Time and Size at Release Experiment: Four Releases of Three Size Categories of Juvenile Coho Salmon from the Quinsam Hatchery in the Spring of 1980

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TIME AND SIZE AT RELEASE EXPERIMENT: FOUR RELEASES OF THREE SIZE CATEGORIES OF JUVENILE COHO SALMON FROM THE QUINSAM HATCHERY IN THE SPRING OF 1980

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ABSTRACT

Bilton, H. T., and A. S. Coburn. 1981. Time and size at release experiment: four releases of three size groups of juvenile coho salmon from Quinsam Hatchery, spring of 1980. Can. Data Rep. Fish. Aquat. Sci. No. 252: 23 p.

An experiment is currently in progress at the Quinsam River production hatchery, Campbell River, B.C., to measure the effects of time and size at release of juvenile coho salmon (Oncorhynchus kisutch) on their subsequent survival, growth, distribution, and age at maturity. In the spring of 1980 four releases (April 20, May 10, May 30, and June 19) of juvenile coho salmon each comprising three size groups were released from the Quinsam River hatchery, representing a combined total of 132,056 marked and tagged fish. Prior to each release samples of smolts were obtained for examination for disease, proximate analysis, sea water challenge tests, blood plasma sodium analysis, and histopathological analysis. This report provides, in readily accessible form, background information required to assess the results of this experiment. Specific information on lengths, weights, sex composition, health, and ability of released fish to adapt to sea water is provided.

Key words: Quinsam, coho, data, size, release time.

RÉSUMÉ

Bilton, H. T., and A. S. Coburn. 1981. Time and size at release experiment: four releases of three size groups of juvenile coho salmon from Quinsam Hatchery, spring of 1980. Can. Data Rep. Fish. Aquat. Sci. No. 252: 23 p.

Une expérience est actuellement en cours à la piscifacture de production Quinsam River à Campbell River, en Colombie-Britannique, pour mesurer les effets de la date de libération et de la grosseur de jeunes saumons coho (Oncorhynchus kisutch) sur le taux ultérieur de survie, la croissance, la répartition et l'âge à la maturité. Au printemps de 1980, 132 056 poissons marqués et étiquetés ont été relâchés à quatre reprises (le 20 avril, le 10 et le 30 mai et le 19 juin), chaque fois répartis en trois groupes de grosseur. Avant de les libérer, on a prélevé des échantillons chez les saumoneaux pour examiner l'incidence des maladies, faire des analyses qualitatives, mesurer leur résistance à l'eau de mer, analyser la teneur en sodium du plasma sanguin et réalizer des analyses histopathologiques. Le rapport fournit sous forme facilement consultable des renseignements de base nécessaires pour évaluer les résultats de cette expérience. Il contient en outre des reseignements précis sur la longueur, le poids la répartition des sexes, l'état de santé et le potentiel des poissons à s'adapter à l'eau de mer.

Mots-clés: Quinsam, coho, données, grosseur, date des lâchers.

INTRODUCTION

The purpose of this report is to provide, in readily accessible form, background information required in a current experiment on the effects of time and size at release of juvenile Quinsam River coho salmon (Oncorhynchus kisutch) on their subsequent survival, growth, distribution, and age at maturity. This report has been divided into three major sections: the first deals with the smolt releases; the second deals with disease; and the third with blood sodium analysis.

1. SMOLT RELEASES

MATERIALS AND METHODS

A. DONOR STOCK AND REARING

A part of the production stock of 1978 brood Quinsam hatchery juvenile coho were used for the experiment. Fish assigned to the experiment were not reared separately, but were obtained from ponds of fish being reared for production purposes. Hence, they were reared using the normal hatchery water supply, in four Burrow's ponds at production densities. Fish were fed Oregon moist pellets (OMP) according to hatchery feeding schedules.

B. EXPERIMENTAL DESIGN

The object of the experiment was to release three size groups of juvenile coho at each of four different times. Each size group was replicated three times. Different size groups of coho could not be achieved by manipulating water temperature; they were achieved by grading the population of fish in each pond by length into small, medium, and large size categories. Thus there were nine groups at each release, making a total of 36 groups for all four releases. The design was as shown below.

Size category	Release date and number fish			
	Pond 2 Apr 20	Pond 3 May 10	Pond 5 May 30	Pond 4 June 19
Small	4,000	4,000	4,000	4,000
	4,000	4,000	4,000	4,000
	4,000	4,000	4,000	4,000
Total	12,000	12,000	12,000	12,000
Medium	4,000	4,000	4,000	4,000
	4,000	4,000	4,000	4,000
	4,000	4,000	4,000	4,000
Total	12,000	12,000	12,000	12,000
Large	4,000	4,000	4,000	4,000
	4,000	4,000	4,000	4,000
	4,000	4,000	4,000	4,000
Total	12,000	12,000	12,000	12,000
Grand total	36,000	36,000	36,000	36,000

C. NOSE-TAGGING, MARKING, AND GRADING BY LENGTH

All fish were tagged and marked during November, 1979. Just prior to tagging the fish from each of the four ponds a sample of 1,000 fish was removed. Fish were anesthetized and each was measured for length and then returned to the pond. A length-frequency curve was derived from these data, which was used to determine the size categories to be used. Arbitrarily it was decided that of the fish under the curve, 5% from each end of the curve would be rejected to remove out-riders and that the remaining 90% would be divided into three equal proportions, and would be classified as small, medium, and large.

Once the size categories were determined, marking and tagging of the fish was initiated. Fish were first anesthetized, the adipose fin removed. They were graded to size category and then tagged with the appropriately coded binary magnetic wire nose tag. Tagged fish were returned to the pond from which they originated.

On January 18, 1980, fish in each of the four ponds were sampled for the ratio of unmarked to marked fish, to obtain an estimate of the number of fish in each pond. From this it was estimated there were 83,641 fish in pond 2; 82,368 fish in pond 3; 114,256 fish in pond 4; and 101,239 fish in pond 5. Because of the unequal densities of fish in the ponds, it was decided to reduce the numbers in ponds 4 and 5 to the densities of ponds

2 and 3. During February, the densities in ponds 4 and 5 were reduced accordingly, by removal only of unmarked fish, until the densities were equal to those of ponds 2 and 3. Following this, fish continued to be reared according to standard hatchery procedures.

D. RELEASE

Water temperatures at the Quinsam hatchery usually increase markedly during the latter part of May and June. These conditions increase the risk of a disease outbreak. In an attempt to decrease this risk each pond of fish was treated with terramycin up to 10 days before each release. As will be noted in the next section, these preventative measures were not wholly successful.

On the day of each release, 1,000 marked fish were randomly removed, killed, and retained for subsequent examination for length, weight and sex. In addition, 100 fish were retained alive, for examination by the Diagnostic Services section (G. Hoskins). A further 90 fish (30 small, 30 medium, and 30 large) were held alive without feeding for 24 hours and then frozen for subsequent proximate analysis by Dave Higgs. The head and a section of the body from each of 30 fish (10 small, 10 medium, and 10 large) were preserved in fixative for subsequent histopathological examination by J. McBride. Just prior to each release a sample of 36 fish (12 small, 12 medium, and 12 large) from each pond were retained alive for subsequent measurement by C. Clarke for their blood plasma sodium concentration and their ability to adapt to sea water.

At the time of each release, marked to unmarked fish ratios in the samples obtained indicated that the estimated total number of fish in each pond was:

Pond	Estimate	95% confidence limit
2	88,422	84,400-92,943
3	83,070	79,349-87,157
4	69,470	66,478-72,743
5	79,057	75,544-82,904

Each release of fish began at approximately 1800 hours by removal of stop logs from the end of the pond leading directly to a channel to the river. Fish were released on April 20, May 10, May 30, and June 19, 1980.

Estimates of numbers of tagged fish released will be given below.

RESULTS

NUMBER, SIZE, AND SEX RATIO OF SMOLTS RELEASED

The number of tagged fish released by release date for each of 9 groups are given in Tables 1-4. Also given in Tables 1-4 are estimates (based on release samples) of mean lengths and weights of fish by sex in each of the groups. A total of 143,930 fish were tagged during the previous fall. The following spring a total estimated 133,707 marked fish were released, of which 132,056 were estimated to have a tag (based on incidence of marked fish without a tag in the release samples). Estimated tag loss was: pond 2 - 1.6%, pond 3 - 1.0%, pond 4 - 0.4%, pond 5 - 1.9%.

The sex ratio of smolts in samples from each release by group was compared using the 50% probability test (Langley 1979). Only in one out of the 36 groups (pond 3, May 10 release, tag group 8-20-12) was there a significant difference ($P<.05$) in the sex ratios. Hence, it can be said that the sex ratios of the fish in the individual groups were equal in nearly all cases. Examination of the sex ratio of fish in the total sample from each pond indicates that in ponds 2, 4, and 5 the sex ratio did not differ significantly ($P>.05$), but in pond 3 there were significantly more males.

Comparison of the sex ratio of fish among the three size categories from each pond using chi-square (Langley 1979) indicated there was no significant difference ($P>.05$) in the proportions of males and females in the samples among each group. Hence there was no tendency for one of the sexes to be more heavily represented than the other in any of the three size categories.

Examination of the smolts for sex indicated there were two types of males. One group comprised males that had no indication of development of the gonads, and the other group indicated males having varying stages of gonad development. For smolts from the second release (Pond 3, May 10) 67 out of 985 fish (6.8%) were males with developing gonads. Among those from the third and fourth releases (Pond 5, May 30; and Pond 4, June 19) 57 out of 980 fish (5.8%) and 47 out of 987 fish (4.8%) were males with maturing gonads. Hence, it is reasonable to speculate these are potential precocious males that will mature one year early and return as jacks in the fall of 1980. Table 5 summarizes these data by release group. Comparison of the average weights of these fish with that of all the males in the sample from each release group (Table 5) indicates the maturing smolts were the larger fish from each group. Furthermore, most of the maturing smolts originated from the large size category in each release.

2. DISEASE

This section was provided by the diagnostic services and summarizes the results of disease examination of fish from each of the four releases.

The following samples were collected:

Pond	Case no.	Collection Date	Number of fish collected	
			Random Sample	Moribund Sample
2	80-100	10/4/80	100	7
3	80-121	10/5/80	100	20
5	80-142	21/5/80	100	21
4	80-159	10/6/80	100	22

METHODS

SAMPLING

1. Random samples

One hundred fish were selected at random from each pond on dates indicated above. Capture was by large dip net from at least 5 different locations within the pond.

2. Moribund samples

A few moribund fish or fish showing obvious signs of disease were selected on dates indicated. Numbers vary according to the availability of suitable fish.

3. Sample size

A sample size of 100 fish gives a 95% probability of detecting a disease incidence level of slightly less than 3%.

LABORATORY PROCEDURES

This report is based on the laboratory procedures outlined below.

Because of the amount of work involved not all procedures could be carried out on all samples. The number of fish actually examined out of each sample is given for each procedure.

1. Random samples

One hundred fish were examined for gross external and internal detection of overt pathological change.

-100 fish. Aseptic streaking of kidney tissue onto Tryptic Soy Agar (TSA) and kidney disease medium (KDM) for the detection of bacterial pathogens.
-100 fish. Microscopic examination of stained kidney tissue smears for the detection of pathogenic organisms.
-40 fish. Histological evaluation of H & E stained sections. In most cases observations were limited to the liver.
-50 fish. Microhematocrit values were determined on the first 50 fish in each random sample. Used as an indicator of hemoconcentration problems (Table 6).
-10 fish. This subsample given to Tom McDonald for examination for a selected number of protozoan parasites.
-Examination of Giemsa stained blood films prepared from the first 20 fish from pond 2 and the first 40 fish from pond 4.

2. Moribund samples

-Examination of moribund fish was limited to aseptic streaking of kidney tissue onto TSA and microscopic examination of stained kidney tissue smears for the detection of infectious disease agents.

RESULTS

The results for each pond are summarized below:

POND 2

1. Random sample

(i) Gross examination

- External - normal.
- Internal - single ripe male, otherwise normal.

(ii) Infectious diseases encountered

- single case of bacterial kidney disease.

- single case of Trichodina sp. (protozoan ectoparasite).
- no other parasites found.

(iii) Microhematocrit values

- all fish were within the normal value range for coho smolts.
- average value 41.4%.

(iv) Histology

- liver tissue normal, no evidence of fatty infiltration.
- all internal organs examined appeared normal.
- gill structures showed some evidence of clubbing but judged not severe enough to influence smolt survival.

Blood smears

- all essentially normal.

2. Moribund samples (7 fish)

General findings

- 4 fish had acute furnuculosis
- 1 fish had bacterial kidney disease
- 2 fish free of infectious disease agents

POND 3

A. Random sample

(i) Gross examination

- External - normal.
- Internal - normal.

(ii) Infectious diseases encountered

- single case of furunculosis.
- no parasites found.

(iii) Microhematocrit values

- average value 45.7%.
- 7 fish outside the normal range with elevated values.

(iv) Histology

- liver tissue normal.
- no abnormalities noted.

2. Moribund sample

General findings

All moribund fish sampled were heavily infected with furunculosis

POND 5

1. Random sample

(i) Gross examination

- External - 12 fish had cloudy cornea in one or both eyes. These fish tended to be darker in color than the others and in poorer general condition.
- Internal - normal.

(ii) Infectious diseases encountered

- 1 case of furnunculosis.
- 2 cases of myxobacterial infection.
- no parasites found.

(iii) Microhematocrit value

- average - 43.0%.
- all except one were within the normal value range for coho smolts.

(iv) Histology

- liver tissue essentially normal.

2. Moribund sample

General findings

All moribund fish were heavily infected by furunculosis.

POND 4

1. Random sample

(i) Gross examination

- External - 90 fish had eroded or abraided noses and/or external swellings, 4 of these also had severely eroded fins, 2 had severe abdominal swellings accompanied by exophthalmia and clouding of the cornea was observed in several fish.
- Internal - 9 fish had flaccid, congested intestines which contained a yellow mucus and the liver contained massive hematomas.

(ii) Infectious diseases encountered

- the causative agent of furunculosis was readily isolated from 10 fish.
- no parasites found.

(iii) Microhematocrit values

- average value 46.2%.
- 10 fish had hematocrit values outside the normal range.

(iv) Histology

- liver lesions found in 3 fish.

(v) Blood smears

- 6 out of 40 blood smears examined showed some degree of abnormal erythrocyte morphology.

2. Moribund sample

General findings

- all moribund fish sampled had acute furunculosis.

CONCLUSIONS

The main finding of this work was the general deterioration of smolt health in ponds 4 and 5 and the increasing severity of the furunculosis. Furunculosis was the only infectious disease encountered which may have a significant influence on survival of these releases. It

should be noted that the causative agent, Aeromonas salmonicida, can not normally be detected in the carrier state, therefore, all isolations were probably from actively infected fish. Except for pond 2, the results indicate that the majority of the losses were due to furunculosis.

When sampled, pond 4 and 5 fish were showing acute signs of stress and infection. Past observations have suggested that smolting stress and low oxygen levels may cause clouding of the eyes and promote furunculosis. Corneal clouding was observed in the random samples from both pond 4 and 5. Pond 4 fish were in particularly poor condition. Approximately 90% of the fish in this pond had external swellings, abrasions and/or other disease signs. A random pond 4 sample collected, separate from this work, on June 20, 1980 and examined exclusively for furunculosis showed the incidence of infection had increased to 31%. This level of infection and the poor physical condition of pond 4 fish suggest their survival following release may not be as high as for the other three ponds.

Next year, if the work is repeated, it may be advisable to place all fish on an automatic 10-day treatment of Furazolidone or Terramycin before release. This will ensure that all ponds are treated the same. All marking and handling of the fish should be completed as early as possible to avoid stressing the fish as they approach smolting.

3. BLOOD PLASMA SODIUM ANALYSIS

This section was provided by C. Clarke and summarizes the results of plasma sodium analysis of fish from each of the four releases.

From Tables 7 and 8 it is evident that ability to adapt to sea water was similar in all ponds from April 20th to June 19th. Furthermore, there was little relation between size and hyposmoregulatory ability. This is often observed in coho near the time of smolting. However, at the time of the first seawater challenge test on March 28th, performance was clearly related to size (the test groups reached about 167 mmo/L compared with about 163 mmo/L in coho from the Big Qualicum Experimental rearing channel).

ACKNOWLEDGMENTS

The authors would like to thank Messrs J. Van Tyne, R. Reinhardt, and the Quinsam River hatchery staff for their help and cooperation in the carrying out of this work.

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Table 1. Numbers of tagged coho smolts in the nine groups released at Quinsam hatchery from pond 2 on April 20, 1980. Mean lengths and weights by sex, of smolts sampled at release are given.

Tag code	Number tagged fish released	Size group	Length mm								
			Male			Female			Male and Female		
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N
8-20-1	3,736	small	105.47	10.95	47	103.56	9.96	69	104.34	10.37	116
8-20-7	3,690	small	102.71	11.07	56	102.90	11.24	39	102.79	11.08	95
8-20-9	3,795	small	108.14	9.62	43	108.06	8.55	46	108.10	9.03	89
8-20-2	3,797	medium	115.54	7.57	54	114.84	6.63	51	115.20	7.10	105
8-20-5	3,795	medium	116.83	8.49	64	112.82	8.66	51	115.05	8.76	115
8-20-6	3,783	medium	116.21	7.45	63	114.73	8.21	64	115.46	7.85	127
8-20-3	3,758	large	126.09	8.27	58	124.53	6.66	55	125.33	7.54	113
8-20-4	3,739	large	125.22	8.07	59	121.98	8.19	53	123.69	8.25	112
8-20-8	3,779	large	127.45	9.85	58	124.68	9.32	50	126.17	9.66	108
Total	33,872		116.49	12.36	502	114.29	11.62	478	115.42	12.05	980

Table 1 (cont'd)

Tag code	Number tagged fish released	Size group	Weight g									95% confidence limits
			Male			Female			Male and Female			
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	
8-20-1	3,736	small	14.57	4.55	47	13.91	3.65	69	14.18	4.04	116	13.44-14.92
8-20-7	3,690	small	13.49	4.24	56	13.56	4.18	39	13.52	4.19	95	12.67-14.38
8-20-9	3,795	small	15.43	4.41	43	15.15	3.84	46	15.28	4.10	89	14.42-16.15
8-20-2	3,797	medium	19.02	3.67	54	18.44	2.74	51	18.74	3.25	105	18.11-19.37
8-20-5	3,795	medium	19.30	3.97	64	17.75	3.82	51	18.61	3.96	115	17.88-19.35
8-20-6	3,783	medium	18.96	3.44	63	18.55	3.66	64	18.76	3.54	127	18.13-19.38
8-20-3	3,758	large	24.23	4.67	58	23.11	4.04	55	23.69	4.39	113	22.87-24.51
8-20-4	3,739	large	23.72	4.28	59	22.27	4.22	53	23.03	4.30	112	22.23-23.84
8-20-8	3,779	large	25.32	5.95	58	23.08	5.14	50	24.28	5.67	108	23.20-25.36
Total	33,872		19.58	5.95	502	18.46	5.26	478	19.03	5.65	980	18.68-19.39

Table 2. Number of tagged coho smolts in the nine groups released at Quinsam hatchery from pond 3 on May 10, 1980. Mean lengths and weights by sex, of smolts sampled at release are given.

Tag code	Number of tagged fish released	Size group	Length mm								
			Male			Female			Male and female		
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N
8-20-10	3,790	small	119.10	7.06	51	116.57	7.95	44	117.93	7.55	95
8-20-15	3,778	small	118.27	7.88	62	117.79	7.74	47	118.06	7.78	109
8-20-18	3,781	small	118.98	8.29	51	117.12	8.52	42	118.14	8.40	93
8-20-11	3,743	medium	126.73	8.04	66	123.85	5.72	59	125.37	7.16	125
8-20-13	3,775	medium	127.31	8.05	57	125.80	7.10	56	126.57	7.60	113
8-20-16	3,759	medium	127.98	7.47	61	124.62	6.65	56	126.38	7.25	117
8-20-12	3,768	large	136.27	7.54	66	133.25	7.18	39	135.15	7.51	105
8-20-14	3,769	large	135.56	8.83	64	133.82	6.98	50	134.80	8.08	114
8-20-17	3,759	large	135.91	8.83	58	134.46	6.44	56	135.20	7.75	114
Total	33,922		127.72	10.58	536	125.46	9.68	449	126.69	10.23	985

Table 2 (cont'd)

Tag code	Number of tagged fish released	Size group	Weight g									95% confidence limits
			Male			Female			Male and female			
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	
8-20-10	3,790	small	18.27	3.09	51	17.32	3.57	44	17.83	3.34	95	17.15-18.51
8-20-15	3,778	small	17.93	3.47	62	17.76	3.35	47	17.85	3.41	109	17.20-18.50
8-20-18	3,781	small	17.83	3.22	51	17.36	3.48	42	17.62	3.33	93	16.93-18.31
8-20-11	3,743	medium	21.97	4.00	66	20.46	2.63	59	21.26	3.49	125	20.64-21.88
8-20-13	3,775	medium	22.06	4.15	57	21.43	3.61	56	21.75	3.89	113	21.02-22.47
8-20-16	3,759	medium	21.94	4.09	61	21.04	3.41	56	21.51	3.79	117	20.81-22.20
8-20-12	3,768	large	26.86	4.80	66	24.88	4.12	39	26.13	4.64	105	25.23-27.02
8-20-14	3,769	large	26.50	5.35	64	25.89	3.99	50	26.23	4.79	114	25.34-27.12
8-20-17	3,759	large	27.00	5.39	58	25.70	3.54	56	26.36	4.60	114	25.51-27.22
Total	33,922		22.45	5.56	536	21.42	4.74	449	21.98	5.22	985	21.65-22.30

Table 3. Number of tagged coho smolts in the nine groups released at Quinsam hatchery from pond 5 on May 30, 1980. Mean lengths and weights by sex, of smolts sampled at release are given.

Tag code	Number of tagged fish released	Size group	Length mm								
			Male			Female			Male and female		
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N
8-20-28	3,631	small	124.45	7.52	44	124.11	8.31	46	124.28	7.89	90
8-20-32	3,660	small	122.87	8.07	48	123.93	6.09	42	123.37	7.19	90
8-20-35	3,637	small	122.27	10.15	45	124.49	7.90	39	123.30	9.18	84
8-20-29	3,613	medium	133.57	6.67	54	130.05	6.88	54	131.81	6.97	108
8-20-31	3,636	medium	134.78	6.88	50	131.34	5.59	53	133.00	6.46	103
8-20-34	3,620	medium	132.01	8.66	66	131.41	6.96	59	131.73	7.88	125
8-20-30	3,688	large	143.42	9.18	52	138.45	6.67	66	140.64	8.22	118
8-20-33	3,603	large	142.97	8.56	70	139.73	6.92	60	141.48	7.98	130
8-20-36	3,611	large	145.07	10.96	67	140.23	8.36	65	142.69	10.03	132
Total	32,699		134.53	12.03	496	132.53	9.41	484	133.54	10.86	980

Table 3 (cont'd)

Tag code	Number of tagged fish released	Size group	Weight g									95% confidence limits
			Male			Female			Male and female			
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	
8-20-28	3,631	small	19.98	3.72	44	19.98	3.87	46	19.98	3.77	90	19.19-20.77
8-20-32	3,660	small	19.32	3.47	48	20.12	3.17	42	19.69	3.34	90	18.99-20.39
8-20-35	3,637	small	19.01	4.43	45	20.19	3.42	39	19.56	4.02	84	18.69-20.43
8-20-29	3,613	medium	24.90	4.10	54	22.62	3.74	54	23.76	4.07	108	22.99-24.54
8-20-31	3,636	medium	25.13	3.62	50	23.54	3.25	53	24.31	3.51	103	23.62-24.99
8-20-34	3,620	medium	24.03	4.63	66	23.29	3.68	59	23.68	4.21	125	22.94-24.43
8-20-30	3,688	large	30.42	6.31	52	27.36	4.29	66	28.71	5.47	118	27.71-29.71
8-20-33	3,603	large	30.46	5.72	70	28.09	4.57	60	29.37	5.33	130	28.44-30.29
8-20-36	3,611	large	31.56	7.02	67	28.80	5.44	65	30.21	6.42	132	29.10-31.31
Total	32,699		25.56	6.84	496	24.29	5.23	484	24.94	6.13	980	24.55-25.32

Table 4. Number of tagged coho smolts in the nine groups released at Quinsam hatchery from pond 4 on June 19, 1980. Mean lengths and weights by sex, of smolts sampled at release are given.

Tag code	Number of tagged fish released	Size group	Length mm								
			Male			Female			Male and female		
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N
8-20-19	3,593	small	124.52	9.84	71	123.98	8.32	50	124.30	9.21	121
8-20-24	3,526	small	125.05	7.71	58	122.40	9.73	60	123.70	8.86	118
8-20-27	3,142	small	122.65	11.61	46	123.90	9.14	53	123.32	10.32	99
8-20-20	3,563	medium	134.54	7.27	55	132.13	5.96	45	133.46	6.79	100
8-20-22	3,582	medium	134.79	9.41	63	133.55	8.02	54	134.22	8.78	117
8-20-25	3,524	medium	134.63	7.60	54	131.34	7.03	62	132.87	7.45	116
8-20-21	3,572	large	141.53	10.87	53	138.56	6.87	46	140.15	9.30	99
8-20-23	3,534	large	143.19	10.05	59	138.14	8.28	51	140.84	9.57	110
8-20-26	3,527	large	144.82	10.58	55	141.27	7.64	52	143.09	9.40	107
Total	31,563		133.87	12.26	514	131.45	10.34	473	132.71	11.44	987

Table 4 (cont'd)

Tag code	Number of tagged fish released	Size group	Weight g									95% confidence limits
			Male			Female			Male and female			
			$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	
8-20-19	3,593	small	20.36	4.52	71	20.43	4.15	50	20.39	4.35	121	19.60-21.17
8-20-24	3,526	small	20.38	4.09	58	19.41	4.40	60	19.89	4.26	118	19.11-20.66
8-20-27	3,142	small	19.60	5.21	46	19.91	4.35	53	19.76	4.74	99	18.82-20.71
8-20-20	3,563	medium	25.31	4.45	55	23.87	2.93	45	24.66	3.89	100	23.89-25.44
8-20-22	3,582	medium	25.71	5.24	63	24.60	4.30	54	25.20	4.84	117	24.31-26.08
8-20-25	3,524	medium	24.93	4.70	54	23.85	4.12	62	24.35	4.42	116	23.54-25.16
8-20-21	3,572	large	29.64	7.25	53	27.84	4.52	46	28.81	6.17	99	27.58-30.04
8-20-23	3,534	large	30.24	6.47	59	27.42	4.87	51	28.93	5.93	110	27.81-30.05
8-20-26	3,527	large	31.01	7.47	55	29.03	4.50	52	30.05	6.26	107	28.85-31.25
Total	31,563		25.19	6.93	514	23.91	5.43	473	24.58	6.28	987	24.19-24.97

Table 5. The number, percent, and mean weight of maturing male smolts in the four release samples from the Quinsam hatchey in 1980.

Tag code	Pond no.	Size group	No. smolts sampled	Maturing males			Percent maturing males in sample	$\bar{x}$ weight all smolts (g)
				No.	$\bar{x}$ weight (g)	SD		
8-20-10	3	small	95	1	24.29	0.00	0.10	17.83
8-20-15	3	small	109	6	19.67	2.04	5.50	17.85
8-20-18	3	small	93	4	19.51	3.52	4.30	17.62
8-20-11	3	medium	125	2	32.10	2,09	1.60	21.26
8-20-13	3	medium	113	6	25.80	6.64	5.31	21.75
8-20-16	3	medium	117	7	29.44	2.94	5.98	21.51
8-20-12	3	large	105	20	29.98	5.49	19.05	26.13
8-20-14	3	large	114	11	31.84	4.87	9.65	26.23
8-20-17	3	large	114	10	32.22	7.09	8.77	26.36
Total			985	67			6.80	
8-20-19	4	small	121	1	22.48	0.00	0.83	20.39
8-20-24	4	small	118	0	-	-	0.00	19.89
8-20-27	4	small	99	0	-	-	0.00	19.76
8-20-20	4	medium	100	2	33.61	3.34	2.00	24.66
8-20-22	4	medium	117	6	30.77	3.33	5.13	25.20
8-20-25	4	medium	116	5	31.24	5.54	4.31	24.35
8-20-21	4	large	99	12	34.10	8.66	12.12	28.81
8-20-23	4	large	110	11	38.49	7.43	10.00	28.93
8-20-26	4	large	107	10	37.46	9.40	9.34	30.05
Total			987	47			4.76	
8-20-28	5	small	90	0			0.00	19.98
8-20-32	5	small	90	0			0.00	19.69
8-20-35	5	small	84	0			0.00	19.56
8-20-29	5	medium	108	6	29.61	4.53	5.55	23.76
8-20-31	5	medium	103	2	26.97	3.20	1.94	24.31
8-20-34	5	medium	125	3	31.02	6.29	2.40	23.68
8-20-30	5	large	118	9	37.78	4.62	7.63	28.71
8-20-33	5	large	130	21	36.05	4.31	16.15	29.37
8-20-36	5	large	132	16	40.83	5.62	12.12	30.21
Total			980	57			5.82	

Table 6. Microhematocrit values for smolts sampled from each of the four ponds.

Fish number	Pond number			
	2	3	5	4
1	31%	42%	46%	45%
2	46	45	44	44
3	50	42	42	43
4	46	52	42	39
5	47	45	44	46
6	44	45	47	45
7	42	46	40	49
8	38	33	49	49
9	-	52	42	46
10	44	47	43	41
11	42	45	38	52
12	42	47	43	49
13	41	43	49	47
14	42	44	45	28
15	33	45	45	43
16	38	42	48	48
17	42	48	47	54
18	39	42	48	48
19	42	40	34	45
20	41	41	42	46
21	34	48	49	43
22	36	48	43	52
23	31	46	47	43
24	40	45	44	43
25	44	53	43	46
26	40	49	47	54
27	44	55	43	51
28	-	52	41	50
29	49	45	43	43
30	43	49	46	45
31	43	48	45	53
32	42	48	39	45
33	41	37	30	52
34	49	49	40	53
35	43	42	38	50
36	42	40	43	49
37	40	55	44	45
38	40	50	45	48
39	42	50	40	47
40	43	51	39	50
41	45	53	37	55
42	38	45	43	38
43	43	43	53	44
44	35	40	48	43
45	45	45	50	45
46	43	41	48	49
47	40	44	50	40
48	42	43	40	36
49	42	43	37	43
50	48	41	41	49
Average	41.4	45.7	43.0	46.2

Normal value range for coho smolts - 30 to 50%

Table 7. Blood sodium levels for three size groups of coho smolts in each of 4 releases from the Quinsam hatchery in 1980.

Pond no.	Release date	Size* group	n	Length of sodium sample group in mm		Blood sodium mm	
				$\bar{x}$	±S.E.	$\bar{x}$	±S.E.
2	Apr. 20/80	small	12	100.8	1.8	171.5	1.61
		medium	11	116.3	1.2	170.1	2.09
		large	13	132.6	1.6	167.4	0.89
3	May 10/80	small	12	115.1	2.9	167.4	1.6
		medium	11	133.4	1.2	170.9	2.1
		large	12	146.0	2.4	171.1	1.5
5	May 30/80	small	13	121.1	2.1	171.5	1.9
		medium	13	136.0	0.6	170.8	1.7
		large	13	148.2	1.9	171.4	1.8
4	June 19/80	small	12	132.6	2.6	172.1	2.1
		medium	12	149.6	1.0	167.9	2.1
		large	11	164.1	2.0	167.5	2.1

*Size grouping based on approx. equal division of sodium sample group. Average lengths of these groups do not necessarily correspond to average lengths of release sample of tagged fish.

Table 8. Blood sodium levels of three size groups of coho smolts in each of 4 ponds at the Quinsam hatchery between March 28 and July 19, 1980.

		Pond 2		Pond 3		Pond 5		Pond 4	
		Length	Sodium	Length	Sodium	Length	Sodium	Length	Sodium
March 28	small	98.6	179.7	96.3	182.9	95.6	181.7	96.7	182.3
	medium	112.1	173.6	108.8	176.6	106.1	172.9	111.8	179.4
	large	125.2	172.9	125.0	167.6	125.9	173.0	131.7	171.2
April 20	small	100.8	171.5	104.4	177.1	97.9	175.9	104.0	171.8
	medium	116.3	170.1	115.8	168.3	117.1	168.6	115.9	168.3
	large	132.6	167.4	134.6	167.8	139.7	167.6	133.9	167.5
May 10	small			115.1	167.4	107.1	169.7	119.6	173.3
	medium			133.4	170.9	128.4	167.4	134.1	169.9
	large			146.0	171.1	143.0	168.8	145.9	169.7
May 30	small					121.1	171.5	122.8	171.8
	medium					136.0	170.8	136.2	170.8
	large					148.2	171.4	143.2	168.0
June 19	small							136.6	172.1
	medium							149.6	167.9
	large							164.1	167.5