

LM 277

LIFE HISTORY OF WINTER
STEELHEAD (Salmo gairdneri) IN
THE VEDDER-CHILLIWACK RIVER
- BASED ON SCALE SAMPLES
COLLECTED BETWEEN 1948 and 1975

by

Alan Caverly, Fish and Wildlife Assistant

Submitted to:

Vic Swiatkiewicz, Regional Fisheries Biologist
Region 2 Fish and Wildlife Branch, Burnaby

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TABLE OF CONTENTS

List of Figures	pg.	1
List of Tables	pg.	2
Abstract	pg.	3
Introduction	pg.	4
Materials and Methods	pg.	6
Results		
(1948-1959)	pg.	7
(1958-1975)	pg.	24
Discussion		
(i) Age Class	pg.	41
(ii) Freshwater Age	pg.	42
(iii) Saltwater Age	pg.	42
(iv) Repeat Spawning	pg.	43
(v) Sex Ratio	pg.	43
(vi) Timing of the Run	pg.	44
Conclusions	pg.	48
Recommendations	pg.	49
List of References	pg.	50
Appendix	pg.	51

List of Figures

1948 - 1959

Fig. 1	Lower Fraser Valley in Southwestern British Columbia Showing Vedder-Chilliwack River	pg. 5
Fig. 2	Age Class Structure of Winter Run Steelhead in the Vedder-Chilliwack River (1953-1959)	pg. 10
Fig. 3	Freshwater Ages of Winter Steelhead	pg. 13
Fig. 3	Saltwater Ages of Winter Steelhead	pg. 13
Fig. 4	Yearly Sex Ratio of Winter Steelhead Caught By Anglers (1948-1957)	pg. 17
Fig. 5	Monthly Sex Ratio of Winter Steelhead	pg. 19
Fig. 6	Timing of the Run-Based on Angler Catch Per Month	pg. 21
Fig. 7	Timing of the Run - Based on Angler Catch per Week	pg. 23

1958 - 1975

Fig. 8	Age Class Structure of Winter Run Steelhead in the Vedder-Chilliwack River (1960 - 1975)	pg. 27
Fig. 9	Freshwater Ages of Winter Steelhead	pg. 30
Fig. 9	Saltwater Ages of Winter Steelhead	pg. 30
Fig. 10	Yearly Sex Ratio of Winter Steelhead Caught By Anglers (1958-1975)	pg. 34
Fig. 11	Monthly Sex Ratio of Winter Steelhead	pg. 36
Fig. 12	Timing of the Run - Based on Angler Catch per Month	pg. 38
Fig. 13	Timing of the Run - Based on Angler Catch per Week	pg. 40
Fig. 14	Monthly Discharge of the Vedder-Chilliwack River For A Three Year Period	pg. 46
Fig. 15	Mean Monthly Temperature ($^{\circ}$ C) For One Year on the Vedder-Chilliwack River	pg. 47

LIST OF TABLES

1948-1959

TABLE I	Age Class Structure of Winter Run Steelhead In The Vedder-Chilliwack River (1953-1959)	pg. 9
TABLE II	Freshwater Ages of Winter Steelhead	pg.11
TABLE III	Saltwater Ages of Winter Steelhead	pg.12
TABLE IV	Comparison of Saltwater Age Groups Between Early Run and Late Run Steelhead	pg.14
TABLE V	Age Class of Repeat Spawning Winter Run Steelhead	pg.15
TABLE VI	Yearly Sex Ratio of Winter Run Steelhead Caught by Anglers (1948-1957)	pg.16
TABLE VII	Sex Ratio By Month of Wild Winter Steelhead in the Chilliwack River	pg.18
TABLE VIII	Timing of the Run - Based on Angler Catch Per Month	pg.20
TABLE IX	Timing of the Run - Based on Angler Catch Per Week	pg.22

1958-1975

TABLE X	Age Class Structure of Winter Run Steelhead in the Vedder-Chilliwack River (1960-1975)	pg.26
TABLE XI	Freshwater Age Groups of Winter Steelhead	pg.28
TABLE XII	Saltwater Age Groups of Winter Run Steelhead	pg.29
TABLE XIII	Comparison of Saltwater Age Groups Between Early and Late Run Steelhead	pg.31
TABLE XIV	Age Class of Repeat Spawning Winter Steelhead	pg.32
TABLE XV	Yearly Sex Ratio of Winter Run Steelhead Caught By Anglers (1958-1975)	pg.33
TABLE XVI	Sex Ratio By Month of Wild Winter Steelhead Caught by Anglers	pg.35
TABLE XVII	Timing of the Run - Based on Angler Catch Per Month	pg.37
TABLE XVIII	Timing of the Run - Based on Angler Catch Per Week	pg.39

ABSTRACT

Approximately 1800 steelhead scale samples were available for this study. The samples were obtained from steelhead caught by anglers from 1948 to 1975. All the samples were used for determination of sex ratio and timing of the run. Only those samples from 1953 to 1975 were used for age analysis (about 1000). The remaining samples were previously examined for age in a study by Maher and Larkin (1954). The results of the Maher and Larkin study were compared to those of this report.

The samples from the Chilliwack river winter steelhead were broken into separate time periods to compare changes in the population characteristics from past to present. No significant changes were noted. The two time periods were roughly 1948 to 1958 and from 1957 to 1975.

For 1953-59 the most common age class was 3.2+ (33.5%) followed by 3.1+ (29.2%). The most common freshwater age was 3. (64.3%) and the most common saltwater age .2+ (53.1%). During the early part of the run (Nov.-Dec.) the .2+ fish were most common in the catch and during the later run (Jan.-Apr.) the .1+ fish were the most common. Only 3.4% of the sample were repeat spawners, 14 females and 9 males. For 1948-1957 the overall sex ratio for females to males was 1.5:1. For timing of the run the best month was December (40.4%) and the best week Dec. 23-31 (20.4%). This may be biased by an annual fishing derby December 26.

For 1958-1975 the most common age was again 3.2+ (45.1%) followed by 3.1+ (24.5%). Most common freshwater age was 3. (67.5%) and most common saltwater age .2+ (70.5%). The .2+ fish were again more common than .1+ during the early run. Sex ratio of females to males for 1958-1975 was again 1.5:1. Angling regulation by sex ratio may be justifiable in the future. Timing of the run again found the best month to be December (43.4%) and Dec. 23-31 the best week (18.7%). The peak catches occurred during the months having a high average water flow (and wide fluctuations) and water temperatures averaging 3.8°C to 3.4°C.

In addition to wild fish about 120 samples were examined from hatchery fish caught between 1955 and 1961. Hatchery fish generally had a saltwater age of .1+ (98.2%) and the sex ratio for females to males was 1.1:1.

It appeared that hatchery interbreeding with natural stock may have changed the dominant wild age class to .1+ during four seasons following hatchery introductions.

INTRODUCTION

The Chilliwack River begins in the Cascade Mountain Range in Washington, draining north into Chilliwack Lake (elevation 620 m.) The river drains west from the lake, flowing into the Fraser River (Fig. 1). The Chilliwack River drains an area of 484 square miles as described by Hartman (1968).

The Chilliwack River has always supported runs of all five Pacific salmon, chum pinks and coho predominate. Winter run steelhead also enter the Chilliwack system from November to April (of the following year). The river's close proximity to Greater Vancouver has made it the most heavily fished stream in the Lower Mainland. This demand, in addition to destructive flood control measures, logging and commercial interception have drastically reduced the steelhead stocks.

Funding through the Salmonid Enhancement Program has made it possible to begin projects intended to increase the Chilliwack's steelhead population. Obtaining baseline life history information of the stocks is an initial step and the subject of this report. Scale samples from almost 900 angler caught steelhead were examined to determine the age class structure, freshwater age, saltwater age and incidence of repeat spawning of the population. These samples, plus an additional 800 samples used in a previous study by Maher and Larkin (1954) were examined for sex ratio and timing of the run. The results of the study are presented in this report.

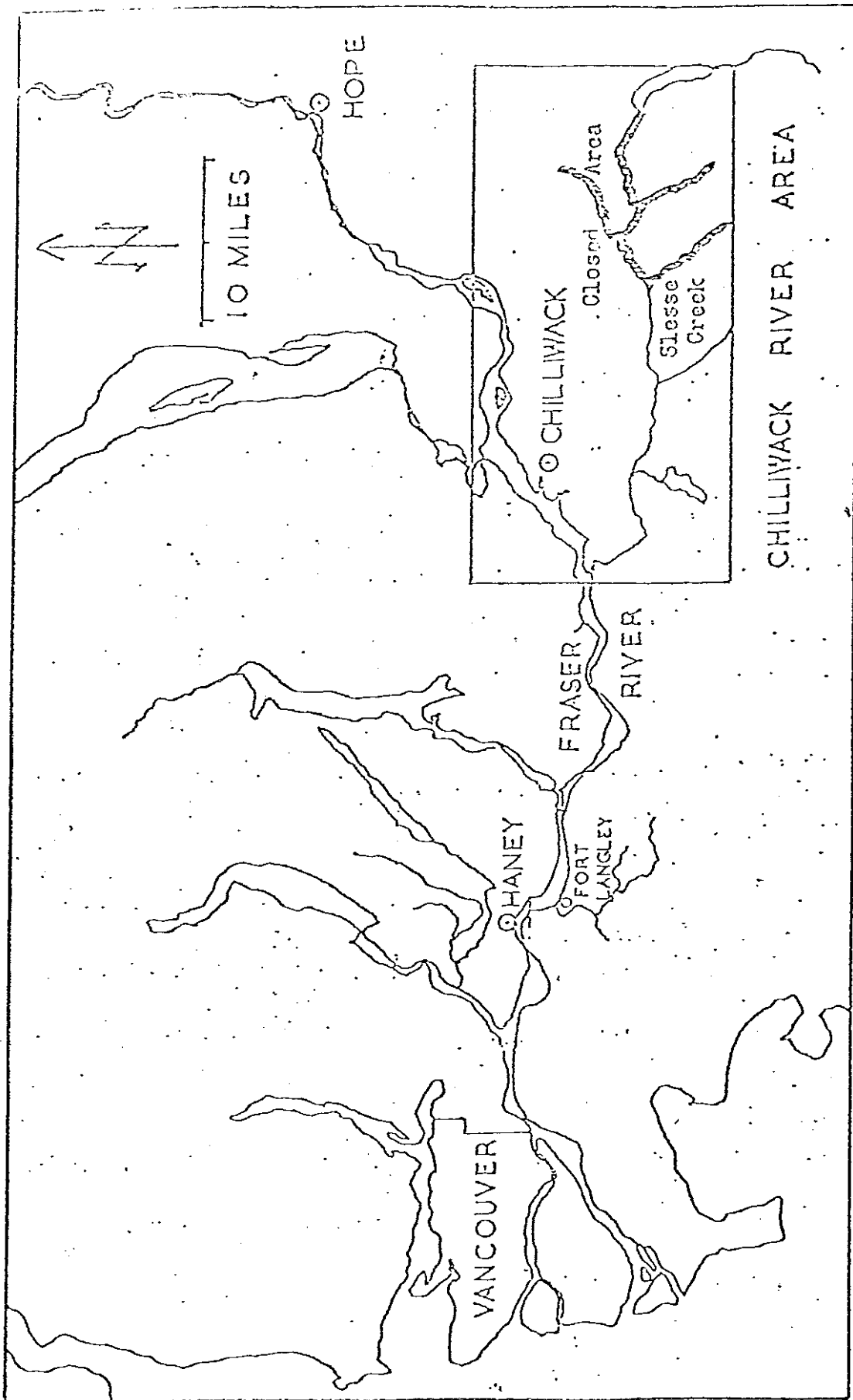


Fig. 1 Lower Fraser Valley Area in Southwestern British Columbia showing Vedder-Chilliwack River.

MATERIALS AND METHODS

The materials and methods in this report are virtually the same as those outlined by Caverly (1977) Reports I and II. A major difference is that none of the scale samples were photomicrographed.

The age designation for steelhead is the most widely accepted notation i.e. a fish aged 3.2+ has spent 3 winters in freshwater as a juvenile before smolting and going to sea. This steelhead then spent an additional 2 winters in the ocean before returning to the river at the start of the third ocean winter (+). The fish would be in it's sixth year. An S designation indicates a spawning check and is included as one winter. An H indicates hatchery origin.

Scales samples were collected from angler caught steelhead by Fish and Wildlife personnel and the anglers themselves from 1948 to 1975. All samples were pressed onto cellulose acetate for a permanent impression. Rough data is on scale sample record sheets. Two time periods were examined separately, then compared. These were roughly from 1948-1959 and 1960-1975.

RESULTS (1948 - 1959)

I. Age Class (1953-1959) (Table I) (Fig. 2) ^{→ 537 see table 1}

A total of (4)7 scales were read for both fresh and saltwater growth. The most common age class was 3.2+ (33.5%). Another frequent age for Chilliwack steelhead was 3.1+ (29.2%). Other age class that occurred frequently were 2.2+ (16.2%) and 2.1+ (14.7%). Sample size was (5)37.

Freshwater Age (Table II) (Fig. 3)

Samples from 557 fish were used for freshwater age determination. The most common age was 3. (64.3%) followed by 2. (25.3%). Age 2+ fish made up another 4.5% and 4. only 4.1%.

Saltwater Age (Table III) (Fig. 3)

For wild steelhead the most common saltwater age was .2+ (53.1%). Also very common was the age group .1+ (46.6%). During the season of 1953/54 and 1959/60 the number of .1+ fish exceeded the number of .2+ fish.

Saltwater Age 1955-1959 Hatchery Returns (Table III)

There were 111 hatchery steelhead scale samples from this 5 year period. By far the most common saltwater age was .1+ (98.2%). Only 2 fish (1.8%) were aged .2+.

Saltwater Age Groups - Early Run vs Late Run (1953-1959) (Table IV)

During the early steelhead run (Nov.-Dec.) age .1+ fish made up 41.3% of the total catch and .2+ made up 58.6%. The later run (Jan.-Apr.) had .1+ fish making up 50.8% and .2+ made up 49.2% of the total catch.

Repeat Spawning (Table V)

A total of 23 repeat spawners were found, making up 3.4% of the steelhead sampled. Of these 9 were males and 14 were females. The most common age was 3.1S+ (11 fish). Also common were ages 2.1S+ and 3.2S+. Hatchery fish were aged H.S+ and .H.1S+.

RESULTS - cont'd.

Sex Ratio - Yearly (1948-1957) (Table VI) (Fig. 4)

The overall sex ratio for wild winter run steelhead in the Chilliwack River was 1.5:1 favouring females over males. The range was 1:1 to 2.5:1. Sample size was 1120.

For hatchery steelhead the overall sex ratio was 0.7:1 favouring males. Sample size was 24.

Sex Ratio - Monthly (Table VII) (Fig. 5)

To determine differences in early and late run fish variation in sex ratio for wild fish was examined by month. The highest ratio of females to males occurred in April (3:1) and the lowest in January (1.3:1).

Timing of the Run - Monthly (Table VIII) (Fig. 6)

From a sample size of 1161 fish the highest monthly catch occurred in December with 469 steelhead (40.4%). January was also productive with 355 fish (30.6%) and February with 181 fish (15.6%). The December 26 steelhead derby may have biased the results.

Timing of the Run - Weekly (Table IX) (Fig. 7)

The six peak weeks of angler catch were from December 8 to January 22. This time period accounted for 70% of the total sample (1070 fish). The best week was December 23-31 with 218 fish (20.4%). This is also the week of the annual Vedder-Chilliwack steelhead derby on December 26.

Table I Age Class Structure of Winter Run Steelhead in the Vedder-Chilliwack River (1953-1959)

		Total Age Group								
Year	Sex	1.2+	2.1+	2.2+	3.+	3.1+	3.2+	4.1+	4.2+	Total
1953/54	M	-	4	3	1	5 _(3?)	5	1	-	42
	F	-	1	2	-	11	5	1	-	
	Total	-	5	5	1	19	10	2	-	
1954/55	M	-	11	4	-	8	12	-	1	91
	F	-	8	6	-	20	20	-	1	
	Total	-	19	10	-	28	32	-	2	
1955/56	M	1	2	4	1	10	3 _(2?)	1	-	57
	F	-	4	6	-	8	14	1	-	
	Total	1	6	10	1	18	19	2	-	
1956/57	M	-	8	4	-	8	14	1	-	83
	F	-	7	10	-	13	14	3	1	
	Total	-	15	14	-	21	28	4	1	
1957/58	M	-	9	8	-	18	14	1	-	111
	F	-	5	10	-	14	27	1	4	
	Total	-	14	18	-	32	41	2	4	
1958/59	M	-	10	13	-	11 _(1?)	15 _(1?)	1	-	114
	F	-	4	14	-	11	30	3	-	
	Total	-	14	27	-	23	46	4	-	
1959/60	M	-	2	-	-	6	1 _(1?)	-	-	39
	F	-	4	3	-	14	6	1	1	
	Total	-	6	3	-	20	8	1	1	
Total	M	1	46	36	2	66	64	5	1	221
	F	-	33	51	-	91	116	10	7	308
	Unknown	-	-	-	-	4	4	-	-	8
	Total	1	79	87	2	157	180	15	8	537
	%	0.2%	14.7%	16.2%	0.4%	29.2%	33.5%	2.8%	1.5%	

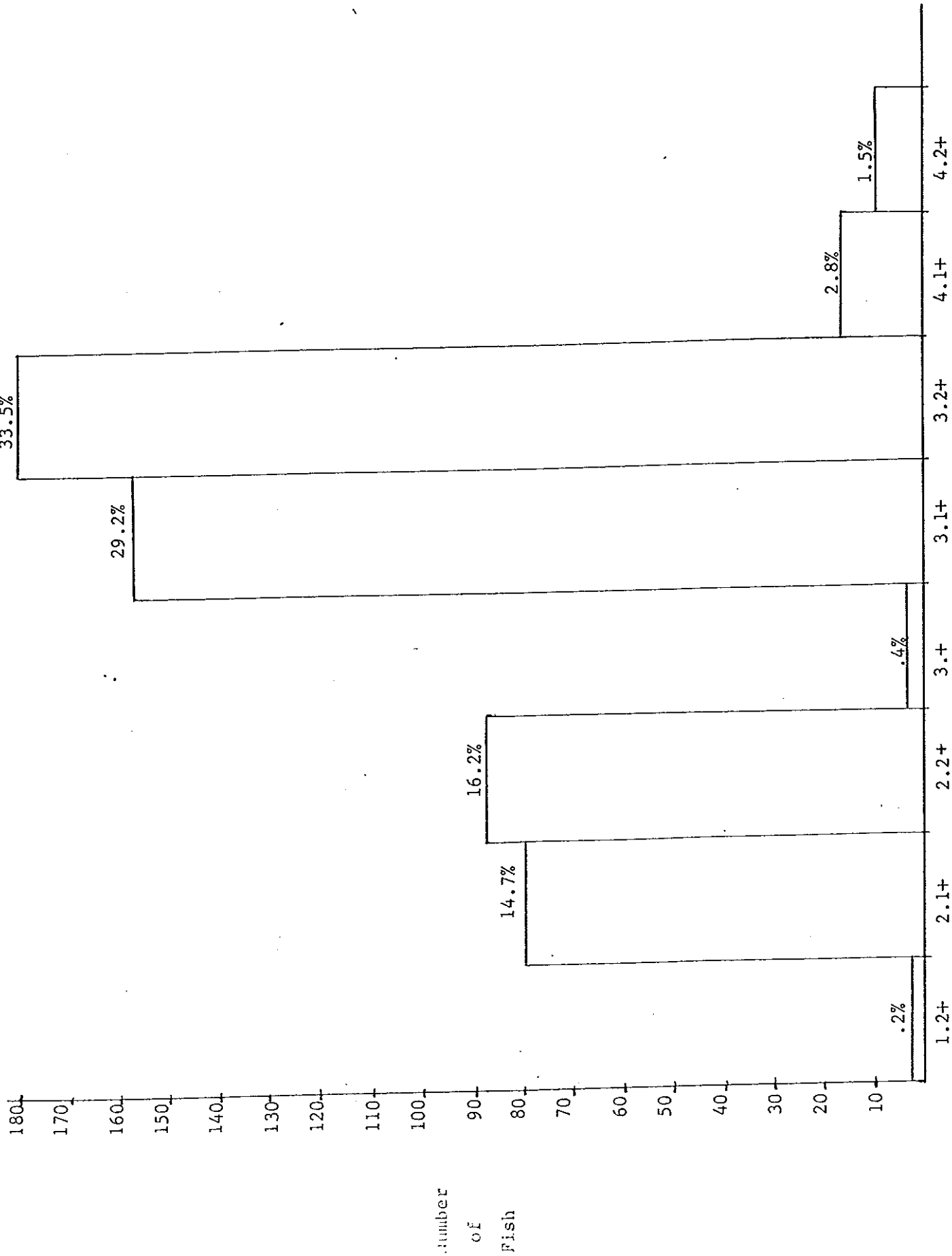


FIG. 2 AGE CLASS STRUCTURE OF WINTER RUN STEELHEAD IN THE VEDDER-CHILLIWACK RIVER (1953-1959)

TABLE II FRESHWATER AGES OF WINTER STEELHEAD (1953-1959)

Year	Freshwater Age						Total
	1.	2.	2+.	3.	3+.	4.	
1953/54	M	-	7	-	11	-	1
	F	-	3	-	15(3?)	1	1
	Total	-	10	-	26	1	2
1954/55	M	-	13	1	21	-	1
	F	-	14	2	46	-	1
	Total	-	27	3	67	-	2
1955/56	M	1	5	1	14	-	1
	F	-	7	3	23	1	1
	Total	1	12	4	39	1	2
1956/57	M	-	13	2	25	-	1
	F	-	12	3	26	1	4
	Total	-	25	5	51	1	5
1957/58	M	-	15	1	34	1	1
	F	-	13	3	39	2	5
	Total	-	28	4	73	3	6
1958/59	M	-	19	3	26(??)	1	-
	F	-	14	4	43	2	4
	Total	-	33	7	71	3	4
1959/60	M	-	2	-	7(1?)	-	-
	F	-	4	2	20	-	2
	Total	-	6	2	28	-	2
TOTAL	M	1	74	8	138	2	5
	F	-	67	17	212	7	18
	Unknown	-	-	-	8	-	-
TOTAL %		1	141	25	358	9	23
		0.2%	25.3%	4.5%	64.3%	1.6%	4.1%

Table III Saltwater Ages of Winter Steelhead (1953-1959)

(*) Hatchery Origin

Year	Sex	Saltwater Age			Total
		.+	.1+	.2+	
1953/54	M	1	10	8	19
	F	-	14	8	22
	Total	1	24	16	41
1954/55	M	-	20	18	38
	F	-	29	31	60
	Total	-	49	49	98
1955/56	M	1	15	8	24
	F	-	15(2*)	20	35(2*)
	Total	1	30(2*)	28	59(2*)
1956/57	M	-	16(11*)	24	40(11*)
	F	-	25(7*)	29	52(7*)
	Total	-	41(18*)	53	92(18*)
1957/58	M	-	27(17*)	24	51(17*)
	F	-	25(9*)	43(1*)	68(10*)
	Total	-	52(26*)	67 (1*)	119(27*)
1958/59	M	-	22(24*)	28	50(24*)
	F	-	18(39*)	43(1*)	61(40*)
	Total	-	40(63*)	71(1*)	111(64*)
1959/60	M	-	7	2	9
	F	-	19	10	29
	Total	-	26	12	38
Total Wild	M	2	117	112	231
	F	-	143	184	327
	Total	2	260	296	558
	%	.4%	46.6%	53.1%	
*Hatchery Fish	M	-	52	-	52
	F	-	57	2	59
	Total	-	109	2	111
	%	-	98.2%	1.8%	
Total Hatchery and Wild	Total	2	369	298	669
	%	0.3%	55.2%	44.5%	

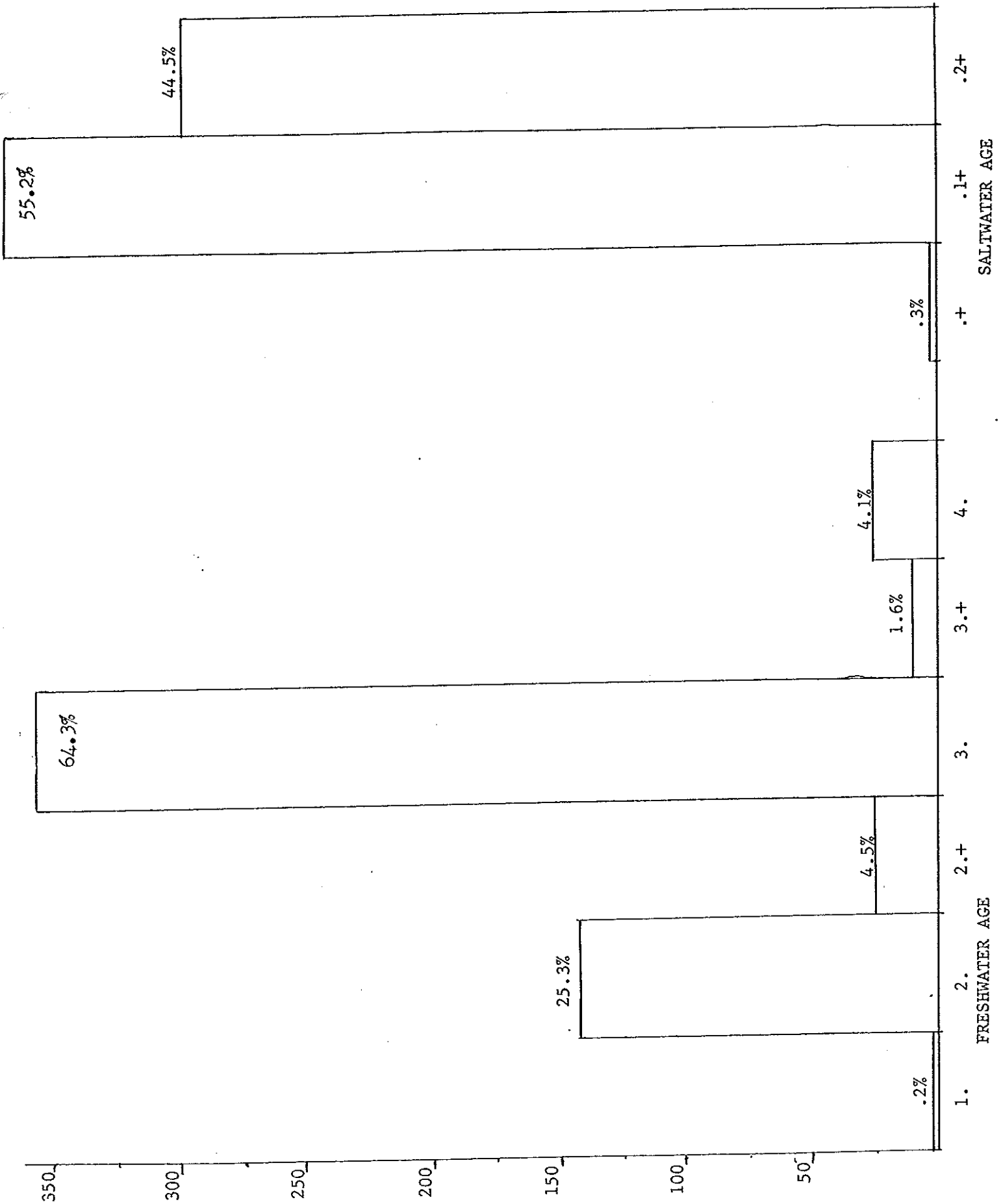


Fig. 3 FRESHWATER AND SALTWATER AGES OF WINTER STEELHEAD (1953-1959)

Table IV. Comparison of Saltwater Age Groups Between Early Run and Late Run Steelhead (1953-59)

Saltwater Age						
Year	.1+			.2+		Total
	Nov-Dec	Jan-Apr	Total	Nov-Dec	Jan-Apr	
1953/54	7	17	24	5	10	15
1954/55	6	43	49	19	30	49
1955/56	6	24	30	5	23	28
1956/57	20	19	39	29	24	53
1957/58	8	44	62	9	58	67
1958/59	23	17	40	57	14	71
1959/60	26	-	26	12	-	12
Total	96	164	270	136	159	295
% of Total	35.6%	60.7%		46.1%	53.9%	

Saltwater Age						
Year	Nov.-Dec.			Jan.-Apr.		Total
	.1+	.2+	Total	.1+	.2+	
53/54	7	5	12	17	10	27
54/55	6	19	25	43	30	73
55/56	6	5	11	24	23	47
56/57	20	29	49	19	24	43
57/58	8	9	17	44	58	102
58/59	23	57	80	17	14	31
59/60	26	12	38	-	-	-
Total	96	136	232	164	159	323
% of Total	41.3%	58.6%		50.8%	49.2%	

TABLE V AGE CLASS OF REPEAT SPAWNING WINTER RUN STEELHEAD (1953-1959)

Year	Sex	Age Class								Total
		2.1S+	3.1S+	3+.1S+	3.2S+	4.S+	4.2S+	H.S+*	H.1S+*	
1954/55	M	-	1	-	-	-	-	-	-	
	F	1	3	-	1	-	-	-	-	
	Total	1	4	-	1	-	-	-	-	
1955/56	M	-	-	-	-	-	-	-	-	
	F	1	1	1	-	-	-	-	-	
	Total	1	1	1	-	-	-	-	-	
1956/57	M	1	2	-	-	1	-	1	-	
	F	-	-	-	-	-	-	-	-	
	Total	1	2	-	-	1	-	1	-	
1957/58	M	-	1	-	-	-	-	-	-	
	F	-	1	-	-	-	-	-	-	
	Total	-	2	-	-	-	-	-	-	
1958/59	M	-	-	-	1	-	-	-	-	
	F	-	2	-	1	-	1	-	1	
	Total	-	2	-	2	-	1	-	1	
1959/60	M	-	-	-	-	-	-	-	-	
	F	-	-	-	-	-	-	-	1	
	Total	-	-	-	-	-	-	-	1	
TOTAL	M	2	4	-	1	1	-	1	-	8(1*)
	F	1	7	1	2	-	1	-	2	12(2*)
	Total Wild	3	11	1	3	1	1	-	-	20
	Total	3	11	1	3	1	1	1	2	23

Repeat spawners made up 3.4% of the 1953-1959 wild fish sample and 2.6% of the hatchery fish sample.

* Hatchery origin

Table VI Yearly Sex Ratio of Winter Run Steelhead Caught by Anglers (1948-1957)

Year	Sex		Female:Male Ratio
	Male	Female	
1948	6	14	2.3:1
1949	58	77	1.3:1
1950	10	25	2.5:1
1951	57	83	1.5:1
1952	148	232	1.6:1
1953	38	62	1.6:1
1954	27	28	1:1
1955	32	58	1.8:1
1956W	45	57	1.3:1
*1956H	4	4	1:1
1957W	28	35	1.3:1
*1957H	10	6	0.6:1
Total Wild	449	671	1.5:1
Total Hatchery	14	10	0.7:1
Total	463	681	1.5:1

* Hatchery Returns

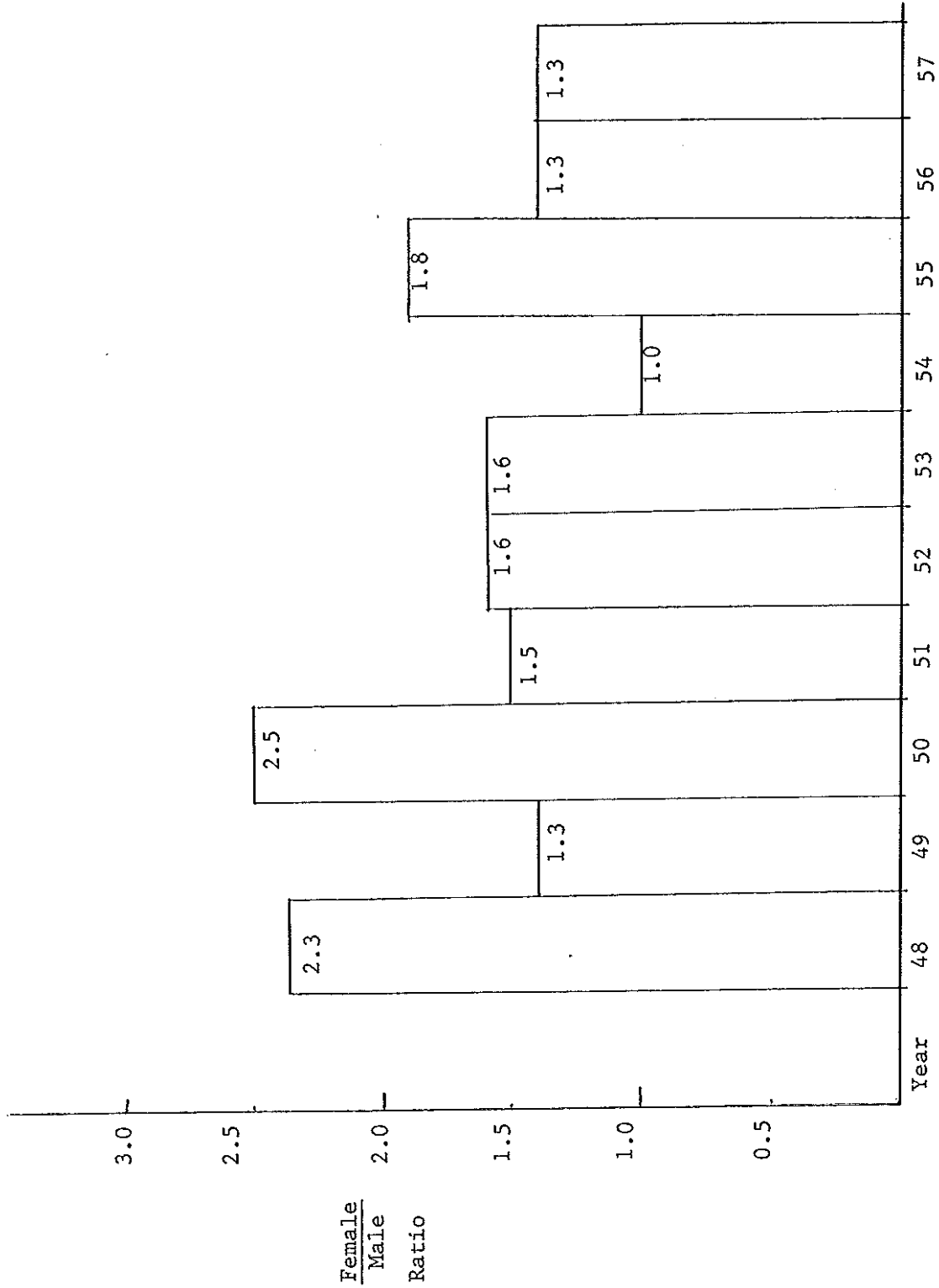
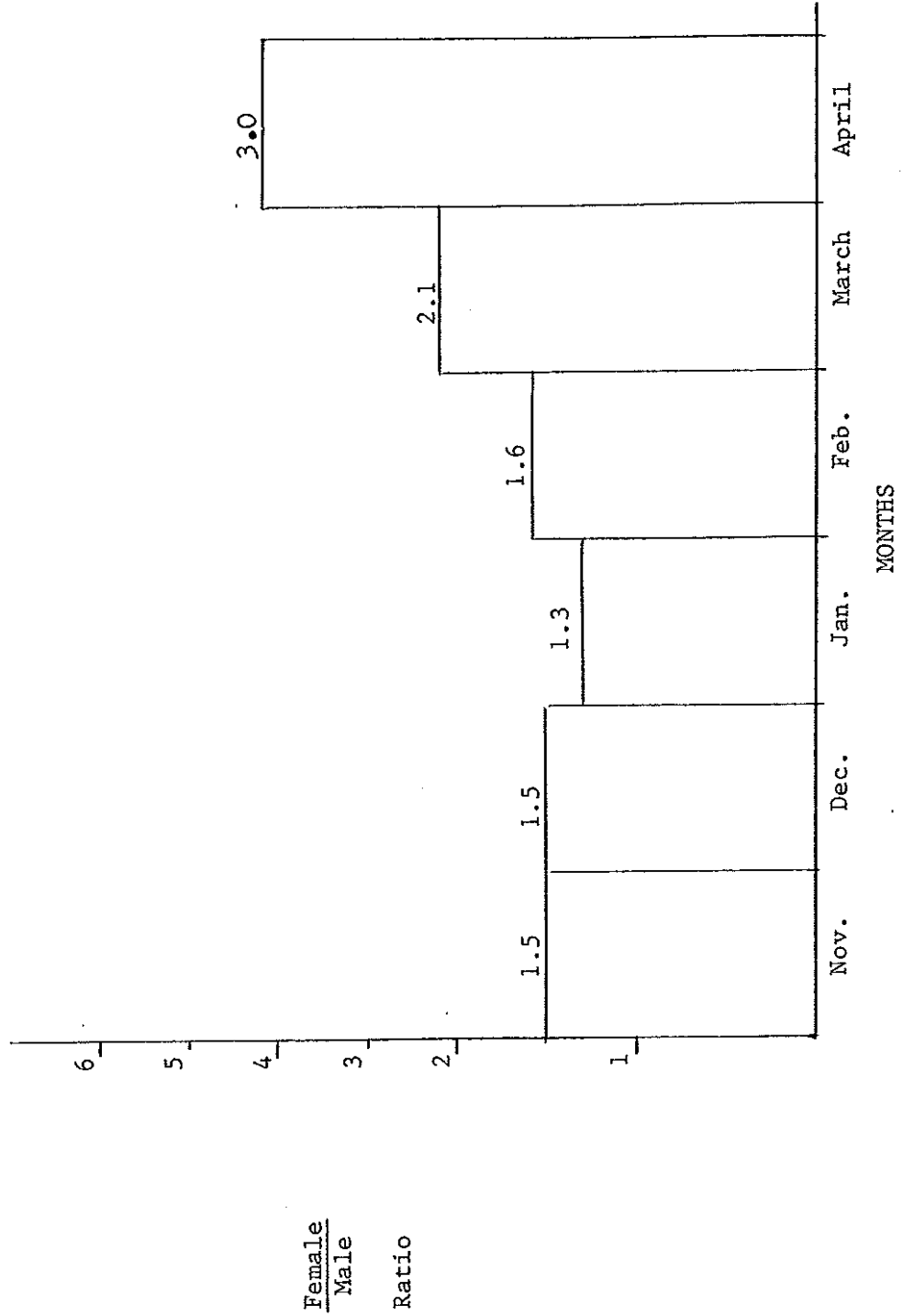


FIG. 4 YEARLY VARIATION OF SEX RATIO FOR CHILLIWACK STEELHEAD
(WILD FISH ONLY - 1948-1957)

Years	Nov.			Dec.			Jan.			Feb.			Mar.			Apr.		
	M	F	F:M Ratio	M	F	F:M Ratio	M	F	F:M Ratio	M	F	F:M Ratio	M	F	F:M Ratio	M	F	F:M Ratio
1948	-	-	-	6	14	2.3:1	-	-	-	-	-	-	-	-	-	-	-	-
1949	-	-	-	21	18	0.9:1	12	24	2:1	22	33	1.5:1	2	2	1:1	1	0	-
1950	1	-	-	-	2	-	4	9	2.3:1	3	5	1.7:1	2	8	4:1	-	-	-
1951	-	-	-	13	27	2.1:1	33	39	1.2:1	3	4	1.3:1	6	7	1.2:1	1	4	4:1
1952	-	2	-	94	149	1.6:1	38	45	1.2:1	9	16	1.8:1	6	15	2.5:1	1	4	4:1
1953	-	-	-	5	9	1.8:1	19	25	1.3:1	10	16	1.6:1	4	9	2.6:1	-	3	-
1954	-	1	-	12	15	1.3:1	7	7	1:1	4	4	1:1	3	1	0.3:1	1	-	-
1955	-	-	-	5	6	1.2:1	14	15	1.1:1	9	18	2:1	4	15	3.8:1	-	4	-
1956	3	3	1:1	23	23	1:1	9	11	1.2:1	4	11	2.8:1	4	4	1:1	2	5	2.5:1
1957	-	-	-	9	9	1:1	11	15	1.4:1	5	2	2.5:1	2	7	3.5:1	1	2	2:1
TOTAL	4	6	1.5:1	188	272	1.5:1	147	190	1.3:1	69	109	1.6:1	33	68	2.1:1	7	21	3:1

TABLE VII SEX RATIO BY MONTH OF WILD WINTER STEELHEAD CAUGHT
BY ANGLERS IN THE CHILLIWACK RIVER (1948-1957)

FIG. 5 AVERAGE MONTHLY SEX RATIO WINTER STEELHEAD CAUGHT BY ANGLERS
(1948-1957) - includes hatchery fish



Months

Years	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.*	Total
1948	-	-	-	-	-	-	-	-	-	-	-	20	20
1949	36	55	5	-	-	-	-	-	-	-	-	39	135
1950	13	8	10	-	1	-	1	-	-	1	1	2	37
1951	72	7	13	5	3	1	-	-	-	-	-	41	142
1952	85	25	22	5	-	-	-	-	1	-	2	243	383
1953	43	26	13	3	-	-	-	-	-	-	-	17	104
1954	14	8	4	1	1	-	-	-	-	-	1	27	56
1955	29	28	19	4	-	-	-	-	-	-	-	11	91
1956	23	15	10	8	-	-	-	-	-	-	6	51	113
1957	38	9	11	4	-	-	-	-	-	-	-	18	80
Total	355	181	107	30	5	1	1	0	1	1	10	469	1161
%	30.6%	15.6%	9.2%	2.6%	0.4%	0.1%	0.1%	0	0.1%	0.1%	0.9%	40.4%	

Table VIII. Timing of the run - based on angler catch per month (1948-1957)

* A bias may have been introduced in December by the Steelhead Derby on the 26th.

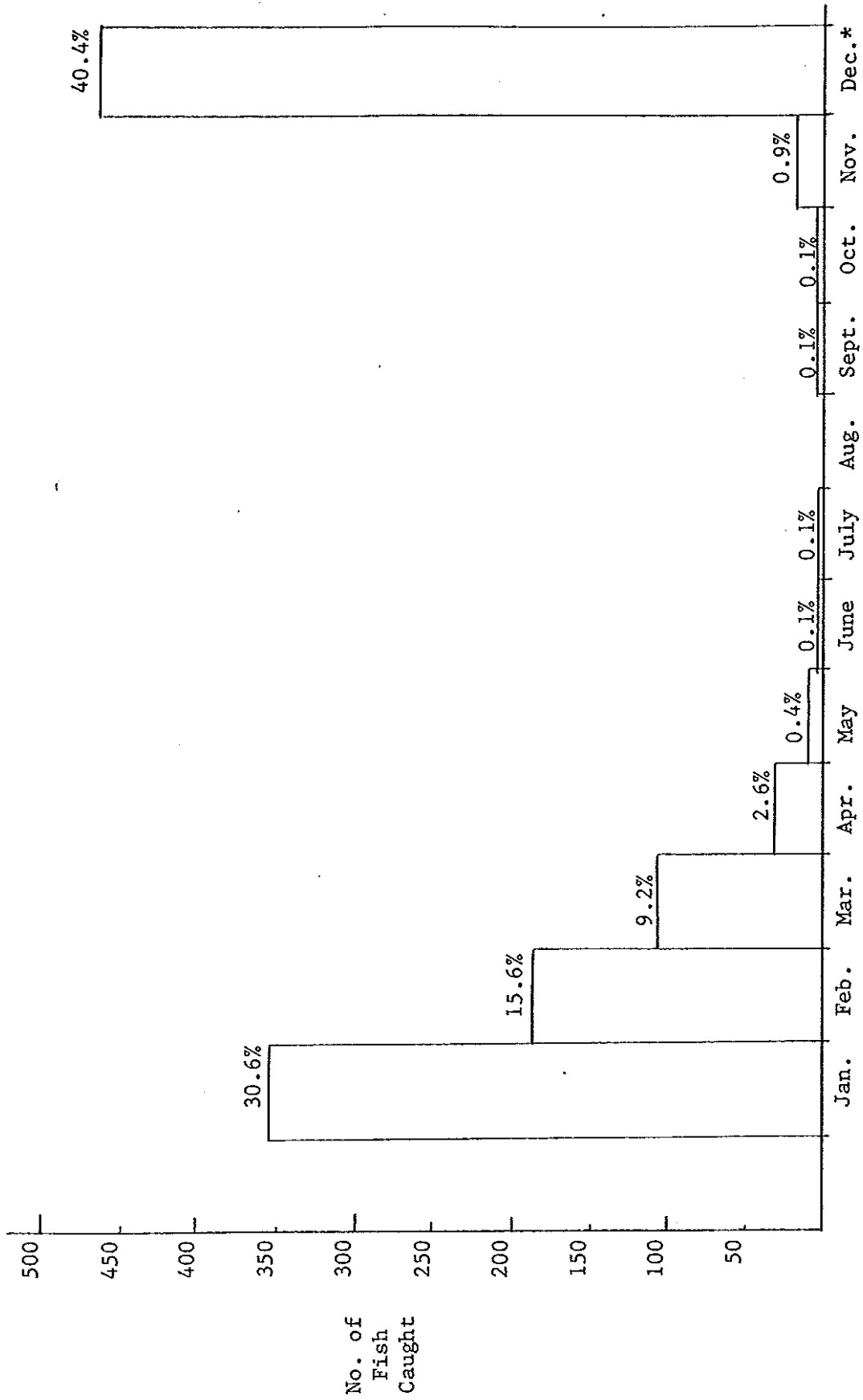


FIG. 6 TIMING OF THE RUN - BASED ON ANGLER CATCH PER MONTH (1948-1957)

* Dec. 26 Derby may bias results.

Years	January			February			March			December			Total
	1-7	8-14	15-22	23-31	1-7	8-14	15-22	23-31	1-7	8-14	15-22	23-31*	
1948	-	-	-	-	-	-	-	-	1	14	5	-	20
1949	5	8	14	9	21	20	10	4	-	6	5	28	132
1950	8	3	2	-	6	-	2	-	4	-	-	2	27
1951	25	10	25	12	5	-	1	1	7	4	9	28	131
1952	8	44	23	10	4	5	14	2	8	7	71	68	368
1953	39	1	3	2	2	4	11	6	3	5	3	14	93
1954	-	3	9	2	1	3	1	3	2	1	12	6	52
1955	7	8	2	12	7	6	9	6	10	2	1	9	80
1956	6	10	3	4	5	1	4	5	1	4	3	47	94
1957	17	7	8	6	3	4	2	-	8	-	1	16	73
Total	115	94	89	57	54	43	54	27	45	23	110	218	1070
%	10.7%	8.8%	8.3%	5.3%	5.0%	4.0%	5.0%	2.5%	4.2%	2.1%	10.3%	20.4%	

Table IX. Timing of the Run - Based on Angler Catch per Week (1948-1957)

* A bias may have been introduced by the Dec. 26 Steelhead Derby

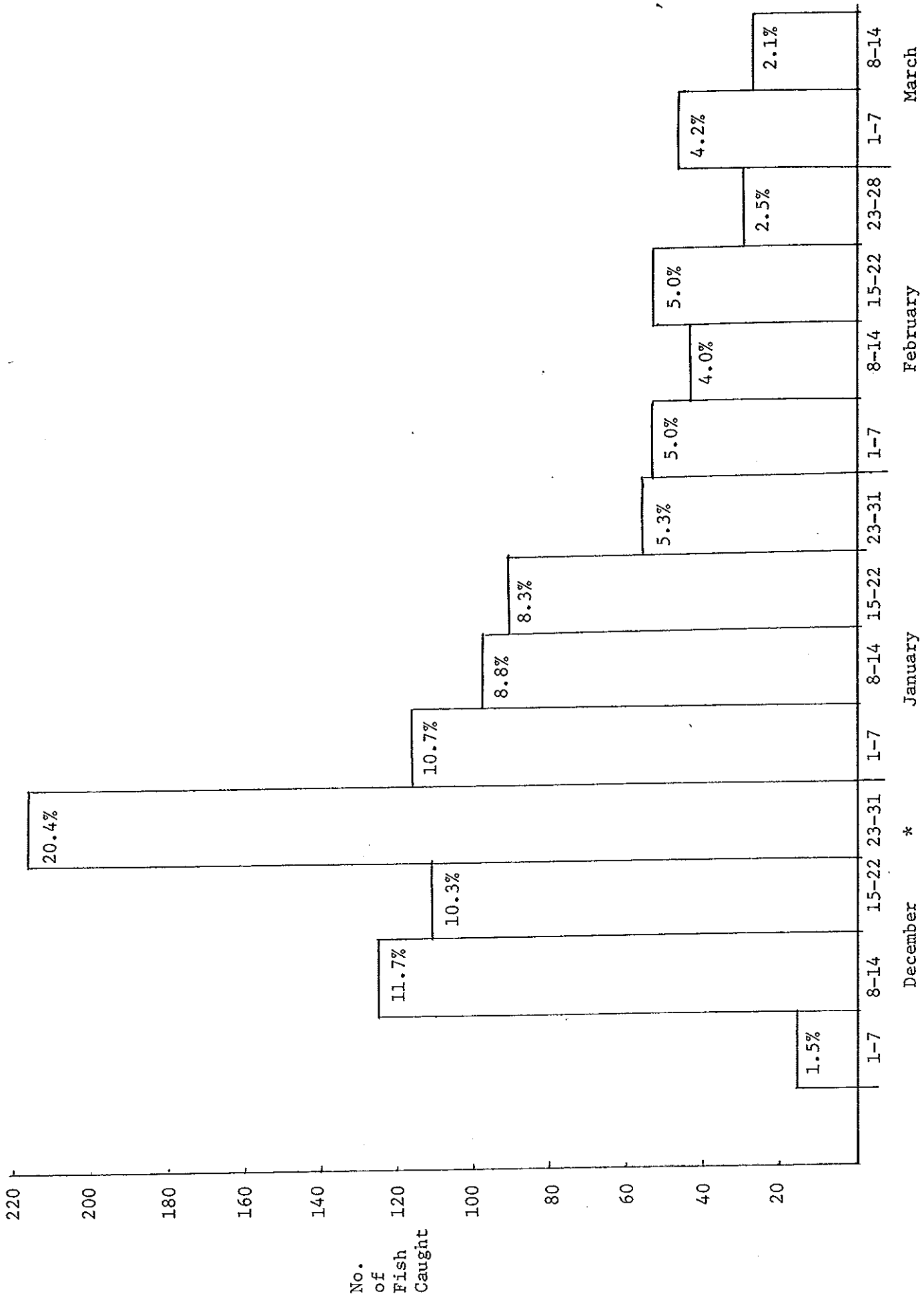


Fig. 7 Timing of the run - based on angler catch per week (1948-1957)

* A bias may be introduced by the Dec. 26 derby.

RESULTS (1958-1975)

Age Class 1960-1975 (Table X) (Fig. 8)

A total of 257 scale samples were readable for this time period. The most common age class was again 3.2+ (45.1%) followed by 3.1+ (24.5%). Other common age groups were once again 2.2+ (14.4%) and 2.1+ (7%).

Freshwater Age (Table XI) (Fig. 9)

A total of 271 samples were used for this time period. The most common freshwater age was 3. (67.5%) followed by 2. (20.7%). The age group 4. made up only 7.4%.

Saltwater Age (Table XII) (Fig. 9)

A total of 269 samples were examined from this time period. The most common saltwater age was .2+ (70.5%) followed by .1+ (38.6%). During the seasons of 1960/61 and 1961/62 the number of .1+ exceeded the number of .2+ fish.

Saltwater Age - Early Run vs Late Run (Table XIII)

During the early run (Nov.-Dec.) age .1+ fish made up 35.3% of the total catch and .2+ made up 65.3%. The late run fish (Jan.-Apr.) in the .1+ group made up 45.2% and the .2+ made up 56.3% of the total catch.

Repeat Spawning (Table XIV)

A total of 14 repeat spawners, making up 4.4% of the total winter run sample, were found in this time period. Of these 13 were females and one a male. The most common ages were 3.1S+, 2.1S+, and 3.2S+.

Sex Ratio - Yearly (1958-1975) (Table XV) (Fig. 10)

The overall sex ratio for winter run steelhead from this time period was 1.5:1 favouring females. The range was 1:1 to 2.8:1. Sample size was 565. For 97 hatchery fish the ratio was 1.3:1 favouring females.

RESULTS - cont'd.

Sex Ratio - Monthly (Table XVI) (Fig. 11)

The average monthly ratio of females to males varied from a high of 1.7:1 in December to a low of 0.2:1 in April. January's sex ratio, based on a larger sample size than April, was 1:1.

Timing of the Run - Monthly (Table XVII) (Fig. 12)

From a sample of 683 steelhead the highest monthly catch again occurred in December with 296 fish (43.4%). January followed with 142 fish (20.8%). The December 26 derby may have introduced a bias to the catch in that month.

Timing of the Run - Weekly (Table XVIII) (Fig. 13)

The three peak weeks for angler catch of steelhead were December 8-31. These weeks accounted for 44.4% of the total catch (610 fish). The rest of the catch was evenly spread throughout the season. The best week was Dec. 23-31 with 18.7% (114 fish) but this may be biased by the December 26 derby.

TABLE X. AGE CLASS STRUCTURE OF WINTER RUN STEELHEAD
IN THE VEDDER-CHILLIWACK RIVER (1960-1975).

		AGE CLASS								
YEAR	SEX	1.2+	2.1+	2.2+	2.3+	3.1+	3.2+	4.1+	4.2+	TOTAL
1960/61	M	-	2	1	-	3	3	1	-	
	F	1	3	4 ^(1?)	-	10	3 ^(1?)	1	1	
	TOTAL	1	5	6	-	13	6	2	1	35
1961/62	M	-	3	2	-	2	2	-	-	
	F	-	1	-	-	12	2	4	-	
	TOTAL	-	4	2	-	14	4	4	-	28
1962/63	M	-	1	-	-	1	1	-	-	
	F	-	-	2	-	1	8	-	-	
	TOTAL	-	1	2	-	2	0	-	-	14
1968/69	M	-	4	2	1	9	16	-	3	
	F	-	2	7	-	6	38	1	3	
	TOTAL	-	6	9	1	15	54	1	6	92
1969/70	M	-	-	3	-	1	1	-	-	
	F	-	-	1	-	2	-	-	-	
	TOTAL	-	-	4	-	3	1	-	-	8
1972/73	M	-	-	5	-	4	11	-	-	
	F	-	1	5	-	1	18	2	3	
	TOTAL	-	1	10	-	5	29	2	3	50
1973/74	M	-	-	-	-	5	2	-	-	
	F	-	-	-	-	5	-	-	1	
	TOTAL	-	-	-	-	10	2	-	1	8
1974/75	M	-	-	1	-	2	5	-	-	
	F	-	- ^(1?)	3	-	4	5	1	-	
	TOTAL	-	1	4	-	6	10	1	-	22
	M	-	10	14	1	27	41	1	3	
	F	1	7	22	-	36	74	9	8	
	UNKNOWN	-	1	1	-	-	1	-	-	
	TOTAL	1	18	37	1	63	116	10	11	257
	%	0.4%	7%	14.4%	0.4%	24.5%	45.1%	4%	4.3%	

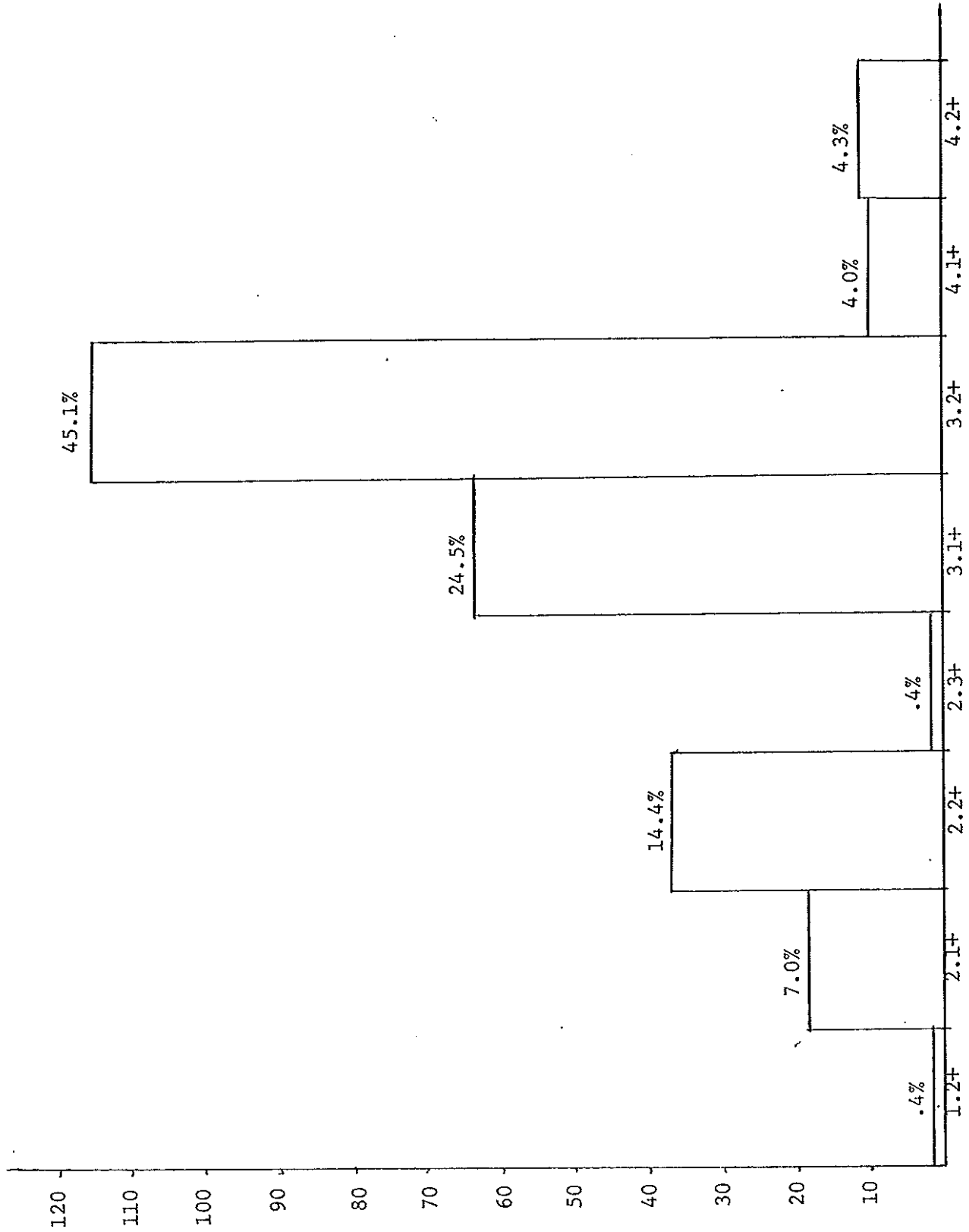


Fig. 8 Age class structure of winter run steelhead in the Vedder-Chilliwack River (1960-1975)

TABLE XI. FRESHWATER AGE GROUPS OF WINTER

STEELHEAD (1960 - 1975)

YEAR	SEX	1.	2.	2+	3.	3+	4.	TOTAL
1960/61	M	-	4	-	6	1	1	
	F	1	8	-	15	-	2	
	TOTAL	1	14	-	22	1	3	41
1961/62	M	-	5	-	5	-	-	
	F	-	-	1	15	1	4	
	TOTAL	-	5	1	20	1	4	31
1962/63	M	-	1	-	2	-	-	
	F	-	1	1	9	-	-	
	TOTAL	-	2	1	11	-	-	14
1968/69	M	-	6	1	23	1	2	
	F	-	9	1	45	1	4	
	TOTAL	-	15	2	68	2	6	93
1969/70	M	-	3	1	1	-	-	
	F	-	1	-	2	-	-	
	TOTAL	-	4	1	3	-	-	8
1972/73	M	-	5	-	14	1	-	
	F	-	6	-	22	-	5	
	TOTAL	-	11	-	36	1	5	33
1973/74	M	-	-	-	7	-	-	
	F	-	-	-	-	-	1	
	TOTAL	-	-	-	7	-	1	8
1974/75	M	-	1 (1?)	-	6 (1?)	1	-	
	F	-	3	-	9	-	1	
	TOTAL	-	5	-	16	1	1	23
TOTAL	M	-	25	2	64	4	3	98
	F	1	28	3	117	2	17	168
	UNKNOWN	-	3	-	2	-	-	5
	TOTAL	1	56	5	183	6	20	271
	%		0.4%	20.7%	1.9%	67.5%	2.2%	7.4%

Table XII. Saltwater age groups of winter run steelhead (1960-1975)

(*) Hatchery Origin

Year	Sex	.1+	.2+	.3+	Total
1960/61	M	6	5 ^(2?)	-	36(1*)
	F	14(1*)	9	-	
	Total	20(1*)	16	-	
1961/62	M	7	6	-	33
	F	17	3	-	
	Total	24	9	-	
1962/63	M	2	1	-	15
	F	1	11	-	
	Total	3	12	-	
1968/69	M	14	22	1	102
	F	12	53	-	
	Total	26	75	1	
1969/70	M	1 ^(1?)	3	-	8
	F	2	1	-	
	Total	4	4	-	
1972/73	M	4	19	1	57
	F	4	29	-	
	Total	8	48	1	
1973/74	M	5	3	-	9
	F	-	1	-	
	Total	5	4	-	
1974/75	M	2 ^(1?)	7 ^(1?)	-	25
	F	5	9	-	
	Total	8	17	-	
Total	M	41	66	2	285
	F	67 (1*) ⁵⁵	116	-	
	Unknown	2	3	-	
	Total	110 98	201 185	2	
	%	38.6% 34.4%	70.5% 64.9%	0.7%	

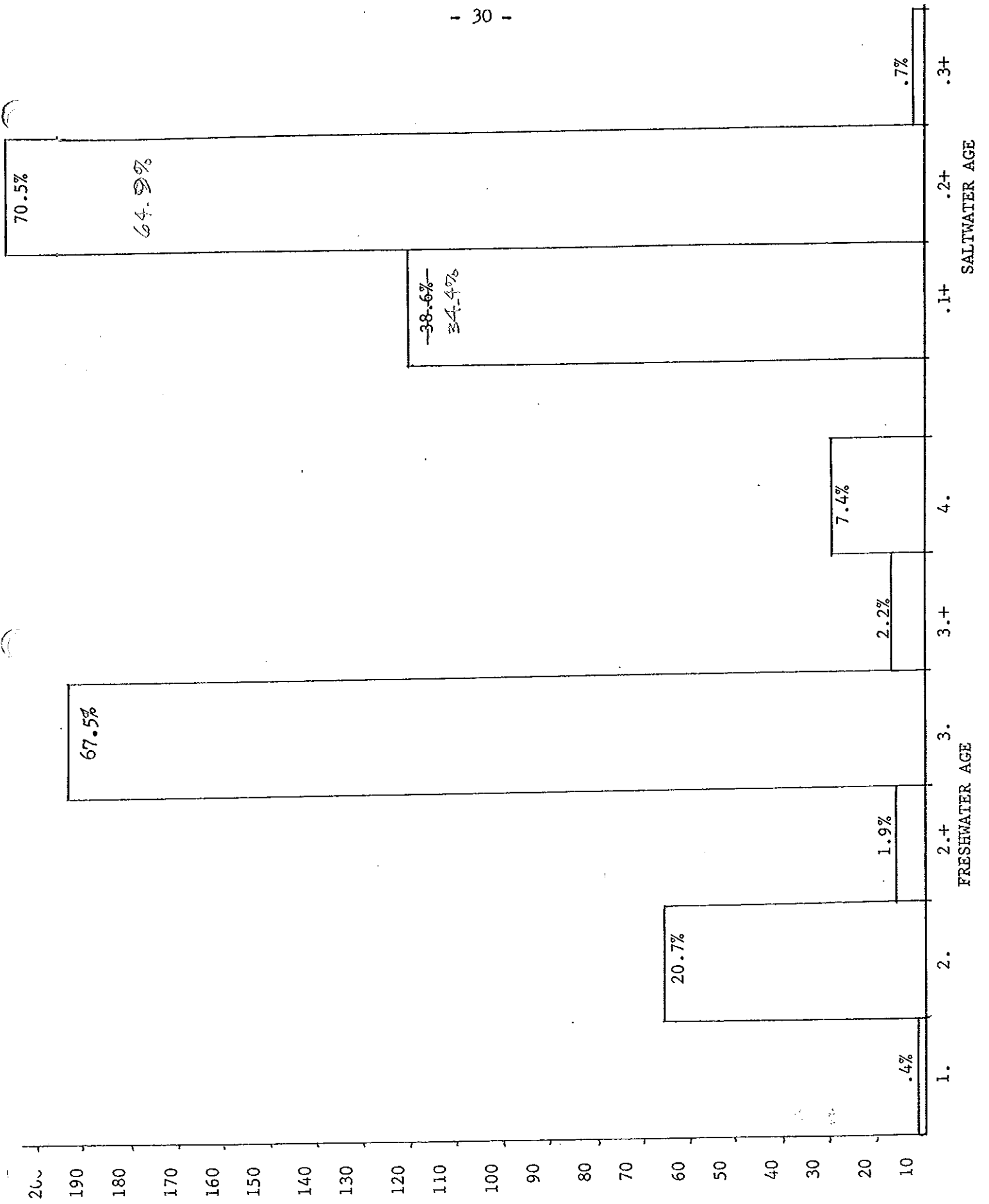


Fig. 9 FRESHWATER AND SALTWATER AGES OF WINTER STEELHEAD (1960-1975)

Table XIII. COMPARISON OF SALTWATER AGE GROUPS BETWEEN EARLY AND LATE RUN STEELHEAD (1960-1975)

Saltwater Age						
Year	.1+			.2+		
	Nov.-Dec.	Jan.-Apr.	Total	Nov.-Dec.	Jan.-Apr.	Total
1960/61	-	24	24	1	8	9
1961/62	26	1	27	15	-	15
1962/63	3	-	3	13	-	13
1968/69	26	1	27	76	-	76
1969/70	-	3	3	1	3	4
1972/73	-	8	8	-	48	48
1973/74	4	1	5	3	1	4
1974/75	-	8	8	-	16	16
TOTAL	59	46	132	109	76	185
% of Total	44.7%	34.9%		58.9%	41.1%	

Saltwater Age						
Year	Nov.-Dec.			Jan.-Apr.		
	.1+	.2+	Total	.1+	.2+	Total
60/61	-	1	1	24	8	32
61/62	26	15	41	15	-	15
62/63	3	13	16	-	-	-
68/69	26	76	102	1	-	-
69/70	-	1	1	3	3	6
72/73	-	-	-	8	48	56
73/74	4	3	7	1	1	2
74/75	-	-	-	8	16	24
Total	59	109	167	61	76	135
% of Total	35.3%	65.2%		45.2%	55.3%	

Table XIV. Age Class of Repeat Spawning Winter Steelhead (1960-1975)

		Age Class					
Year	Sex	2.1S+	2.2S+	3.1S+	3.2S+	R.1S+	Total
1960/61	M	-	-	-	-	-	
	F	(1?)	-	2	-	1	
	Total	1	-	2	-	1	4
1961/62	M	-	-	-	-	-	
	F	-	-	1	-	-	
	Total	-	-	1	-	-	1
1968/69	M	-	-	-	-	-	
	F	1	1	1	1	-	
	Total	1	1	1	1	-	4
1972/73	M	-	-	-	-	-	
	F	-	-	1	2	-	
	Total	-	-	1	2	-	3
1974/75	M	-	-	(1?)	-	-	
	F	-	-	-	-	-	
	Total	-	-	1	-	-	1
Total	M	1	-	-	-	-	1
	F	1	1	5	3	1	11
	Unknown	1	-	1	-	-	2
	Total	3	1	6	3	1	14

Repeat Spawners Made Up 4.4% of the Total No. of Sample Examined from 1960-1975 (318)

TABLE XV. YEARLY SEX RATIO OF WINTER RUN STEELHEAD CAUGH BY ANGLERS (1958-1975)

Year	Sex		Male:Female Ratio
	Male	Female	
1958	83	108	1.3:1
*1958 H	23	17	1.4:1
1959	25	44	1.8:1
*1959 H	19	34	1.8:1
1961	28	47	1.7:1
*1961 H	1	1	1:1
1962	5	14	2.8:1
1964	-	2	-
1968	40	69	1.7:1
*1968 H	-	1	
1969	1	1	1:1
1970	4	3	1.3:1
1971	-	2	-
1973	30	37	1.2:1
1975	9	14	1.6:1
Total Wild	225	340	1.5:1
Total Hatchery	43	54	1.3:1
TOTAL	268	394	1.5:1

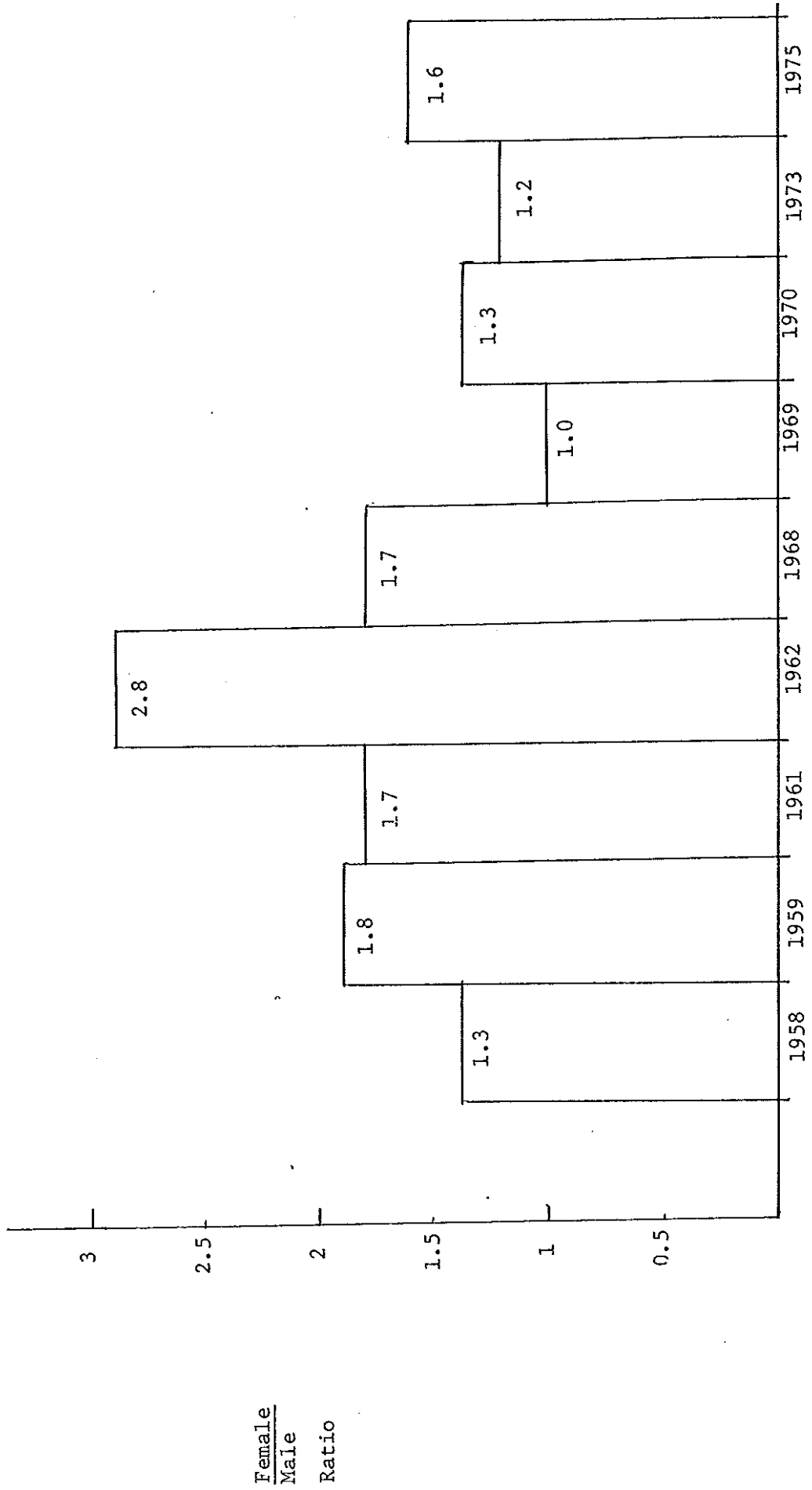


Fig. 10 Yearly Variation in Sex Ratio of Vedder-Chilliwack Steelhead (1958-1975)

Years	Nov.			Dec.			Jan.			Feb.			March			Apr.		
	M	F	F:M Ratio	M	F	F:M Ratio	M	F	F:M Ratio	M	F	F:M Ratio	M	F	F:M Ratio	M	F	F:M Ratio
1958	2	1	0.5:1	32	48	1.5:1				15	22	1.5:1	10	16	1.6:1	-	5	-
1959	-	-	-	9	29	3.2:1	11	9	0.8:1	2	2	1:1	3	4	1.3:1	-	-	-
1961	-	-	-	13	20	1.5:1	7	8	1.1:1	8	10	1.3:1	5	10	2:1	-	-	-
1962	-	-	-	5	12	2.4:1	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-
1968	3	6	2:1	35	62	1.8:1	2	1	0.5:1	-	-	-	-	-	-	-	-	-
1969	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-
1970	-	-	-	-	-	-	-	-	-	-	-	-	3	3	1:1	1	1	1
1971	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
1973	-	-	-	6	1	0.2:1	7	8	1.1:1	9	17	1.9:1	8	11	1.4:1	-	-	-
1975	-	1	-	-	1	-	6	8	1.3:1	3	4	1.3:1	-	-	-	-	-	-
Total	5	8	1.6:1	101	174	1.7:1	33	34	1:1	37	57	1.5:1	29	44	1.5:1	1	6	0.2:1

Table XVI Sex Ratio by Month of Wild Winter Steelhead Caught by Anglers (1958-1975)

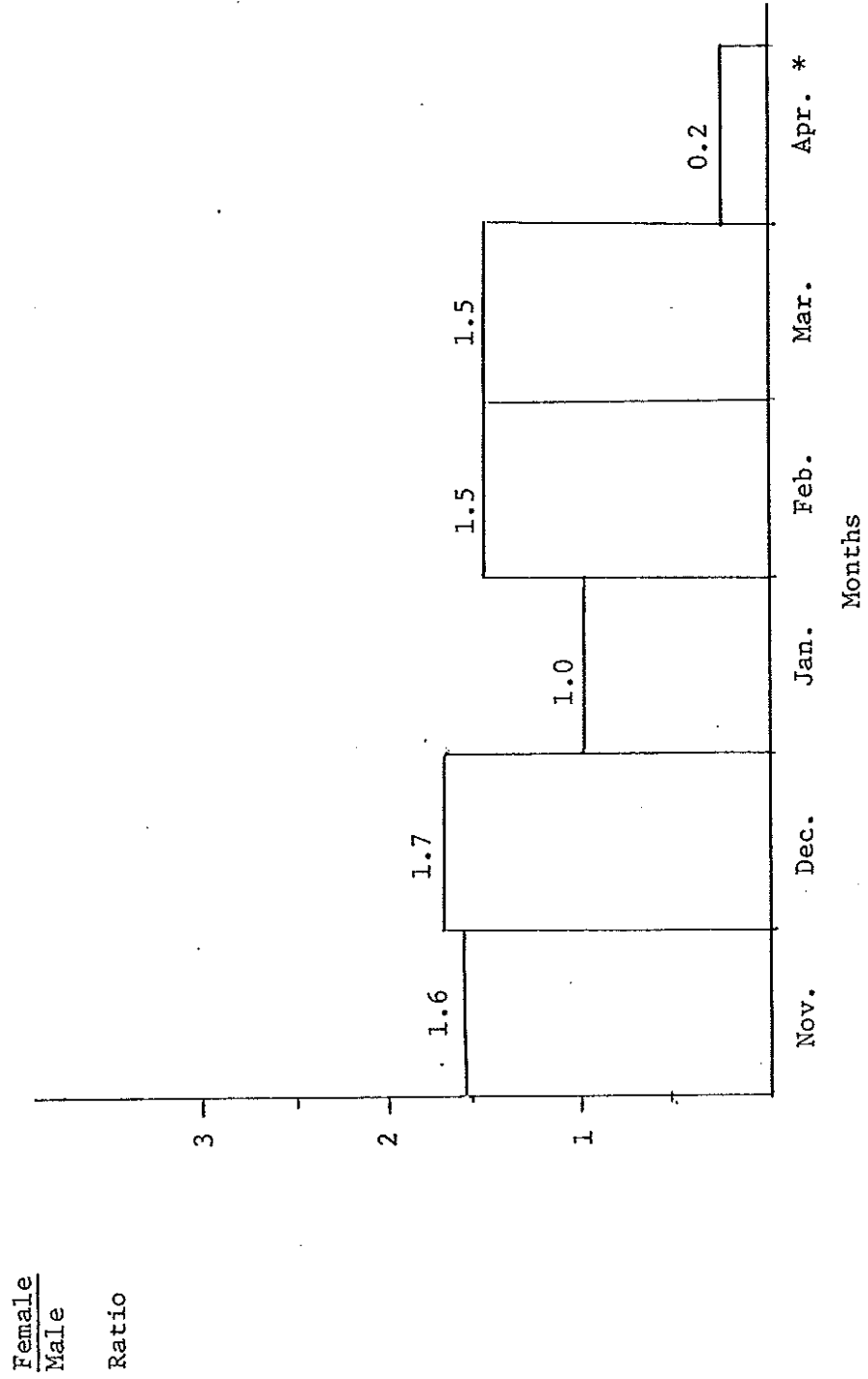


Fig. 11 Average monthly sex ratio of wild winter steelhead caught by anglers (1958-1975)

* Small sample size

YEARS	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec*	TOTAL
1958	45	51	30	5	-	-	-	-	-	-	6	97	234
1959	44	14	25	3	-	-	-	-	1	-	-	41	128
1961	16	12	18	-	-	-	-	-	-	-	-	33	79
1962	-	-	-	-	2	-	-	-	-	-	-	17	19
1964	1	1	-	-	-	-	-	-	-	-	-	1	3
1968	3	-	-	-	-	-	-	-	-	-	9	98	110
1969	-	1	-	-	-	-	-	1	-	-	-	1	3
1970	-	-	6	1	-	-	-	-	2	-	-	-	9
1971	-	-	-	1	1	-	-	-	-	-	-	-	2
1973	15	26	19	-	-	-	-	-	-	-	-	7	67
1974	1	1	-	-	-	-	-	-	-	-	-	-	2
1975	17	7	-	1	-	-	-	-	-	-	1	1	27
TOTAL	142	113	98	11	3	0	0	1	3	0	16	296	683
%	20.8%	16.6%	14.3%	1.6%	0.4%	0	0	0.2%	0.4%	0	2.3%	43.4%	

TABLE XVII. TIMING OF THE RUN - BASED ON ANGLER CATCH PER MONTH (1958-1975)

* A bias may be introduced by the December 26 Steelhead Derby.

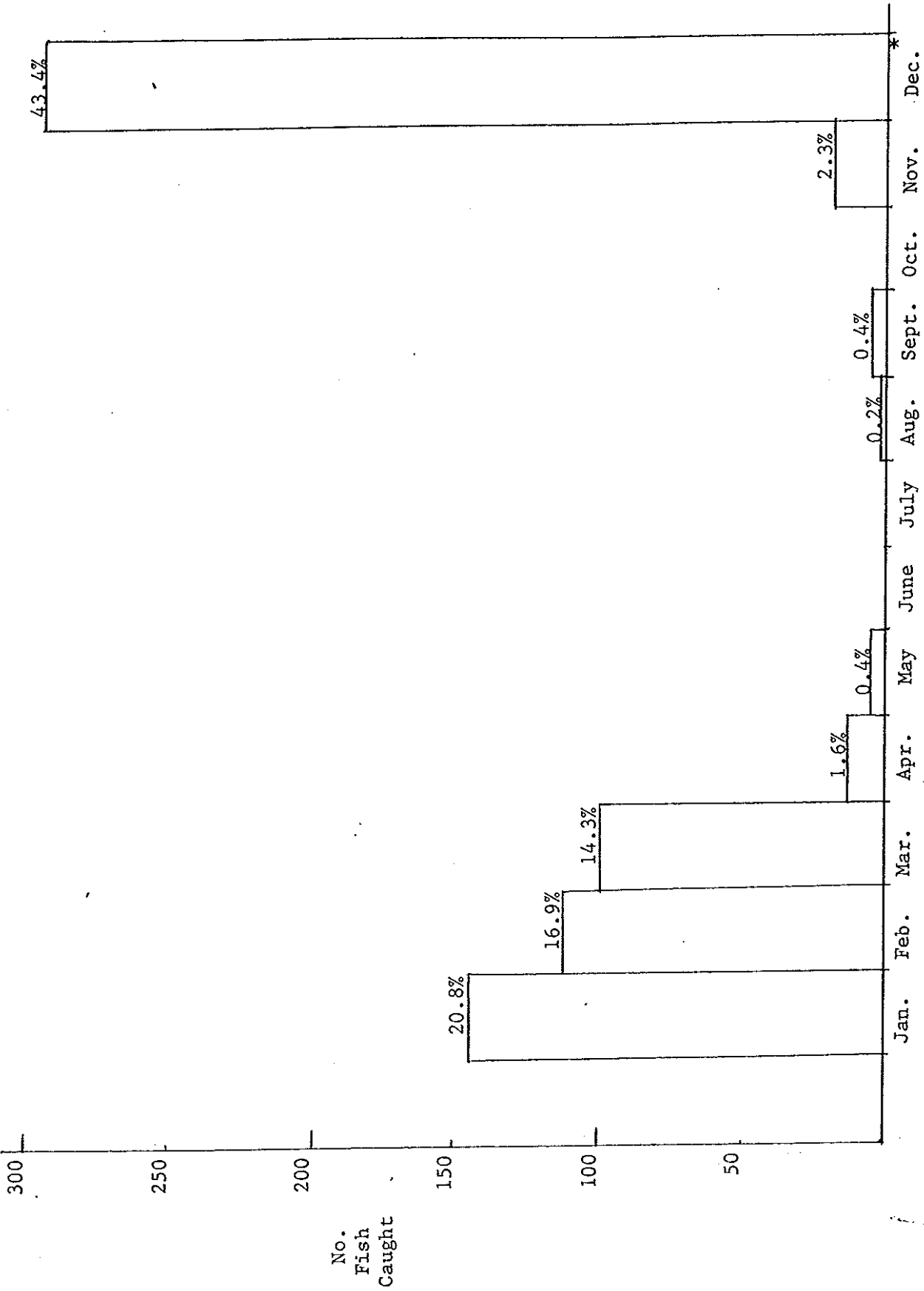


FIG.12 TIMING OF THE RUN - BASED ON ANGLER CATCH PER MONTH (1958-1975)

* A bias may be introduced by the Dec. 26 Derby.

YEAR	January			February			March		December			TOTAL	
	1-7	8-14	15-22	23-31	1-7	8-14	15-22	22-31	1-7	8-14	15-22		23-31*
1958	13	7	13	12	31	15	3	2	7	9	18	43	208
1959	9	13	15	7	2	6	2	3	3	15	15	19	116
1961	1	9	2	4	3	3	2	4	7	5	1	31	73
1962	-	-	-	-	-	-	-	-	-	-	-	17	17
1964	-	1	1	-	-	-	-	-	-	-	1	-	3
1968	2	2	-	-	-	-	-	-	-	-	23	3	102
1969	-	-	-	-	-	1	-	-	-	-	-	-	2
1970	-	-	-	-	-	-	-	-	-	1	-	-	1
1973	-	-	-	15	8	6	4	8	3	10	6	1	61
1974	-	-	-	1	-	-	1	-	-	-	-	-	2
1975	8	2	6	1	7	-	-	-	-	-	1	-	25
TOTAL	33	34	37	40	51	31	12	17	20	40	64	114	610
%	5.4%	5.6%	6.0%	6.5%	8.4%	5.1%	2.0%	2.8%	3.3%	6.5%	10.5%	18.7%	

Table XVIII. TIMING OF THE RUN - BASED ON ANGLER CATCH PER WEEK (1958-1975)

* A bias may be introduced by the December 26 Steelhead Derby.

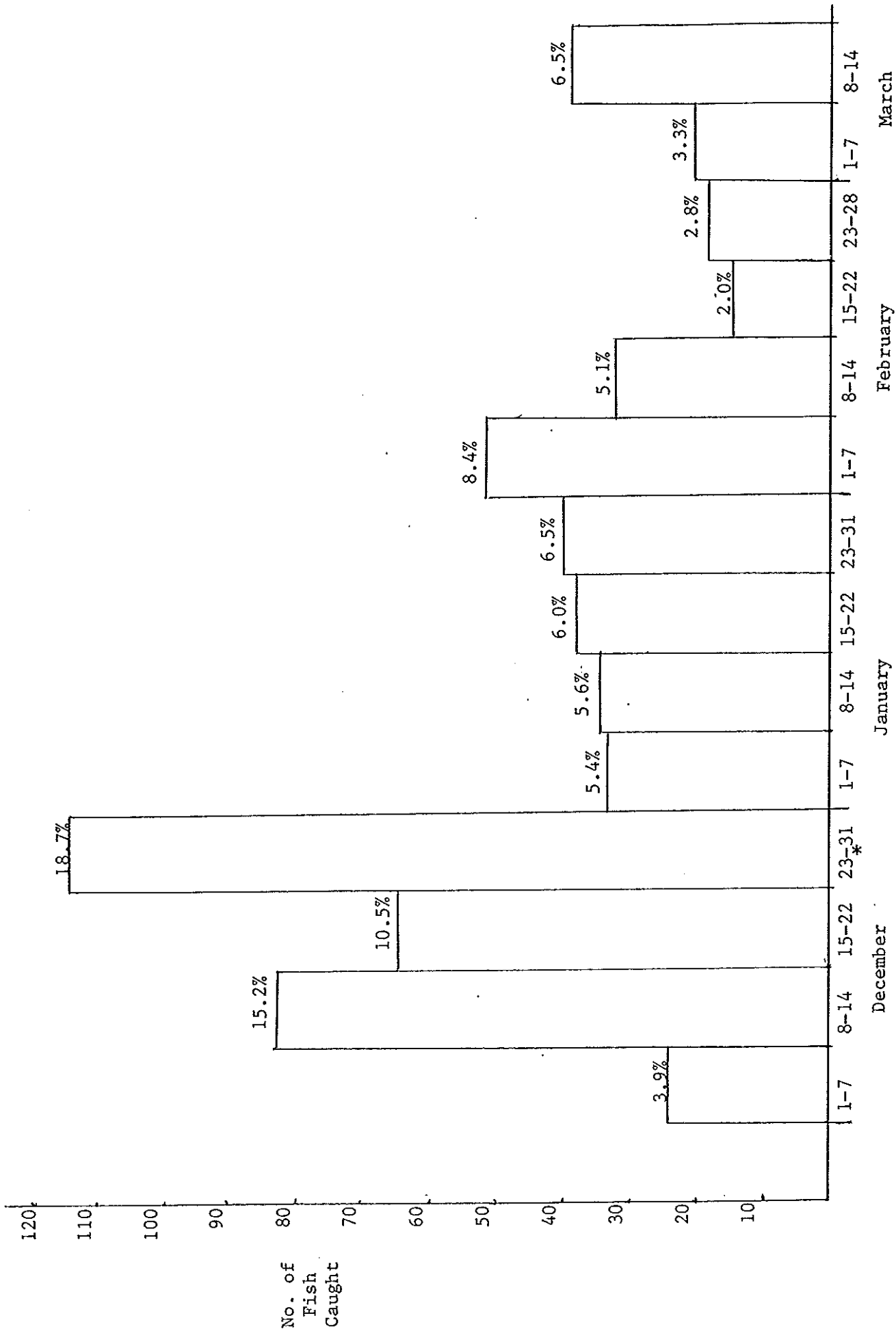


FIG. 12 TIMING OF THE RUN - BASED ON ANGLER CATCH PER WEEK (1958-1975)

* Dec. 26 Derby may bias results.

DISCUSSION

The results in this report are based on scale samples collected from steelhead caught by anglers in the Chilliwack River from 1948 to 1975. The total sample size is about 1850. Of these, the first 800, from 1948 to 1953, were only used for sex ratio and timing of the run. These scales were previously read for a life history study by Maher and Larkin (1954). The remaining 1050 samples were used for age determination in this study.

To compare changes in the steelhead population from past to present, two rough time periods were chosen; from 1948 to 1959 and from 1960 until the present.

(1) Age Class

From 1953 - 1959 the most common age class was 3.2+ (33.5%) followed by 3.1+ (29.2%). From 1960 - 1975 the most common age class was again 3.2+ (45.1%), followed by 3.1+ (24.5%). This compares to the results of Maher and Larkin (1954), which found the most common age to be 2/2 (31.1%) followed by 2/3 (30.7%). The differences in results may be due to the different age notation used and the difficulty in locating the first freshwater annulus. Interestingly though, the age groups 3/1 and 3/2 made up 17.7 and 17.3 percent respectively, in the Maher and Larkin study. In comparison, in this report, 2.2+ fish made up roughly 15% of the total sample from 1953-1975.

The fact that the Chilliwack steelhead population has two dominant age classes (3.1+ and 3.2+) may be one significant reason why this river's strong runs have held up over the past years. Any factor that would cause the run to be diminished in a particular year (ie. floods) would affect different year classes of 3.1+ and 3.2+ fish. In other words, a run of fish in the river at any time consists of two dominant age classes but different year classes. The 3.1+ fish are progeny from the run 5 years past and 3.2+ are progeny from 6 years past. Any natural or unnatural disaster in any particular year would affect only a portion of the runs 5 and 6 years in the future. This fact should dampen the overall effects of any disaster in a single season. A two year disaster, in contrast, could wipe out both year classes and, therefore, both age classes for two seasons in the future.

(ii) Freshwater Age

The most common freshwater age from 1953-1959 was 3. (64.3%) followed by 2. (25.3%). For 1960-1975 the most common age was again 3. (67.5%) and 2. (20.7%). These results suggest that the majority of the Chilliwack watershed produces steelhead smolts in 3 years, but some tributaries may be more productive and can produce 2 year smolts. Future adult scale studies on the Chilliwack watershed could identify these tributaries by juvenile or smolt sampling methods. The factors that influence the productivity of these tributaries could provide new insight into enhancement possibilities for less productive areas.

The freshwater age results in this report differ from those found by Maher and Larkin (1954) where 3/ fish made up 35.4% and 2/ made up 62.1%. But Maher and Larkin also determined that there was a fairly high incidence of + growth after the last freshwater annulus (5.9%). For the time period of 1953 - 1975 in this report, a number of fish were also found with + freshwater growth (5.6%). As suggested by Maher and Larkin, this would indicate a late migration of ocean-bound smolts in late summer or fall.

(iii) Saltwater Age

The most common saltwater age for 1953-1959 was .2+ (53.1%) followed by .1+ (46.6%). For the later period from 1960-1975 the most common ocean age was again .2+ (70.5%) followed by .1+ (38.6%). A significant number of hatchery origin steelhead were caught from 1955-1959. These fish are returns from smolt releases in the 1950's as described by Cartwright (1969). From a total of 111 samples the saltwater age of hatchery fish was almost exclusively .1+ (98.2%). An interesting fact is that during the seasons of 1953/54, 1959/60, 1960/61, 1961/62 the number of .1+ wild fish caught exceeded the number of .2+ fish. This may be a result of hatchery fish interbreeding with wild fish, altering the age class structure during these four seasons. But it could also be a result of some environmental factor affecting the .2+ class of steelhead for those years.

The existence of separate runs of steelhead in the Chilliwack River has been suggested by Usher (1975) and Anonymous (1969). The early run was made up of larger steelhead and the late run fish averaged smaller in size. An attempt was made to compare early and late run fish by saltwater age. From 1953-1959

for early run (Nov.-Dec.) steelhead .1+ fish made up 41.3% of the catch and .2+ made up 58.6%. The later run (Jan.-Apr.) fish aged .1+ made up 50.8% of the catch during these months and .2+ fish were in similar numbers with 49.2%. These results appear to indicate a higher percentage of large .2+ steelhead in the early run and a higher percentage of small .1+ fish in the late run. Total sample size was 555.

The results for 1960-1975 differed but still seemed to indicate the different runs. The early run was made up of 35.3% steelhead aged .1+ and 65.3% fish aged .2+. The late run fish aged .1+ made up 45.2% and .2+ the other 56.3%. Once again the greater number of .2+ fish in the early run and increased number of .1+ in the later run appears to be reflected in the results. Sample size was 290 and in several of the sample years only scales from Nov.-Dec. were collected.

(iv) Repeat Spawning

From 1953-1959 repeat spawners made up 3.4% of the total sample. Of these, 9 were males and 14 were females. For the time period from 1960-1975 repeat spawning steelhead made up 4.4% of the total sample, 11 were females, one a male and for two fish the sex was unknown. Similar results were found in other Lower Mainland streams by Withler (1964) and Caverly (1977), reports I and II. Maher and Larkin (1954) had similar findings for Chilliwack steelhead with roughly 5% of the samples made up of repeat spawners and a female to male ratio of 11:1. The high incidence of females appears to be due to their higher rate of survival following the first spawning as described by Withler (1966).

(v) Sex Ratio

The overall yearly sex ratio from 1948-1957 was 1.5:1 favoring females. From 1958-1975 the female to male ratio was also 1.5:1. No significant changes occurred from past to the present (ie. decline in number of females) although wide annual fluctuations were common. The predominance of females is probably a result of angling selectivity and may be justification for regulation of the sport fishery by sex (ie. catch and release all females). Similar high incidence of females in the catch was described by Withler (1966) and Caverly (1977), reports I, II and III for many Lower Mainland Streams.

From 1955-1959 the ratio of females to males for hatchery origin steelhead was 1.1:1. Similar results were found by Caverly (1977) report III for Capilano Hatchery steelhead. Angling appears to select an even portion of male and female hatchery steelhead.

A comparison of monthly variation in sex ratio was used to compare the early and late run steelhead. The most significant fact that appeared was that the ratio of females to males in January was generally lower than the remainder of the season. This would suggest two possibilities; first a greater number of males are present in the river at this time and the second possibility is that there is a shortage of females in the area open to angling. The former possibility is the most likely. This would support evidence presented by Anonymous (1969) where similar sex ratios occurred in January and were assumed to represent a number of males preceding the late run of steelhead. Anonymous stated that in general, it has been found that in salmon and trout populations, males precede the females in the spawning run.

(vi) Timing of the Run

A monthly breakdown for timing of the run, determined the peak month for 1948-1957 to be December, with 40.4% of the total catch, followed by January with 30.6%. Similar results were found between 1958-1975 with 43.4% of the catch in December and 20.8% in January. Roughly 28% of the remainder of the catch for 1948-1975 came from February and March.

A weekly breakdown of angler catch determined the peak week for 1948-1957 to be December 22-31 with 20.4% of the total catch. And again, during 1958 and 1975 the peak week was December 22-31 with 18.7% of the total. An annual steelhead derby is held December 26 and contributed many scale samples over the entire time period. This may introduce a bias into the results, but the derby is supposed to coincide with the peak of the steelhead run and the number of fish caught that day certainly relates to the number of fish present in the river.

During the earlier time period, from 1948-1957, no timing trends were apparent to separate early and late run fish. The decline in catch after the peak week was fairly constant. But during the later period from 1958-1975 a decrease in catch appeared in the first two weeks of January, followed by an

increase until the first week of February when it declined again. This may provide some indication of late run timing and also illustrates the smaller numbers of fish in the late run as compared to early run.

An attempt to correlate water flows (Fig. 13) and water temperature (Fig. 14) with timing of the run showed that peak catches of steelhead occurred during the months with a high average flow and water temperatures from 3.8°C to 3.4°C and falling. The water flow during December and January was probably fluctuating constantly with heavy rains and fresh runs of fish entered on the higher flows. Angler catch would increase as the river began to drop. The lowest water temperatures occurred in January (1.7°C) and may be related to smaller catches of steelhead during the first two weeks of that month. The season recorded for temperature was 1967/68 and it is assumed this represents an average year.

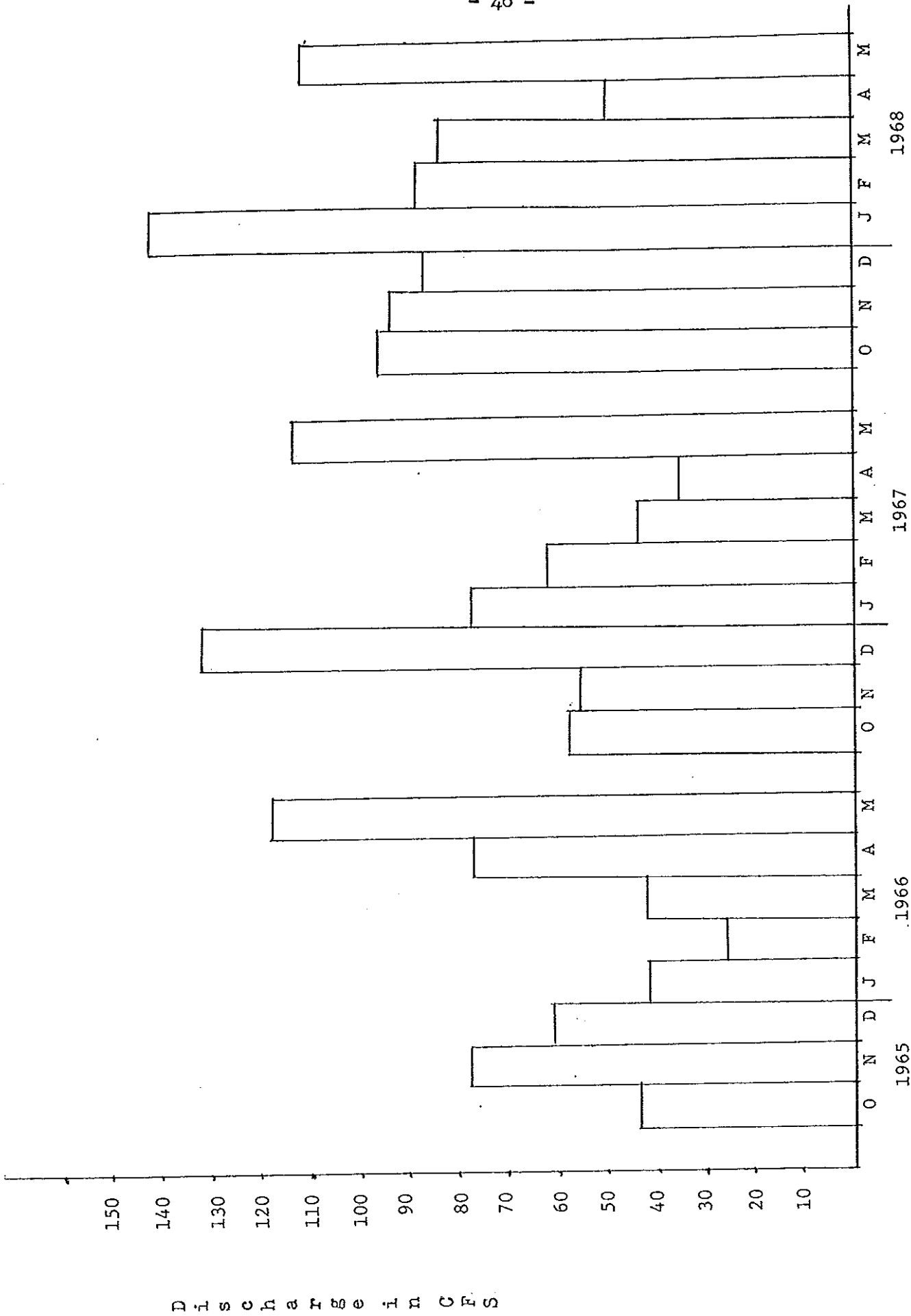


Fig. 14 Monthly Discharge of the Vedder-Chilliwack River for a Three Year Period

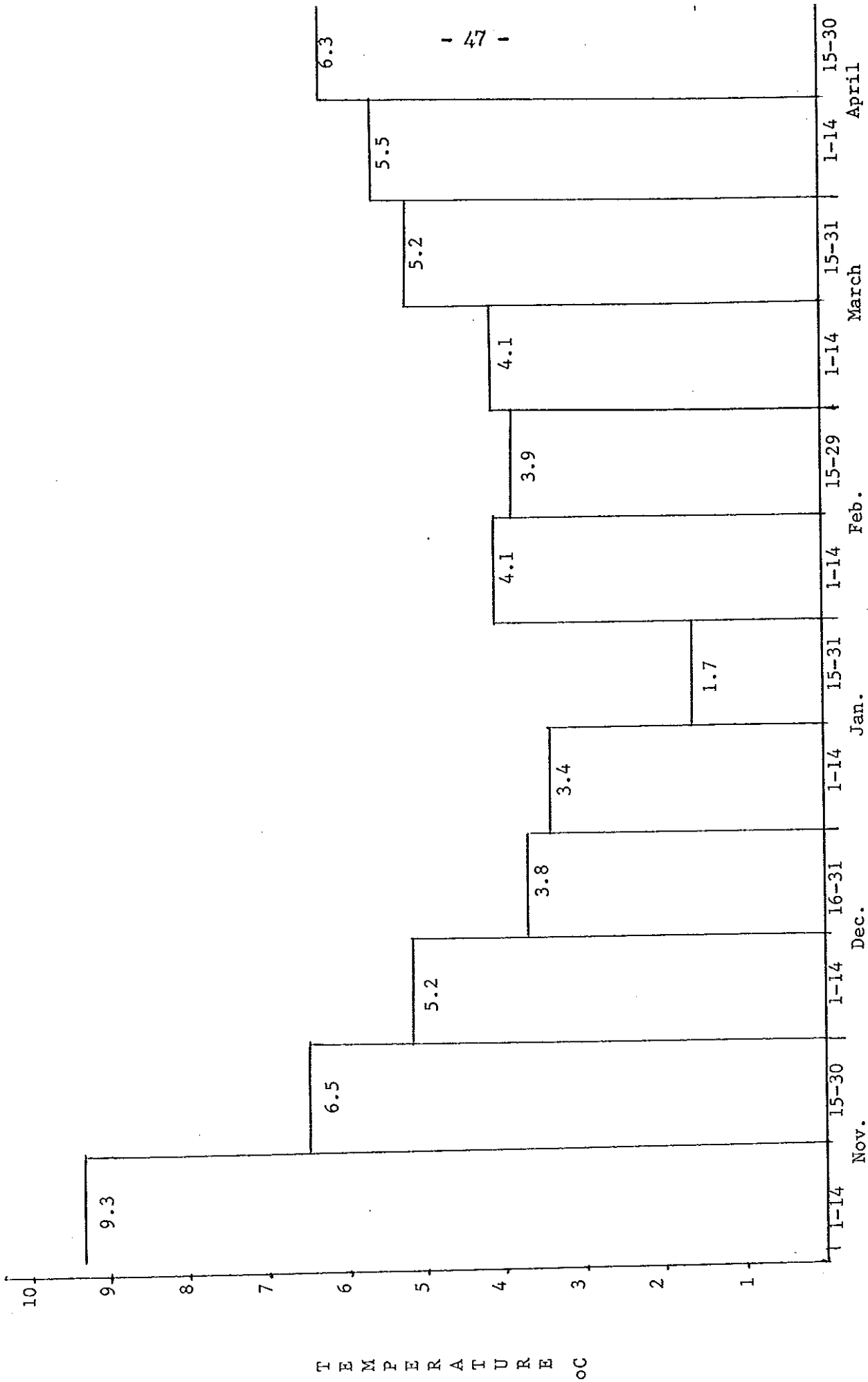


FIG.15 MEAN MONTHLY TEMPERATURE (°C) FOR ONE YEAR ON THE VEDDER-CHILLIWACK RIVER
 - Station at B.C. Hydro Bridge

CONCLUSIONS

1. The high percentage of two age classes of steelhead in the Chilliwack River (3.1+ and 3.2+) is an important factor in the strength of the runs from year to year.
2. The relatively frequent occurrence of 2-year smolts may indicate that parts of the Chilliwack watershed are quite productive in relation to the majority of rearing areas.
3. The occurrence of 2+ and 3+ freshwater ages indicates a small late migration of smolts.
4. A higher percentage of .1+ steelhead during several seasons may be a result of hatchery steelhead, which are predominantly .1+, interbreeding with wild fish to change the age class structure of the natural stock.
5. A higher percentage of .1+ steelhead in the Jan.-Apr. time period may indicate the presence of a late run of fish averaging smaller in size.
6. There were no significant changes in sex ratio of angler caught steelhead from 1948 until now.
7. Angling appears to select male and female hatchery steelhead at a ratio of 1.1:1.
8. During the month of January, a high proportion of males in the catch may indicate the start of the late run.
9. A decrease in catch in the first two weeks of January followed by an increase in February may represent the late run of steelhead.
10. Highest catches of steelhead coincided with the month of highest water flows (December).

RECOMMENDATIONS

1. Life history studies on the Chilliwack River in the future should be directed at juveniles, smolts and adult returns from hatchery plants.
2. An examination of early and late run stocks should be an initial step before future enhancement projects. The two runs contribute to the strength of the stock and age class diversity in the Chilliwack River.
3. The high incidence of female fish in angler's catches may be justification for regulation of the sport fishery by sex ratio, (ie. Catch and Release for all female steelhead).
4. Future examination of sex ratio and timing of the run should be done with a non-selective sampling technique.

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SEPTEMBER				OCTOBER				NOVEMBER			
DATE	MAX.	MIN.	MEAN	DATE	MAX.	MIN.	MEAN	DATE	MAX.	MIN.	MEAN
1	57.0	57.0	57.0	1	53.5	52.5	53.0	1	45.5	42.0	43.75
2	57.0	56.0	56.5	2	52.0	50.5	51.25	2	46.0	42.0	44.0
3	56.0	54.0	55.0	3	50.5	50.0	50.25	3	46.0	45.5	45.75
4	57.0	53.0	55.0	4	51.0	50.0	50.5	4	45.5	43.0	44.25
5	57.5	54.0	55.75	5	51.0	50.0	50.5	5	44.0	44.0	44.0
6	58.5	54.5	56.5	6	51.0	51.0	51.5	6	45.5	44.0	44.75
7	58.5	56.0	57.25	7	51.0	49.5	50.25	7	46.0	45.5	45.75
8	58.0	56.0	57.0	8	50.5	49.5	50.0	8	46.5	46.0	46.25
9	57.5	55.0	56.25	9	51.5	50.5	51.0	9	46.5	46.5	46.5
10	58.0	56.0	57.0	10	51.5	51.5	51.5	10	46.5	46.5	46.5
11	59.0	56.5	57.75	11	51.5	43.0	49.75	11	46.5	45.0	45.75
12	59.0	56.5	57.75	12	49.0	47.5	48.25	12	46.0	45.5	45.75
13	58.5	56.5	57.5	13	49.0	46.5	47.75	13	46.0	46.0	46.0
14	58.5	56.0	57.25	14	48.5	47.0	47.75	14	46.5	46.5	46.5
15	58.0	56.0	57.0	15	48.5	46.0	47.25	15	46.5	46.0	46.25
16	57.5	55.0	56.25	16	49.0	48.0	48.5	16	46.0	46.0	46.0
17	58.0	56.0	57.0	17	49.0	47.0	48.0	17	46.0	45.0	45.5
18	59.0	56.5	57.75	18	48.5	47.0	47.75	18	45.5	45.5	45.5
19	59.0	56.5	57.75	19	48.0	46.5	47.25	19	45.5	44.0	44.75
20	58.5	55.0	56.75	20	47.5	47.5	47.5	20	44.5	43.5	44.0
21	55.0	53.0	54.0	21	47.5	47.5	47.5	21	43.5	43.0	43.25
22	56.0	53.0	54.5	22	47.5	46.5	47.0	22	44.0	43.0	43.5
23	57.0	55.5	56.75	23	46.5	46.0	46.25	23	44.0	44.0	44.0
24	57.5	54.0	55.75	24	46.0	45.0	45.5	24	44.0	44.0	44.0
25	57.0	54.5	55.75	25	45.0	45.0	45.0	25	44.0	42.0	43.0
26	57.0	54.5	55.75	26	45.0	44.5	44.75	26	43.0	41.5	41.75
27	55.5	55.0	55.25	27	44.5	44.5	44.5	27	41.5	41.5	41.5
28	55.0	53.5	54.25	28	44.5	44.0	44.25	28	42.0	41.5	41.75
29				29	44.0	44.0	44.0	29	42.0	42.0	42.0
30				30	45.0	44.0	44.5	30	42.5	42.0	42.25
31				31	45.5	45.5	45.25				

Appendix 1. Water temperature records for the Vedder - Chilliwack River (1967 - 1968).

VEDDER RIVER (B.C. HYDRO) RYAN RECORDER #8696

DECEMBER 67				JANUARY 68				FEBRUARY 68			
DATE	MAX	MIN	AVERAGE	DATE	MAX	MIN	AVERAGE	DATE	MAX	MIN	AVERAGE
1	42.0	42.0	42.0	1	40.0	40.0	40.0	1	40.0	36.0	37.0
2	43.0	42.0	42.5	2	40.0	38.0	39.0	2	40.0	38.0	39.5
3	43.0	43.0	43.0	3	38.0	38.0	38.0	3	40.5	39.5	39.75
4	43.0	42.5	42.75	4	39.0	38.0	38.5	4	40.0	40.0	40.0
5	43.0	42.0	42.5	5	39.0	41.0	39.0	5	40.0	40.0	40.0
6	42.0	41.5	41.75	6	38.0	38.5	38.75	6	40.0	39.0	39.5
7	42.0	42.0	42.0	7	39.0	38.5	38.75	7	39.0	38.5	38.25
8	42.0	42.0	42.0	8	38.5	38.5	38.5	8	39.5	38.5	39.0
9	42.5	42.5	42.5	9			38.50	9	39.5	39.0	39.25
10	43.0	42.0	42.5	10	CHART		37.75	10	39.5	39.0	39.25
11	42.0	39.0	40.5	11	RIPPLE		37.50	11	41.5	39.0	39.25
12	39.5	39.0	39.25	12			37.00	12	41.5	38.5	40.0
13	39.0	38.0	38.5	13			36.50	13	40.0	39.0	39.5
14	38.0	38.0	38.0	14			36.25	14	40.0	39.5	39.75
15	38.5	38.0	38.25	15	P.W.		36.50	15	39.0	38.0	38.5
16	39.5	38.5	39.0	16			36.00	16	38.5	37.5	38.0
17	39.5	39.5	39.5	17			36.00	17	38.5	37.0	37.75
18	40.0	38.0	39.0	18			35.50	18	38.5	36.0	36.25
19	38.0	36.0	37.0	19			35.50	19	39.0	38.0	38.5
20	36.0	34.0	35.0	20			35.25	20	40.0	39.0	39.5
21	34.5	34.0	34.25	21			35.00	21	42.5	40.0	40.25
22	37.0	34.5	35.75	22			35.00	22	40.5	40.5	40.5
23	39.5	37.0	38.0	23			34.75	23	44.0	40.5	42.25
24	40.0	38.5	39.25	24			34.50	24	40.0	37.0	38.5
25	39.5	40.5	40.0	25			34.50	25	41.0	37.5	39.25
26	42.0	39.5	40.75	26			34.50	26	41.0	37.0	39.0
27	43.0	42.0	42.5	27			44.50	27	40.0	37.0	38.5
28	43.0	42.0	42.5	28	34.5	39.5	34.5	28	40.0	38.0	39.0
29	42.0	41.5	41.75	29	34.5	38.5	33.5	29	41.0	38.0	39.5
30	40.0	39.5	39.75	30	36.0	34.5	35.25	30			
31	40.0	40.0	40.0	31	36.0	36.0	36.0	31			

Page 10

WELDER R. (E.C. HYDRO) RYAN RECORDER # 8696

MARCH				APRIL				MAY			
DATE	MAX	MIN	MEAN	DATE	MAX	MIN	MEAN	DATE	MAX	MIN	MEAN
1	41	40	40.5	1	42	40	41	1	43	40	41.5
2	41	39	40	2	45	42	43.5	2	46	41	43.5
3	40	39	39.5	3	45	41	43	3	47	42	44.5
4	40	39	39.5	4	42	42	42	4	46	42	44
5	40	38	39	5	42	41	41.5	5	42	40	41
6	39	37	38	6	42	41	41.5	6	42	41	41.5
7	40	38	39	7	43	41	42	7	47	42	44.5
8	40	37	38.5	8	43	40	41.5	8	47	43	45
9	39	37	38	9	46	40	43	9	49	43	46
10	40	39	39.5	10	46	43	44.5	10	49	43	46
11	40	40	40	11	44	41	42.5	11	49	43	46
12	40	39	39.5	12	42	39	40.5	12	48	42	45
13	40	40	40	13	42	39	40.5	13	44	42	43
14	40	40	40	14	40	40	40	14	44	43	43.5
15	40	40	40	15	41	40	40.5	15	47	43	45
16	40	40	40	16	44	39	41.5	16	49	43	46
17	40	40	40	17	44	40	42	17	49	44	46.5
18	43	40	41.5	18	44	42	43	18	50	44	47
19	43	40	41.5	19	42	40	41	19	49	45	47
20	43	40	41.5	20	45	41	43	20	45	43	44
21	43	41	42	21	46	40	43	21	44	43	43.5
22	43	42	42.5	22	46	41	43.5	22			
23	43	42	42.5	23	46	43	44.5	23			
24	43	41	42	24	45	42	43.5	24			
25	42	41	41.5	25	44	42	43	25			
26	41	41	41	26	44	42	43	26			
27				27	47	43	45	27			
28				28	49	43	46	28			
29	45	42	43.5	29	49	44	46.5	29			
30	45	39	41	30	45	43	45.5	30			
31	47	40	41	31				31			