

TROLL SALMON INVESTIGATION PROGRESS REPORT

July-December 1959

Oregon Fish Commission
Research Division
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INTRODUCTION

In June 1959 Jack Van Hying officially left Troll Salmon Investigations after 11 years as its project leader to take over the position of Assistant Director of Research. Bob Loeffel replaced him as Troll Salmon project leader. The adjustment and orientation phases of the transfer were essentially completed by July.

Project activities for the period July 1 to December 31, 1959 were centered around sampling of the troll salmon catch, processing of tags, analysis of the data collected during the two 1959 cruises, and preparation of material for the annual PMFC meeting.

MEETINGS ATTENDED

The Pacific Marine Fisheries Commission meeting held in San Francisco from November 16 to 18 was attended, and a paper was presented. Two meetings to discuss material to be presented at the PMFC meeting were held with Pete Bergman and Heater Heyamoto of the Washington State Department of Fisheries. A project leaders' meeting was attended in Clackamas on November 5. A congressional hearing called by the U. S. Senate Committee on Interstate and Foreign Commerce to discuss pending national fisheries legislation was attended in Astoria on November 10. Senators Bartlett of Alaska and Neuberger of Oregon were the committee members present. A meeting was held in Aberdeen with Pete Bergman on December 17 to discuss plans for the second year of the PMFC-sponsored study of the Astoria-Westport spring fishery.

REPORTS SUBMITTED

A report discussing the catch of the 1959 Oregon troll fishery and the activity of the Fish Commission in marine salmon research during 1959 was submitted to Clackamas for presentation at PMFC.

A report discussing the extent to which the 1959 Oregon troll salmon catch was sampled for marks was also prepared and submitted.

PERSONNEL

In addition to the personnel change mentioned earlier, Bob Rohland and Gilbert Pauley left in September after a summer of sampling the catch of the troll fishery for marks. They were employed under the Columbia River Fishery Development Program. Both men returned to school.

EQUIPMENT PURCHASED OR CONSTRUCTED

A "live bait" style holding tank was constructed for use in the fatigue-mortality studies. Made of 3/4" marine plywood, it is 3 feet wide by 4 feet long by 4 feet high. Liquid capacity is about 350 gallons.

THE 1959 OREGON TROLL FISHERY

Statistics for the 1959 Oregon troll chinook and silver catch indicate the total landings to be approximately 1.5 million pounds. This would make 1959 be the second poorest year since record keeping began in 1925. Astoria area landings approached those for 1958, but landings at the important coastal ports were down by about 70% for chinook and 40% for silvers. The troll chinook catch made up about 0.5 million pounds of the combined catch.

The low catches appear to be primarily due to a lack of fish. However, tuna appeared on the Oregon tuna grounds in July and were available in good numbers into September. This resulted in many of the larger salmon trollers directing their efforts away from salmon during what is normally an important part of the salmon fishing season. The magnitude of silver landings was further reduced because of the small average size of fish in the 1959 catch. This was evidenced by the fact that at least one major company that usually sells their silvers on the fresh market canned all but their largest fish until late in the 1959 season.

CATCH SAMPLING

Portions of the landings of both chinook and silvers made in ports from Coos Bay north to Ilwaco were processed for information on average weights and the presence of marked fish. The actual recoveries of marked fish are presented in Table 1. The most prevalent mark found was the adipose-left ventral release from the Klaskanine Hatchery. These marks appeared in the Washington fishery in good numbers and were also reported in northern California catches. The fish bearing this mark were fed the Oregon moist pellet.

Two samplers were employed for the summer on federal CRFDP funds from the ocean mark sampling program. One was stationed at Coos Bay from June to September and the other at Astoria from April to September.

The extent to which the catch was examined for marks was the subject of a report submitted during this period. Since the data contained therein were preliminary, there is little value in presenting detailed comment here. The estimated per cent sampled was 12 for chinook and 20 for silvers.

FATIGUE-MORTALITY STUDY

This study began in late 1957 and was continued in 1958. Field work was not resumed again until August 1959 when four 1-day cruises on the troller Dreamer were made. The infrequent catch of small salmon resulted in only 12 "shakers" being caught on the four trips. Six of the 12 were suitable for use in the study. Because of the poor success and infrequent operation of the Dreamer, sea activity was discontinued.

At this point attention was switched to mature fish, primarily silvers, returning to Klaskanine and Foley Creek hatcheries. Silver jacks made up the bulk of the experimental fish although a few 3-year-old male and female silvers and one chinook jack were sampled. In all 51 fish were utilized in the season's work, 34 of which came from the Klaskanine Hatchery. Forty-three usable blood

Table 1. Actual Recoveries of Marked Chinook and Silver Salmon
in the 1959 Oregon Troll Fishery by Mark, Species, and Month.

	Chinook							Silver						
	April	May	June	July	Aug.	Sept.	Oct.	Total	June	July	Aug.	Sept.	Oct.	Total
D								0		1				1
D-Ad								0				2		2
D-Ad-RV	1							1						0
D-LV								0	1	3		1		5
D-RV	1							1	8	17	7	10	3	45
Ad								0	3	2	7	4		16
Ad-LV	1		6	1		2		10	49	43	17	24	7	140
Ad-LV-RV								0	1	1	1			3
Ad-RV	6		4	2				12	7	7		4	1	19
Ad-IP	2							2	1	1				2
Ad-RP	4		2	3				9		1				1
An								0	1					1
An-LV								0		1				1
An-RP								0	1					1
LV	13		3	3				19	17	10	2	5		34
LV-RV	1							1	21	19	9	2	4	55
LV-RP				1				1						0
LV-IM			2					2	1					1
LV-RM					2	1		3		1				1
RV	1				1			2	6	10	2	2		20
RV-IM								0		1		1		2
RV-IM-RM								0				1		1
RV-RM				3				3						0
IP				1	1			2	5	5				10
IP-RP								0		1				1
IP-IM								0		1				1
RP								0	4	5		2		11
Total	30	0	17	14	4	3	0	68	126	130	45	58	14	373

1/ Includes Washington Columbia River ports.

samples were obtained. A portion of the fish were successfully sampled twice--once before holding and again following a period in a holding tank containing either fresh water or tranquilizer. The pre-holding samples were taken from the dorsal aorta near the point of attachment of the third gill arch while the post-holding samples were obtained by heart puncture via the ventral surface of the fish. Analysis of the blood samples is being conducted using the facilities of the Oregon State University Seafoods Laboratory. Bob Ellis was in charge of this work and is responsible for the efforts described above.

SCALE NUCLEUS TYPES FOR LOWER COLUMBIA RIVER FALL CHINOOK

Scale samples taken from juvenile and adult fall chinook from the Washougal River in 1957 were partially of the "stream" or sub 2 type. Scale samples from chinook caught in September 1958 in the below-Bonneville gill-net fishery contained a greater proportion of stream-type scales than did samples from August-caught fish from this fishery. The migration of chinook over Bonneville Dam is very small after mid-September indicating that chinook taken in the mid-September-October fishery were for the most part destined for the streams below Bonneville. This led to the hypothesis that fall chinook entering the streams below Bonneville Dam were characterized to an important degree by a stream type of early life history.

In order to learn more of the frequency of stream-type life history among these fish, scale samples were taken from the 1959 zone 2 fall chinook catch by troll salmon personnel. The effort resulted in the collection and reading of 852 scale samples. The resulting age-life history composition is tabulated by length in Table 2. Samples containing stream-type scales made up 417 of the 763 readable samples or 55%. This is an appreciable change from the 8%

Table 2. Age-Length Composition of Columbia River
Chinook from the 1959 September-October
Zone 2 Gill-Net Catch.

Fork Length (Inches)	Age Groups										Sub- total	Unreadable	Total
	22	21	32	31	42	41	52	51	62	61			
14	1										1		1
15													
16	1	2									3		3
17	1	8									9		9
18		5			1						6		6
19		3	4								7		7
20		4	2	2							8		8
21			8	5							13		13
22			6	7							13	1	14
23		1	13	12			1				27	1	28
24			23	13	2						38	1	39
25			8	9	1		1				19	2	21
26			7	18	2	1					28	6	34
27			10	25	3	2	1				41	3	44
28			8	27	11	4	1				51	3	54
29				25	8	2	2	3			40	3	43
30				16	13	6					35	7	42
31			1	10	13	6	8	1			39	6	45
32				3	18	12	6	3			42	6	48
33				1	14	11	16	2			44	9	53
34				3	22	7	8	11	1		52	5	57
35					10	5	12	5			32	6	38
36					6	6	29	13			54	5	59
37					4	3	26	12		1	46	6	52
38					3	3	29	8		1	44	5	49
39						1	19	6		1	27	6	33
40					1		11	5			17	3	20
41							11	4			15	3	18
42							5	1			6	1	7
43							5	1			6		6
44												1	1
45													
Total	3	23	90	176	132	69	191	75	1	3	763	89	852

1/ Includes all non-assignable scales.

that the sub-2-type samples formed of the 1959 August zone 1 and 2 catch. Six weekly samples were collected during the September-October season. Age-group frequencies were compiled by week and are presented in Table 3. The proportion of stream-type scales varied from 40 to 87% but did not show a consistent increase as the season progressed. However, in almost all cases sub 2's were an important part of a given year class's contribution to the weekly sample. The large range of stream-type percentages between weeks suggests that appreciable differences in early life history may be found between lower Columbia River races of fall chinook.

Table 3. Age Composition by Week of Columbia River Chinook from the 1959 September-October Zone 2 Gill-Net Catch.

Week Ending	Age Group										Total	Sub-2 Total	Per Cent Sub 2's	
	2 ₂	2 ₁	3 ₂	3 ₁	4 ₂	4 ₁	5 ₂	5 ₁	6 ₂	6 ₁				
Sept. 19			5	22	77	40	36	24	12			216	86	40
Sept. 26	2	8	31	45	28	10	33	3	1			161	95	59
Oct. 3			5	20	19	14	8	37	3			106	71	67
Oct. 10			5	8	19	16	9	20	31			108	44	41
Oct. 17	1			7	8	22	2	58	3			101	88	87
Oct. 31				2	8	12	4	19	23		3	71	33	46
Total	3	23	90	176	132	69	191	75	1	3	763	417	55	

These data indicate that the lower Columbia races of fall chinook do not necessarily fit the often used axiom that "fall chinook go to the ocean in the first year of life and spring chinook in the second year". Further they suggest the possibility that fall chinook races inhabiting the Oregon and Washington coastal streams, which are similar to the lower Columbia tributaries, may possess similar life history patterns.

Most of the fish in the age samples were also sexed. The resulting age-sex frequencies by week are shown in Table 4.

Table 4. Weekly Age-Sex Composition of Columbia River Chinook from the 1959 September-October Zone 2 Gill-Net Catch.

Week Ending		Age Group										Regenerate	Total
		2 ₂	2 ₁	3 ₂	3 ₁	4 ₂	4 ₁	5 ₂	5 ₁	6 ₂	6 ₁		
Sept. 19	M		5	19	41	15	8	8	5			14	115
	F			3	36	25	28	16	7			20	135
Sept. 26	M	2	8	30	26	6	1	7				5	85
	F			1	19	22	9	26	3	1		4	85
Oct. 3	M	4		16	12	5	5	12	1			4	59
	F	1		4	7	8	3	19	1			4	47
	- 1/					1		6	1			2	10
Oct. 10	M		5	8	12	10	3	8	10			6	62
	F				7	6	6	12	21			10	62
Oct. 17	M	1		6	4	2		14				5	32
	F				4	16	2	37	2			5	66
	-			1		4		7	1			2	15
Oct. 31	M			1	4	3		5	5			5	23
	F			1	4	9	4	14	18		3	3	56
Total	M	7	18	80	99	41	17	54	21			39	376
	F	1		9	77	86	52	124	52	1	3	46	451
	-			1		5		13	2			4	25
Grand Total		8	18	90	176	132	69	191	75	1	3	89	852

1/ Sex undetermined

1959 ASTORIA-WESTPORT STUDY

General

This study was conducted jointly with the Washington State Department of Fisheries as a Pacific Marine Fisheries Commission project. Field work was carried out in the spring of 1959. The reasons for doing the study, the procedures

used, and certain catch and tagging information were presented in the January to June 1959 progress report.

Tag recoveries from fish released on this cruise came in throughout the summer. Rewards were paid and letters sent to each finder telling of the time, place, and reason for tagging. The recovery reached 28% of the fish released by the end of December.

Analysis of Catch Data

Age reading, and compilation and analysis of the data began in July so that a report could be made to the PMFC meeting in November. Only data collected by Oregon personnel was included in the PMFC report and will be discussed here.

Relative Abundance

One of the objectives of the program was the determination of the abundance of chinook in the Astoria-Westport area during the period March 15-April 15 for comparison with similar values made during the pre-closure years. The commercial fisherman employed for the test fishing was Larry Cooper from Newport who had fished the Astoria-Westport area extensively prior to the 1956 closure.

Table 5 shows the catch per day recorded during the 1959 cruise and comparative values for the commercial fishery for pertinent earlier years. The catch per day for the March 15-31, 1959 period was 14 fish or 140 pounds. This is well below the catch per day recorded for comparable fishing periods of 1952-55 and indicates a reduction in the abundance of chinook in the Astoria-Willapa Bay area despite the added protection afforded by the closure. The catch per day made during the first 15 days of April was very similar to that observed for March but may not be compared so directly to the values shown for the commercial fishery in the earlier years. The April values for the years

1951-55 are for the entire month so reflect the poorer fishing that the last half of April usually brings to this area. For 1956-59 they are for the last half of the month. Even so the 1951-55 values are generally larger than those realized during this cruise, again indicating a lowered abundance. The catch of 22 fish per day for the commercial fleet for April 15-30, 1959 compared favorably with earlier values, but the average size of the fish involved was small.

Table 5. Catch per Day of Legal Chinook Caught in the Astoria-Willapa Bay Area from March 15-April 30, 1951-59.

Year	Month 1/			
	March		April	
	Numbers	Pounds	Numbers	Pounds
1951	—	—	26	252
1952	22	252	16	161
1953	40	428	25	256
1954	34	327	22	242
1955	23	205	25	253
1956	—	—	33	366
1957	—	—	13	120
1958	—	—	5	50
1959	—	—	22	151
1959 ^{2/}	14	140	16	141

1/ Commercial fishing period March 15-April 30, 1951-55; April 15-30, 1956-59.

2/ Test fishing catch March 15-31 and April 1-14.

Age Composition

Scale samples were taken from all chinook except 5 in order that the age composition and early life history might be determined. Age assignments were made by Van Hyning and Loeffel both of whom independently read all of the collection once. All first round disagreements were read again by both parties resulting in resolution of all but 4 samples. These 4 samples were sent to Heater Heyamoto (WSDF) for a final decision.

The fish caught ranged in age from their second to their sixth year with fish in their third year making up 64% of the total catch (Table 6). Fish with ocean-type scales were most abundant comprising 73% of the catch. Of the 212 legal fish caught 135 were 3₁'s. The next most important group was the 4₂'s. The sub-legal chinook taken were about equally distributed between 2₁'s, 3₂'s, and 3₁'s.

The relation of 4₁'s to 3₁'s in the portion of the catch that was of marketable size is disturbing. It is at the start of the season that the ratio of 4₁'s over 3₁'s should be the largest. The low value observed here could indicate that too heavy a catch was made of the 1955 brood year in the third year of life. However, other possibilities are that the 1955 brood year was not as productive as the 1956 brood year or that a separation by age had moved the fourth-year fish to other parts of the ocean.

Table 7 presents the age composition of the fish which died following catching. The balance of the fish included in Table 6 were tagged and released.

Estimate of Spring Chinook Component of Catch

Past work has demonstrated that Columbia River spring chinook make up part of the March-April troll catch taken in the Astoria-Westport area. However, the closure was enacted to protect Columbia River fall chinook. Consequently, a determination of the contribution of spring chinook to the test fishing catch was of import. This was done by noting the frequency of stream-type or sub 2 scales in the samples taken, since this characteristic is generally considered to be associated with spring rather than fall chinook (with due respect to the preceding early life history discussion). The estimate obtained shows that about 30% of the legal fish caught were spring chinook. The approximate age composition of these fish may be deduced from Table 6.

Table 6. Age-Length Composition of Chinook Taken on the Spring Cruise, March 17-April 14, 1959^{1/}.

Total Length (Inches)	Age Group							Total
	2 ₁	3 ₂	3 ₁	4 ₂	4 ₁	5 ₂	6 ₂	
Sub-legal								
12	4							4
13	6							6
14	5							5
15	7							7
16	6							6
17	4	5						9
18		5						5
19		4						4
20		1	3					4
21		4	3					7
22		4	4					8
23		3	8		1			12
24		1	7					8
25		1	10	1				12
Legal								
26			26	2	3			31
27			22	1	1			24
28			27	3	1			31
29			22	8				30
30			20	4	4	1		29
31			10	4	2	1		17
32			4	3	3	2		12
33			2	2				4
34			2	5	1	2		10
35				2	5	1		8
36				1		1		2
37						5		5
38					1			1
39						1	1	2
40						5		5
41						1		1
Sub-legal								
Nos.	32	28	35	1	1			97
Per cent	33.0	28.9	36.0	1.0	1.0			
Legal								
Nos.			135	35	21	20	1	212
Per cent			63.6	16.5	9.9	9.4	0.5	
Total								
Nos.	32	28	170	36	22	20	1	309
Per cent	10.4	9.1	55.0	11.6	7.1	6.5	0.3	

^{1/} Seventeen fish were not assignable as to age so are not included in this table.

Table 7. Age-Length Composition of Chinook Mortalities from the Spring Cruise, March 17-April 14, 1959.

Length	Age Group					No Scales	Total
	2 ₁	3 ₂	3 ₁	4 ₂	5 ₂		
13	1						1
14						1	1
15	1						1
16	2					1	3
18		1					1
22			1				1
26			2				2
27			1				1
29			1				1
32				1			1
33			1				1
40					1		1
Total	4	1	6	1	1	2	15

Barbed Hooks Versus Barbless Hooks

Barbless hooks are considered to be more desirable, in some respects, than barbed hooks for use in a fishery where a portion of the catch is to be released alive. Application of this idea to the troll salmon fishery was viewed as a method by which the mortality of the discarded non-marketable salmon might be reduced. The theory had not been tested, so to this end, barbless hooks were employed daily on half of the lures fished during the cruise. The hooks used were of the usual Siwash type with the barb completely filed off.

The chinook catch on barbed and barbless hooks was 184 and 142, respectively. The length-frequency distribution by gear of capture is shown in Table 8 and Figure 1. At two points the curves differ noticeably. These are in the number of fish 21 inches and under and the number of 28-31-inch fish. In both cases barbed hooks caught the greater number.

The total catch and the numbers of legal and sub-legal chinook taken were compared statistically between gear of capture (Table 9). The hypothesis tested

Table 8. Length-Frequency Distribution of Chinook
Taken on the Spring Cruise by Gear of Capture,
March 17-April 14, 1959.

Total Length (Inches)	Gear		Total
	Barbed	Barbless	
<14	8	3	11
14-15	8	5	13
16-17	13	3	16
18-19	7	3	10
20-21	7	4	11
22-23	8	12	20
24-25	11	9	20
26-27	29	30	59
28-29	36	28	64
30-31	31	20	51
32-33	7	9	16
34-35	10	8	18
36-37	2	5	7
38-39	2	1	3
40-41	5	2	7
Total	184	142	326

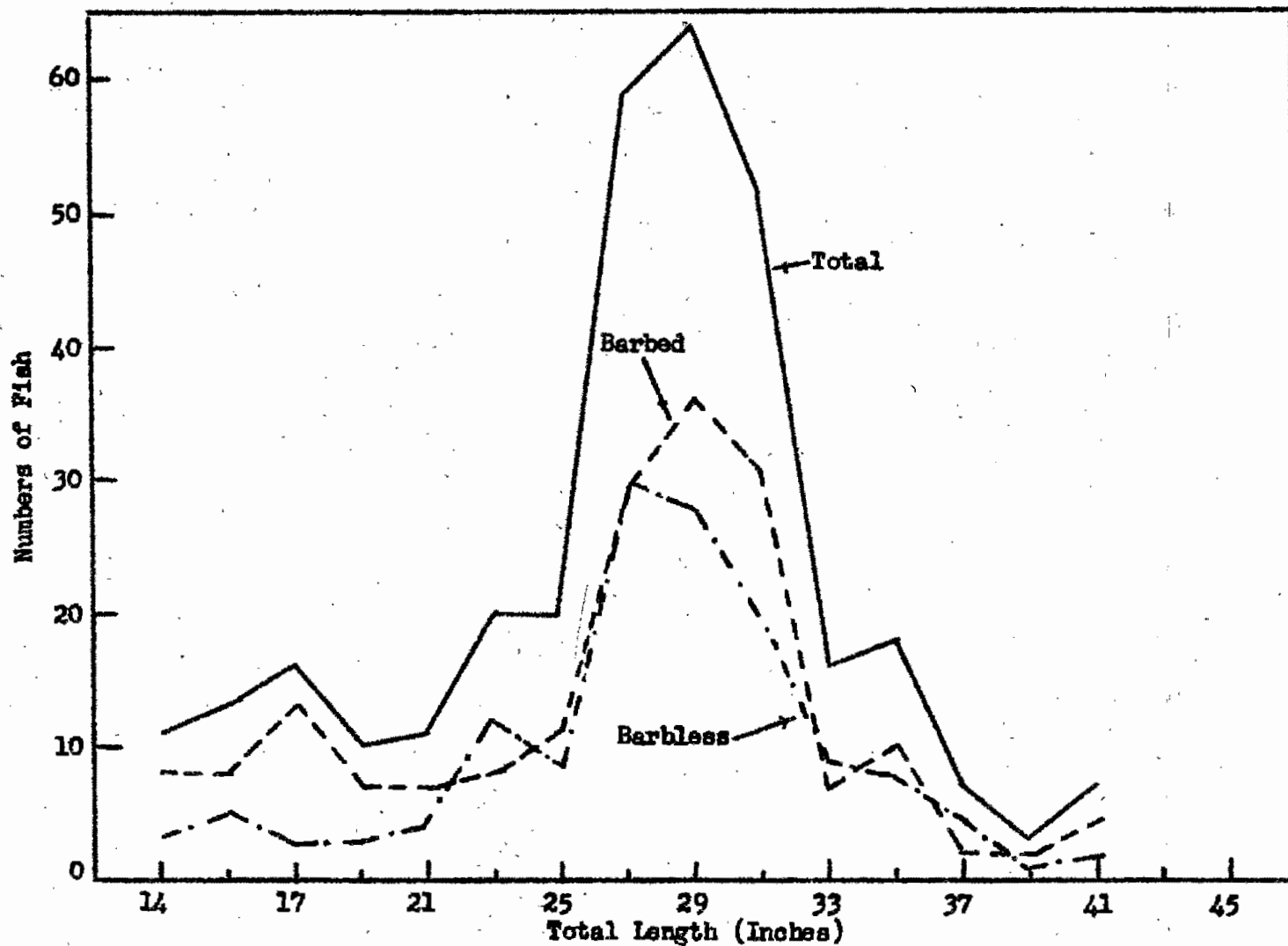


Figure 1. Length-Frequency Distribution of Chinook Taken on the Spring Cruise by Gear of Capture, March 17-April 14, 1959.

Table 9. Chi-Square Comparison of the Numbers of Chinook Taken on Barbed and Barbless Hooks, Spring Cruise, March 17-April 14, 1959.

Hypothesis (common to all 3 tests): barbed and barbless hooks are equally efficient for catching chinook.

Gear	Obs. Freq. f	Hypo. Freq. h	$f-h$	$(f-h)^2$	$(f-h)^2/h$
<u>Total Catch</u>					
Barbed	184	163	20.5	410.25	2.517
Barbless	142	163	-20.5	410.25	2.517
Total	326	326			5.034

Chi-square (1 d.f.) = 5.034 $P < 0.05$. Conclusion: hypothesis rejected, there is a significant difference in the numbers of chinook caught on barbed and barbless hooks.

Catch of Legal Chinook

Barbed	122	112.5	9.5	90.25	0.8022
Barbless	103	112.5	-9.5	90.25	0.8022
Total	225	225			1.6044

Chi-square (1 d.f.) = 1.6044 $P > 0.20$. Conclusion: accept the hypothesis, there is not a significant difference in the numbers of legal chinook caught on barbed and barbless hooks.

Catch of Sub-Legal Chinook

Barbed	62	50.5	11.5	132.25	2.6188
Barbless	39	50.5	-11.5	132.25	2.6188
Total	101	101			5.2376

Chi-square (1 d.f.) = 5.2376 $P < 0.05$. Conclusion: hypothesis rejected, there is a significant difference in the numbers of sub-legal chinook caught on barbed and barbless hooks.

was that both hooks were equally efficient at catching chinook. The tests demonstrated that when the total catch was considered, barbed hooks took significantly more fish than barbless hooks. More important, though, than their relative efficiency on fish of all sizes is the effectiveness of each hook on legal and sub-legal chinook. The catch of legal fish was not found to be significantly different between hooks, but the catch of sub-legal chinook on barbed hooks was significantly greater. Further tests were run (Table 10) to determine whether the average size of chinook differed according to the hook used in capture. No significant difference in size was found even though the sub-legal fish caught on barbless gear averaged 1.7 inches longer than those caught on barbed hooks (Table 11).

Fifteen fish died during the cruise, 7 of which were of legal size. Of these 7, 4 were taken on barbed hooks. However, 7 of the 8 sub-legal mortalities were caught on barbed hooks. This offers some evidence that barbless hooks could reduce discard mortality.

These data, while not conclusive, are encouraging to proponents of barbless hooks. The catch of legal fish, while less on barbless hooks than on barbed, was not significantly different. However, even if the difference had been significant, a reduction in the overall catch would not necessarily result. The legal fish that escaped at any given time are partially available for capture at a later date. In addition, the reduced catch of sub-legal chinook and the probable reduction of the mortality of those that are caught and released must result in a greater proportion of the stocks reaching marketable size. These two factors would act to compensate for a lowered catching efficiency—if one exists—of barbless hooks.

Table 10. Length-Frequency Distribution of Legal and Sub-Legal Chinook Caught on the Spring Cruise by Gear of Capture with Chi-Square Comparison of the Distribution Between Gear.

Length	Legal			Length	Sub-Legal		
	Barbed	Barbless	Total		Barbed	Barbless	Total
26-28	44	47	91	< 14	8	3	11
29-31	52	31	83	14-16	14	6	20
32-34	14	12	26	17-19	14	5	19
35-37	5	10	15	20-22	12	7	19
> 37	7	3	10	23-25	14	18	32
Total	122	103	225	Total	62	39	101

Hyp. Barbed and barbless hooks catch fish of all sizes with equal efficiency.

Chi-square (4 d.f.) = 7.3 $P > 0.10$

Conclusion: accept, there is not a significant difference in the length-frequency distributions of legal chinook caught on barbed and barbless hooks.

Hyp. Barbed and barbless hooks catch fish of all sizes with equal efficiency.

Chi-square (4 d.f.) = 6.7 $P > 0.10$

Conclusion: accept, there is not a significant difference in the length-frequency distributions of sub-legal chinook caught on barbed and barbless hooks.

Table 11. Average Length^{1/} of Legal and Sub-Legal Chinook by Gear of Capture, Spring Cruise, March 17-April 14, 1959.

Gear	Size Group	
	Legal	Sub-Legal
Barbed	30.0 (N=122)	18.6 (N=62)
Barbless	29.8 (N=103)	20.3 (N=39)

^{1/} Measurements are extended total length in inches.

Analysis of Tag Recovery Data

Recovery of tags was dependent on voluntary return by the finder. Each tag carried a return address and notice that a reward would be paid for its return. Total recovery by December 31, 1959 was 88 out of 311 released or 28.3%.

Dispersion from Tagging Area and Contribution by Stream

Table 12 depicts the movement of the tagged chinook and the number of recoveries made in each area. These fish went as far south as San Francisco Bay and north to central Vancouver Island. The main areas of recapture were off San Francisco Bay and along the northern Washington coast. There is some evidence that the fish, which moved north following tagging, were moving south to enter the Columbia River in August and September (note August recoveries in area 8 and 9). This is in contrast to the lack of recoveries in areas 3-5 in August and September following the known movement of tagged fish down the coast in June and July.

Freshwater recoveries of tags were limited to only three rivers: the Fraser, Columbia, and Sacramento-San Joaquin. This designates these rivers as contributors to the fishery under study, but does not eliminate the possibility of fish from other streams being involved. The numbers recovered by river were Fraser-1, Columbia-36, and Sacramento-San Joaquin-3. This suggests the Columbia as being important, but does not evaluate it directly due to great differences in recovery efficiency between rivers. Ten of the tags recovered in the Columbia system were from spring chinook. No tags were recovered from the spring runs in either the Fraser or Sacramento rivers. The Fraser recovery was from a fish taken in the commercial fishery near the mouth and was reported as a "white" chinook.

Table 12. Chinook Tag Returns from the 1959 Spring Cruise to December 31, 1959, by Month and Area of Recovery

Recovery Area	Month of Recovery										Total	Per Cent
	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.			
1. Sacramento-San Joaquin								1	1	1	3	3.4
2. Central Calif. Coast				8	1						9	10.2
3. Northern Calif. Coast			2								2	2.3
4. Southern Oregon Coast				1							1	1.1
5. Central Oregon Coast			1	1							2	2.3
6. N. Ore.-S. Wash. Coast	1			1	3						5	5.7
7. Columbia River	1	8			8	13	6 ^{Feb.}				36	40.9
8. Central Wash. Coast		1	3	2	4						10	11.4
9. Northern Wash. Coast			4	5	2	1					12	13.6
10. Inside Waters ^{1/}			1			1					2	2.3
11. Canadian Coast			3	2	1						6	6.8
Total Recoveries	2	9	14	20	19	15	7	1	1		88	100.0
Per Cent of Total Recoveries	2.3	10.2	15.9	22.7	21.6	17.0	8.0	1.1	1.1		99.9	

^{1/} Inside waters include Puget Sound, Straits of Georgia, and the Fraser River.

Effect on Columbia Fall Chinook Escapement

Analysis has not progressed to the development of a quantitative evaluation of the benefit the closure afforded the Columbia fall chinook stocks. Fish tagged during the test period appeared at three Columbia River fall chinook egg-taking stations (Spring Creek-9, Big White Salmon-1, and Little White Salmon-5) indicating that some additional spawners were realized. A method for extrapolating from this information to a calculated total number of additional hatchery spawners is being studied. This, however, would say nothing of the addition to the natural spawning stock.

The distribution of tag recoveries on fall chinook within the Columbia River was somewhat surprising. Table 13 shows the number of fall chinook handled and the number of tags recovered at three hatchery complexes. Examination of 47,000 fall chinook at the Little White Salmon-Spring Creek group of stations produced 15 tags while 9,000 fish, of closely related stocks, returning to Oregon hatcheries in the Bonneville Dam area produced no tags. This disparity could be the result of a difference in the oceanic distribution of the two stocks, but could also be due to chance. The passage of upper-river fall chinook over The Dalles Dam totaled 85,000 fish in 1959. No recoveries were received from these fish nor were any positive sightings of our tags made by counters at the dam.

Recoveries in the Tagging Area

One of the objections of Astoria-Westport-based fishermen and processors to the closure was that many of the fish protected by the closure would be caught later in other areas by other people. Table 12 bears out their contention in that only 6% of the recoveries were made in the tagging area. The other 94% of the recoveries were not necessarily a loss to these people, however, since some additional spawning did result from the closure.

Table 13. Number of Chinook Handled and Tags Found at Various Columbia River Hatcheries During the 1959 Spawning Season.

Hatchery	No. Chinook Examined	Tags Found
Spring Creek, Little White Salmon, Big White Salmon	47,149	15
Bonneville, Cascade, Oxbow	9,240	0
Remainder of lower Columbia hatcheries	3,233	0
Total	59,622	15

Relative Recovery by Commercial and Sport Gear

Table 14 depicts the distribution of the tag recoveries by gear of recovery including those escaping from all fisheries. Since the non-reported segment of the tags recovered by each fishery cannot be assumed to be the same for all fisheries, the exact relationship of the recoveries of each group to each other is not estimated by these data. This difficulty notwithstanding, the data indicates that the sport fishery was an important factor in the total fishing mortality exerted on the tagged fish.

Return by Age at Tagging

The degree and area of recovery of tagged chinook varied considerably according to the age and/or life history at tagging (Table 15). The 3₁'s (36% recovered) and 4₁'s (41%) displayed the greatest movement from the tagging area and were the most vulnerable to recapture. The recoveries from both groups were made from California north to the west coast of Vancouver Island. Columbia River recoveries formed 41% of the 3₁'s recovered compared to 22% for the 4₁'s. The 3₂'s, 4₂'s, and 5₂'s showed a much more limited distribution, with recoveries coming primarily or entirely from the Columbia River spring run or adjacent coastal areas. This difference in spatial distribution of the

Table 14. Distribution of Tag Returns by Area and Gear of Recovery, Spring Cruise, March 17-April 14, 1959.

	Sport		Commercial		Hatchery		Total	
	No.	%	No.	%	No.	%	No.	%
Ocean	19	21.6	29	33.0			48	54.5
River								
Spring	2	2.3	7	8.0	1	1.1	10	11.4
Fall	6	6.8	8	9.1	16	18.2	30	34.0
Total	27	30.7	44	50.0	17	19.3	88	99.9 100.0

Table 15. Tag Returns to December 31, 1959 by Age Group and Recovery Area for Chinook from the Spring Cruise, March 17-April 14, 1959.

Recovery Area (name)	Age Group							No Age	Total
	21	32	31	42	41	32	62		
Sacramento-San Joaquin			2					1	2
Central Calif. Coast			4		2			3	6
Northern Calif. Coast			1		1				2
Southern Oregon Coast			1						1
Central Oregon Coast			1	1					2
N. Ore.-S. Wash. Coast				4	1				5
Columbia River		1	24	6	2	3			36
Central Wash. Coast			10						10
Northern Wash. Coast			11		1				12
Inside Waters ^{1/}			1	1					2
Canadian Coast			4		2				6
Total Recovered	0	1	59	12	9	3	0	4	88
No. Tagged	28	27	164	35	22	19	1	15	311
Per Cent Recovered	0	4	36	34	41	16	0	3	28.3

^{1/} Inside waters include Puget Sound, Straits of Georgia, and the Fraser River.

recoveries between stream and ocean-type fish indicates that a meaningful distinction was made when the scales were read and adds credibility to the use of scale reading for making this separation. None of the twenty-eight 2_1 's tagged were recovered nor was the one 6_2 fish recovered. Hooking and tagging mortality could vary with age and may be partly accountable for the failure of returns from the 2_1 fish.

Gear-Treatment Effect on Survival

As mentioned previously both barbed and barbless hooks were used for fish capture. One of the anticipated benefits of barbless hooks is a reduced mortality of the discarded sub-legal chinook. A relative measure of this benefit could be obtained by comparing the percentage returns of fish tagged and released following capture on the two hooks. This is accomplished below. However, consideration was first given to whether the fish was anesthetized before tagging. The anesthetic, MS 222, was used at a 1:5,000 dilution on some fish in an attempt to reduce the inimical effect of tagging.

Because, as shown earlier, the percentage recovery of the tags varied between age groups and because the application of the anesthetic was not proportional to the numbers in each age group, analysis for a gear-treatment effect was restricted to fish of age 3_1 . Table 16 shows the numbers tagged and recovered and the per cent recovery for each gear-treatment group. The per cent recovered did not vary greatly or consistently between groups. The bivariate nature of the data made two tests of the benefits of each variable necessary. Visual evaluation of Table 16 yields conflicting results as to the improved survival gained from the use of either variable. Evaluation of the data statistically revealed no significant differences in the recovery rates.

Table 16. Recovery of 3₁ Age-Group Chinook by Gear-Treatment Group and Chi-Square Comparisons of the Rate of Tag Return Between Groups.

	Gear-Treatment Group				Total
	Barbed Anesthetic	Barbless Anesthetic	Barbed No Anesthetic	Barbless No Anesthetic	
No. Recovered	18	20	14	7	59
No. Tagged	51	55	35	23	164
Per Cent	35.3	36.4	40.0	30.4	36.0

Chi-Square Tests

Hypothesis: (Same for both tests) The rate of tag return is not related to gear of capture.

Treatment Constant-Compare between gear

Barbed-Anesthetic vs. Barbless-Anesthetic Chi-square (1 d.f.) = 0.013 $P > 0.90$

Barbed-No Anesthetic vs. Barbless-No Anesthetic Chi-square (1 d.f.) = 0.550
 $P > 0.30$

Hypothesis: (Same for both tests) The rate of tag return is not related to gear of capture.

Gear Constant-Compare between treatment

Barbed-Anesthetic vs. Barbed-No Anesthetic Chi-square (1 d.f.) = 0.195
 $P > 0.50$

Barbless-Anesthetic vs. Barbless-No Anesthetic Chi-square (1 d.f.) = 0.251
 $P > 0.50$

Conclusions: Cannot reject on any test. The rate of tag return was not affected by the variables tested.

OFFSHORE SALMON SURVEY

This study carried out in May and June 1959 was the subject of a cruise report (Ore. Fish Comm. Cruise Report - Offshore Salmon Survey) and was further discussed in the progress report immediately preceding this one.

Tagged fish released during this cruise were recovered through the course of the summer. By the end of December returns from the 74 chinook tagged reached 11 fish or 15%. Silver recoveries by the same date totaled 21 fish or 17% of the 126 tagged.

Three variables or duo-variables are under study in the program: (1) spatial distribution and degree of recovery by tagging area; (2) a comparison of Petersen, spaghetti, and dart tags for use on salmon; and (3) a determination of the benefits of barbless hooks towards increasing survival of released non-marketable salmon and of anesthetizing before tagging to reduce tagging mortality. The number of fish tagged by species and the number and per cent recovered for each condition under study are shown in Table 17. Appropriate statistical analysis of these returns has not been made. Examination of the recovery data for the two tagging areas reveals little difference in recovery rate between areas for both chinook and silvers. Of the 3 types of tags tested the dart tag has yielded the poorest returns on both species while the return rate of spaghetti and Petersen tags is similar. The gear-treatment data indicate that barbless hooks and anesthetic are beneficial in that returns from fish receiving neither of these benefits were low for both species. Discretion should be exercised in using these data at face value, however, since no evaluation of the effect of the variables of the other two groups on the variables under study has been made nor has the age composition of the chinook in each group been shown to be the same. Returns from commercial gear have exceeded those from sport gear for both species.

Table 17. Summary of Flicker Tagging May-June 1959 and the Subsequent Recoveries Through December 31, 1959.

	Silver		Chinook	
	No.	%	No.	%
Number Tagged				
By place of tagging				
Bandon	86		61	
Newport	40		13	
Total	126		74	
By type of tag				
Spaghetti	50		32	
Petersen	57		36	
Dart	19		6	
Total	126		74	
By gear-treatment				
Barbed - Anesthetic	32		16	
Barbed - No Anesthetic	31		20	
Barbless - Anesthetic	31		19	
Barbless - No Anesthetic	31		18	
Total	125 ^{1/}		73 ^{1/}	
Number and Per Cent Recovered				
By place of tagging				
Bandon	15	17.4	9	14.8
Newport	6	15.0	2	15.4
Total	21	16.7	11	14.9
By type of tag				
Spaghetti	9	18.0	6	18.8
Petersen	10	17.5	5	13.9
Dart	2	10.5	0	0.0
Total	21	16.7	11	14.9
By gear-treatment				
Barbed - Anesthetic	8	25.0	2	12.5
Barbed - No Anesthetic	3	9.7	2	10.0
Barbless - Anesthetic	6	19.3	6	31.6
Barbless - No Anesthetic	4	12.9	1	5.6
Total	21	16.8	11	15.1
By recapture gear				
Sport	9	7.2	1	1.4
Commercial	12	9.5	9	12.2
Hatchery	0	0.0	1	1.4
Total	21	16.7	11	14.9

^{1/} One fish tagged was not assignable to one of these categories.

SEAL STOMACH EXAMINATION

The stomachs of seven seals were examined during August and September. One of the animals was taken in a gill net. The other six were small seals (40-60 pounds) killed with a rifle in one afternoon near the mouth of the Columbia River. The stomach of the larger seal contained a few unidentifiable bones as the only solid matter. The other stomachs were empty.

TAG RETURNS FROM EARLIER STUDIES

Two tags were returned which had been put on chinook during the 1958 fatigue-mortality program. Details of the recoveries are shown in Table 18.

Table 18. Recoveries from 1958 Tagging.

Tag	Tagging			Recovery		
	Location	Date	Total Length (Inches)	Location	Date	Total Length (Inches)
A 487	Mouth of Columbia R.	9-26-58	21	Mouth of Columbia R.	6-18-59	About 28
A 405	Off Win- chester Bay	6-11-58	20	Off Yaquina Head	7-9-59	27

Robert E. Loeffel
Robert J. Ellis