.8
8-20-62	L	10.41	9,882	8	0	8	33	3	36	34	9	44	35	16	51	0	9	9	111	1.12	37	0.37	148	1.50	75.0
8-20-63	L	10.30	10,160	12	4	17	25	8	33	41	16	58	26	13	39	5	1	6	109	1.07	43	0.42	152	1.50	71.7
	T	10.47	29,873	29	4	34	100	15	115	116	47	165	70	49	119	5	12	17	321	1.07	128	0.43	449	1.50	71.5
Grand Total		9.10	89,973	63	13	77	247	34	282	327	101	429	204	162	365	31	24	55	875	0.97	336	0.37	1,211	1.35	72.3

* No. released corrected for tag loss and "estuary kills".

Appendix 2c. Estimated returns of Quinsam chinook by age in the catch (C) and escapement (E) for releases on June 16, 1983.

3rd RELEASE - JUNE 16, 1983

Tag code	Juveniles Size	Mean Wt. (g)	No. * released	Age 2 C	Age 2 E	Age 2 C+E	Age 3 C	Age 3 E	Age 3 C+E	Age 4 C	Age 4 E	Age 4 C+E	Age 5 C	Age 5 E	Age 5 C+E	Age 6 C	Age 6 E	Age 6 C+E	ALL AGES C No.	C % Surv.	E No.	E % Surv.	C + E No.	C + E % Surv.	Catch as % of total return
8-21-01	S	10.95	9,915	12	2	14	11	5	16	19	12	31	23	10	33	0	0	0	65	0.66	29	0.29	94	0.95	69.1
8-21-02	S	10.87	10,176	3	2	5	16	1	17	14	6	20	8	17	25	0	9	9	41	0.40	36	0.35	77	0.76	53.2
8-21-03	S	10.44	9,884	1	0	1	20	1	21	27	6	32	25	17	42	0	0	0	73	0.74	24	0.24	97	0.98	75.3
	T	10.75	29,975	16	4	20	47	7	54	60	24	83	56	44	100	0	9	9	179	0.60	89	0.30	268	0.89	66.8
8-21-04	M	12.79	9,928	11	1	12	22	2	24	26	9	35	27	16	43	0	4	4	86	0.87	32	0.32	118	1.19	72.9
8-21-05	M	12.74	9,946	0	0	0	20	5	26	26	10	37	22	25	47	2	4	6	71	0.71	44	0.44	115	1.16	61.7
8-21-06	M	12.05	9,944	0	1	1	14	3	17	32	12	43	11	21	33	0	1	1	56	0.56	38	0.38	95	0.96	58.9
	T	12.53	29,818	11	2	13	56	10	67	84	31	115	60	62	123	2	9	11	213	0.71	114	0.38	328	1.10	64.9
8-21-07	L	14.68	9,937	13	0	13	28	4	32	18	20	37	18	15	32	0	4	4	77	0.77	43	0.43	120	1.21	64.2
8-21-08	L	14.52	9,922	8	1	9	24	5	29	35	8	43	18	22	39	0	0	0	85	0.86	35	0.35	120	1.21	70.8
8-21-09	L	14.02	9,954	4	1	5	20	9	29	40	17	56	40	16	56	0	0	0	104	1.04	43	0.43	147	1.48	70.7
	T	14.41	29,813	25	2	27	72	18	90	93	45	136	76	53	127	0	4	4	266	0.89	121	0.41	387	1.30	68.7
Grand Total		12.56	89,606	52	8	60	175	35	211	237	100	334	192	159	350	2	22	24	658	0.73	324	0.36	983	1.10	66.9

* No. released corrected for tag loss and "estuary kills".

Appendix 2d. Estimated returns of Quinsam chinook by age in the catch (C) and escapement (E) for releases on July 7, 1983.

4th RELEASE - JULY 7, 1983

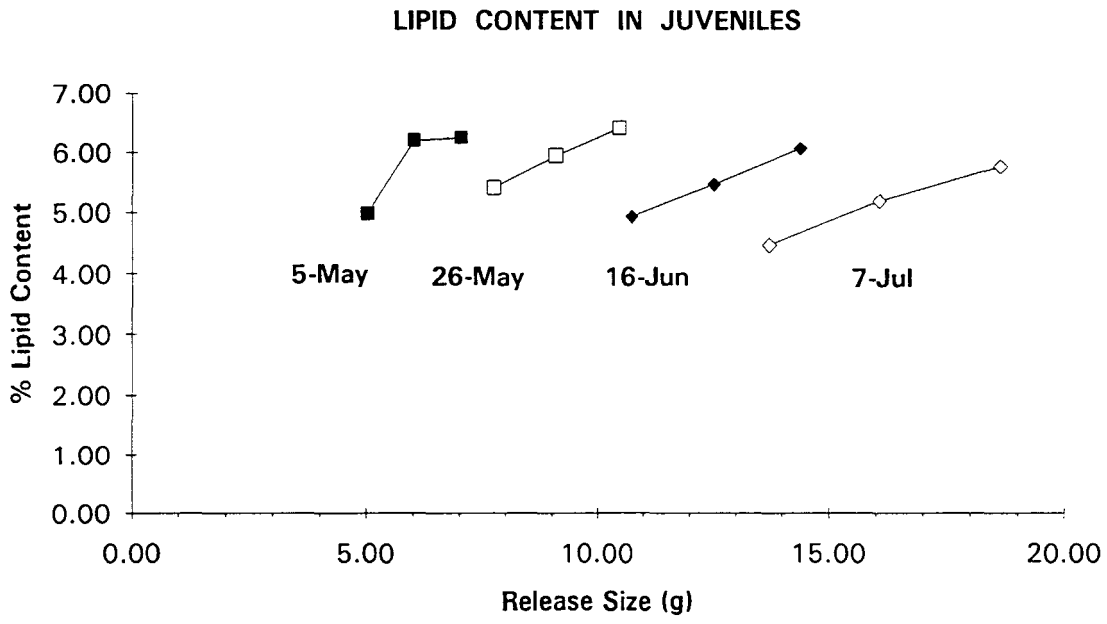
Tag code	Juveniles Size	Mean Wt. (g)	No. * released	Age 1 E	Age 2 C	Age 2 E	Age 2 C+E	Age 3 C	Age 3 E	Age 3 C+E	Age 4 C	Age 4 E	Age 4 C+E	Age 5 C	Age 5 E	Age 5 C+E	Age 6 C	Age 6 E	Age 6 C+E	ALL AGES C No.	ALL AGES C % Surv.	ALL AGES E No.	ALL AGES E % Surv.	ALL AGES C + E No.	ALL AGES C + E % Surv.	Catch as % of total return
8-21-10	S	14.14	9,842	0	11	4	15	9	1	10	10	8	17	19	12	32	0	0	0	49	0.50	26	0.26	74	0.75	66.2
8-21-11	S	13.44	9,822	0	2	1	3	31	0	31	26	5	31	27	6	33	0	6	6	86	0.88	18	0.18	104	1.06	82.7
8-21-12	S	13.59	9,883	0	0	0	0	9	1	10	17	7	24	10	10	21	0	0	0	37	0.37	19	0.19	55	0.56	67.3
	T	13.72	29,547	0	13	5	18	49	2	51	53	20	72	56	28	86	0	6	6	172	0.58	63	0.21	233	0.79	73.8
8-21-13	M	16.23	9,872	0	5	0	5	19	2	21	10	4	14	3	14	17	0	3	3	37	0.37	24	0.24	61	0.62	60.7
8-21-14	M	16.04	9,812	0	3	0	3	15	1	16	21	6	27	12	19	30	0	2	2	51	0.52	28	0.29	79	0.81	64.6
8-21-15	M	15.96	9,875	1	11	0	11	6	3	9	24	10	35	11	14	24	0	0	0	52	0.53	28	0.28	80	0.81	65.0
	T	16.08	29,559	1	19	0	19	40	6	46	55	20	76	26	47	71	0	5	5	140	0.47	80	0.27	220	0.74	63.6
8-21-48	L	18.67	10,547	0	6	1	7	2	1	3	15	5	20	15	8	22	0	0	0	38	0.36	15	0.14	52	0.49	73.1
8-21-51	L	18.60	9,816	0	3	0	3	22	1	23	15	7	22	26	11	38	0	0	0	67	0.68	20	0.20	86	0.88	77.9
8-21-54	L	18.66	10,021	0	8	0	8	22	2	23	12	8	20	20	15	35	0	3	3	61	0.61	28	0.28	89	0.89	68.5
	T	18.64	30,384	0	17	1	18	46	4	49	42	20	62	61	34	95	0	3	3	166	0.55	63	0.21	227	0.75	73.1
Grand Total		16.17	89,490	1	49	6	55	135	12	146	150	60	210	143	109	252	0	14	14	478	0.53	206	0.23	680	0.76	70.3

* No. released corrected for tag loss and "estuary kills".

Appendix 3. Relationship between size at release, body lipid content at release, and total survival of Quinsam chinook for time and size releases in 1983. *

Release Date		Release Size (g)	% Lipid	% Overall Survival
5-May	Small	5.04	5.00	1.00
	Medium	6.04	6.21	1.58
	Large	7.06	6.25	1.93
	Average	6.05	5.82	1.51
26-May	Small	7.76	5.43	1.17
	Medium	9.08	5.95	1.37
	Large	10.47	6.41	1.50
	Average	9.10	5.93	1.35
16-Jun	Small	10.75	4.96	0.89
	Medium	12.53	5.48	1.10
	Large	14.41	6.07	1.30
	Average	12.56	5.50	1.10
7-Jul	Small	13.72	4.47	0.79
	Medium	16.08	5.19	0.74
	Large	18.64	5.77	0.75
	Average	16.17	5.14	0.76

* Release sizes and survival data from Appendix 2; lipid content data from Bilton et al. 1984a.



Appendix Fig. 3-1. Relationship between size at release and body lipid content for Quinsam chinook from time and size releases in 1983.

Appendix 4. Linear and quadratic equations and coefficients of determination (r^2) for the survival (catch plus escapement) vs size at release relationships shown in Figure 3. Linear equations were used when significant at α = .05, otherwise quadratic equations were used to improve fit to the data.

Release Year	Release Date	Equation	r^2	n	Probability (p)
1982	May 5 *	$3.562 - 1.882x + 0.360x^2$	0.517	9	n/a **
"	May 26	$-5.809 + 2.317x - 0.163x^2$	0.263	9	n/a
"	June 16	$-3.253 + 0.970x - 0.045x^2$	0.395	9	n/a
"	July 7	$-0.486 + 0.291x - 0.011x^2$	0.196	6	n/a
1983	May 5	$-1.311 + 0.465x$	0.844	9	0.000
"	May 26	$0.294 + 0.116x$	0.481	9	0.038
"	June 16	$-0.218 + 0.105x$	0.648	9	0.009
"	July 7	$2.774 - 0.242x + 0.007x^2$	0.030	9	n/a

* For the May 5, 1982 release, r^2 linear = 0.473; p = .072 (i.e., linear equation would account for 47.3 % of data variability, compared to 51.7% accounted for by quadratic equation shown above).

** "n/a" signifies not applicable.

Appendix 5a. Age composition of Quinsam chinook in the catch (C) and escapement (E) for small sized releases on May 5, 1982.

1st RELESE -- MAY 5, 1982 -- Small

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-21-19	S	2.16	6,693	C	6	8.7	2	2.9	52	75.4	5	7.2	4	5.8	69	100.0	3.99
				E	0	0.0	1	4.2	8	33.3	12	50.7	2	8.3	24	100.0	4.49
				C + E	6	6.5	3	3.2	61	65.6	17	18.3	6	6.5	93	100.0	4.15
8-21-20	S	2.39	9,161	C	0	0.0	20	29.4	31	45.6	10	14.7	6	8.8	68	100.0	3.97
				E	0	0.0	0	0.0	2	8.7	15	65.2	5	21.7	23	100.0	4.91
				C + E	0	0.0	20	22.0	33	36.3	25	27.5	12	13.2	91	100.0	4.27
8-21-21	S	2.18	8,739	C	12	15.6	1	1.3	42	54.5	18	23.4	4	5.2	77	100.0	4.01
				E	0	0.0	3	18.8	3	18.8	5	31.3	5	31.3	16	100.0	4.75
				C + E	12	12.9	4	4.3	45	48.4	23	24.7	9	9.7	93	100.0	4.14
	Total S	2.25	24,593	C	18	8.4	23	10.7	125	58.4	33	15.4	14	6.5	214	100.0	3.99
				E	0	0.0	4	6.3	13	20.6	32	50.8	12	19.0	63	100.0	4.70
				C + E	18	6.5	27	9.7	139	50.2	65	23.5	27	9.7	277	100.0	4.19

Appendix 5b. Age composition of Quinsam chinook in the catch (C) and escapement (E) for medium sized releases on May 5, 1982.

1st RELEASE -- MAY 5, 1982 -- Medium

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	Age 7 No.	Age 7 %	All Ages No.	All Ages %	Mean Age
8-21-22	M	2.70	9,705	C	11	16.7	9	13.6	30	45.5	13	19.7	2	3.0	0	0.0	66	100.0	3.73
				E	0	0.0	1	3.4	3	10.3	25	86.2	0	0.0	0	0.0	29	100.0	4.83
				C + E	11	11.6	10	10.5	33	34.7	38	40.0	2	2.1	0	0.0	95	100.0	4.06
8-21-23	M	2.92	10,006	C	10	10.0	6	6.0	44	44.0	28	28.0	10	10.0	0	0.0	100	100.0	4.14
				E	0	0.0	3	8.6	10	28.6	15	42.9	4	11.4	3	8.6	35	100.0	4.83
				C + E	10	7.5	10	7.5	54	40.3	43	32.1	14	10.4	3	2.2	134	100.0	4.37
8-21-24	M	3.18	10,050	C	13	17.1	10	13.2	32	42.1	18	23.7	3	3.9	0	0.0	76	100.0	3.84
				E	0	0.0	3	8.1	10	27.0	17	45.9	7	18.9	0	0.0	37	100.0	4.76
				C + E	13	11.5	14	12.4	42	37.2	35	31.0	10	8.8	0	0.0	113	100.0	4.17
	Total M	2.94	29,761	C	34	14.0	25	10.3	106	43.8	59	24.4	15	6.2	0	0.0	242	100.0	3.93
				E	0	0.0	7	6.9	23	22.8	57	56.4	11	10.9	3	3.0	101	100.0	4.80
				C + E	34	9.9	34	9.9	129	37.7	116	33.9	26	7.6	3	0.9	342	100.0	4.22

Appendix 5c. Age composition of Quinsam chinook in the catch (C) and escapement (E) for large sized releases on May 5, 1982.

1st RELEASE -- MAY 5, 1982 -- Large

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	Age 7 No	Age 7 %	All Ages No.	All Ages %	Mean Age
8-21-25	L	3.71	9,475	C	10	8.3	26	21.5	41	33.9	36	29.8	8	6.6	0	0.0	121	100.0	4.05
				E	0	0.0	1	1.7	14	23.7	38	64.4	6	10.2	0	0.0	59	100.0	4.83
				C + E	10	5.6	27	15.0	55	30.6	74	41.1	15	8.3	0	0.0	180	100.0	4.34
8-21-26	L	3.67	9,692	C	8	11.0	13	17.8	29	39.7	21	28.8	3	4.1	0	0.0	73	100.0	4.03
				E	0	0.0	8	13.1	12	19.7	33	54.1	8	13.1	0	0.0	61	100.0	4.67
				C + E	8	6.0	21	15.7	40	29.9	53	39.6	11	8.2	0	0.0	134	100.0	4.25
8-21-27	L	3.85	9,583	C	3	3.2	12	12.9	35	37.6	39	41.9	3	3.2	0	0.0	93	100.0	4.25
				E	0	0.0	1	2.2	14	30.4	29	63.0	2	4.3	0	0.0	46	100.0	4.70
				C + E	3	2.2	14	10.1	49	35.3	68	48.9	5	3.6	0	0.0	139	100.0	4.42
	Total L	3.74	28,750	C	21	7.3	51	17.8	105	36.6	96	33.4	14	4.9	0	0.0	287	100.0	4.11
				E	0	0.0	10	6.0	40	24.1	100	60.2	16	9.6	0	0.0	166	100.0	4.73
				C + E	21	4.6	62	13.7	144	31.8	196	43.3	31	6.8	0	0.0	453	100.0	4.35

1st RELEASE -- MAY 5, 1982 -- All sizes

	Total	3.01	83,104	C	73	9.8	99	13.3	336	45.2	188	25.3	43	5.8	0	0.0	743	100.0	4.02
				E	0	0.0	21	6.4	76	23.0	189	57.3	39	11.8	3	0.9	330	100.0	4.75
				C + E	73	6.8	123	11.5	412	38.4	376	35.1	84	7.8	3	0.3	1,072	100.0	4.26

Appendix 5d. Age composition of Quinsam chinook in the catch (C) and escapement (E) for small sized releases on May 26, 1982.

2nd RELEASE -- MAY 26, 1982 -- Small

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-21-28	S	5.32	9,403	C	17	13.9	13	10.7	47	38.5	38	31.1	8	6.6	122	100.0	4.09
				E	2	2.9	4	5.9	18	26.5	36	52.9	7	10.3	68	100.0	4.56
				C + E	19	10.0	17	8.9	65	34.2	74	38.9	15	7.9	190	100.0	4.26
8-21-29	S	5.18	9,553	C	8	7.0	18	15.7	54	47.0	27	23.5	9	7.8	115	100.0	4.13
				E	0	0.0	2	3.0	26	38.8	34	50.7	5	7.5	67	100.0	4.63
				C + E	8	4.4	20	11.0	80	44.0	61	33.5	14	7.7	182	100.0	4.31
8-21-30	S	5.46	9,041	C	24	24.2	8	8.1	30	30.3	29	29.3	8	8.1	99	100.0	3.89
				E	0	0.0	6	10.9	11	20.0	30	54.5	8	14.5	55	100.0	4.73
				C + E	24	15.6	15	9.7	41	26.6	59	38.3	15	9.7	154	100.0	4.17
	Total S	5.32	27,997	C	49	14.6	39	11.6	131	39.0	94	28.0	25	7.4	336	100.0	4.04
				E	2	1.1	12	6.3	55	28.9	100	52.6	20	10.5	190	100.0	4.63
				C + E	51	9.7	52	9.9	186	35.4	194	36.9	44	8.4	526	100.0	4.25

Appendix 5e. Age composition of Quinsam chinook in the catch (C) and escapement (E) for medium sized releases on May 26, 1982.

2nd RELEASE -- MAY 26, 1982 -- Medium

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-21-31	M	6.91	10,156	C	31	12.3	114	45.2	68	27.0	28	11.1	10	4.0	252	100.0	3.48
				E	0	0.0	5	9.3	13	24.1	30	55.6	6	11.1	54	100.0	4.69
				C + E	31	10.1	119	38.9	81	26.5	58	19.0	16	5.2	306	100.0	3.69
8-21-32	M	6.88	10,266	C	13	9.2	24	16.9	56	39.4	42	29.6	6	4.2	142	100.0	4.00
				E	2	3.0	7	10.4	23	34.3	32	47.8	2	3.0	67	100.0	4.31
				C + E	15	7.2	31	14.8	79	37.8	75	35.9	8	3.8	209	100.0	4.12
8-21-33	M	6.70	9,730	C	21	12.7	32	19.4	41	24.8	71	43.0	0	0.0	165	100.0	3.98
				E	0	0.0	3	5.6	17	31.5	27	50.0	7	13.0	54	100.0	4.70
				C + E	21	9.6	35	16.0	57	26.0	99	45.2	7	3.2	219	100.0	4.16
	Total M	6.83	30,152	C	65	11.6	170	30.4	165	29.5	141	25.2	16	2.9	559	100.0	3.76
				E	2	1.1	15	8.6	53	30.3	89	50.9	15	8.6	175	100.0	4.55
				C + E	67	9.1	185	25.2	217	29.6	232	31.6	31	4.2	734	100.0	3.96

Appendix 5f. Age composition of Quinsam chinook in the catch (C) and escapement (E) for large sized releases on May 26, 1982.

2nd RELEASE -- MAY 26, 1982 -- Large

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	Age 7 No.	Age 7 %	All Ages No.	All Ages %	Mean Age
8-21-34	L	8.41	10,188	C	8	5.5	22	15.2	48	33.1	66	45.5	0	0.0	0	0.0	145	100.0	4.17
				E	0	0.0	11	16.4	26	38.8	27	40.3	3	4.5	0	0.0	67	100.0	4.33
				C + E	8	3.8	33	15.6	74	34.9	93	43.9	3	1.4	0	0.0	212	100.0	4.22
8-21-35	L	8.09	10,364	C	27	22.3	18	14.9	48	39.7	20	16.5	7	5.8	0	0.0	121	100.0	3.65
				E	1	1.8	8	14.0	19	33.3	23	40.4	7	12.3	0	0.0	57	100.0	4.54
				C + E	28	15.7	26	14.6	67	37.6	43	24.2	14	7.9	0	0.0	178	100.0	3.94
8-21-36	L	8.17	10,144	C	25	11.7	38	17.8	99	46.3	48	22.4	4	1.9	0	0.0	214	100.0	3.85
				E	0	0.0	4	6.5	24	38.7	25	40.3	6	9.7	3	4.8	62	100.0	4.68
				C + E	25	9.1	42	15.3	122	44.4	73	26.5	10	3.6	3	1.1	275	100.0	4.04
	Total L	8.22	30,696	C	60	12.5	78	16.3	195	40.6	134	27.9	11	2.3	0	0.0	480	100.0	3.90
				E	1	0.5	23	12.4	69	37.1	75	40.3	16	8.6	3	1.6	186	100.0	4.51
				C + E	61	9.2	101	15.2	263	39.5	209	31.4	27	4.1	3	0.5	665	100.0	4.07

2nd RELEASE -- MAY 26, 1982 -- All sizes

	Total	6.84	88,845	C	174	12.7	287	20.9	491	35.7	369	26.8	52	3.8	0	0.0	1,375	100.0	3.88
				E	5	0.9	50	9.1	177	32.1	264	47.9	51	9.3	3	0.5	551	100.0	4.56
				C + E	179	9.3	338	17.6	666	34.6	635	33.0	102	5.3	3	0.2	1,925	100.0	4.07

Appendix 5g. Age composition of Quinsam chinook in the catch (C) and escapement (E) for small sized releases on June 16, 1982.

3rd RELEASE -- JUNE 16, 1982 -- Small

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-21-37	S	8.43	9,434	C	11	8.9	32	26.0	49	39.8	31	25.2	0	0.0	123	100.0	3.81
				E	0	0.0	2	4.7	11	25.6	24	55.8	6	14.0	43	100.0	4.79
				C + E	11	6.6	34	20.4	60	35.9	55	32.9	6	3.6	167	100.0	4.04
8-21-38	S	7.76	9,720	C	13	15.1	11	12.8	31	36.0	24	27.9	8	9.3	86	100.0	4.08
				E	0	0.0	4	6.8	17	28.8	33	55.9	4	6.8	59	100.0	4.56
				C + E	13	9.0	15	10.3	48	33.1	57	39.3	12	8.3	145	100.0	4.28
8-21-39	S	7.32	9,356	C	7	7.4	31	33.0	24	25.5	26	27.7	5	5.3	94	100.0	3.86
				E	0	0.0	1	2.6	12	31.6	20	52.6	4	10.5	38	100.0	4.61
				C + E	7	5.3	32	24.2	36	27.3	46	34.8	10	7.6	132	100.0	4.12
	Total S	7.84	28,510	C	31	10.2	74	24.4	104	34.3	81	26.7	13	4.3	303	100.0	3.90
				E	0	0.0	7	5.0	40	28.6	77	55.0	14	10.0	140	100.0	4.64
				C + E	31	7.0	81	18.2	144	32.4	158	35.6	28	6.3	444	100.0	4.14

Appendix 5h. Age composition of Quinsam chinook in the catch (C) and escapement (E) for medium sized releases on June 16, 1982.

3rd RELEASE -- JUNE 16, 1982 -- Medium

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-21-40	M	10.36	10,003	C	6	5.6	37	34.3	35	32.4	27	25.0	3	2.8	108	100.0	3.85
				E	1	2.6	4	10.5	16	42.1	16	42.1	1	2.6	38	100.0	4.32
				C + E	7	4.8	41	28.1	51	34.9	43	29.5	4	2.7	146	100.0	3.97
8-21-41	M	9.61	10,389	C	7	4.9	24	16.7	56	38.9	49	34.0	9	6.3	144	100.0	4.23
				E	0	0.0	3	5.8	18	34.6	29	55.8	2	3.8	52	100.0	4.58
				C + E	7	3.6	27	13.8	74	37.8	78	39.8	10	5.1	196	100.0	4.29
8-21-42	M	8.87	9,705	C	22	15.9	41	29.7	39	28.3	33	23.9	4	2.9	138	100.0	3.71
				E	0	0.0	2	5.4	11	29.7	20	54.1	3	8.1	37	100.0	4.54
				C + E	22	12.6	43	24.6	50	28.6	53	30.3	7	4.0	175	100.0	3.89
	Total M	9.62	30,097	C	35	9.0	102	26.2	130	33.3	109	27.9	16	4.1	390	100.0	3.94
				E	1	0.8	9	7.1	45	35.4	65	51.2	6	4.7	127	100.0	4.49
				C + E	36	7.0	111	21.5	175	33.8	174	33.7	21	4.1	517	100.0	4.06

Appendix 5i. Age composition of Quinsam chinook in the catch (C) and escapement (E) for large sized releases on June 16, 1982.

3 rd RELEASE -- JUNE 16, 1982 -- Large

Tag code	Juveniles Size group	Mean Wt. (g)	No. released	Recovere	Age 2 No.	%	Age 3 No.	%	Age 4 No.	%	Age 5 No.	%	Age 6 No.	%	Age 7 No.	%	All Ages No.	%	Mean Age
8-21-43	L	11.19	10,575	C	11	8.1	21	15.4	68	50.0	30	22.1	6	4.4	0	0.0	136	100.0	3.99
				E	0	0.0	3	4.8	29	46.8	24	38.7	6	9.7	0	0.0	62	100.0	4.53
				C + E	11	5.6	24	12.1	97	49.0	54	27.3	13	6.6	0	0.0	198	100.0	4.19
8-21-44	L	12.26	10,092	C	5	3.9	25	19.5	55	43.0	32	25.0	11	8.6	0	0.0	128	100.0	4.15
				E	0	0.0	5	8.9	17	30.4	25	44.6	6	10.7	3	5.4	56	100.0	4.73
				C + E	5	2.7	31	16.8	71	38.6	57	31.0	17	9.2	3	1.6	184	100.0	4.32
8-21-45	L	10.52	10,038	C	17	9.2	49	26.6	41	22.3	73	39.7	3	1.6	0	0.0	184	100.0	3.96
				E	0	0.0	2	3.8	14	26.9	29	55.8	6	11.5	0	0.0	52	100.0	4.67
				C + E	17	7.2	52	22.0	55	23.3	102	43.2	10	4.2	0	0.0	236	100.0	4.15
	Total L	11.32	30,705	C	33	7.4	95	21.2	164	36.6	135	30.1	20	4.5	0	0.0	448	100.0	4.02
				E	0	0.0	10	5.9	60	35.3	78	45.9	18	10.6	3	1.8	170	100.0	4.64
				C + E	33	5.3	107	17.3	223	36.1	213	34.5	40	6.5	3	0.5	618	100.0	4.22

3 rd RELEASE -- JUNE 16, 1982 -- All sizes

	Total	9.64	89,312	C	99	8.7	271	23.8	398	34.9	325	28.5	49	4.3	0	0.0	1,141	100.0	3.96
				E	1	0.2	26	5.9	145	33.2	220	50.3	38	8.7	3	0.7	437	100.0	4.60
				C + E	100	6.3	299	18.9	542	34.3	545	34.5	89	5.6	3	0.2	1,579	100.0	4.15

Appendix 5j. Age composition of Quinsam chinook in the catch (C) and escapement (E) for small sized releases on July 7, 1982.

4th RELEASE -- JULY 7, 1982 -- Small

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-21-46	S	10.23	9,004	C	10	11.2	10	11.2	36	40.4	30	33.7	4	4.5	89	100.0	4.13
				E	0	0.0	3	9.4	11	34.4	12	37.5	5	15.6	32	100.0	4.47
				C + E	10	8.3	13	10.7	47	38.8	42	34.7	9	7.4	121	100.0	4.22
8-21-47	S	9.78	9,186	C	4	4.7	36	42.4	28	32.9	13	15.3	4	4.7	85	100.0	3.73
				E	0	0.0	3	8.3	12	33.3	19	52.8	2	5.6	36	100.0	4.56
				C + E	4	3.3	39	32.2	40	33.1	32	26.4	6	5.0	121	100.0	3.98
	Total S	10.00	18,190	C	14	8.0	46	26.4	64	36.8	43	24.7	8	4.6	174	100.0	3.94
				E	0	0.0	6	8.8	23	33.8	31	45.6	7	10.3	68	100.0	4.51
				C + E	14	5.8	52	21.5	87	36.0	74	30.6	15	6.2	242	100.0	4.10

Appendix 5k. Age composition of Quinsam chinook in the catch (C) and escapement (E) for medium sized releases on July 7, 1982.

4th RELEASE -- JULY 7, 1982 -- Medium

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	Age 7 No	Age 7 %	All Ages No.	All Ages %	Mean Age
8-21-49	M	13.38	9,510	C	7	6.7	31	29.5	39	37.1	23	21.9	4	3.8	0	0.0	105	100.0	3.83
				E	0	0.0	2	5.1	12	30.8	17	43.6	5	12.8	3	7.7	39	100.0	4.87
				C + E	7	4.9	33	22.9	51	35.4	40	27.8	10	6.9	3	2.1	144	100.0	4.15
8-21-50	M	12.78	6,815	C	11	18.0	11	18.0	18	29.5	22	36.1	0	0.0	0	0.0	61	100.0	3.89
				E	0	0.0	1	3.8	15	57.7	9	34.6	1	3.8	0	0.0	26	100.0	4.38
				C + E	11	12.6	12	13.8	33	37.9	31	35.6	1	1.1	0	0.0	87	100.0	4.03
	Total M	13.13	16,325	C	18	10.8	42	25.3	57	34.3	45	27.1	4	2.4	0	0.0	166	100.0	3.85
				E	0	0.0	3	4.6	27	41.5	26	40.0	6	9.2	3	4.6	65	100.0	4.68
				C + E	18	7.8	45	19.5	84	36.4	71	30.7	11	4.8	3	1.3	231	100.0	4.11

Appendix 5l. Age composition of Quinsam chinook in the catch (C) and escapement (E) for large sized releases on July 7, 1982.

4th RELEASE -- JULY 7, 1982 -- Large

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	Age 7 No.	Age 7 %	All Ages No.	All Ages %	Mean Age
8-21-52	L	16.42	9,646	C	10	13.7	22	30.1	35	47.9	6	8.2	0	0.0	0	0.0	73	100.0	3.51
				E	0	0.0	3	7.0	13	30.2	27	62.8	0	0.0	0	0.0	43	100.0	4.56
				C + E	10	8.7	25	21.7	48	41.7	33	28.7	0	0.0	0	0.0	115	100.0	3.93
8-21-53	L	15.71	9,158	C	19	20.0	25	26.3	29	30.5	22	23.2	0	0.0	0	0.0	95	100.0	3.57
				E	1	2.4	2	4.8	22	52.4	17	40.5	0	0.0	0	0.0	42	100.0	4.31
				C + E	20	14.6	27	19.7	51	37.2	39	28.5	0	0.0	0	0.0	137	100.0	3.80
	Total L	16.07	18,804	C	29	17.3	47	28.0	64	38.1	28	16.7	0	0.0	0	0.0	168	100.0	3.54
				E	1	1.2	5	5.9	35	41.2	44	51.8	0	0.0	0	0.0	85	100.0	4.44
				C + E	30	11.9	52	20.6	99	39.3	72	28.6	0	0.0	0	0.0	252	100.0	3.86

4th Release -- July 7, 1982 -- All sizes

	Total	13.1	53,319	C	61	12.0	135	26.6	185	36.4	116	22.8	12	2.4	0	0.0	508	100.0	3.78
				E	1	0.5	14	6.4	85	39.0	101	46.3	13	6.0	3	1.4	218	100.0	4.53
				C + E	62	8.6	149	20.6	270	37.2	217	29.9	26	3.6	3	0.4	725	100.0	4.02
TOTAL 1982 RELEASES				C	407	10.8	792	21.0	1,410	37.5	998	26.5	156	4.1	0	0.0	3,763	100.0	3.92
				E	7	0.5	111	7.3	483	31.6	774	50.7	141	9.2	12	0.8	1,528	100.0	4.63
				C + E	414	7.8	909	17.2	1,890	35.7	1,773	33.5	301	5.7	12	0.2	5,299	100.0	4.13

Appendix 6a. Age composition of Quinsam chinook in the catch (C) and escapement (E) for small sized releases on May 5, 1983.

1st Release -- May 5, 1983 -- Small

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-20-46	S	5.08	9,763	C	6	8.3	16	22.2	21	29.2	29	40.3	0	0.0	72	100.0	4.01
				E	1	2.7	2	5.4	8	21.6	21	56.8	4	10.8	37	100.0	4.57
				C + E	7	6.4	19	17.4	29	26.6	51	46.8	4	3.7	109	100.0	4.28
8-20-47	S	5.07	9,846	C	3	4.9	10	16.4	25	41.0	22	36.1	1	1.6	61	100.0	4.13
				E	0	0.0	4	21.1	6	31.6	9	47.4	0	0.0	19	100.0	4.26
				C + E	3	3.7	14	17.3	30	37.0	32	39.5	1	1.2	81	100.0	4.12
8-20-48	S	4.97	10,159	C	7	8.4	13	15.7	43	51.8	17	20.5	4	4.8	83	100.0	4.02
				E	1	3.8	3	11.5	7	26.9	12	46.2	3	11.5	26	100.0	4.50
				C + E	8	7.3	16	14.7	50	45.9	29	26.6	7	6.4	109	100.0	4.14
	Total S	5.04	29,768	C	16	7.4	39	18.1	89	41.2	68	31.5	5	2.3	216	100.0	4.05
				E	2	2.4	9	11.0	21	25.6	42	51.2	7	8.5	82	100.0	4.48
				C + E	18	6.0	49	16.4	109	36.5	112	37.5	12	4.0	299	100.0	4.18

Appendix 6b. Age composition of Quinsam chinook in the catch (C) and escapement (E) for medium sized releases on May 5, 1983.

1st Release -- May 5, 1983 -- Medium

Tag code	Juveniles: Size group	Juveniles: Mean Wt. (g)	Juveniles: No.* released	Recovered	Age 2: No.	Age 2: %	Age 3: No.	Age 3: %	Age 4: No.	Age 4: %	Age 5: No.	Age 5: %	Age 6: No.	Age 6: %	All Ages: No.	All Ages: %	Mean Age
8-20-49	M	6.01	10,637	C	5	4.8	31	29.5	29	27.6	40	38.1	0	0.0	105	100.0	3.99
				E	1	1.4	7	10.1	19	27.5	31	44.9	11	15.9	69	100.0	4.64
				C + E	6	3.4	38	21.8	48	27.6	71	40.8	11	6.3	174	100.0	4.25
8-20-50	M	6.06	9,803	C	9	8.3	30	27.5	33	30.3	36	33.0	0	0.0	109	100.0	3.85
				E	0	0.0	3	7.0	10	23.3	31	72.1	0	0.0	43	100.0	4.74
				C + E	9	5.9	33	21.6	43	28.1	67	43.8	0	0.0	153	100.0	4.08
8-20-51	M	6.06	9,880	C	7	6.4	21	19.3	35	32.1	46	42.2	0	0.0	109	100.0	4.10
				E	1	2.4	3	7.1	7	16.7	31	73.8	0	0.0	42	100.0	4.62
				C + E	8	5.3	24	15.9	42	27.8	77	51.0	0	0.0	151	100.0	4.25
	Total M	6.04	30,320	C	21	6.5	82	25.4	97	30.0	122	37.8	0	0.0	323	100.0	3.98
				E	2	1.3	13	8.4	36	23.4	93	60.4	11	7.1	154	100.0	4.66
				C + E	23	4.8	95	19.9	133	27.8	215	45.0	11	2.3	478	100.0	4.19

Appendix 6c. Age composition of Quinsam chinook in the catch (C) and escapement (E) for large sized releases on May 5, 1983.

1st Release -- May 5, 1983 -- Large

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-20-52	L	7.28	10,221	C	18	10.8	52	31.1	49	29.3	47	28.1	2	1.2	167	100.0	3.80
				E	3	4.9	12	19.7	24	39.3	19	31.1	3	4.9	61	100.0	4.11
				C + E	21	9.2	64	28.1	73	32.0	66	28.9	5	2.2	228	100.0	3.89
8-20-53	L	6.92	9,794	C	5	3.9	44	34.4	57	44.5	22	17.2	0	0.0	128	100.0	3.75
				E	4	6.5	7	11.3	28	45.2	23	37.1	0	0.0	62	100.0	4.13
				C + E	10	5.3	50	26.3	85	44.7	45	23.7	0	0.0	190	100.0	3.87
8-20-54	L	6.98	9,812	C	4	4.8	32	38.1	36	42.9	12	14.3	0	0.0	84	100.0	3.67
				E	1	1.3	13	17.3	30	40.0	26	34.7	5	6.7	75	100.0	4.28
				C + E	5	3.1	45	28.3	66	41.5	39	24.5	5	3.1	159	100.0	3.99
	Total L	7.06	29,827	C	27	7.1	128	33.8	142	37.5	81	21.4	2	0.5	379	100.0	3.75
				E	8	4.0	32	16.2	82	41.4	68	34.3	8	4.0	198	100.0	4.18
				C + E	36	6.2	159	27.6	224	38.8	150	26.0	10	1.7	577	100.0	3.91

1st Release -- May 5, 1983 -- All sizes

	Total	6.05	89,915	C	64	7.0	249	27.1	328	35.7	271	29.5	7	0.8	918	100.0	3.90
				E	12	2.8	54	12.4	139	32.0	203	46.8	26	6.0	434	100.0	4.41
				C + E	77	5.7	303	22.4	466	34.4	477	35.2	33	2.4	1,354	100.0	4.07

Appendix 6d. Age composition of Quinsam chinook in the catch (C) and escapement (E) for small sized releases on May 26, 1983.

2nd Release -- May 26, 1983 -- Small

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-20-55	S	8.07	10,494	C	5	5.6	17	18.9	36	40.0	21	23.3	11	12.2	90	100.0	4.18
				E	0	0.0	1	5.6	4	22.2	11	61.1	2	11.1	18	100.0	4.78
				C + E	5	4.6	18	16.7	40	37.0	32	29.6	13	12.0	108	100.0	4.28
8-20-56	S	7.75	9,855	C	4	3.7	21	19.6	51	47.7	22	20.6	9	8.4	107	100.0	4.10
				E	1	2.7	1	2.7	10	27.0	23	62.2	2	5.4	37	100.0	4.65
				C + E	5	3.5	22	15.3	61	42.4	44	30.6	11	7.6	144	100.0	4.21
8-20-57	S	7.44	9,935	C	5	6.7	12	16.0	35	46.7	21	28.0	2	2.7	75	100.0	4.04
				E	2	7.1	3	10.7	5	17.9	17	60.7	1	3.6	28	100.0	4.43
				C + E	7	6.8	15	14.6	39	37.9	38	36.9	3	2.9	103	100.0	4.11
	Total S	7.76	30,284	C	14	5.1	50	18.4	122	44.9	64	23.5	22	8.1	272	100.0	4.11
				E	3	3.6	5	6.0	19	22.9	51	61.4	5	6.0	83	100.0	4.60
				C + E	17	4.8	55	15.5	140	39.4	114	32.1	27	7.6	355	100.0	4.20

Appendix 6e. Age composition of Quinsam chinook in the catch (C) and escapement (E) for medium sized releases on May 26, 1983.

2nd Release -- May 26, 1983 -- Medium

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-20-58	M	9.30	10,014	C	14	16.3	14	16.3	40	46.5	17	19.8	0	0.0	86	100.0	3.66
				E	1	2.4	3	7.3	10	24.4	24	58.5	3	7.3	41	100.0	4.61
				C + E	15	11.8	17	13.4	50	39.4	41	32.3	3	2.4	127	100.0	3.97
8-20-59	M	9.06	9,870	C	6	5.3	58	50.9	20	17.5	27	23.7	2	1.8	114	100.0	3.62
				E	3	8.3	3	8.3	8	22.2	18	50.0	4	11.1	36	100.0	4.47
				C + E	9	6.0	61	40.7	28	18.7	45	30.0	6	4.0	150	100.0	3.83
8-20-60	M	8.88	9,932	C	0	0.0	25	30.5	29	35.4	26	31.7	2	2.4	82	100.0	4.06
				E	2	4.2	8	16.7	17	35.4	20	41.7	0	0.0	48	100.0	4.08
				C + E	2	1.5	34	26.2	46	35.4	46	35.4	2	1.5	130	100.0	4.09
	Total M	9.08	29,816	C	20	7.1	97	34.4	89	31.6	70	24.8	4	1.4	282	100.0	3.76
				E	6	4.8	14	11.2	35	28.0	62	49.6	7	5.6	125	100.0	4.37
				C + E	26	6.4	112	27.5	124	30.5	132	32.4	11	2.7	407	100.0	3.96

Appendix 6f. Age composition of Quinsam chinook in the catch (C) and escapement (E) for large sized releases on May 26, 1983.

2nd Release -- May 26, 1983 -- Large

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-20-61	L	10.71	9,831	C	9	8.9	42	41.6	41	40.6	9	8.9	0	0.0	101	100.0	3.50
				E	0	0.0	4	8.3	22	45.8	20	41.7	2	4.2	48	100.0	4.42
				C + E	9	6.0	46	30.9	63	42.3	29	19.5	2	1.3	149	100.0	3.79
8-20-62	L	10.41	9,882	C	8	7.2	33	29.7	34	30.6	35	31.5	0	0.0	111	100.0	3.84
				E	0	0.0	3	8.1	9	24.3	16	43.2	9	24.3	37	100.0	4.84
				C + E	8	5.4	36	24.3	44	29.7	51	34.5	9	6.1	148	100.0	4.11
8-20-63	L	10.30	10,160	C	12	11.0	25	22.9	41	37.6	26	23.9	5	4.6	109	100.0	3.88
				E	4	9.3	8	18.6	16	37.2	13	30.2	1	2.3	43	100.0	3.88
				C + E	17	11.2	33	21.7	58	38.2	39	25.7	6	3.9	152	100.0	3.92
	Total L	10.47	29,873	C	29	9.0	100	31.2	116	36.1	70	21.8	5	1.6	321	100.0	3.74
				E	4	3.1	15	11.7	47	36.7	49	38.3	12	9.4	128	100.0	4.36
				C + E	34	7.6	115	25.6	165	36.7	119	26.5	17	3.8	449	100.0	3.94

2nd Release -- May 26, 1983 -- All sizes

	Total	9.10	89,973	C	63	7.2	247	28.2	327	37.4	204	23.3	31	3.5	875	100.0	3.86
				E	13	3.9	34	10.1	101	30.1	162	48.2	24	7.1	336	100.0	4.42
				C + E	77	6.4	282	23.3	429	35.4	365	30.1	55	4.5	1,211	100.0	4.02

Appendix 6g. Age composition of Quinsam chinook in the catch (C) and escapement (E) for small sized releases on June 16, 1983.

3rd Release -- June 16, 1983 -- Small

Tag code	Juveniles: Size group	Juveniles: Mean Wt. (g)	Juveniles: No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-21-01	S	10.95	9,915	C	12	18.5	11	16.9	19	29.2	23	35.4	0	0.0	65	100.0	3.82
				E	2	6.9	5	17.2	12	41.4	10	34.5	0	0.0	29	100.0	4.03
				C + E	14	14.9	16	17.0	31	33.0	33	35.1	0	0.0	94	100.0	3.88
8-21-02	S	10.87	10,176	C	3	7.3	16	39.0	14	34.1	8	19.5	0	0.0	41	100.0	3.66
				E	2	5.6	1	2.8	6	16.7	17	47.2	9	25.0	36	100.0	4.72
				C + E	5	6.5	17	22.1	20	26.0	25	32.5	9	11.7	77	100.0	4.16
8-21-03	S	10.44	9,884	C	1	1.4	20	27.4	27	37.0	25	34.2	0	0.0	73	100.0	4.04
				E	0	0.0	1	4.2	6	25.0	17	70.8	0	0.0	24	100.0	4.67
				C + E	1	1.0	21	21.6	32	33.0	42	43.3	0	0.0	97	100.0	4.15
	Total S	10.75	29,975	C	16	8.9	47	26.3	60	33.5	56	31.3	0	0.0	179	100.0	3.87
				E	4	4.5	7	7.9	24	27.0	44	49.4	9	10.1	89	100.0	4.48
				C + E	20	7.5	54	20.1	83	31.0	100	37.3	9	3.4	268	100.0	4.06

Appendix 6h. Age composition of Quinsam chinook in the catch (C) and escapement (E) for medium sized releases on June 16, 1983.

3rd Release -- June 16, 1983 -- Medium

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-21-04	M	12.79	9,928	C	11	12.8	22	25.6	26	30.2	27	31.4	0	0.0	86	100.0	3.80
				E	1	3.1	2	6.3	9	28.1	16	50.0	4	12.5	32	100.0	4.63
				C + E	12	10.2	24	20.3	35	29.7	43	36.4	4	3.4	118	100.0	4.03
8-21-05	M	12.74	9,946	C	0	0.0	20	28.2	26	36.6	22	31.0	2	2.8	71	100.0	4.03
				E	0	0.0	5	11.4	10	22.7	25	56.8	4	9.1	44	100.0	4.64
				C + E	0	0.0	26	22.6	37	32.2	47	40.9	6	5.2	115	100.0	4.32
8-21-06	M	12.05	9,944	C	0	0.0	14	25.0	32	57.1	11	19.6	0	0.0	56	100.0	4.02
				E	1	2.6	3	7.9	12	31.6	21	55.3	1	2.6	38	100.0	4.47
				C + E	1	1.1	17	17.9	43	45.3	33	34.7	1	1.1	95	100.0	4.17
	Total M	12.53	29,818	C	11	5.2	56	26.3	84	39.4	60	28.2	2	0.9	213	100.0	3.93
				E	2	1.8	10	8.8	31	27.2	62	54.4	9	7.9	114	100.0	4.58
				C + E	13	4.0	67	20.4	115	35.1	123	37.5	11	3.4	328	100.0	4.17

Appendix 6i. Age composition of Quinsam chinook in the catch (C) and escapement (E) for large sized releases on June 16, 1983.

3rd Release -- June 16, 1983 -- Large

Tag code	Juveniles: Size group	Juveniles: Mean Wt. (g)	Juveniles: No. released	Recovered	Age 2: No.	Age 2: %	Age 3: No.	Age 3: %	Age 4: No.	Age 4: %	Age 5: No.	Age 5: %	Age 6: No.	Age 6: %	All Ages: No.	All Ages: %	Mean Age
8-21-07	L	14.68	9,937	C	13	16.9	28	36.4	18	23.4	18	23.4	0	0.0	77	100.0	3.53
				E	0	0.0	4	9.3	20	46.5	15	34.9	4	9.3	43	100.0	4.44
				C + E	13	10.8	32	26.7	37	30.8	32	26.7	4	3.3	120	100.0	3.78
8-21-08	L	14.52	9,922	C	8	9.4	24	28.2	35	41.2	18	21.2	0	0.0	85	100.0	3.74
				E	1	2.9	5	14.3	8	22.9	22	62.9	0	0.0	35	100.0	4.54
				C + E	9	7.5	29	24.2	43	35.8	39	32.5	0	0.0	120	100.0	3.93
8-21-09	L	14.02	9,954	C	4	3.8	20	19.2	40	38.5	40	38.5	0	0.0	104	100.0	4.12
				E	1	2.3	9	20.9	17	39.5	16	37.2	0	0.0	43	100.0	4.12
				C + E	5	3.4	29	19.7	56	38.1	56	38.1	0	0.0	147	100.0	4.09
	Total L	14.41	29,813	C	25	9.4	72	27.1	93	35.0	76	28.6	0	0.0	266	100.0	3.83
				E	2	1.7	18	14.9	45	37.2	53	43.8	4	3.3	121	100.0	4.36
				C + E	27	7.0	90	23.3	136	35.1	127	32.8	4	1.0	387	100.0	3.95

3rd Release -- June 16, 1983 -- All sizes

	Total	12.56	89,606	C	52	7.9	175	26.6	237	36.0	192	29.2	2	0.3	658	100.0	3.87
				E	8	2.5	35	10.8	100	30.9	159	49.1	22	6.8	324	100.0	4.47
				C + E	60	6.1	211	21.5	334	34.0	350	35.6	24	2.4	983	100.0	4.05

Appendix 6j. Age composition of Quinsam chinook in the catch (C) and escapement (E) for small sized releases on July 7, 1983.

4th Release -- July 7, 1983 -- Small

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-21-10	S	14.14	9,842	C	11	22.4	9	18.4	10	20.4	19	38.8	0	0.0	49	100.0	3.76
				E	4	15.4	1	3.8	8	30.8	12	46.2	0	0.0	26	100.0	3.96
				C + E	15	20.3	10	13.5	17	23.0	32	43.2	0	0.0	74	100.0	3.89
8-21-11	S	13.44	9,822	C	2	2.3	31	36.0	26	30.2	27	31.4	0	0.0	86	100.0	3.91
				E	1	5.6	0	0.0	5	27.8	6	33.3	6	33.3	18	100.0	4.89
				C + E	3	2.9	31	29.8	31	29.8	33	31.7	6	5.8	104	100.0	4.08
8-21-12	S	13.59	9,883	C	0	0.0	9	24.3	17	45.9	10	27.0	0	0.0	37	100.0	3.92
				E	0	0.0	1	5.3	7	36.8	10	52.6	0	0.0	19	100.0	4.26
				C + E	0	0.0	10	18.2	24	43.6	21	38.2	0	0.0	55	100.0	4.20
	Total S	13.72	29,547	C	13	7.6	49	28.5	53	30.8	56	32.6	0	0.0	172	100.0	3.87
				E	5	7.9	2	3.2	20	31.7	28	44.4	6	9.5	63	100.0	4.32
				C + E	18	7.7	51	21.9	72	30.9	86	36.9	6	2.6	233	100.0	4.05

Appendix 6k. Age composition of Quinsam chinook in the catch (C) and escapement (E) for medium sized releases on July 7, 1983.

4th Release -- July 7, 1983 -- Medium

Tag code	Juveniles: Size group	Mean Wt. (g)	No. released	Recovered	Age 1 No.	Age 1 %	Age 2 No.	Age 2 %	Age 3 No.	Age 3 %	Age 4 No.	Age 4 %	Age 5 No.	Age 5 %	Age 6 No.	Age 6 %	All Ages No.	All Ages %	Mean Age
8-21-13	M	16.23	9,872	C	0		5	13.5	19	51.4	10	27.0	3	8.1	0	0.0	37	100.0	3.30
				E	0		0	0.0	2	8.3	4	16.7	14	58.3	3	12.5	24	100.0	4.58
				C + E	0		5	8.2	21	34.4	14	23.0	17	27.9	3	4.9	61	100.0	3.80
8-21-14	M	16.04	9,812	C	0		3	5.9	15	29.4	21	41.2	12	23.5	0	0.0	51	100.0	3.82
				E	0		0	0.0	1	3.6	6	21.4	19	67.9	2	7.1	28	100.0	4.79
				C + E	0		3	3.8	16	20.3	27	34.2	30	38.0	2	2.5	79	100.0	4.10
8-21-15	M	15.96	9,875	C	0		11	21.2	6	11.5	24	46.2	11	21.2	0	0.0	52	100.0	3.67
				E	1	3.6	0	0.0	3	10.7	10	35.7	14	50.0	0	0.0	28	100.0	4.25
				C + E	1	1.3	11	13.8	9	11.3	35	43.8	24	30.0	0	0.0	80	100.0	3.86
	Total M	16.08	29,559	C	0	0.0	19	13.6	40	28.6	55	39.3	26	18.6	0	0.0	140	100.0	3.63
				E	1	1.3	0	0.0	6	7.5	20	25.0	47	58.8	5	6.3	80	100.0	4.54
				C + E	1	0.5	19	8.6	46	20.9	76	34.5	71	32.3	5	2.3	220	100.0	3.93

Appendix 6l. Age composition of Quinsam chinook in the catch (C) and escapement (E) for large sized releases on July 7, 1983.

4th Release -- July 7, 1983 -- Large

Tag code	Juveniles Size group	Mean Wt. (g)	No. released	Recovered	Age 1 No.	%	Age 2 No.	%	Age 3 No.	%	Age 4 No.	%	Age 5 No.	%	Age 6 No.	%	All Ages No.	%	Mean Age
8-21-48	L	18.67	10,547	C	0		6	15.8	2	5.3	15	39.5	15	39.5	0	0.0	38	100.0	4.03
				E	0		1	6.7	1	6.7	5	33.3	8	53.3	0	0.0	15	100.0	4.33
				C + E	0		7	13.5	3	5.8	20	38.5	22	42.3	0	0.0	52	100.0	4.10
8-21-51	L	18.60	9,816	C	0		3	4.5	22	32.8	15	22.4	26	38.8	0	0.0	67	100.0	3.91
				E	0		0	0.0	1	5.0	7	35.0	11	55.0	0	0.0	20	100.0	4.30
				C + E	0		3	3.5	23	26.7	22	25.6	38	44.2	0	0.0	86	100.0	4.10
8-21-54	L	18.66	10,021	C	0		8	13.1	22	36.1	12	19.7	20	32.8	0	0.0	61	100.0	3.77
				E	0		0	0.0	2	7.1	8	28.6	15	53.6	3	10.7	28	100.0	4.68
				C + E	0		8	9.0	23	25.8	20	22.5	35	39.3	3	3.4	89	100.0	4.02
	Total L	18.64	30,384	C	0		17	10.2	46	27.7	42	25.3	61	36.7	0	0.0	166	100.0	3.89
				E	0		1	1.6	4	6.3	20	31.7	34	54.0	3	4.8	63	100.0	4.48
				C + E	0		18	7.9	49	21.6	62	27.3	95	41.9	3	1.3	227	100.0	4.07

4 th Release -- July 7, 1983 -- All sizes

	Total	16.17	89,490	C	0	0.0	49	10.3	135	28.2	150	31.4	143	29.9	0	0.0	478	100.0	3.80
				E	1	0.5	6	2.9	12	5.8	60	29.1	109	52.9	14	6.8	206	100.0	4.46
				C + E	1	0.1	55	8.1	146	21.5	210	30.9	252	37.1	14	2.1	680	100.0	4.02
TOTAL				C	0	0.0	228	7.8	806	27.5	1,042	35.6	810	27.7	40	1.4	2,926	100.0	3.87
1983				E	1	0.1	39	3.0	135	10.4	400	30.9	633	48.9	86	6.6	1,294	100.0	4.46
RELEASES				C + E	1	0.0	269	6.4	942	22.3	1,439	34.1	1,444	34.2	126	3.0	4,221	100.0	4.05

Appendix 7a. Mean lengths (POHL, mm) by age of males (M) and females (F) in the escapement of Quinsam chinook for time and size releases in 1982 (n = sample size). *

Release Date	Juveniles Size	Mean Wt. (g)	Age 2 ** M	Age 3 ** M	Age 4 M	Age 4 F	Age 4 Total	Age 5 M	Age 5 F	Age 5 Total	Age 6 M	Age 6 F	Age 6 Total
May 5	S	2.25	-	469 (3)	716 (9)	750 (1)	720 (10)	803 (3)	813 (20)	811 (23)	837 (4)	851 (6)	846 (10)
	M	2.94	-	514 (5)	749 (14)	718 (3)	744 (17)	811 (14)	844 (25)	832 (39)	790 (1)	865 (8)	857 (9)
	L	3.74	-	526 (7)	748 (26)	793 (4)	754 (30)	852 (20)	833 (46)	839 (66)	885 (3)	868 (9)	872 (12)
	T	3.01	-	510 (15)	743 (49)	760 (8)	745 (57)	832 (37)	831 (91)	832 (128)	849 (8)	863 (23)	859 (31)
May 26	S	5.32	373 (2)	516 (9)	731 (32)	745 (9)	739 (41)	831 (22)	824 (43)	826 (65)	867 (3)	877 (11)	875 (14)
	M	6.83	283 (2)	535 (13)	733 (25)	752 (17)	741 (42)	826 (21)	821 (34)	823 (55)	831 (2)	848 (8)	845 (10)
	L	8.22	-	578 (14)	768 (37)	753 (18)	763 (55)	839 (19)	836 (29)	838 (48)	893 (2)	859 (12)	863 (14)
	T	6.84	328 (4)	547 (36)	746 (94)	751 (44)	748 (138)	832 (62)	826 (106)	828 (168)	864 (7)	862 (31)	863 (38)
June 16	S	7.84	-	512 (3)	714 (24)	754 (9)	725 (33)	838 (20)	827 (31)	831 (51)	856 (4)	872 (7)	867 (11)
	M	9.62	474 (1)	523 (5)	746 (24)	741 (10)	745 (34)	826 (10)	822 (34)	823 (44)	886 (2)	856 (3)	868 (5)
	L	11.32	-	520 (9)	747 (28)	766 (16)	754 (44)	780 (14)	839 (36)	822 (50)	817 (3)	850 (10)	842 (13)
	T	9.64	474 (1)	520 (17)	736 (76)	756 (35)	742 (111)	817 (44)	830 (101)	826 (145)	850 (9)	859 (20)	856 (29)
July 7	S	10.00	-	493 (5)	717 (12)	784 (6)	739 (18)	813 (6)	829 (14)	824 (20)	-	884 (7)	884 (7)
	M	13.13	-	524 (3)	724 (15)	769 (4)	734 (19)	830 (6)	833 (10)	832 (16)	-	863 (5)	863 (5)
	L	16.07	412 (1)	577 (5)	742 (17)	762 (12)	750 (29)	837 (13)	848 (17)	843 (30)	-	-	-
	T	13.10	412 (1)	532 (13)	729 (44)	769 (22)	742 (66)	830 (25)	838 (41)	835 (66)	-	875 (12)	875 (12)

* Postorbital-hypural lengths for escapement recoveries to total system (i.e., returns to hatchery fence and dead-pitches in Campbell and Quinsam rivers).

** Age 2 and age 3 fish with length data were all males.

Appendix 7b. Mean lengths (POHL, mm) by age of males (M) and females (F) in the escapement of Quinsam chinook for time and size releases in 1983 (n = sample size).*

Release Date	Juveniles Size	Mean Wt. (g)	Age 2 ** M		Age 3 M		Age 3 F		Age 3 Total		Age 4 M		Age 4 F		Age 4 Total		Age 5 M		Age 5 F		Age 5 Total		Age 6 M		Age 6 F		Age 6 Total	
May 5	S	5.04	431	(2)	537	(8)	-		537	(8)	687	(10)	704	(4)	692	(14)	826	(10)	819	(34)	821	(44)	-		850	(5)	850	(5)
	M	6.04	386	(2)	570	(12)	-		570	(12)	704	(16)	757	(13)	728	(29)	806	(26)	843	(50)	831	(76)	-		928	(4)	928	(4)
	L	7.06	347	(7)	574	(25)	591	(2)	575	(27)	736	(42)	761	(22)	745	(64)	818	(22)	843	(39)	834	(61)	-		863	(2)	863	(2)
	T	6.05	370	(11)	566	(45)	591	(2)	567	(47)	722	(68)	754	(39)	733	(107)	814	(58)	837	(123)	829	(181)	-		881	(11)	881	(11)
May 26	S	7.76	347	(2)	563	(5)	-		563	(5)	705	(7)	751	(8)	729	(15)	823	(13)	812	(40)	814	(53)	-		826	(5)	826	(5)
	M	9.08	381	(6)	575	(14)	-		575	(14)	711	(12)	746	(13)	729	(25)	818	(16)	837	(35)	831	(51)	-		882	(5)	882	(5)
	L	10.47	352	(3)	579	(13)	-		579	(13)	729	(25)	753	(15)	738	(40)	815	(10)	832	(38)	829	(48)	-		850	(7)	850	(7)
	T	9.10	367	(11)	575	(32)	-		575	(32)	720	(44)	750	(36)	734	(80)	819	(39)	826	(113)	824	(152)	-		852	(17)	852	(17)
June 16	S	10.75	393	(3)	549	(5)	825	(1)	595	(6)	704	(12)	767	(5)	723	(17)	780	(13)	839	(33)	828	(46)	-		848	(3)	848	(3)
	M	12.53	327	(2)	565	(9)	720	(1)	580	(10)	715	(20)	710	(5)	714	(25)	833	(21)	827	(28)	830	(49)	-		857	(5)	857	(5)
	L	14.41	342	(2)	565	(18)	-		565	(18)	735	(23)	764	(9)	743	(32)	854	(15)	832	(30)	840	(45)	940	(1)	866	(1)	903	(2)
	T	12.56	359	(7)	562	(32)	775	(2)	575	(34)	721	(55)	750	(19)	729	(74)	831	(49)	833	(91)	832	(140)	940	(1)	855	(9)	864	(10)
July 7	S	13.72	423	(2)	552	(2)	-		552	(2)	706	(8)	740	(6)	720	(14)	812	(6)	828	(20)	824	(26)	849	(1)	855	(2)	853	(3)
	M	16.08	-		525	(6)	-		525	(6)	715	(14)	737	(1)	717	(15)	812	(14)	860	(25)	843	(39)	955	(1)	860	(1)	908	(2)
	L	18.64	338	(1)	597	(2)	-		597	(2)	706	(11)	750	(5)	720	(16)	812	(8)	828	(23)	824	(31)	-		830	(1)	830	(1)
	T	16.17	395	(3)	545	(10)	-		545	(10)	710	(33)	744	(12)	719	(45)	812	(28)	840	(68)	832	(96)	902	(2)	850	(4)	867	(6)

* Postorbital-hypural lengths for escapement recoveries to total system (i.e. returns to hatchery fence and dead-pitches in Campbell and Quinsam rivers).

** Age 2 fish with length data were all males.

Appendix 8a. Mean weights (kg) by age of males (M) and females (F) in the escapement of Quinsam chinook for time and size releases in 1982 (n = sample size). *

Release Date	Juveniles Size	Mean Wt. (g)	Age 2 ** M	Age 3 ** M	Age 4 M	Age 4 F	Age 4 Total	Age 5 M	Age 5 F	Age 5 Total	Age 6 M	Age 6 F	Age 6 Total
May 5	S	2.25	-	2.43 (2)	9.08 (4)	11.75 (1)	9.61 (5)	15.15 (1)	13.15 (7)	13.40 (8)	14.00 (1)	13.95 (2)	13.97 (3)
	M	2.94	-	2.99 (3)	11.49 (7)	9.70 (1)	11.26 (8)	11.63 (2)	14.08 (9)	13.64 (11)	-	17.80 (2)	17.80 (2)
	L	3.74	-	3.35 (6)	10.75 (14)	12.02 (3)	10.98 (17)	17.70 (2)	14.68 (10)	15.18 (12)	14.25 (1)	18.25 (2)	16.92 (3)
	T	3.01	-	3.08 (11)	10.69 (25)	11.50 (5)	10.83 (30)	14.76 (5)	14.06 (26)	14.17 (31)	14.13 (2)	16.67 (6)	16.03 (8)
May 26	S	5.32	1.25 (2)	3.50 (8)	9.88 (15)	11.77 (5)	10.35 (20)	15.37 (3)	14.35 (12)	14.55 (15)	-	17.29 (4)	17.29 (4)
	M	6.83	0.75 (2)	4.01 (11)	9.56 (15)	10.91 (9)	10.07 (24)	14.70 (1)	13.43 (8)	13.57 (9)	9.35 (1)	16.15 (2)	13.88 (3)
	L	8.22	-	4.97 (10)	12.69 (20)	10.66 (12)	11.93 (32)	12.14 (4)	14.01 (6)	13.26 (10)	16.75 (1)	14.78 (2)	15.43 (3)
	T	6.84	1.00 (4)	4.20 (29)	10.91 (50)	10.96 (26)	10.92 (76)	13.67 8)	13.99 (26)	13.91 (34)	13.05 (2)	16.38 (8)	15.71 (10)
June 16	S	7.84	-	3.03 (1)	10.40 (11)	10.49 (8)	10.44 (19)	12.91 (3)	13.64 (11)	13.48 (14)	-	14.80 (1)	14.80 (1)
	M	9.62	2.70 (1)	3.81 (2)	11.13 (15)	11.29 (6)	11.18 (21)	12.55 (2)	13.75 (13)	13.59 (15)	14.85 (1)	15.85 (1)	15.35 (2)
	L	11.32	-	3.38 (8)	11.85 (10)	11.98 (10)	11.91 (20)	9.60 (1)	14.90 (11)	14.46 (12)	-	15.20 (3)	15.20 (3)
	T	9.64	2.70 (1)	3.42 (11)	11.11 (36)	11.31 (24)	11.19 (60)	12.24 (6)	14.08 (35)	13.81 (41)	14.85 (1)	15.25 (5)	15.18 (6)
July 7	S	10.00	-	2.99 (4)	10.66 (5)	12.62 (5)	11.64 (10)	-	16.58 (5)	16.58 (5)	-	19.41 (4)	19.41 (4)
	M	13.13	-	3.28 (3)	10.75 (7)	11.03 (2)	10.81 (9)	15.80 (1)	14.00 (1)	14.90 (2)	-	13.67 (3)	13.67 (3)
	L	16.07	1.70 (1)	4.75 (5)	10.15 (12)	11.37 (7)	10.60 (19)	11.38 (2)	15.90 (7)	14.89 (9)	-	-	-
	T	13.10	1.70 (1)	3.80 (12)	10.43 (24)	11.77 (14)	10.92 (38)	12.85 (3)	16.02 (13)	15.42 (16)	-	16.95 (7)	16.95 (7)

* Adult weights for escapement recoveries at hatchery fence only.

** Age 2 and age 3 fish with weight data were all males.

Appendix 8b. Mean weights (kg) by age of males (M) and females (F) in the escapement of Quinsam chinook for time and size releases in 1983 (n = sample size).*

Release Date	Juveniles Mean Size	Wt. (g)	Age 2 ** M		Age 3 M		F		Total		Age 4 M		F		Total		Age 5 M		F		Total		Age 6 M		F		Total	
May 5	S	5.04	2.18	(2)	4.39	(7)	-		4.39	(7)	8.05	(3)	9.83	(2)	8.76	(5)	13.13	(5)	13.80	(16)	13.64	(21)	-		15.56	(4)	15.56	(4)
	M	6.04	1.54	(2)	4.79	(7)	-		4.79	(7)	8.71	(11)	10.86	(8)	9.62	(19)	11.93	(12)	15.73	(23)	14.42	(35)	-		-		-	
	L	7.06	0.96	(6)	4.63	(18)	6.38	(2)	4.80	(20)	9.48	(20)	11.56	(14)	10.34	(34)	12.54	(15)	14.83	(24)	13.95	(39)	-		-		-	
	T	6.05	1.32	(10)	4.62	(32)	6.38	(2)	4.72	(34)	9.11	(34)	11.18	(24)	9.97	(58)	12.40	(32)	14.90	(63)	14.06	(95)	-		15.56	(4)	15.56	(4)
May 26	S	7.76	0.88	(1)	3.24	(2)	-		3.24	(2)	7.94	(5)	9.14	(5)	8.54	(10)	13.08	(8)	14.07	(20)	13.79	(28)	-		14.17	(5)	14.17	(5)
	M	9.08	1.21	(6)	4.66	(9)	-		4.66	(9)	7.23	(6)	10.11	(8)	8.88	(14)	12.67	(7)	14.99	(21)	14.41	(28)	-		16.23	(3)	16.23	(3)
	L	10.47	0.87	(2)	4.68	(7)	-		4.68	(7)	8.82	(13)	10.33	(11)	9.51	(24)	12.43	(4)	14.91	(21)	14.51	(25)	-		12.23	(3)	12.23	(3)
	T	9.10	1.10	(9)	4.51	(18)	-		4.51	(18)	8.24	(24)	10.01	(24)	9.13	(48)	12.79	(19)	14.66	(62)	14.22	(81)	-		14.20	(11)	14.20	(11)
June 16	S	10.75	1.03	(2)	4.31	(3)	-		4.31	(3)	6.08	(2)	10.75	(2)	8.41	(4)	11.64	(10)	15.66	(15)	14.05	(25)	-		-		-	
	M	12.53	0.91	(2)	4.20	(8)	10.25	(1)	4.87	(9)	8.76	(14)	10.00	(2)	8.92	(16)	13.78	(9)	15.39	(13)	14.73	(22)	-		15.58	(1)	15.58	(1)
	L	14.41	0.85	(2)	4.68	(12)	-		4.68	(12)	10.30	(8)	11.06	(5)	10.59	(13)	15.12	(5)	13.63	(16)	13.99	(21)	-		16.25	(3)	16.25	(3)
	T	12.56	0.93	(6)	4.47	(23)	10.25	(1)	4.71	(24)	9.05	(24)	10.76	(9)	9.52	(33)	13.16	(24)	14.84	(44)	14.25	(68)	-		15.80	(3)	15.80	(3)
July 7	S	13.72	0.50	(1)	3.95	(1)	-		3.95	(1)	7.80	(2)	11.23	(2)	9.51	(4)	9.25	(2)	15.13	(10)	14.15	(12)	15.35	(1)	-		15.35	(1)
	M	16.08	-		4.10	(5)	-		4.10	(5)	8.17	(6)	10.35	(1)	8.48	(7)	12.82	(9)	16.95	(7)	14.63	(16)	-		-		-	
	L	18.64	0.94	(1)	-		-		-		8.66	(5)	10.53	(4)	9.49	(9)	13.25	(4)	13.99	(11)	13.79	(15)	-		-		-	
	T	16.17	0.72	(2)	4.08	(6)	-		4.08	(6)	8.30	(13)	10.70	(7)	9.14	(20)	12.46	(15)	15.14	(28)	14.20	(43)	15.35	(1)	-		15.35	(1)

* Adult weights for escapement recoveries at hatchery fence only.

** Age 2 fish with weight data were all males.

Appendix 9. Catch distribution by area of Quinsam chinook by release date and size, 1982 and 1983 releases.*

1982 RELEASES

Release Date	Juv. Size	Estimated Recoveries by Area						Release Date	Juv. Size	% by Area					
		AL	N/C	IN	OUT	WA/OR	Total			AL	N/C	IN	OUT	WA/OR	Total
May 5	S	130	76	8	0	0	214	May 5	S	60.7	35.5	3.7	0.0	0.0	100
	M	118	86	38	0	0	242		M	48.8	35.5	15.7	0.0	0.0	100
	L	150	80	50	0	5	285		L	52.6	28.1	17.5	0.0	1.8	100
	Tot.	398	242	96	0	5	741		Tot.	53.7	32.7	13.0	0.0	0.7	100
May 26	S	135	138	58	6	0	337	May 26	S	40.1	40.9	17.2	1.8	0.0	100
	M	221	255	85	0	0	561		M	39.4	45.5	15.2	0.0	0.0	100
	L	220	193	68	0	0	481		L	45.7	40.1	14.1	0.0	0.0	100
	Tot.	576	586	211	6	0	1,379		Tot.	41.8	42.5	15.3	0.4	0.0	100
June 16	S	157	103	39	5	0	304	June 16	S	51.6	33.9	12.8	1.6	0.0	100
	M	155	172	57	8	0	392		M	39.5	43.9	14.5	2.0	0.0	100
	L	248	146	53	0	0	447		L	55.5	32.7	11.9	0.0	0.0	100
	Tot.	560	421	149	13	0	1,143		Tot.	49.0	36.8	13.0	1.1	0.0	100
July 7	S	82	49	39	6	0	176	July 7	S	46.6	27.8	22.2	3.4	0.0	100
	M	73	53	36	4	0	166		M	44.0	31.9	21.7	2.4	0.0	100
	L	49	107	12	0	0	168		L	29.2	63.7	7.1	0.0	0.0	100
	Tot.	204	209	87	10	0	510		Tot.	40.0	41.0	17.1	2.0	0.0	100
TOTAL		1,738	1,458	543	29	5	3,773	TOTAL		46.1	38.6	14.4	0.8	0.1	100

1983 RELEASES

Release Date	Juv. Size	Estimated Recoveries by Area						Release Date	Juv. Size	% by Area					
		AL	N/C	IN	OUT	WA/OR	Total			AL	N/C	IN	OUT	WA/OR	Total
May 5	S	86	103	28	0	0	217	May 5	S	39.6	47.5	12.9	0.0	0.0	100
	M	112	153	54	0	4	323		M	34.7	47.4	16.7	0.0	1.2	100
	L	157	130	92	0	0	379		L	41.4	34.3	24.3	0.0	0.0	100
	Tot.	355	386	174	0	4	919		Tot.	38.6	42.0	18.9	0.0	0.4	100
May 26	S	136	117	18	0	0	271	May 26	S	50.2	43.2	6.6	0.0	0.0	100
	M	124	100	46	10	0	280		M	44.3	35.7	16.4	3.6	0.0	100
	L	125	150	42	0	5	322		L	38.8	46.6	13.0	0.0	1.6	100
	Tot.	385	367	106	10	5	873		Tot.	44.1	42.0	12.1	1.1	0.6	100
June 16	S	69	71	38	0	0	178	June 16	S	38.8	39.9	21.3	0.0	0.0	100
	M	98	92	24	0	0	214		M	45.8	43.0	11.2	0.0	0.0	100
	L	109	118	40	0	0	267		L	40.8	44.2	15.0	0.0	0.0	100
	Tot.	276	281	102	0	0	659		Tot.	41.9	42.6	15.5	0.0	0.0	100
July 7	S	70	65	37	0	0	172	July 7	S	40.7	37.8	21.5	0.0	0.0	100
	M	49	83	8	0	0	140		M	35.0	59.3	5.7	0.0	0.0	100
	L	67	65	31	3	0	166		L	40.4	39.2	18.7	1.8	0.0	100
	Tot.	186	213	76	3	0	478		Tot.	38.9	44.6	15.9	0.6	0.0	100
TOTAL		1,202	1,247	458	13	9	2,929	TOTAL		41.0	42.6	15.6	0.4	0.3	100

* Data from MRP database (minor discrepancies with other tables in totals due to round off errors).
Major catch areas: AL- Alaska, N/C - North/Central, IN - Inside, OUT - Outside, WA/OR - Washington/Oregon.

Appendix 10. Catch distribution by gear of Quinsam chinook by release date and size, 1982 and 1983 releases. *

1982 RELEASES

Release Date	Juv. Size	Estimated Recoveries by Gear U.S.	Net	Troll	Sport	Total
May 5	S	130	37	40	7	214
	M	118	86	19	19	242
	L	155	62	36	33	286
	Tot.	403	185	95	59	742
May 26	S	135	109	63	29	336
	M	221	238	62	38	559
	L	220	136	85	41	482
	Tot.	576	483	210	108	1,377
June 16	S	157	84	28	35	304
	M	155	129	73	38	395
	L	248	113	61	24	446
	Tot.	560	326	162	97	1,145
July 7	S	82	50	15	29	176
	M	73	53	24	17	167
	L	49	64	39	16	168
	Tot.	204	167	78	62	511
TOTAL		1,743	1,161	545	326	3,775

Release Date	Juv. Size	% by Gear U.S.	Net	Troll	Sport	Total
May 5	S	60.7	17.3	18.7	3.3	100
	M	48.8	35.5	7.9	7.9	100
	L	54.2	21.7	12.6	11.5	100
	Tot.	54.3	24.9	12.8	8.0	100
May 26	S	40.2	32.4	18.8	8.6	100
	M	39.5	42.6	11.1	6.8	100
	L	45.6	28.2	17.6	8.5	100
	Tot.	41.8	35.1	15.3	7.8	100
June 16	S	51.6	27.6	9.2	11.5	100
	M	39.2	32.7	18.5	9.6	100
	L	55.6	25.3	13.7	5.4	100
	Tot.	48.9	28.5	14.1	8.5	100
July 7	S	46.6	28.4	8.5	16.5	100
	M	43.7	31.7	14.4	10.2	100
	L	29.2	38.1	23.2	9.5	100
	Tot.	39.9	32.7	15.3	12.1	100
TOTAL		46.2	30.8	14.4	8.6	100

1983 RELEASES

Release Date	Juv. Size	Estimated Recoveries by Gear U.S.	Net	Troll	Sport	Total
May 5	S	86	64	53	15	218
	M	116	96	56	55	323
	L	157	122	42	59	380
	Tot.	359	282	151	129	921
May 26	S	136	62	46	29	273
	M	124	100	32	26	282
	L	130	103	59	28	320
	Tot.	390	265	137	83	875
June 16	S	69	63	27	21	180
	M	98	54	36	27	215
	L	109	74	55	26	264
	Tot.	276	191	118	74	659
July 7	S	70	50	13	38	171
	M	49	47	28	16	140
	L	67	47	27	24	165
	Tot.	186	144	68	78	476
TOTAL		1,211	882	474	364	2,931

Release Date	Juv. Size	% by Gear U.S.	Net	Troll	Sport	Total
May 5	S	39.4	29.4	24.3	6.9	100
	M	35.9	29.7	17.3	17.0	100
	L	41.3	32.1	11.1	15.5	100
	Tot.	39.0	30.6	16.4	14.0	100
May 26	S	49.8	22.7	16.8	10.6	100
	M	44.0	35.5	11.3	9.2	100
	L	40.6	32.2	18.4	8.8	100
	Tot.	44.6	30.3	15.7	9.5	100
June 16	S	38.3	35.0	15.0	11.7	100
	M	45.6	25.1	16.7	12.6	100
	L	41.3	28.0	20.8	9.8	100
	Tot.	41.9	29.0	17.9	11.2	100
July 7	S	40.9	29.2	7.6	22.2	100
	M	35.0	33.6	20.0	11.4	100
	L	40.6	28.5	16.4	14.5	100
	Tot.	39.1	30.3	14.3	16.4	100
TOTAL		41.3	30.1	16.2	12.4	100

* Data from MRP database (minor discrepancies with other tables in totals due to round off errors). Gear categories: U.S. - all gears, B.C. net, B.C. troll, B.C. sport.

Appendix 11a. Estimated catch of Quinsam chinook by age in Alaska and B.C. waters, and the proportion of total catch taken in Alaska by release date and size, 1982 releases. *

Release		AGE 2				AGE 3				AGE 4				AGE 5				AGE 6				ALL AGES			
Group		AL	BC	TOT	% AL	AL	BC	TOT	% AL	AL	BC	TOT	% AL	AL	BC	TOT	% AL	AL	BC	TOT	% AL	AL	BC	TOT	% AL
5-May	S	0	18	18	0.0%	5	18	23	21.7%	101	24	125	80.8%	13	20	33	39.4%	11	3	14	78.6%	130	84	214	60.7%
	M	2	32	34	5.9%	7	18	25	28.0%	79	27	106	74.5%	24	35	59	40.7%	8	7	15	53.3%	118	124	242	48.8%
	L	0	21	21	0.0%	18	33	51	35.3%	74	31	105	70.5%	52	39	91	57.1%	6	8	14	42.9%	150	131	281	53.4%
	Total	2	71	73	2.7%	30	69	99	30.3%	254	82	336	75.6%	89	94	183	48.6%	25	18	43	58.1%	398	339	737	54.0%
26-May	S	1	48	49	2.0%	11	28	39	28.2%	85	46	131	64.9%	30	64	94	31.9%	10	15	25	40.0%	135	201	336	40.2%
	M	1	64	65	1.5%	29	141	170	17.1%	129	36	165	78.2%	55	86	141	39.0%	8	8	16	50.0%	221	338	559	39.5%
	L	2	61	63	3.2%	35	43	78	44.9%	126	69	195	64.6%	55	79	134	41.0%	4	7	11	36.4%	220	262	482	45.6%
	Total	4	173	177	2.3%	75	212	287	26.1%	340	151	491	69.2%	140	229	369	37.9%	22	30	52	42.3%	576	801	1377	41.8%
16-Jun	S	5	26	31	16.1%	30	44	74	40.5%	78	26	104	75.0%	37	44	81	45.7%	7	6	13	53.8%	157	147	304	51.6%
	M	0	35	35	0.0%	46	56	102	45.1%	75	55	130	57.7%	27	82	109	24.8%	8	8	16	50.0%	155	240	395	39.2%
	L	0	33	33	0.0%	52	43	95	54.7%	118	46	164	72.0%	71	64	135	52.6%	7	13	20	35.0%	248	198	446	55.6%
	Total	5	94	99	5.1%	128	143	271	47.2%	271	127	398	68.1%	135	190	325	41.5%	22	27	49	44.9%	560	585	1145	48.9%
7-Jul	S	1	13	14	7.1%	12	34	46	26.1%	45	19	64	70.3%	25	18	43	58.1%	0	8	8	0.0%	82	94	176	46.6%
	M	0	18	18	0.0%	27	15	42	64.3%	25	32	57	43.9%	20	25	45	44.4%	2	2	4	50.0%	73	94	167	43.7%
	L	0	29	29	0.0%	6	41	47	12.8%	44	20	64	52.6%	0	28	28	0.0%	0	0	0	-	49	119	168	29.2%
	Total	1	60	61	1.6%	45	90	135	33.3%	114	71	185	61.6%	45	71	116	38.8%	2	10	12	16.7%	204	307	511	39.9%

* Date from MRP database (minor discrepancies with other tables in totals due to round off errors).
Washington / Oregon catches were negligible and were excluded from data.

Appendix 11b. Estimated catch of Quinsam chinook by age in Alaska and B.C. waters, and the proportion of total catch taken in Alaska by release date and size, 1983 releases. *

Release Group		AGE 2				AGE 3				AGE 4				AGE 5				AGE 6				ALL AGES			
		AL	BC	TOT	% AL	AL	BC	TOT	% AL	AL	BC	TOT	% AL	AL	BC	TOT	% AL	AL	BC	TOT	% AL	AL	BC	TOT	% AL
5-May	S	0	16	16	0.0%	14	25	39	35.9%	45	44	89	50.6%	22	46	68	32.4%	5	0	5	100.0%	86	132	218	39.4%
	M	0	17	17	0.0%	21	61	82	25.6%	43	54	97	44.3%	48	74	122	39.3%	0	0	0	-	112	207	319	35.1%
	L	1	26	27	3.7%	38	90	128	29.7%	80	62	142	56.3%	38	43	81	46.9%	0	2	2	0.0%	157	223	380	41.3%
	Total	1	59	60	1.7%	73	176	249	29.3%	168	160	328	51.2%	108	163	271	39.9%	5	2	7	71.4%	355	562	917	38.7%
26-May	S	0	14	14	0.0%	12	38	50	24.0%	78	44	122	63.9%	32	32	64	50.0%	13	9	22	59.1%	136	137	273	49.8%
	M	0	20	20	0.0%	45	52	97	46.4%	51	38	89	57.3%	25	45	70	35.7%	2	2	4	50.0%	124	158	282	44.0%
	L	2	27	29	6.9%	37	58	95	38.9%	67	49	116	57.8%	14	56	70	20.0%	5	0	5	100.0%	125	190	315	39.7%
	Total	2	61	63	3.2%	94	148	242	38.8%	196	131	327	59.9%	71	133	204	34.8%	20	11	31	64.5%	385	485	870	44.3%
16-Jun	S	1	15	16	6.3%	18	29	47	38.3%	31	29	60	51.7%	18	38	56	32.1%	0	0	0	-	69	111	180	38.3%
	M	0	11	11	0.0%	27	29	56	48.2%	47	37	84	56.0%	23	37	60	38.3%	0	2	2	0.0%	98	117	215	45.6%
	L	0	25	25	0.0%	22	50	72	30.6%	62	31	93	66.7%	25	51	76	32.9%	0	0	0	-	109	155	264	41.3%
	Total	1	51	52	1.9%	67	108	175	38.3%	140	97	237	59.1%	66	126	192	34.4%	0	2	2	0.0%	276	383	659	41.9%
7-Jul	S	0	13	13	0.0%	16	33	49	32.7%	39	14	53	73.6%	15	41	56	26.8%	0	0	0	-	70	101	171	40.9%
	M	1	18	19	5.3%	0	40	40	0.0%	35	20	55	63.6%	13	13	26	50.0%	0	0	0	-	49	91	140	35.0%
	L	0	17	17	0.0%	23	23	46	50.0%	22	20	42	66.7%	22	39	61	36.1%	0	0	0	-	67	98	165	40.6%
	Total	1	48	49	2.0%	39	96	135	28.9%	96	54	150	64.0%	50	93	143	35.0%	0	0	0	-	186	290	476	39.1%

* Data from MPR database (minor discrepancies with other tables in totals due to round off errors).
Washington / Oregon catches were negligible and were excluded from data.

Appendix 12. Studies on inter- and intraspecific interactions involving Quinsam chinook juveniles.

Levings et al. (1986) conducted beach-seine surveys between March 1982 to December 1983, on juvenile chinook in the Campbell River estuary and adjacent waters. These authors observed that during May and June, the estuary was used extensively by both wild and hatchery juveniles. Total abundance of juvenile salmon was much higher in 1982 than 1983 (Appendix Table 12-1) suggesting greater competition in 1982. However, no density-dependent effects on juvenile chinook were apparent in 1982, based on rates of increase in mean juvenile size (Appendix Table 12-2). Moreover, total survival was higher for the 1982 compared to 1983 study releases (1.69% vs 1.18%).

Levings et al. (1986) suggested that of all our study releases, the small sized May groups probably interacted most strongly with the even smaller wild chinook fry since the latter also aggregated in shallower nearshore areas in spring. Consequently, the greatest potential for competition in the estuary between hatchery produced and wild juveniles may be expected for early releases of smaller hatchery fish. However, Levings et al. (1986) found that in both 1982 and 1983, the relatively smaller May releases showed higher ($p<0.01$) rates of increase in weight compared to the relatively larger June and July releases.

There was evidence that the most significant food limitations and inter- and intraspecific interactions for Quinsam chinook juveniles may occur in the transition zone, just outside the estuary (Levings et al. 1986). This was based on finding peak biomass of both wild and hatchery juvenile chinook in that zone in mid-June. From mid-to-late June, the transition zone also supports high densities of pink and chum juveniles, many of which may be Fraser River outmigrants (Levings and Kotyk 1983), thereby further increasing competition for the available resources.

Append. Table 12-1. Comparison of physical and biological parameters, Campbell River estuary, 1982 and 1983.

PARAMETER	1982	1983	COMMENTS	SOURCE
Surface water temperatures	Cooler	Warmer	Warmer by about 2°C in spring and summer of 1983 compared to 1982.	Levings et al. (1986)
Total biomass of juvenile salmon (g/100 sq. m)	~230	~125	Much lower total biomass in 1983.	McAllister and Brown (unpubl.)
Catch of total juvenile salmon (per 100 sq. m)	~82	~22	Much lower total abundance in 1983.	McAllister and Brown (unpubl.)
Catch of wild chinook juveniles (per 100 sq. m)	~39	~12	Much lower abundance in 1983.	Levings et al. (1986) and McAllister and Brown (unpubl.)
Wild chinook juveniles - rates of increase in mean length and weight	0.46 mm/d 2.1%/d *	0.55 mm/d 2.7%/d *	No significant differences between 1982 and 1983 (Appendix Table 12-2).	Levings et al. (1986)
Experimental chinook - rates of increase in mean size per release group			Growth rates for May releases similar in 1982 and 1983 (Appendix Table 12-2).	Levings et al. (1986)
Experimental chinook - mean size			Significantly higher mean lengths and weights for May 1983 releases.	Levings et al. (1986)

* Instantaneous rate of increase in mean weight (Levings et al. (1986).

Appendix Table 12-2. Rates of increase in mean length (mm/day) and weight (g) of juvenile chinook in Campbell River estuary during May - September of 1982 and 1983. *

Chinook	Release	1982 RELEASES			1983 RELEASES		
Stock	Date	W_O **	mm/day	G ***	W_O **	mm/day	G ***
Wild	March +	0.7 g	0.46	0.021	0.6 g	0.55	0.027
Hatchery	May 5 ++	3.0 g	0.61	0.022	6.1 g	0.57	0.021
	May 26 ++	6.8 g	0.70	0.023	9.1 g	0.53	0.019
	June 16 ++	9.6 g	0.47	0.014	12.6 g	-	-
	July 7 ++	13.1 g	0.48	0.015	16.2 g	0.26	0.007

* Data from Table 4 in Levings et al. (1986). Data for wild chinook are for estuarine zone only. Data for hatchery chinook are for estuarine and transition zones combined since mean sizes of hatchery chinook were similar for the two zones.

** W_o - mean weight at first appearance in estuary for wild juveniles, and at release for hatchery juveniles.

*** G - Instantaneous rate of increase in weight $(\ln W_2 - \ln W_1) / t$ where W_1 and W_2 are the mean weights at the start and end of the time period (t).

+ First appearance of wild chinook fry in estuary was in March.

++ All size groups combined per release time group.

Appendix 13. Possible effects of the 1982/83 El Nino event on the survival of salmon.

Mean monthly surface water temperatures for 1982 and 1983 were compared at three locations: Campbell River estuary (for temperature graphs see Fig. 2 in Levings et al. 1986), Strait of Georgia and Queen Charlotte Strait (Appendix Table 13-1). In all three areas, the spring and summer water temperatures were generally higher in 1983 than 1982. These temperature differences may be attributed in part to the El Nino event which commenced in the fall of 1982 (B. Hargraves, pers. comm.). The effects were felt most strongly in the outside B.C. waters during the spring of 1983 when the ocean surface temperatures increased by 1-2°C (H. Freeland, pers. comm.).

An El Nino event typically results in extensive changes in coastal water temperatures and upwelling patterns (Johnson 1988, D. Maskas, pers. comm.). This may lead to a reduced food supply for juvenile salmon. Johnson (1988) observed that the 1982/83 El Nino event resulted in reduced returns and lower average sizes of Oregon's chinook and coho salmon, and poor survival of Oregon's coho smolts that entered the ocean in the spring of 1983. Likewise in our study, the total survival of Quinsam chinook was lower for 1983 compared to 1982 releases (1.69% vs 1.18%, respectively).

An El Nino may also "trigger" other conditions that may adversely affect early marine survival of juveniles. For example, the influx of mackerel into B.C. waters during the 1992/93 El Nino event resulted in heavy predation on juvenile chinook from the Robertson Creek Hatchery (B. Hargraves, pers. comm.).

Appendix Table 13-1. Mean monthly surface water temperatures (°C) in the Strait of Georgia and Queen Charlotte Strait, 1982 and 1983. *

STRAIT OF GEORGIA (Chrome Is.)				QUEEN CHARLOTTE STRAIT (Pine Is.)			
Month	1982	1983	Normal**	Month	1982	1983	Normal **
Jan	7.7	8.7	7.1	Jan	7.2	8.2	7.5
Feb	8.1	8.7	7.2	Feb	7.0	8.2	7.3
Mar	8.4	9.1	7.8	Mar	7.4	8.9	7.4
Apr	9.6	10.8	9.1	Apr	7.9	9.2	7.9
May	12.8	13.6	11.7	May	8.6	9.8	8.7
Jun	17.8	15.3	14.8	Jun	9.6	10.0	9.4
Jul	17.7	15.9	16.8	Jul	10.2	10.7	10.0
Aug	17.5	17.6	17.0	Aug	10.3	11.3	10.1
Sep	15.6	14.5	14.4	Sep	9.8	10.7	9.8
Oct	12.2	11.7	11.3	Oct	9.3	10.1	9.6
Nov	9.6	9.8	9.1	Nov	9.2	10.0	9.0
Dec	8.7	7.7	7.8	Dec	8.2	8.8	8.1

* Water temperatures from H. Freeland (pers.comm.). Chrome Island is located in Strait of Georgia approximately 80 km SE of Campbell River estuary; Pine Island is located in Queen Charlotte Strait approximately 270 km NW of Campbell River estuary.

** "Normal" sea-surface temperatures based on mean monthly values averaged over 1961-1994 for Chrome Island, and 1937-1994 for Pine Island.

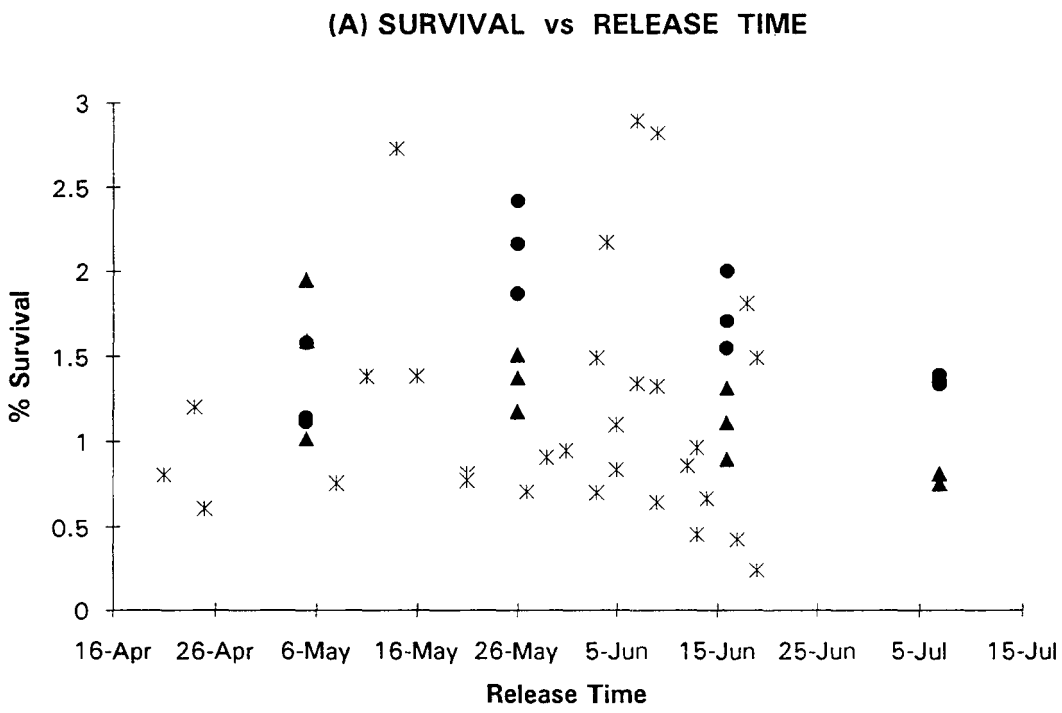
Appendix 14. Historical survival rates for Quinsam hatchery chinook, 1974 - 1986 broods.

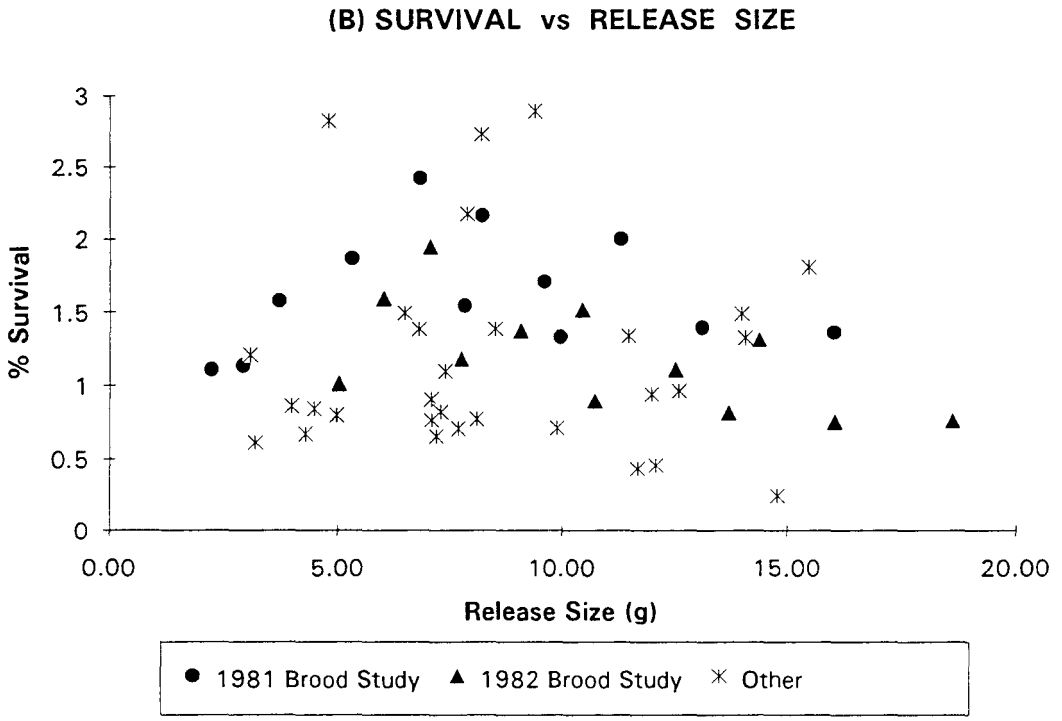
Total survivals for Quinsam hatchery chinook are shown for 1974 to 1986 broods in Appendix Table 14-1. (Note that all releases were made into Quinsam River; those groups released into estuarial, transition and marine zones (1982-1985 broods) were excluded to remove the effects of different release sites). The 54 groups (production and experimental) were released between April 21 and July 7 at a mean size of 2.3 g to 18.6 g. The data were plotted against release time and release size (Appendix Fig. 14-1). Despite considerable scatter of data points, highest survivals (>1.5%) were generally observed for early May to mid-June releases at 5-10 g. This release time-size window encompasses the optimum release time-size range (May releases at 6-10 g) obtained in the present study.

Appendix Table 14-1. Historical survival rates for Quinsam hatchery chinook, 1974-1986 broods.*

Brood	Release			%	Brood	Release			%
Year	Date	Year	Size	Survival	Year	Date	Year	Size	Survival
1974	9-June	75	4.80	2.83	1982	5-May	83	5.04	1.02
1975	14-June	76	4.30	0.67		5-May	83	6.04	1.60
1976	7-June	77	9.40	2.90		5-May	83	7.06	1.95
1977	5-June	78	4.50	0.84		26-May	83	7.76	1.18
	5-June	78	7.40	1.10		26-May	83	9.08	1.38
	12-June	78	4.00	0.86		26-May	83	10.47	1.51
1978	3-June	79	6.50	1.50		16-June	83	10.75	0.90
1979	29-May	80	7.10	0.91		16-June	83	12.53	1.11
	9-June	80	7.20	0.65		16-June	83	14.41	1.32
1980	11-May	81	6.80	1.39		7-July	83	13.72	0.82
	21-May	81	7.30	0.81		7-July	83	16.08	0.76
	3-June	81	7.70	0.71		7-July	83	18.64	0.76
1981	5-May	82	2.25	1.11		21-Apr	83	5.00	0.81
	5-May	82	2.94	1.14		16-May	83	8.50	1.39
	5-May	82	3.74	1.58		7-June	83	11.50	1.34
	26-May	82	5.32	1.87	1983	25-Apr	84	3.20	0.61
	26-May	82	6.83	2.42		9-Jun	84	14.10	1.33
	26-May	82	8.22	2.17		13-Jun	84	12.60	0.97
	16-June	82	7.84	1.55	1984	24-Apr	85	3.10	1.20
	16-June	82	9.62	1.71		31-May	85	12.00	0.95
	16-June	82	11.32	2.01		18-Jun	85	15.50	1.81
	7-July	82	10.00	1.33		19-Jun	85	14.00	1.49
	7-July	82	13.13	1.39	1985	13-Jun	86	12.10	0.46
	7-July	82	16.07	1.36		17-Jun	86	11.70	0.43
	14-May	82	8.20	2.74		19-Jun	86	14.80	0.24
	4-June	82	7.90	2.18	1986	8-May	87	7.10	0.76
						21-May	87	8.10	0.78
						27-May	87	9.90	0.71

* % Survival = [Total recovered to catch plus escapement / Total Released] x 100.





Appendix Fig. 14-1. Survival of Quinsam chinook vs release time (A) and release size (B), 1974-1986 broods (study results for 1981 and 1982 broods shown with distinctive symbols).

Appendix 15. Current production strategy for Quinsam hatchery chinook and recommendations to improve survival.

The majority (~2/3) of Quinsam chinook juveniles are reared at the hatchery and released to Quinsam River, generally from late April to mid-May at 5-8 g (D. Ewart, pers. comm.). The remainder of the production are seapen-reared 2-4 weeks prior to release. These juveniles are initially reared at the hatchery until mid-April, then transferred at 3-5 g to seapens, and released from seapens early to mid-May at approximately 6-11g (D. Ewart, pers. comm.). Preliminary return data for 1987 to 1991 broods indicate that seapen-reared juveniles have improved survivals compared to freshwater releases (B. Anderson, pers. comm.).

Results from our study suggest that the current freshwater production strategy may be improved by releasing juveniles during May at a somewhat larger size of 6-9 g. (Note that a possible late April release of larger juveniles is still to be tested). For seapen-reared chinook, survivals of progressively larger juveniles released at a later date should be tested in a simplified study where release times would range from early May to mid-June.

Ultimately, survivals of freshwater versus seapen-reared groups (of similar release time and size) should be compared for a minimum of three brood years in order to assess the survival advantage (if any) of the two different release strategies.

The current and recommended time-size release strategies for Quinsam hatchery chinook are summarized below.

	CURRENT STRATEGY	RECOMMENDED STRATEGY
FRESHWATER-REARED (released to Quinsam R.)	Late April to mid-May at 5-8 g	During May at 6-9 g *
SEAPEN-REARED (released to saltwater)	Early to mid-May at 6-11 g	Not available at this time.

* Also, avoid releasing small juveniles (<5 g) at any time, and avoid delaying releases beyond mid-June. A possible late April release of larger juveniles is still to be tested. Note that maximum achievable size by late April is approximately 7 g, and by late May approximately 10 g (D. Ewart, pers. comm.).

Determining the survival advantage (if any) of late April releases of larger juveniles

The present time-size study did not include April releases. However, survival trends observed for earliest releases ((May 5, Fig. 3) do not preclude the possibility that high survivals may also be achieved for late April releases of larger juveniles. Therefore, it is recommended to compare survivals of late April releases of larger juveniles (~5-7 g) to survivals of similar sized juveniles released during May. Additional studies on release time-size effects may not be required. Rather, the return data for freshwater releases from 1987 to 1994 broods may be analyzed since these broods included both the late April releases of approximately 5-7 g juveniles and the mid-May releases of approximately 7-8 g juveniles.

Appendix 16. Assessing the suitability of using the chi-square analysis to test for release time effects on catch distribution (based on discussions with B. Pyper).

The chi-square analysis has been generally used to test for significant differences in catch distribution by area or gear among different groups of fish (Irvine and Ward 1989, Schubert and Lister 1986). This test has been designed for use on the actual observed data rather than estimated numbers, since the chi-square statistic does not account for the considerable variance associated with expanding the observed recoveries into estimated numbers. That is, applying a chi-square test to estimated numbers would mean applying a statistical test to a set of treated numbers with an unknown error or variance.

When applying the chi-square test to the observed (rather than estimated) recoveries, an assumption is made that the catch:sample ratio is identical for each fishing strata sampled by area and gear. To test whether this assumption was valid for our data, and hence whether the observed recoveries could be used in a chi-square analysis, the catch distribution for each age group was tabulated separately using the observed and estimated recoveries. The inflation factor (i.e., No. Estimated / No. Observed) was then calculated for each data cell, and the degree of variation in the inflation factors across the four release time groups assessed. Appendix Table 16-1 shows the calculations for catch recoveries of age 5 chinook from 1982 releases. Note that each age group was treated separately in order to remove year-to-year variability in fishing pattern. Also, due to limited numbers of observed recoveries, only four major catch areas were identified (Alaska, North-Central, Inside and Outside, Fig. 9).

It was postulated that if the inflation factors showed little variability across the four release groups, then the observed recoveries could be tested using the chi-square statistic. This is because the differences in observed recoveries between the four release groups would closely reflect the differences as indicated by the estimated recoveries. (Note that the estimated recoveries provide the most likely estimates of relative abundance by catch area).

In our case, the variability in the inflation factors across the four release groups was pronounced. For example, inflation factors ranged from 2.5 to 6.0 for the age 5 recoveries (Appendix Table 16-1). This variability was not surprising given that recoveries from each catch area represent multiple fishing strata, each with its own array of catch:sample ratios. For example, the "Inside" recoveries included catches taken by different gears in Johnstone Strait and Strait of Georgia. Based on the above findings, we concluded that the observed catch recoveries for Quinsam chinook could not be tested using the chi-square statistic. Since no other formal statistical analyses were available at this time, we compared visually the relative catch distributions for the different release groups using graphs based on the estimated catch recoveries (Fig. 8).

Appendix Table 16-1. Calculating inflation factors between the observed and estimated catch recoveries for age 5 Quinsam chinook from 1982 releases (all replicates and size groups combined to increase sample size).

AGE 5 RECOVERIES BY RELEASE GROUP AND CATCH AREA - 1982 RELEASES

	ALASKA	NORTH-CENTRAL	INSIDE	OUTSIDE
		NO. OBSERVED RECOVERIES		
May 5	30	22	4	0
May 26	50	35	23	1
June 16	38	36	19	2
July 7	11	13	5	0
		NO. ESTIMATED RECOVERIES		
May 5	87	81	15	0
May 26	140	147	79	6
June 16	135	123	65	5
July 7	45	51	17	4
		INFLATION FACTORS *		
May 5	2.90	3.68	3.75	-
May 26	2.80	4.20	3.43	6.00
June 16	3.55	3.42	3.42	2.50
July 7	4.09	3.92	3.40	4.00

* Inflation factor = (No. Estimated / No. Observed) for each data cell. Note that actual inflation factors are based on sampling rates by area, week and gear.