

OREGON COASTAL SALMON and STEELHEAD TAGGING PROGRAMS

Part I. Tillamook Bay, 1953

Kenneth A. Henry

Part II. Siletz River, 1954

Alfred R. Morgan



FISH COMMISSION OF OREGON

Portland, Oregon

Contribution No. 28

May 1964

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OREGON COASTAL SALMON AND STEELHEAD TAGGING PROGRAMS

Part I. Tillamook Bay, 1953

Kenneth A. Henry^①

ABSTRACT

To aid in the management of the Tillamook Bay commercial salmon fishery, a tagging program was conducted on the salmon and steelhead trout runs in 1953. General migration behavior, the minimum length of time the fish remained in the fishery, population sizes, and fishing mortalities were determined from this study.

INTRODUCTION

During the 1953 fall commercial fishing season, the Oregon Fish Commission conducted a tagging program on salmon (*Oncorhynchus*) and steelhead trout (*Salmo gairdneri*) runs into Tillamook Bay to obtain data for the management of the fishery. The purpose of this program was to obtain estimates of: (1) the size of the population of each species; (2) the commercial fishing intensity; and (3) the length of time fish remain in the bay before moving to the spawning grounds.

Five main rivers enter Tillamook Bay, located approximately 50 miles south of the Columbia River: the Miami, Kilchis, Wilson, Trask, and Tillamook. Drainage areas of the two largest tributaries, the Wilson and Trask, are 159 and 143 square miles, respectively. Lower reaches of the five rivers flow through farm land while the upper watersheds are largely in burned-over timberland which has been or is being logged.

In 1953, the commercial fishery on Tillamook Bay extended from August 15 to December 10. The August-September fishery was primarily for fall chinook (*O. tschawytscha*). A large portion of the silver salmon (*O. kisutch*) run passes through the bay during October, while the chum salmon (*O. keta*) run occurs primarily during November. Some steelhead trout appear during the latter part of the chum salmon run. Gill nets are the only commercial fishing gear used. In 1953, drift nets were permitted the entire season and most set nets from October 15 to the end of the season. A 36-hour week-end closure was in effect until the set nets began to fish. All Oregon coastal streams except Tillamook Bay were closed to commercial salmon fishing in 1956. In this bay a 30-day maximum commercial season was permitted for the purpose of harvesting chum salmon. This season has been set by the Fish Commission from November 1 to November 30 each year from 1957 through 1961. In 1962 no commercial salmon fishing was allowed due to the decline in the chum salmon run.

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METHODS

Tagging operations on Tillamook Bay in 1953 began the last part of August and continued to December 10. A pair of plastic Petersen disc tags, held to the back of the fish by a nickel pin, were used. Fish for tagging were caught by commercial fishermen using gill nets with 6½- to 9¾-inch stretched mesh and 100 to 130 fathoms long. Generally two fishermen fished each night except during the week-end closures when additional men were employed.

The tagging crew (usually two biologists) and all the tagging equipment were in a small skiff. When a fish was caught in the net, the taggers hauled it into the skiff, placed it in a canvas tagging cradle, excised the tip of the caudal fin, tagged and released it. Removing the tip of the caudal fin helped to identify fish which subsequently lost their tags. In some instances it was necessary to cut a few meshes of the net in order to extract the fish with minimum injury. The tag number, fork length, tagging location, and condition of the fish were recorded. Fish were classified according to their apparent condition: those in condition 1 appeared uninjured and swam away quickly when released; condition 2 fish appeared slightly distressed and swam away rather slowly; condition 3 fish were injured or floated upon being released. Fish not discovered until the net was hauled into the boat at the end of a drift and found badly injured or dead were sold to fish dealers in the area with the proceeds going to the State of Oregon.

There were six principal fish buyers on Tillamook Bay who acquired most of the commercially caught fish. Fish were examined for tags, tag scars, and clipped caudal fins at the buyers nearly every day and a ratio of number tagged to number not tagged in the commercial catch was obtained. No attempt was made to sample the sport catch for tags or to intensively sample the spawning grounds for tagged fish.

CHINOOK SALMON

Tillamook Bay streams produce good runs of fall chinook salmon with an average annual commercial catch from 1928-53 of 319,400 pounds. Numbers of fall chinook also are taken by sport fishermen on the bay and in the tributaries. The average annual sport catch in Tillamook Bay and its tributaries, as estimated by an Oregon Fish Commission census, for the 7-year period 1947-53 was approximately 16,200 pounds. Spring chinook are not available to the commercial fishery.

Numbers Tagged, Areas of Tagging, and Mortality

The fishing area on Tillamook Bay is divided into a number of different drifts or locations (Figure 1). Fishermen tend to fish certain drifts, hence the area of tagging was dependent on which drift the fisherman chose. The first chinook was tagged on August 23 and the last on November 28. There were 491 fall chinook salmon tagged during the season (Table 1).

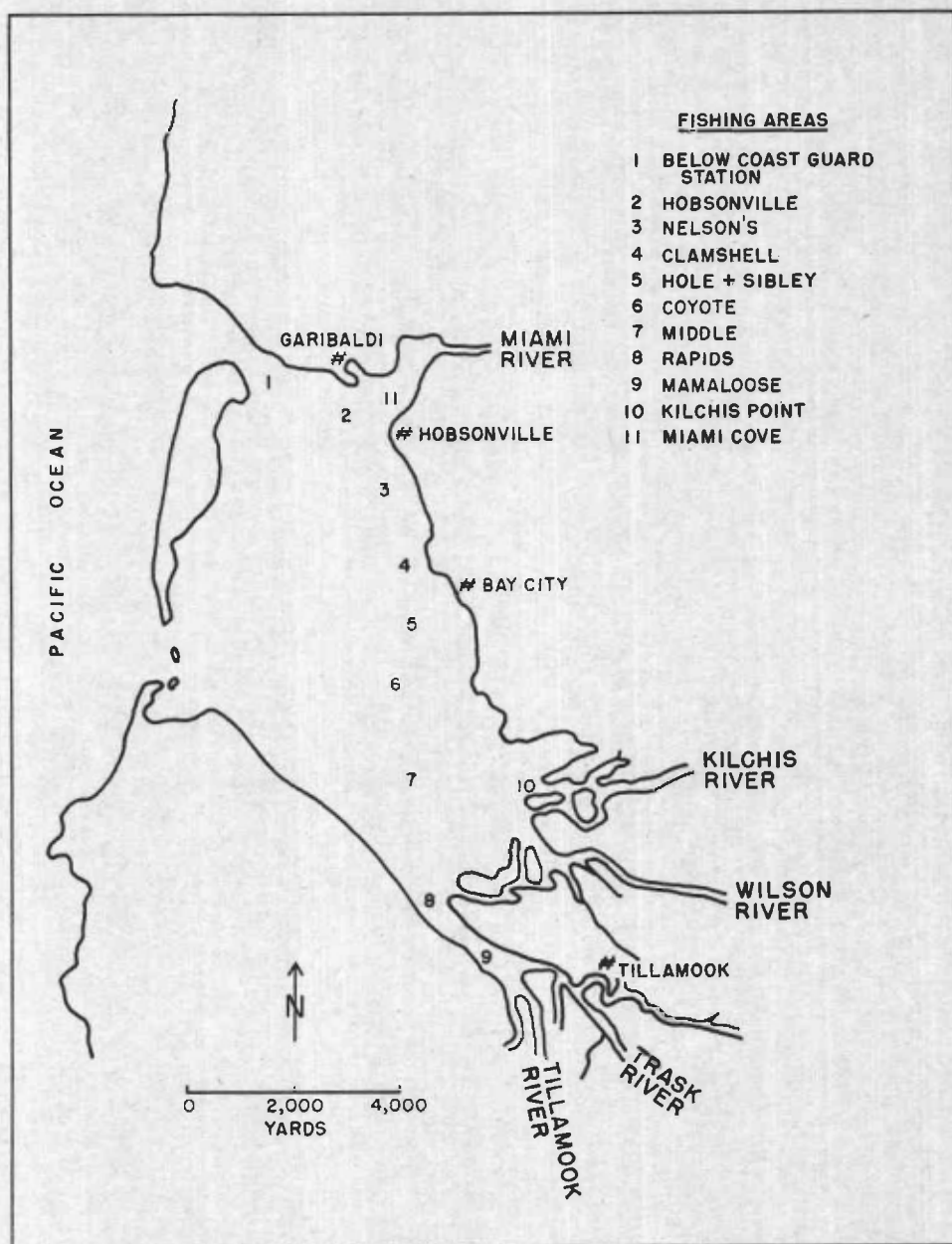


FIGURE 1. TILLAMOOK BAY SHOWING COMMERCIAL FISHING AREAS.

TABLE 1. NUMBER OF CHINOOK SALMON TAGGED AND RECOVERED IN THE COMMERCIAL FISHERY ACCORDING TO TAGGING AREA.

Tagging Area	Number Tagged	Number Recovered	Per Cent Recovered
1. Below Coast Guard Station	0	0	*****
2. Hobsonville	61	14	23.0
3. Nelson's	158	46	29.1
4. Clamshell	131	36	27.5
5. Hole + Sibley	25	8	32.0
6. Coyote	43	16	37.2
7. Middle	35	13	37.1
8. Rapids	38	12	31.6
9. Mamaloose	0	0	*****
Total	491	145	29.5

Fish captured for tagging were occasionally injured or at least exhausted. The apparent condition of the tagged fish when released was recorded in one of three categories (Table 2). Fish which appeared critically injured were not tagged. No significant difference could be demonstrated in the number of fish recovered from each category.

TABLE 2. NUMBER OF TAGGED CHINOOK SALMON RELEASED IN EACH CONDITION AND THE NUMBER AND PER CENT RECOVERED IN THE COMMERCIAL FISHERY.

Condition	Number Released	Number Recovered	Per Cent Recovered
1	178	44	24.7
2	155	54	34.8
3	158	47	29.7
Total	491	145	29.5

Recoveries From the Commercial Fishery

If the salmon moved continually through the fishing area towards the spawning grounds and did not mill in the bay, the fish tagged in the upper drifts (Rapids) would soon be out of the fishing area and would not be recaptured proportionally to those tagged and released in the lower drifts. To study this possibility, tag recoveries from the commercial fishery were examined according to area of tagging. Nine recoveries in Table 1 did not come from samples of the commercial catch, but were turned in by the cannery or fishermen. The percentage of the tagged chinook recaptured in the commercial fishery was fairly constant for all nine areas with a range of only 23 to 37 per cent. Under the hypothesis that the number of tagged fish recaptured in the commercial fishery was independent of the area of release, a chi-square value of 3.851 ($P=0.68$) was

calculated. This value is not significant and indicates that all the fish tagged in the different areas had approximately the same chance of being recaptured in the commercial fishery.

An analysis of tag recoveries according to direction of migration from the area tagged explains why fish tagged nearest the spawning grounds were recaptured in much the same proportion as those tagged in the lower bay. Direction of migration could be determined for only 64 recoveries. Under the hypothesis that the same number of fish moved "up" as "down", a chi-square value of 0.288 ($P=0.61$) with 1 degree of freedom was obtained. The hypothesis therefore was not rejected. In other words, there was no significant difference in the numbers of fish moving downstream or upstream. These results are dependent on the numbers of fish tagged in the different areas, and should therefore be viewed with caution.

Tagged chinook salmon from all areas were available to the fishery for nearly the same length of time. Exact date of recovery was known for 142 of the tag recoveries (Table 3). The average time out before recapture in the commercial fishery for all recoveries was 4.8 days. Although the uppermost drift in which tagged fish were released (Rapids) had the fastest average recovery (3.8 days), there was no consistent trend that indicated that fish nearest the spawning grounds were available for a shorter period than fish tagged in the lower bay. These figures must be considered

TABLE 3. ELAPSED TIME BETWEEN TAGGING AND RECAPTURE IN THE COMMERCIAL FISHERY FOR CHINOOK SALMON.

Tagging Area	Number of Fish Recovered	Days Between Release and Recapture	
		Average	Range
2. Hobsonville	14	5.6	1-22
3. Nelson's	45	4.7	0-26
4. Clamshell	35	4.8	0-21
5. Hole + Sibley	8	5.9	0-24
6. Coyote	15	4.7	0-17
7. Middle	13	4.9	0-14
8. Rapids	12	3.8	0-11
Total	142	4.8	

as the minimum time tagged fish were available to the commercial fishery in the various areas. For example, fish recaptured from those tagged on Clamshell Drift were at least available for an average of 4.8 days; this might have been more if these fish had not been recaptured when they were. Although there was little difference in the averages for the various areas, an examination of the ranges indicates that the maximum recorded time out before recapture in the commercial fishery was greater for fish from the lower bay. One fish, recaptured 59 days after tagging, was excluded from this analysis since it had apparently spawned in some tributary and drifted downstream.

The date of recovery was plotted against tagging date for 142 recoveries from the commercial fishery (Figure 2). A perpendicular to the X-axis dropped from any number on this figure gives the date of tagging. The distance between the diagonal line and the numbers on or above, measured on the perpendicular axis, represents the time elapsed between tagging and recovery of one or more fish in the commercial fishery. Distribution of recoveries seems to indicate a comparatively slow migration of chinook during September and early October and fairly rapid movement from mid-October to the end of the season. Only one fish tagged after October 11 was recovered after more than five days, whereas a number of recoveries from the earlier tagging were out longer than five days. Since there is no other information available on the migration speed of Tillamook Bay salmon, it is not known whether these data can be applied to other years or are subject to annual variations.

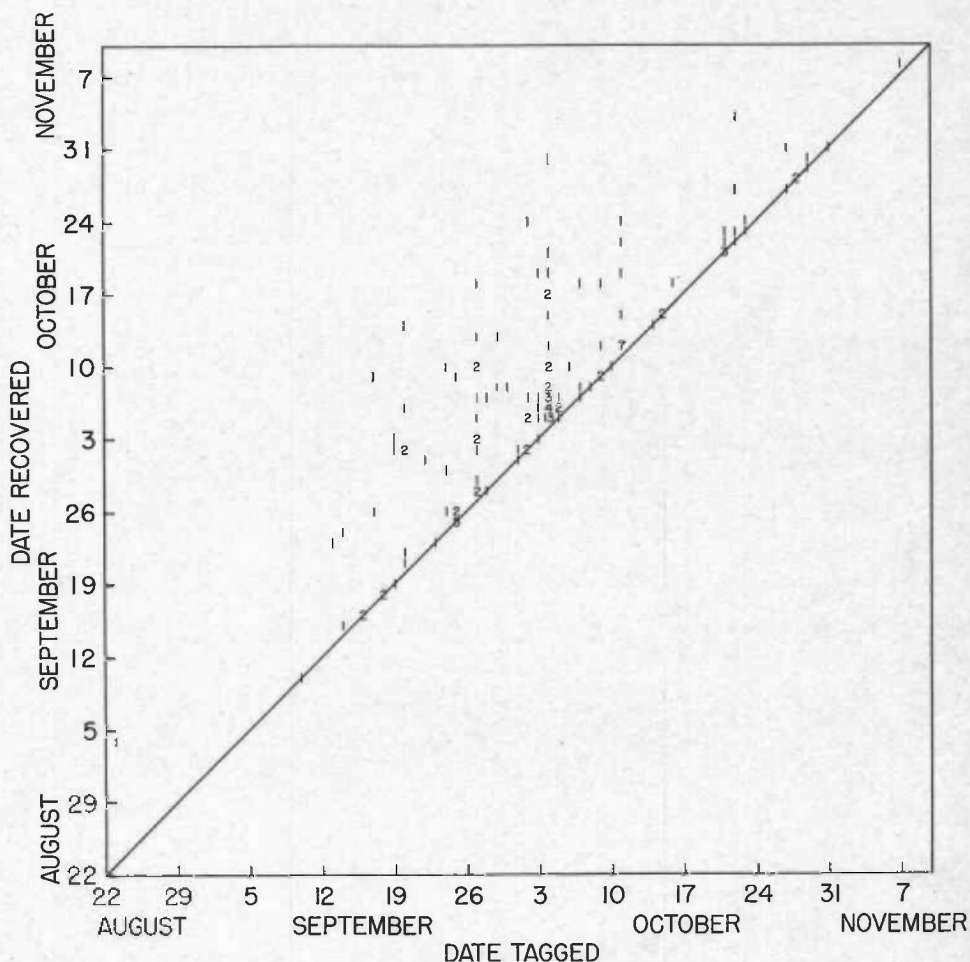


FIGURE 2. RECOVERIES OF TAGGED CHINOOK SALMON BY THE COMMERCIAL FISHERY ACCORDING TO DATE TAGGED AND RECOVERED.

During the season 5,589 chinook salmon, or 89 per cent of the calculated total catch, were examined for tags. In this sample, 136 tags and 23 tag scars were observed, and 9 additional tags were turned in by fishermen and dealers (some of these tags could have come from fish observed in the sample with tag scars). This made a total of 168 recaptures in the commercial landings (Table 4). Assuming that the numbers of recoveries in time of tagged fish approximate a Poisson distribution (Chapman, 1948), confidence limits may be introduced by reference to Ricker (1937, p. 352). Thus, for the 159 recoveries actually observed in the sample, with 95 per cent confidence, the true number of tags in the sample should be between 136 and 186. Extrapolating to the entire catch would give 95 per cent confidence limits of 153 and 209 tags in the commercial catch. For each fish with a tag or tag scar, there were 35 untagged fish.

Since the commercial landings are recorded in pounds of fish, it was necessary to use average weight data obtained from samples by the biolo-

TABLE 4. NUMBER OF TAGS AND TAG SCARS RECOVERED FROM SAMPLING THE CHINOOK SALMON COMMERCIAL CATCH AND CALCULATED RECOVERIES IN THE TOTAL CATCH.

Week Ending	Number of Fish Sampled	Number of Recaptures			Calculated Number of Fish in the Commercial Catch ^①	Calculated Number of Tags and Tag Scars Recovered in Commercial Catch
		Tags	Tag Scars	Total		
August 22	108	0	0	0	272	0
29	45	0	0	0	92	0
Sept. 5	178	0	0	0	242	0
12	229	1	1	2	303	2.6
19	316	5	1	6	369	7.0
26	757	12	1	13	873	15.0
Oct. 3	761	17	4	21	797	22.0
10	957	52	5	57	958	57.1
17	758	19	5	24	853	27.0
24	679	19	2	21	711	22.0
31	376	9	2	11	393	11.5
Nov. 7	194	1	2	3	196	3.0
14	107	1	0	1	110	1.0
21	78	0	0	0	78	0
28	20	0	0	0	27	0
Dec. 5	26	0	0	0	26	0
12	0	0	0	0	1	0
Entire Season	5,589	136	23	159	6,301	168.2

① Based on average weight of samples of the commercial catch by week.

gists throughout the season to convert pounds to numbers. These conversions introduce a possible source of error in some of the subsequent calculations. Average weight for the entire season was 25.7 pounds, and the weekly average varied from 17.3 to 28.5. From the average weight data and the pounds taken each week, it was calculated that the commercial fishery caught 6,301 chinook salmon during the season.

The data were summarized to show the calculated percentage of fish tagged each week that were eventually recovered in the commercial fishery (Table 5).

The calculated per cent recovered of the total number tagged each week was not consistent throughout the season. There was increased fishing intensity with the use of set nets starting in mid-October. However, about 70 per cent of the total chinook catch had been landed before the set nets were permitted to fish. Thirty-three tags were recovered after the set nets started fishing of which 17 were caught in drift nets, 1 in a set net, and 15 unspecified as to gear used.

TABLE 5. NUMBER OF CHINOOK SALMON TAGGED AND TAGS RECOVERED IN THE COMMERCIAL FISHERY BY WEEK TAGGED.

<i>Week Ending</i>	<i>Number Tagged Each Week</i>	<i>Actual Recoveries in Samples of the Commercial Catch, by Week Tagged^①</i>	<i>Calculated Recoveries in the Commercial Catch, by Week Tagged</i>	<i>Calculated Per Cent Tag Recovery in Season's Catch, by Week Tagged</i>
August 29	4	0	0	0
Sept. 5	7	0	0	0
12	10	2.00	2.12	21.1
19	37	12.82	13.56	36.6
26	65	19.24	20.35	31.3
Oct. 3	87	33.69	35.64	41.0
10	166	50.32	53.23	32.1
17	70	17.21	18.21	26.0
24	27	14.16	14.98	55.5
31	11	8.56	9.06	82.4
Nov. 7	3	1.00	1.06	35.3
14	1	0	0	0
21	3	0	0	0
28	0	0	0	0
Dec. 5	0	0	0	0
12	0	0	0	0
Total	491	159.00	168.20	34.3

^① Recoveries of tag scars are assigned to each tagging week in proportion to the tag recoveries.

Under the hypothesis that a tag was either recovered or not recovered independent of the time of tagging, a chi-square value of 7.760 ($P=0.26$) with 6 degrees of freedom was calculated. Tag scars were not included in this analysis. The time of tagging evidently had no significant effect on whether a tagged chinook was recovered in the commercial fishery.

Recoveries From Sport Fishery, Spawning Grounds, and Other River Systems

Nine tagged chinook salmon were reported by sport fishermen: 6 from the Wilson River, 2 from the Tillamook, and 1 from the Kilchis. No attempt was made to sample the sport catch and all tag returns were voluntary.

Spawning ground surveys began in September and continued until January, but no effort was made to sample the spawning fish intensively for tags. Four tagged chinook salmon were recovered from Tillamook Bay spawning grounds: 1 from the Trask River at the Oregon Fish Commission hatchery, 2 from the Tillamook River, and 1 from the Wilson River.

Three tags were recovered from the Nehalem River commercial fishery (about 10 miles north of Tillamook Bay) and one recaptured in the Alsea River commercial fishery (about 85 miles south of Tillamook Bay). These fish possibly strayed from Tillamook Bay as a result of the tagging operation or, more likely, they originated in the other river systems and had wandered into Tillamook Bay.

Estimate of Population Available to the Commercial Fishery

Accurate estimation of the size of an adult salmon population by tagging has been a problem to fishery workers. Most procedures are designed for a "closed" population (i.e., without any recruitment). Salmon, with their extensive migrations, do not lend themselves to the usual methods of estimation.

Chapman and Junge (1954) devised a method for estimating the size of migrating fish populations by tagging at one locality and sampling in another. In many instances this method can be applied to salmon populations. Unfortunately, however, tagging and recovery for Tillamook Bay took place in the same general locality in the midst of an active fishery, so the Chapman-Junge formula was not applicable.

Schaefer (1951a and 1951b) devised a method of estimating salmon populations which recognized the fact that fish were migrating through an area and consequently the number tagged and number sampled would not be the same proportion of the population throughout the run. Although this procedure has been criticized as magnifying the sampling error, it appears to be as reliable as any available.

In this experiment only a few fish were tagged the first two weeks and none of these was recovered. The population estimate calculated by Schaefer's formulae is based only on those periods which have tag recoveries (September 6 to November 14). Some of the tag scars recovered may have been from the fish tagged in the first two weeks of tagging, however, since only 11 fish were tagged before September 6, the error

incurred is negligible. Therefore this estimate is of the population of fish available to the fishery from September 6 to November 14, inclusive. It does not estimate the total number entering Tillamook Bay to spawn because some chinook entered the bay before and after this period, and others, although available to the Tillamook Bay fishery, originated in other river systems.

The data from Tillamook Bay were arranged as by Schaefer (1951 b). In Table 6 the tag scars recovered have been included on a proportional basis and total recoveries (tags plus tag scars) are listed by week of release and recovery. The number of fish available for each weekly period is estimated by the formula $NA = \frac{btn}{as}$; the sum of these weekly estimates provides an estimate of 15,512 chinook salmon for this period (Table 7). Symbols used are: a = total tagged fish recovered according to week tagged, t = total fish tagged each week, s = total tagged fish recovered each week, n = number of fish in the samples each week, and b = tag recoveries for each weekly period.

A population estimate was also made using the equation discussed by Chapman (1951): $N = \frac{(n+1)(t+1)}{(s+1)} - 1$, where N = the estimate of the total population, n = the number sampled, s = the number of tagged individuals recovered in the samples, and t = the total number tagged. For this estimate to be accurate, either the weekly tagging or sampling should be in the same proportion to the population present. Using this equation for the same period (September 6 to November 14) with $n = 5,134$, $t = 477$, and $s = 159$; $N = \frac{(5,135)(478)}{(160)} = 15,341$.

Chapman (1948) has provided formulae for calculating upper and lower limits of the population estimate with 95 per cent confidence limits. The upper limit was found to be 17,936 fish and the lower limit 13,042.

If the available chinook salmon population was about 15,500, then a maximum of 36 per cent (5,563) was taken by the commercial fishery during the period September 6 to November 14. This 36 per cent fishing mortality applies only to the population of fish available to the fishery between those dates.

All the population estimates in this report are subject to the normal errors associated with estimating populations by tagging (Bevan, 1959). One of the major errors which can occur is caused by tagging mortality—causing the tagged fish to die unnaturally due to handling—or by the loss of the tag. This latter error is believed to have been almost eliminated from the Tillamook Bay data through the identification of tagged fish by the excised fin and because the fish were available for such a relatively short time after tagging.

SILVER SALMON

Silver salmon runs in Tillamook Bay have been relatively smaller than chinook runs. Landings averaged about 310,000 pounds per season from 1928 through 1953 and since 1945 less than 200,000 pounds.

TABLE 6 TAGGED CHINOOK SALMON RELEASED AND TAG RECOVERIES FROM SAMPLING THE COMMERCIAL CATCH.

Week of Recovery	Week of Tagging																	Total Tags Recovered (s)	Number of Fish Sampled (n)	Fish Per Tag n/s
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
1																			108	
2																			45	
3																			178	
4				2.00														2	229	114.50
5					6.00													6	316	52.67
6					3.25	9.75												13	757	58.23
7					2.47	4.94	13.59											21	761	36.24
8					1.10	3.29	14.25	38.36										57	957	16.79
9						1.26	2.53	6.32	13.89									24	758	31.58
10							3.32	4.42	3.32	9.94								21	679	32.33
11								1.22		1.22	8.56							11	376	34.18
12										3.00								3	194	64.67
13												1.00						1	107	107.00
14																			78	
15																			20	
16																			26	
17																			0	
Tags Recovered (a)				2.00	12.82	19.24	33.69	50.32	17.21	14.16	8.56	1.00						159		
Total Tagged (t)		4	7	10	37	65	87	166	70	27	11	3	1	3						
t/a				5.00	2.89	3.38	2.58	3.30	4.07	1.91	1.29	3.00								

TABLE 7. ESTIMATE OF CHINOOK SALMON POPULATION AVAILABLE TO THE COMMERCIAL FISHERY.^①

Week of Recovery	Week of Tagging																	Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1																		
2																		
3																		
4				1,145														1,145
5					913													913
6					547	1,919												2,466
7					259	605	1,271											2,135
8					53	187	617	2,125										2,982
9						134	206	659	1,785									2,784
10							277	472	437	614								1,800
11								138		80	377							595
12										371								371
13												321						321
14																		
15																		
16																		
17																		
Total				1,145	1,772	2,845	2,371	3,394	2,222	1,065	377	321						15,512

① Calculated from data in Table 6 and method developed by Schaefer (1951b).

The average annual catch of silver salmon by sportsmen on Tillamook Bay and its tributaries, as estimated by Oregon Fish Commission censuses, was about 14,000 pounds during the period 1947-53.

Numbers Tagged, Areas of Tagging, and Mortality

Tagging locations for silver salmon were the same as those shown in Figure 1. The first silver was tagged August 29 and the last November 28, with a total of 255 tagged during the season (Table 8).

Silver salmon captured for tagging were also occasionally injured or exhausted when tagged and apparent condition of tagged fish when released was recorded as for chinook (Table 9). Critically injured fish were not tagged. Using a chi-square test, no significant difference could be demonstrated in the numbers of fish recovered in each condition category.

TABLE 8. NUMBER OF SILVER SALMON TAGGED AND RECOVERED IN THE COMMERCIAL FISHERY ACCORDING TO TAGGING AREA.

Tagging Area	Number Tagged	Number Recovered	Per Cent Recovered
1. Below Coast Guard Station	2	1	50.0
2. Hobsonville	13	0	0.0
3. Nelson's	32	5	15.6
4. Clamshell	36	8	22.2
5. Hole + Sibley	28	2	7.1
6. Coyote	31	5	16.1
7. Middle	62	17	27.4
8. Rapids	51	10	19.6
9. Mamaloose	0	0	-----
Total	255	48	18.8

TABLE 9. NUMBER OF TAGGED SILVER SALMON RELEASED IN EACH CONDITION AND THE NUMBER AND PER CENT RECOVERED IN THE COMMERCIAL FISHERY.

Condition	Number Released	Number Recovered	Per Cent Recovered
1	108	22	20.4
2	82	19	23.2
3	65	7	10.8
Total	255	48	18.8

Recoveries From the Commercial Fishery

There were 48 silvers recovered in the commercial fishery. The percentage of tagged silvers recaptured showed considerable variation for the different tagging areas, ranging from 0 to 50 per cent (Table 8). However, there was no consistent trend and areas in the lower bay did not

have greater or lesser recoveries, on a percentage basis, than the upper bay.

In testing the hypothesis that the capture of a tagged fish by the commercial fishery was independent of the area in which it was released, a chi-square value of 4.722 ($P=0.32$) with 4 degrees of freedom was calculated. Due to the small number of recoveries in some areas, it was necessary to group the results from adjoining tagging sites. This reduced the value of the analysis for distinguishing differences between the separate areas, although only areas in the same general locality were grouped. Nevertheless, in view of the chi-square value obtained, it was concluded that a fish tagged in any area had the same chance of being recaptured.

Analysis of tag recoveries according to direction of migration from the area of release explains why fish tagged nearest the spawning grounds were recaptured in much the same proportion as those tagged in the lower part of the bay. It was possible to determine direction of migration for only 24 of the 48 known recoveries in the commercial fishery. Under the hypothesis that the same number of fish moved "up" as "down", a chi-square value of 2.90 ($P=0.09$) with one degree of freedom was calculated. Therefore, the hypothesis was not rejected although there appeared to be a tendency for more silvers to be caught above the tagging area than below, and random movement was not as apparent as for chinook.

Time elapsed between tagging and recapture in the commercial fishery was examined by analyzing recoveries of silvers tagged in the different areas. Date of recapture was known for 46 recoveries (Table 10).

TABLE 10. ELAPSED TIME BETWEEN TAGGING AND RECAPTURE IN THE COMMERCIAL FISHERY FOR SILVER SALMON.

Tagging Area	Number of Fish Recovered	Days Between Release and Recapture	
		Average	Range
1. Below Coast Guard Station	1	1.0
3. Nelson's	5	3.2	0-8
4. Clamshell	7	6.0	0-18
5. Hole + Sibley	2	3.0	1-5
6. Coyote	5	5.0	1-8
7. Middle	17	6.9	0-30
8. Rapids	9	3.2	0-10
Total	46	5.1	

Average time out before recapture in the commercial fishery for the entire season and all areas was 5.1 days. There is no consistent trend to indicate that fish nearer the spawning grounds were available to commercial fishermen for a shorter period than fish tagged in the lower part of the bay.

Figure 3 shows 46 recoveries made in the commercial fishery according to time of tagging. Distribution of these recoveries does not indicate any

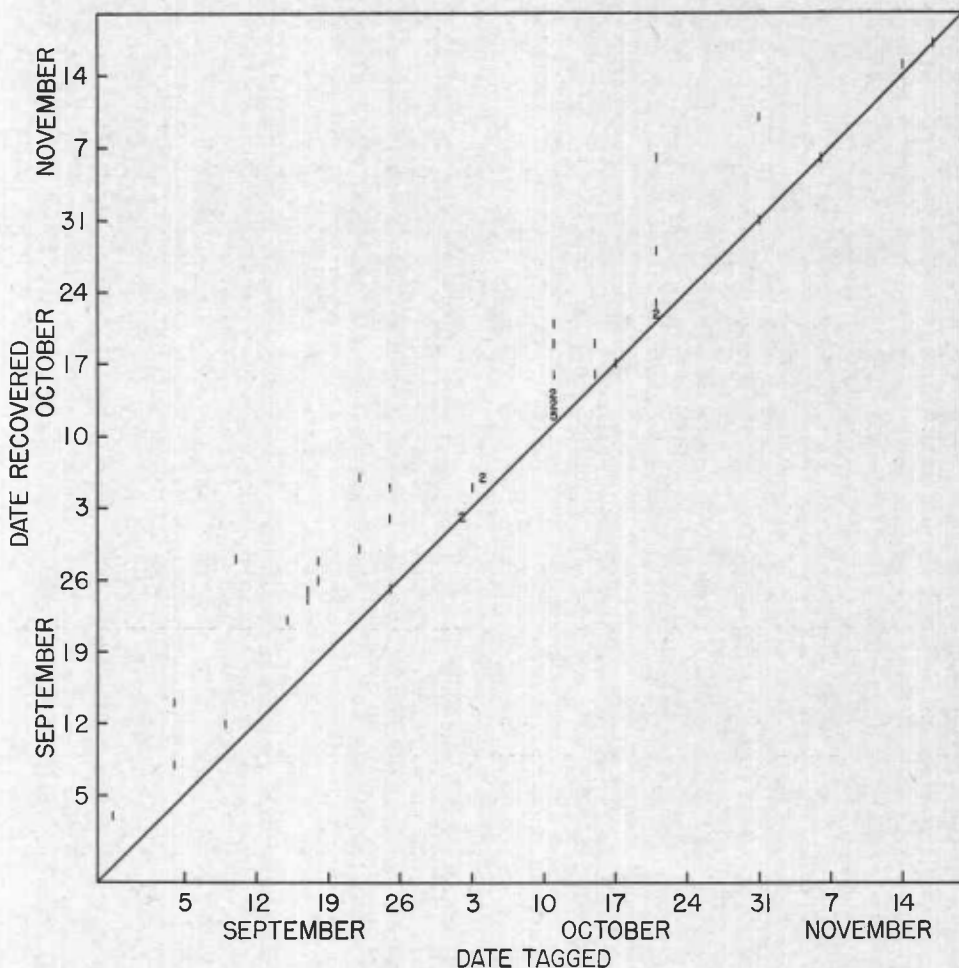


FIGURE 3. RECOVERIES OF TAGGED SILVER SALMON BY THE COMMERCIAL FISHERY ACCORDING TO DATE TAGGED AND RECOVERED.

consistent migration pattern through the fishing area. The fish tagged in early October and November appeared to move out of the fishery quite rapidly.

Daily commercial silver salmon landings in Tillamook Bay were examined by biologists for tags and the ratio of the number of tagged fish to the number not tagged in the commercial catch was obtained. During the season 5,950 silver salmon, or 88 per cent of the calculated total catch (6,799), were sampled and 46 tags and 18 tag scars observed. Two additional tags turned in by fishermen could have come from fish observed in the sample with only a tag scar.

Sixty-four silver salmon with tags or tag scars were recovered by sampling the commercial fishery and 71 recoveries were calculated for

the entire commercial catch (Table 11). Confidence limits may be introduced by reference to Ricker (1937, p. 352). For the 64 recoveries in the sample, with 95 per cent confidence the true number of recoveries in the sample should be between 50 and 82. Extrapolating to the entire catch would give 95 per cent confidence limits of 57 and 93 tags. For each fish with a tag or tag scar, there were 93 untagged fish in the combined weekly samples for the season.

Commercial landings are recorded in pounds of fish and average weights obtained from samples by biologists were used to convert these to numbers. The average weight for the entire season was 10.4 pounds, although the average varied somewhat from week to week. From these data and the total silver salmon poundage landed, the numbers of fish caught each week were computed and it was calculated that the commercial fishery caught 6,799 silver salmon during the season. Average weights were estimated for the weeks ending August 22 and December 5 when only a few fish and no tags were recorded.

TABLE 11. NUMBER OF TAGS AND TAG SCARS RECOVERED FROM SAMPLING THE SILVER SALMON COMMERCIAL CATCH AND CALCULATED RECOVERIES IN THE TOTAL CATCH.

Week Ending	Number of Fish Sampled	Number of Recaptures			Calculated Number of Fish in Commercial Catch ^①	Calculated Number of Tags and Tag Scars Recovered in Commercial Catch
		Tags	Tag Scars	Total		
August 22	1	0	0	0	6	0
29	2	0	0	0	9	0
Sept. 5	105	1	0	1	214	2.0
12	108	2	0	2	164	3.0
19	308	1	2	3	382	3.7
26	233	5	0	5	289	6.2
Oct. 3	571	6	3	9	607	9.6
10	863	5	2	7	917	7.4
17	819	12	0	12	827	12.1
24	990	6	4	10	1,005	10.2
31	335	2	2	4	381	4.6
Nov. 7	517	2	1	3	632	3.7
14	309	1	1	2	398	2.6
21	573	3	3	6	606	6.3
28	129	0	0	0	225	0
Dec. 5	68	0	0	0	102	0
12	19	0	0	0	35	0
Entire Season	5,950	46	18	64	6,799	71.4

① Based on average weight of samples of the commercial catch by week.

The calculated percentage recovered of silvers tagged each week was not consistent throughout the season (Table 12). Increased fishing intensity, resulting from the use of set nets beginning in mid-October, is again indicated. Only 44 per cent of the commercial catch of silver salmon was made before the set nets were permitted to fish. Of the 17 tag recoveries made after set nets started fishing, 5 were caught in drift nets, 1 in a set net, and the remaining 11 in undetermined type of gear.

Under the hypothesis that whether a tag was recovered or not was independent of time of tagging, a chi-square value of 5.521 ($P=0.24$) with 4 degrees of freedom was calculated. Tag scars were not included in this analysis. Time of tagging evidently had no significant effect on whether a tag was recovered in the commercial fishery. Because of the small number of recoveries, the data were grouped by 2-week periods.

TABLE 12. NUMBER OF SILVER SALMON TAGGED AND TAGS RECOVERED IN THE COMMERCIAL FISHERY BY WEEK TAGGED.

Week Ending	Number Tagged Each Week	Actual Recoveries in Samples of the Commercial Catch, by Week Tagged ^①	Calculated Recoveries in the Commercial Catch, by Week Tagged	Calculated Per Cent Tag Recovery in Season's Catch, by Week Tagged
August 29	1	1.0	1.00	100.0
Sept. 5	12	4.0	4.47	37.3
12	6	2.5	2.79	46.5
19	46	5.5	6.15	13.4
26	39	6.8	7.60	19.5
Oct. 3	26	4.4	4.92	18.9
10	13	2.8	3.13	24.1
17	46	17.0	19.00	41.3
24	41	10.5	11.73	28.6
31	9	4.0	4.47	49.7
Nov. 7	3	1.5	1.68	56.0
14	6	2.0	2.23	37.2
21	6	2.0	2.23	37.2
28	1	0	0	0
Dec. 5	0	0	0	0
12	0	0	0	0
Total	255	64.0	71.40	28.0

^① Recoveries of tag scars are assigned to each tagging week in proportion to the tag recoveries.

Recoveries From Sport Fishery, Spawning Grounds, and Other River Systems

Five tagged silver salmon were voluntarily reported by sport fishermen: 2 from the Wilson River, 2 from the Kilchis, and 1 from the Tillamook. No attempt was made to sample the sport catch. No tagged silvers were recovered on the spawning grounds.

Six tags were recovered outside Tillamook Bay: one by a commercial troller 2 miles south of Columbia River Buoy No. 2; and 4 by commercial fishermen and 1 by a sportsman in the Nehalem River. It is believed that

TABLE 13. TAGGED SILVER SALMON RELEASED AND TAG RECOVERIES FROM SAMPLING THE COMMERCIAL CATCH.

Week of Recovery	Week of Tagging																	Total Tags Recovered (s)	Number of Fish Sampled (n)	Fish Per Tag η/s
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
1																			1	
2																			2	
3		1.00																	105	105.00
4			1.00	1.00															108	54.00
5			3.00																308	102.67
6				4.00	1.00														233	46.60
7				1.50	3.00	3.00													571	63.44
8					2.80	1.40	2.90												863	123.29
9								12.00											819	66.25
10								5.00											990	99.00
11									2.00	2.00									335	83.75
12									1.50			1.50							517	172.33
13										2.00			2.00						309	154.50
14											2.00		2.00	2.00					573	95.50
15																			129	
16																			68	
17																			19	
Tags Recovered (a)	1.00	4.00	2.50	5.50	6.80	4.40	2.80	17.00	10.50	4.00	1.50	2.00	2.00	2.00	2.00		64			
Total Tagged (t)	1	12	6	46	39	26	13	46	41	9	3	6	6	6	1					
t/a	1.00	3.00	2.40	8.36	5.74	5.91	4.64	2.71	3.90	2.50	2.00	3.00	3.00	3.00						

TABLE 14. ESTIMATE OF SILVER SALMON POPULATION AVAILABLE TO THE COMMERCIAL FISHERY.^①

Week of Recovery	Week of Tagging																	Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
3	-----	105	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	105
4	-----	-----	162	130	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	292
5	-----	-----	924	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	924
6	-----	-----	-----	-----	1,558	267	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1,825
7	-----	-----	-----	288	796	1,092	1,125	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	3,241
8	-----	-----	-----	-----	-----	1,982	1,020	1,602	-----	-----	-----	-----	-----	-----	-----	-----	-----	4,604
9	-----	-----	-----	-----	-----	-----	-----	2,219	-----	-----	-----	-----	-----	-----	-----	-----	-----	2,219
10	-----	-----	-----	-----	-----	-----	-----	1,345	1,931	-----	-----	-----	-----	-----	-----	-----	-----	3,276
11	-----	-----	-----	-----	-----	-----	-----	-----	653	419	-----	-----	-----	-----	-----	-----	-----	1,072
12	-----	-----	-----	-----	-----	-----	-----	-----	1,008	-----	773	517	-----	-----	-----	-----	-----	1,525
13	-----	-----	-----	-----	-----	-----	-----	-----	-----	745	-----	-----	573	573	-----	-----	-----	773
14	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1,891
15	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
16	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
17	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Total	-----	105	1,086	358	2,354	3,341	2,145	1,602	3,564	4,337	1,192	517	573	573	-----	-----	-----	21,747

① Calculated from data in Table 13 and method developed by Schaefer (1951b).

the latter fish were Nehalem River fish which had wandered into Tillamook Bay; a previous marking experiment (Henry, 1955) has shown that such wandering occurs.

Estimate of Population Available to the Commercial Fishery

In Table 13, data for computing population estimates are presented. Tag scars recovered have been included on a proportional basis, and the total (tags plus tag scars) are listed according to week of recovery and release. Schaefer's formulae and methods (1951b) were used to obtain an estimate of 21,747 for the silver salmon population (Table 14).

Another estimate of the population was made using the Chapman (1951) formula: $n = 5,733$, $t = 254$, and $s = 64$, the population estimate $N = \frac{(5,734)(255)}{(65)} = 22,495$. Using Chapman's formulae (1948, p. 78), 95 per cent confidence limits on the true value of the population estimate of 22,495 would be 28,985 and 17,420.

Assuming that the true population available to the commercial fishery during this period was about 22,000 fish, a maximum of about 29 per cent (6,431) were caught by the commercial fishery. This 29 per cent fishing mortality applies only to the population of fish available to the fishery between August 23 and November 21.

CHUM SALMON

Chum salmon runs into Tillamook Bay have been characterized by rather severe fluctuations (Henry 1953, 1954). From 1928 through 1953, chum landings averaged 730,000 pounds per season. The record was set in 1928 with 2.8 million pounds. There is no sport fishery on these fish.

Numbers Tagged, Areas of Tagging, and Mortality

In Table 15 are listed the numbers of fish tagged and released in each of the localities noted in Figure 1. The first chum salmon was tagged October 11 and the last on December 4. A total of 325 chum salmon was tagged during the season.

TABLE 15. NUMBER OF CHUM SALMON TAGGED AND RECOVERED IN THE COMMERCIAL FISHERY ACCORDING TO TAGGING AREA.

Tagging Area	Number Tagged	Number Recovered	Per Cent Recovered
1. Below Coast Guard Station	42	14	33.3
2. Hobsonville	2	0	0
3. Nelson's	18	5	27.8
4. Clamshell	244	68	27.9
5. Hole + Sibley	2	1	50.0
6. Coyote	8	2	25.0
7. Middle	2	0	0
8. Rapids	7	0	0
9. Mamaloose	0	-----	-----
Total	325	90	27.7

Tag recoveries were analyzed according to the condition of the fish when tagged. A greater percentage of the fish in condition 1 were recaptured (Table 16), but no significant difference could be demonstrated between categories.

TABLE 16. NUMBER OF TAGGED CHUM SALMON RELEASED IN EACH CONDITION AND THE NUMBER AND PER CENT OF THE GROUP RECOVERED IN THE COMMERCIAL FISHERY.

<i>Condition</i>	<i>Number Released</i>	<i>Number Recovered</i>	<i>Per Cent Recovered</i>
1	183	59	32.2
2	98	22	22.4
3	44	9	20.4
Total	325	90	27.7

Recoveries From the Commercial Fishery

Ninety tagged chum salmon were recovered in the commercial fishery in Tillamook Bay. The percentage of tagged chums recaptured shows considerable variation for the different tagging areas (Table 15). Ten of these recoveries were not in the samples taken from the commercial catch.

Under the hypothesis that the number of tagged fish recaptured in the commercial fishery was independent of the area of release, a chi-square value of 2.088 ($P=0.56$) with 3 degrees of freedom was calculated. Some areas were grouped because of the small numbers involved. A more precise chi-square estimate could be obtained by making adjustments for the small numbers (Rao, 1952); however, since 81 per cent of the total number tagged originated in two areas (Clamshell and below the Coast Guard Station) any slight discrepancies in the percentage recovered in the other areas would be relatively insignificant. The conclusion was however, that recapture of a tagged individual was independent of the area of release.

Analysis of chum tag recoveries according to the direction of migration with respect to the area of release shows the general trend of more fish migrating "up" than "down". In this case a significant chi-square value was obtained under the hypothesis that there was no difference in direction of migration for the 48 usable recoveries. This significant value is primarily due to the fact that a comparatively large number of the recoveries came from the group tagged in the lowest area of the bay (below the Coast Guard Station) and could only be caught by showing no migration or moving "up". Recoveries from the group tagged further up bay (Clamshell Drift) tended to show a more random "up" and "down" movement.

Date of recovery was known for 85 of the tags collected by the commercial fishery (Table 17). The average time out before recapture in the commercial fishery for the entire season and all areas combined was 0.9 days, considerably less than for either chinook or silver salmon. Sixty-five per cent (55) of these 85 recoveries were recaptured the same day, and

only 5 per cent after the fourth day. Four other chum salmon, captured in the commercial fishery after they had spawned, were excluded from this analysis.

TABLE 17. ELAPSED TIME BETWEEN TAGGING AND RECAPTURE IN THE COMMERCIAL FISHERY FOR CHUM SALMON.

Tagging Area	Number of Fish Recovered	Days Between Release and Recapture	
		Average	Range
1. Below Coast Guard Station	14	0.8	0-2
3. Nelson's	5	0.8	0-1
4. Clamshell	63	0.8	0-10
5. Hole + Sibley	1	0.0	-----
6. Coyote	2	6.5	0-13
Total	85	0.9	

Date of recovery is plotted against date of release for 85 chum recoveries made in the commercial fishery (Figure 4). Distribution of these recoveries seems to indicate a fairly slow migration through the fishery during early November, followed by a period of more rapid migration, and finally a slowing down again near the end of the season.

Daily commercial chum landings from Tillamook Bay were examined by biologists for tags to obtain the ratio of the number of tagged fish to the number not tagged. During the season, 16,437 chum salmon, or 74.7 per cent of the total catch (22,006), were examined and 80 tags and 10 tag scars observed. Ten additional tags were recovered, but some of these may have been from fish observed in the sample with only a tag scar. Near the end of the season some spawned-out tagged fish which had drifted down from the spawning grounds were caught in the nets. These were excluded from the analysis.

Ninety chum salmon were recovered with tags or tag scars in samples and an estimated 119 recoveries were made in the commercial fishery (Table 18). Confidence limits for the 90 recoveries, at the 95 per cent level, are 73 and 111 (Ricker, 1937). Extrapolating to the entire catch would give 95 per cent confidence limits of 98 and 148 tags. For each fish with a tag or tag scar there were 183 untagged fish.

Average weight data obtained from samples by biologists were used to convert pounds of fish to numbers. The average weight of chum salmon landed during the season was 11.4 pounds, although this varied from week to week. From these average weight data and the total number of pounds of chum salmon caught each week in the commercial fishery, the weekly numbers of salmon landed were computed. The sum of the weekly landings showed the commercial fishery caught slightly over 22,000 chum salmon during the season (Table 18). Average weight data were not available for the weeks ending September 12 and October 10, so

TABLE 18. NUMBER OF TAGS AND TAG SCARS RECOVERED FROM SAMPLING THE CHUM SALMON COMMERCIAL CATCH AND CALCULATED RECOVERIES IN THE TOTAL CATCH.

Week Ending		Number of Fish Sampled	Number of Recaptures			Calculated Number of Fish in Commercial Catch ^①	Calculated Number of Tags and Tag Scars Recovered in Commercial Catch
			Tags	Tag Scars	Total		
Sept.	12	0	0	0	0	4	0
Oct.	3	0	0	0	0	*****	0
	10	1	0	0	0	2	0
	17	20	0	0	0	39	0
	24	164	0	0	0	165	0
	31	673	0	0	0	830	0
Nov.	7	2,497	4	1	5	3,438	6.9
	14	5,374	27	1	28	7,285	38.0
	21	6,459	42	7	49	8,526	64.7
	28	676	1	0	1	1,052	1.6
Dec.	5	520	6	1	7	577	7.8
	12	53	0	0	0	93	0
Entire Season		16,437	80	10	90	22,006	119.0

① Based on the average weight of samples of the commercial catch by week.

TABLE 19. NUMBER OF CHUM SALMON TAGGED AND TAGS RECOVERED IN THE COMMERCIAL FISHERY BY WEEK TAGGED.

Week Ending		Number Tagged Each Week	Actual Recoveries in Samples of the Commercial Catch, by Week Tagged ^①	Calculated Recoveries in the Commercial Catch, by Week Tagged	Calculated Per Cent Tag Recovery in Season's Catch, by Week Tagged
Oct.	17	1	0	0	0
	24	3	0	0	0
	31	7	0	0	0
Nov.	7	27	6.17	8.16	30.2
	14	122	43.17	57.08	46.8
	21	130	33.66	44.50	34.2
	28	21	3.50	4.63	22.0
Dec.	5	14	3.50	4.63	33.1
	12	0	0	0	0
Total		325	90.00	119.0	36.6

① Recoveries of tag scars are assigned to each tagging week in proportion to the tag recoveries.

apparent that most of this chi-square value is contributed by the discrepancy from a single week, November 8-14, when more tags were recovered than expected.

TABLE 20. VALUE OF CHI-SQUARE CALCULATED FROM TAG RECOVERIES OF CHUM SALMON IN THE COMMERCIAL FISHERY ACCORDING TO TIME TAGGED.

<i>Date Tagged</i>	<i>Number Recovered</i>	<i>Number Not Recovered</i>	<i>Total</i>	<i>Expected Recovered</i>	<i>Expected Not Recovered</i>	<i>Chi-square</i>
Before Nov. 8	5	33	38	10.5	27.5	3.98
Nov. 8-14	44	78	122	33.8	88.2	4.26
15-21	31	99	130	36.0	94.0	0.96
22-28	5	16	21	5.8	15.2	0.15
Nov. 29-Dec. 5	5	9	14	3.9	10.1	0.43
Total	90	235	325	90.0	235.0	9.78

Chi-square = 9.78, d.f. = 4, P = 0.046.

Recoveries From Spawning Grounds and Other River Systems

Five tagged chum salmon were recovered from Tillamook Bay spawning grounds: 2 from the Miami River, 2 from the Kilchis, and 1 from the Wilson. One fish was recovered outside Tillamook Bay—in the Columbia River.

Estimate of Population Available to the Commercial Fishery

Schaefer's formulae (1951b) was used to obtain an estimate of the chum salmon population. In Table 21 the tag scars have been included on a proportional basis, and the tags plus tag scars are listed according to the week recovered and released. The same symbols are used as for the chinook population estimate.

The first chum salmon was tagged October 11, but only a few fish were tagged the first 3 weeks and none were recovered in Tillamook Bay. The population estimate of 54,308 (Table 22) calculated by Schaefer's formulae is based only on those periods which have tag recoveries (November 1 to December 5). Some tag scars recovered may have been from the fish tagged in the first 3 weeks; assuming these fish were tagged after October 31 would tend to minimize the population estimate obtained. Since only 11 chum salmon were tagged before November 1, and one of these was recaptured in the Columbia River, the error is considered negligible. The population estimate in this report is for fish available to the commercial fishery from November 1 to December 5, inclusive.

Another estimate of the chum salmon population was made using the Chapman (1951) formula. In this equation, $n = 15,526$, $t = 314$, and $s = 90$. The estimate of the population is: $N = \frac{(15,527)(315)}{(91)} = 53,747$. This estimate is slightly lower than that obtained by Schaefer's formulae. Using

TABLE 21. TAGGED CHUM SALMON RELEASED AND TAG RECOVERIES FROM SAMPLING THE COMMERCIAL CATCH.

Week of Re- covery	Week of Tagging										Total Tags Recov- ered (s)	Number of Fish Sampled (n)	Fish Per Tag n/s
	1	2	3	4	5	6	7	8	9	10			
1												1	
2												20	
3												164	
4												673	
5					5.00						5	2,497	499.40
6						28.00					28	5,374	191.93
7					1.17	15.17	32.66				49	6,459	131.82
8							1.00				1	676	676.00
9								3.50	3.50		7	520	74.29
10												53	
Tags Re- covered (a)					6.17	43.17	33.66	3.50	3.50		90		
Total Tagged (t)	1	3	7	27	122	130	21	14					
t/a					4.38	2.83	3.86	6.00	4.00				

TABLE 22. ESTIMATE OF CHUM SALMON POPULATION AVAILABLE TO THE COMMERCIAL FISHERY.^①

Week of Recovery	Week of Tagging										Total
	1	2	3	4	5	6	7	8	9	10	
1											
2											
3											
4											
5						10,937					10,937
6							15,209				15,209
7						676	5,659	16,618			22,953
8								2,609			2,609
9								1,560	1,040		2,600
10											
Total						11,613	20,868	19,227	1,560	1,040	54,308

① Calculated from data in Table 21 and method developed by Schaefer (1951b).

Chapman's formulae (1948, p. 78), 95 per cent confidence limits for the estimate of 53,747 fish would be 66,450 and 43,383.

Assuming that the true population of chum salmon available to the commercial fishery from November 1 to December 5 was about 54,000 fish, then approximately 39 per cent (20,878) were taken by the commercial fishery during this period. This fishing mortality applies only to the population available to the fishery from November 1 to December 5.

STEELHEAD

During the salmon tagging program an occasional steelhead trout was captured and tagged. Only a few of the very early steelhead are available to the commercial fishery during the chum salmon run. From 1945 through 1953, steelhead landings averaged only 26,000 pounds per season.

Numbers Tagged, Areas of Tagging, and Mortality

The tagging sites listed for steelhead (Table 23) are shown in Figure 1. The first steelhead was tagged on October 21 and the last on December 8 with a total of 62 tagged during the season. As with salmon, the steelhead recovered were grouped according to condition when tagged (Table 24). Although the greatest percentage of fish recovered had been released in condition 1, a chi-square test showed no significant difference in the number of recoveries by condition group.

TABLE 23. NUMBER OF STEELHEAD TAGGED AND RECOVERED IN THE COMMERCIAL FISHERY ACCORDING TO TAGGING AREA.

Tagging Area	Number Tagged	Number Recovered	Per Cent Recovered
1. Below Coast Guard Station	2	0	0
2. Hobsonville	1	0	0
3. Nelson's	5	0	0
4. Clamshell	47	12	25.5
5. Hole + Sibley	1	0	0
6. Coyote	0	0	0
7. Middle	1	0	0
8. Rapids	5	0	0
9. Mamaloose	0	0	0
Total	62	12	19.4

TABLE 24. NUMBERS OF TAGGED STEELHEAD RELEASED IN EACH CONDITION AND THE NUMBER AND PER CENT OF THE GROUP RECOVERED IN THE COMMERCIAL FISHERY.

Condition	Number Released	Number Recovered	Per Cent Recovered
1	23	5	21.7
2	24	5	20.8
3	15	2	13.3
Total	62	12	19.4

Recoveries From the Commercial Fishery

The only steelhead recoveries came from those tagged on Clamshell Drift (Table 23). No significant difference was found in the direction of movement after tagging based on location of the recoveries. Analyzing

the recoveries according to direction of migration with respect to area of release shows a general random movement, although these results are based on only 9 recoveries. A nonsignificant chi-square value was obtained under the hypothesis of no difference in direction of movement. The average time out before recapture in the commercial fishery for 12 recoveries was 2.9 days with a range of from 0 to 12 days.

During the season 2,589 steelhead, or 74 per cent of the total commercial catch (3,497) was sampled by biologists and 12 tags observed.

There were an estimated 16.9 tags in the commercial catch (Table 25). Confidence limits at the 95 per cent level (Ricker, 1937, p. 354) for the 12 actual recoveries would be 6 and 21. Extrapolating to the entire catch would give 95 per cent confidence limits of 8 and 28 tags. There were 216 fish per tag for the entire season.

The average weight for the entire season was 10.4 pounds; the weekly average varied from 9.1 to 13.8 pounds. From these average weight data and the total poundage of steelhead caught the number of fish landed each week was computed. Weights for the last three weeks in November were combined into a single sample because of the small number of fish weighed in the individual weeks. It was calculated that the commercial fishery caught slightly less than 3,500 steelhead during the season.

TABLE 25. NUMBERS OF TAGS RECOVERED FROM SAMPLING THE STEEL-HEAD COMMERCIAL CATCH AND CALCULATED RECOVERIES IN THE TOTAL CATCH.

<i>Week Ending</i>	<i>Number of Fish Sampled</i>	<i>Tags Recovered</i>	<i>Calculated Number of Fish in the Commercial Catch^①</i>	<i>Calculated Number of Tags Recovered in the Commercial Catch</i>
Sept. 26	0	0	0	-----
Oct. 3	1	0	1	-----
10	0	0	0	-----
17	3	0	3	-----
24	16	0	16	-----
31	28	0	28	-----
Nov. 7	143	0	143	-----
14	179	0	195	-----
21	522	0	554	-----
28	644	2	1,022	3.2
Dec. 5	761	9	1,018	12.0
12	292	1	517	1.7
Entire Season	2,589	12	3,497	16.9

① Based on the average weight of samples of the commercial catch by week.

The calculated percentage recovered of the steelhead tagged each week was not consistent throughout the season (Table 26). An estimated 46.7 per cent of the steelhead tagged the last week in November were recaptured in the commercial fishery.

Recoveries From Sport Fishery

One tagged steelhead was captured by a sport fisherman on the Wilson River. None were found on the spawning grounds nor in any other river system.

TABLE 26. NUMBER OF STEELHEAD TAGGED AND TAGS RECOVERED IN THE COMMERCIAL FISHERY BY WEEK TAGGED.

Week Ending	Number Tagged Each Week	Actual Recoveries in Samples of the Commercial Catch, by Week Tagged	Calculated Recoveries in the Commercial Catch, by Week Tagged	Calculated Per Cent Tag Recovery in Season's Catch, by Week Tagged
Oct. 24	2	0	*****	*****
31	3	0	*****	*****
Nov. 7	3	0	*****	*****
14	4	0	*****	*****
21	9	1	1.4	15.6
28	15	5	7.0	46.7
Dec. 5	23	6	8.5	37.0
12	3	0	*****	*****
Total	62	12	16.9	27.3

Estimate of Population Available to the Commercial Fishery

Using the Schaefer formulae (1951b), the steelhead population available to the Tillamook Bay commercial fishery during the period November 14 to December 11, 1953 was calculated at 7,616 fish (Tables 27 and 28).

Using the Chapman (1951) equation with $n = 2,219$, $t = 50$, and $s = 12$ the population was estimated at: $N = \frac{(2,220)(51)}{(13)} = 8,709$. This estimate is higher than that obtained by Schaefer's formulae. Using Chapman's Table (1948, p. 76), 95 per cent confidence limits on the true population value for the 8,709 estimate would be 4,660 and 16,310.

Assuming that the true population was about 8,000 fish, 39 per cent (3,111) were taken by the commercial fishery during the defined period. It should be emphasized that this 39 per cent fishing mortality applies only to the small portion of the steelhead population available between November 14 and December 11.

TABLE 27. TAGGED STEELHEAD RELEASED AND TAG RECOVERIES FROM SAMPLING THE COMMERCIAL CATCH.

Week of Re- covery	Week of Tagging										Total Tags Recov- ered (s)	Number of Fish Sampled (n)	Fish Per Tag n/s
	1	2	3	4	5	6	7	8	9	10			
1												1	
2												3	
3												16	
4												28	
5												143	
6												179	
7												522	
8							1	1			2	644	322.00
9								4	5		9	761	84.56
10									1		1	292	292.00
Tags Re- covered (a)							1	5	6		12		
Total Tagged (t)			2	3	3	4	9	15	23	3			
t/a							9.0	3.0	3.83				

TABLE 28. ESTIMATE OF STEELHEAD POPULATION AVAILABLE TO THE COMMERCIAL FISHERY.①

Week of Recovery	Week of Tagging										Total
	1	2	3	4	5	6	7	8	9	10	
1											
2											
3											
4											
5											
6											
7											
8							2,898	966			3,864
9								1,015	1,619		2,634
10									1,118		1,118
Total							2,898	1,981	2,737		7,616

① Calculated from the data in Table 27 and method developed by Schaefer (1951b).

SUMMARY

- 1. In a tagging program conducted on Tillamook Bay in 1953, 491 fall chinook salmon, 255 silver salmon, 325 chum salmon, and 62 steelhead trout were captured by gill nets and tagged.
- 2. There was no significant difference in the number of tagged fish recovered from any tagging area for the four species.
- 3. A non-significant chi-square value was obtained for tag recoveries of chinook salmon, silver salmon, and steelhead when analyzed according

to whether they had moved "up" or "down" the bay after being tagged. A significant value was obtained for a similar analysis of chum salmon tag recoveries, primarily due to the fact that a comparatively large number of recoveries came from chums tagged in the lowest area of the bay which could only be caught by showing no migration or moving "up".

4. Average elapsed time before recapture in the commercial fishery was 4.7 days for chinook salmon, 5.1 days for silver salmon, 0.9 days for chum salmon, and 2.9 days for steelhead.

5. For chinook salmon, silver salmon, and steelhead, there was no consistent trend to indicate that fish tagged nearer the spawning grounds were available for a shorter time than fish tagged in the lower bay. Chum salmon tagged in the lower bay did appear to be available to the fishery for a longer period than those tagged in the upper bay.

6. Based on elapsed time between tagging and recovery, chinook salmon moved slowly through the fishing area during September and early October and more rapidly from mid-October to the end of the season. Silver salmon migrated slowly through the fishing area in September, slightly faster in October, and rapidly near the end of the season. Chum salmon moved slowly through the fishery during early November, fairly rapidly until November 21, and slowed again near the end of the season.

7. No significant difference could be demonstrated between the number of tags recovered from the three apparent condition groups (good, fair, poor) at time of tagging.

8. Commercial landings were sampled for average weight, tags, and tag scars. During the fishing season the following proportion of the different species were examined for tags: 5,589 chinook salmon or 89 per cent of the total catch; 5,950 silver salmon or 88 per cent; 16,437 chum salmon or 75 per cent; and 2,589 steelhead or 74 per cent.

9. Date of tagging did not appear to have a significant effect on whether or not the fish were recovered for chinook and silver salmon and steelhead. It did appear to affect chum salmon recoveries, but this was probably because many of these fish were tagged in the lower bay.

10. Sport fishermen caught 9 tagged chinook salmon, 5 tagged silver salmon, and 1 tagged steelhead. The spawning grounds were not intensively surveyed.

11. Three tagged chinook were recovered from the Nehalem River and one from the Alsea. Five tagged silvers were recovered from the Nehalem River and one in the ocean near the Columbia River. One tagged chum salmon was recovered in the Columbia River.

12. Schaefer's (1951b) formulae were used to calculate fish populations available to the commercial fishery: 15,512 chinook salmon for the period September 6 to November 14, inclusive; 21,747 silver salmon for the period August 23 to November 21; 54,308 chum salmon for the period November 1 to December 5; and 7,616 steelhead for the period November 15 to December 10.

13. The equation $N = \frac{(n+1)(t+1)}{(s+1)} - 1$ was also used to calculate fish populations available during the designated periods. Populations based on this formula and their 95 per cent confidence limits were calculated to be: chinook salmon, 15,341 and 13,042–17,936; silver salmon, 22,495 and 17,420–28,985; chum salmon, 53,747 and 43,383–66,450; and steelhead, 8,709 and 4,660–16,310.

14. Assuming that the actual populations available to the Tillamook Bay commercial fishery during the designated periods were about 15,500 chinook salmon, 22,000 silver salmon, 54,000 chum salmon, and 8,000 steelhead, then 36 per cent of the chinook salmon, 29 per cent of the silver salmon, 39 per cent of the chum salmon, and 39 per cent of the steelhead were caught by the commercial fishery during the designated periods.

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**OREGON COASTAL SALMON AND STEELHEAD
TAGGING PROGRAMS**

Part II. Siletz River, 1954

Alfred R. Morgan

FISH COMMISSION OF OREGON

Portland, Oregon

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OREGON COASTAL SALMON AND STEELHEAD TAGGING PROGRAMS

Part II. Siletz River, 1954

Alfred R. Morgan^①

ABSTRACT

To aid in the management of the Siletz River commercial salmon fishery, a tagging program was conducted on the salmon and steelhead trout runs in 1954. General migration behavior, the minimum length of time fish remained in the fishery, population estimates, and fishing mortalities were determined.

INTRODUCTION

In 1954 the Oregon Fish Commission conducted a salmon and steelhead tagging program in the Siletz River, which enters the Pacific Ocean at Taft, Oregon, to obtain information on: (1) estimates of the population sizes of the species present; (2) intensity of the commercial gill-net fishery; (3) harvest by the Indian fishery; and (4) time and rate of migration of the various species. The species tagged were chinook salmon (*Oncorhynchus tshawytscha*), silver salmon (*O. kisutch*), chum salmon (*O. keta*), and steelhead trout (*Salmo gairdneri*). All these species were harvested by the commercial gill-net fishery in tidewater and by members of the Siletz Indian tribe both in tidewater and upstream. A sport fishery also harvests chinook and silver salmon and steelhead trout in tidewater and above.

Since commercial fishing in the Siletz River was eliminated in 1956, observations in this report on the commercial fishery no longer apply.

TAGGING

Tagging Methods

The original plan was to capture fish for tagging with large, wire fyke nets used successfully in other areas to catch Pacific salmon. However, three of these nets fished for five weeks caught only one silver salmon. The fyke nets did catch many surf perch, however, and many of these were tagged (Morgan, 1961). The reason for the lack of success with this type of gear was not determined. One disadvantage was that the nets were fished in tidewater where the direction of the current alternated with the tide. Algae collected on the traps and may have caused salmon to avoid the nets or reduced their efficiency. At night, water passing through the wire mesh resulted in luminescence from phosphorescent dinoflagellates which may have caused salmon to avoid the nets. Since the fyke nets did not catch salmon successfully, it was necessary to tag fish from gill nets.

^① Formerly biologist, Oregon Fish Commission; now deceased.

The fish were tagged with fluorescent red Petersen disk tags held to the back by a nickel pin. The tip of the upper lobe of the caudal fin was clipped from each tagged fish for identification if a tag was lost. The tag number, tagging location, fork length, and condition of the fish when released were recorded. If the fish was lively and swam away quickly its condition was listed as good; if the fish appeared tired, dazed, or in any condition other than good, it was listed as weak. Condition was

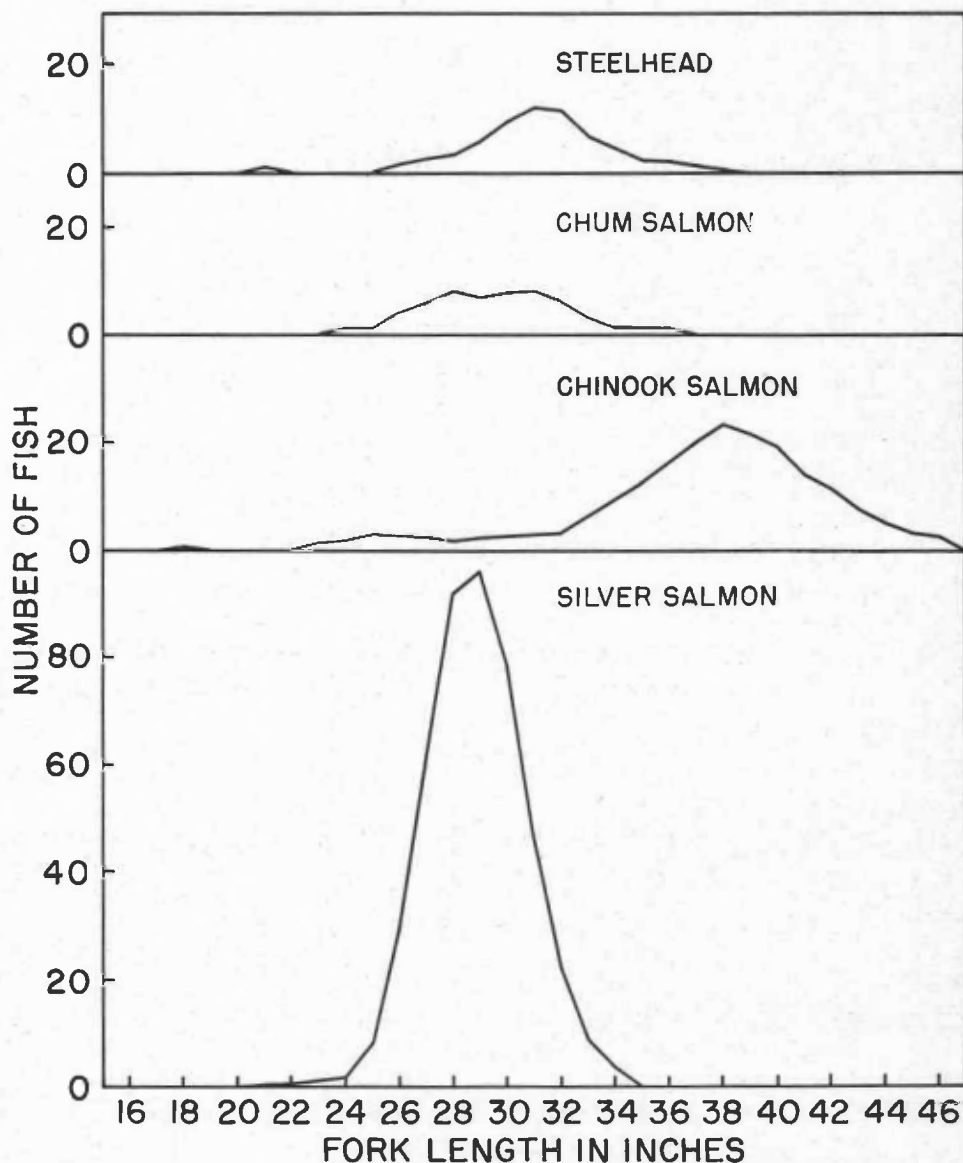


FIGURE 1. LENGTH-FREQUENCY DISTRIBUTIONS OF SALMON AND STEELHEAD TAGGED IN THE SILETZ RIVER IN 1954.

recorded in order to observe, if possible, differences in behavior or rate of recovery of fish in the two classifications. Some fish, injured beyond recovery, were not returned to the water.

Numbers Tagged and Tagging Areas

The first salmon tagged was a silver taken in a fyke net on August 13. By September 14, when it was evident that the fyke nets were unsuccessful, tagging from gill nets began and continued until November 18. The first chinook was tagged September 18. Gill nets used to catch chinook salmon had $8\frac{3}{4}$ - to $9\frac{1}{4}$ -inch mesh, while the nets used to catch silver and chum salmon and steelhead had $6\frac{3}{4}$ - to 7-inch mesh. During the period September 14 to November 18, 1954, 194 chinooks, 445 silvers, 58 chums, and 63 steelhead were tagged and released in apparently viable condition. Length-frequency compositions of the tagged fish are shown in Figure 1. The fish were released either entirely below or in the lower third of the commercial fishing area of the Siletz River (Figure 2). The lower deadline for commercial fishing was approximately 3 miles above the bay entrance and the upper limit was 9 miles above the lower deadline.

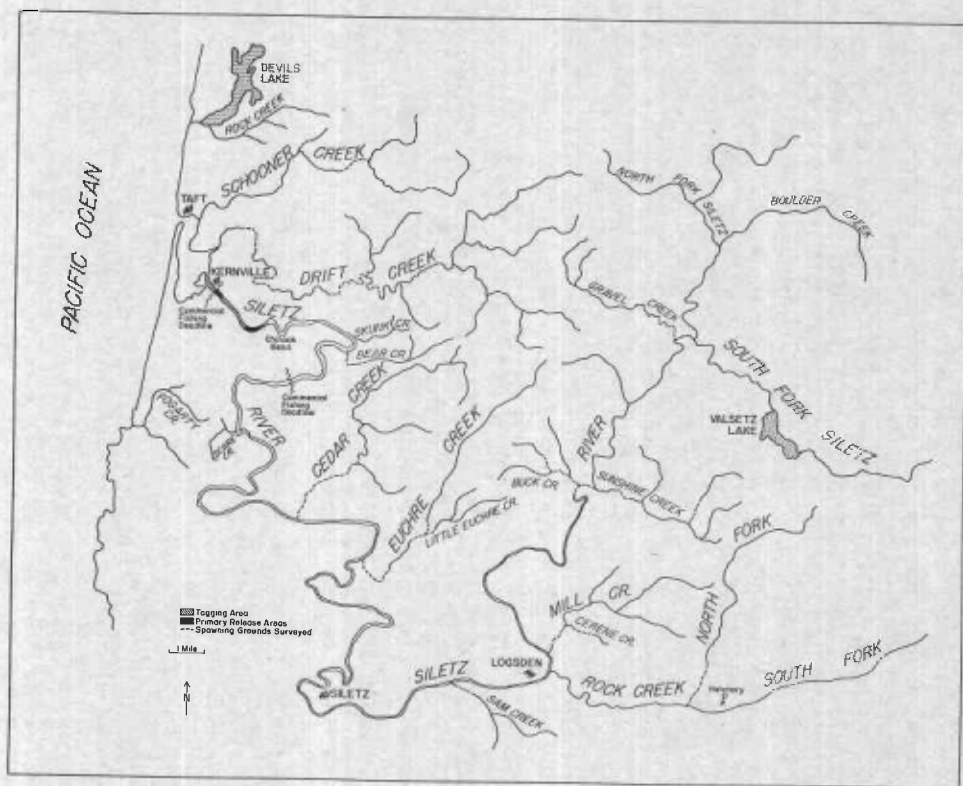


FIGURE 2. SILETZ RIVER SYSTEM, SHOWING TAGGING LOCATION AND SPAWNING AREAS SURVEYED.

CHINOOK SALMON

Condition of Tagged Fish

Most tagged fish were measured and labeled as good or weak depending upon their actions when released. Sixty per cent of the 176 chinook tagged were labeled good, and 53 per cent of the 32 tagged chinook recovered in the commercial fishery belonged to this group. A value of chi-square was calculated for the recoveries from the two categories of tagged chinook released. No significant difference could be demonstrated at the 5-per cent level between the numbers of fish recovered from each condition group. Recovery of tagged chinook in the commercial catch was considered independent of the apparent condition when released.

Although apparent survival of the tagged chinook subsequently taken in the commercial fishery did not seem to be affected by tagging, of 12 fish recovered on the spawning grounds, 9 had been released as good and 3 as weak.

Commercial Fishery

Until 1947, the commercial fishery on the Siletz River used set nets primarily. Set-net licenses ranged from 182 in 1925 to 72 in 1943; drift-net licenses from 31 in 1925 to 3 in 1943 and 1944. After the 1946 season, the Siletz River was open to drift nets only, and drift-net licenses issued increased from 5 in 1946 to 35 in 1947. From 1947 through 1954 an average of 33 drift-net licenses was issued annually for this river. In 1954, the commercial fishery operated from August 15 until October 31.

The average annual catch of chinook was about 28,000 pounds during the period 1939-46. After the elimination of set nets in 1947, the catch increased to about 33,500 pounds annually. In the 1954 season it was approximately 45,500 pounds.

Tag Recoveries in the Commercial Fishery

The commercial catch was sampled as intensively as possible throughout the season and 23 tags and 2 tag scars were observed. Dealers and fishermen returned 7 additional tags. Data were also taken on average weights to be used in converting the reported catch to numbers of fish.

Sampling data for chinook were summarized by weekly periods (Table 1). It is suggested by Chapman (1948) that in tagging experiments where the tag ratio $\left(\frac{s}{n}\right)$ is low, the distribution of recoveries (s) is most closely approximated by the Poisson distribution. Chapman also offers criteria to determine whether the Poisson approximation is the best method to use in finding a confidence interval estimate for N . The Poisson approximation is to be used where $500 < n \leq 1,000$ and $\frac{s}{n} \leq 0.075$. In the present experiment with chinook salmon, $n = 768$, $s = 25$, and $\frac{s}{n} = 0.032$. However, Ricker (1937, equation 6) gave a method for finding a confidence

interval for s when s follows the Poisson distribution. By substituting the value of s (25 in this experiment) in Ricker's equation 6, $(s, \bar{s}) = s + 1.92 \pm 1.96 \sqrt{s+1}$, the 95-per cent upper and lower confidence limits for chinook tags in the samples were calculated to be 37 and 17. These confidence limits were then used to estimate the number of tags that could be expected in the total commercial catch and also in the sport and Indian catches where samples were not available. Extrapolating to the total commercial catch (1,013 fish) from which the samples (768 fish) were taken would give 95-per cent confidence limits of 22 and 49 tags in the total commercial catch.

TABLE 1. NUMBER OF CHINOOK SALMON SAMPLED, TAGS AND SCARS OBSERVED, AND FISH PER TAG IN THE COMMERCIAL CATCH.

Date	Number Sampled	Number of Tags and Scars Observed	Fish Per Tag
Sept. 14-19	79	-----	-----
20-25	101	-----	-----
27-Oct. 2	216	2	108.0
Oct. 4- 9	178	10①	17.8
11-16	83	6	13.8
18-23	90	5	18.0
25-30	21	2	10.5
Total	768	25	27.6

① Includes 2 tag scars.

The number of fish was found by dividing the total weight of the catch by an average weight of 26.6 pounds per fish calculated from a sample of 45 fish taken throughout the season. These fish ranged from 15.0 to 43.5 pounds in weight.

Tag Recoveries in the Sport Fishery

No sport-caught tagged chinook were returned from the Siletz River fishery, but 3 were returned from Drift Creek, a tributary of Siletz Bay. The annual estimate by the Oregon Fish Commission of the 1954 Siletz River sport catch indicated that the fishery took 150 chinook. Since the sport catch was not sampled, the upper and lower 95-per cent confidence limits for tags in samples of the commercial catch (37 and 17) were used to compute confidence limits on the number of tagged chinook recovered by the sport fishery:

$$\frac{768}{17} = \frac{150}{x}; x = 3 \quad \text{and} \quad \frac{768}{37} = \frac{150}{x}; x = 7$$

In addition to voluntary returns of tags from sport-caught fish, 3 Petersen disks were returned by sportsmen who found them on spent, dead chinook.

Tag Recoveries From the Indian Fishery

Members of the Siletz Indian Tribe are permitted by the federal government to fish in the Siletz River. This fishery cannot be regulated by the state of Oregon. During the regular commercial season, the Indians may fish in any part of the Siletz drainage, but after the commercial season, each fisherman is required to fish in waters adjacent to, or flowing through, his property. Fishing rights are handed down from parents to children.

Little data are available on the size of the Indian catch or number of fishermen. During the 1954 season, it was reported that two Indians fished one set net each near the upper commercial deadline. One reported catching a tagged chinook and losing the tag. It is known that at least three Indians operated one set net each in the vicinity of Logsdon, approximately 35 miles above the mouth of the Siletz. Two of these men were interviewed, and one blank tag was obtained, reportedly from a chinook. No information was obtained on the total catch.

An estimate of the Indian catch of chinook may be obtained by using the fish-per-tag figures found in the commercial fishery and spawning ground surveys with tags recovered from the Indian fishery. Assuming the Indian fishery in tidewater caught approximately 28 fish for each tag recovered and in the upper river 11 fish for each tag recovered (based on spawning ground counts), a minimum of 40 chinook was calculated to have been taken by the Indian fishery. This figure is based on only two tag recoveries, and it is not known what percentage of the total tags taken in the Indian fishery were reported.

Tag Recoveries From Spawning Grounds

Only limited time could be given to spawning ground surveys. The areas surveyed are shown in Figure 2. Eighty-three dead chinook were examined for tags throughout the Siletz drainage and 8 tags were recovered; 115 live adult chinook were observed of which 8 were tagged. In surveys on Drift Creek, 2 tags were found on 15 dead chinook and 5 tags on 40 live chinook. No tags were recovered from other drainages.

Migrations in the Siletz River System

Since the majority of chinook were tagged below the commercial fishery, it was expected that tagged fish recovered in the commercial fishery would show positive or upstream migration. This was true of all the commercial recoveries except for one fish which was tagged $2\frac{1}{4}$ miles above the lower deadline and recovered two days later at the lower deadline.

Of 12 tagged chinook recovered on or near the spawning grounds, 5 had made negative or downstream migrations to Drift Creek below both tagging areas. One of these fish had moved approximately $3\frac{1}{2}$ miles downstream to reach the mouth of Drift Creek.

Time elapsed between tagging and spawning was not definitely established. For 6 chinook found on the spawning grounds shortly after death,

elapsed time between tagging and recovery ranged from 27 to 59 days, averaging 44 days.

The two main tagging areas were approximately $1\frac{3}{4}$ miles apart. Of the 13 tagged chinook recovered in the tagging gear, only one had made a positive or upstream migration from the lower to the upper tagging site. It was tagged 20 days before recovery. Of the remaining 12 fish, 5 made negative or downstream migrations, and 7 were recovered at the original tagging site. The time elapsed between tagging and recovery of fish making negative migrations ranged from 2 to 33 days, with an average of 15. For fish recovered at the tagging site, elapsed time ranged from 2 to 36 days, with an average of 16.

Estimate of the Chinook Salmon Population

The value of the study was reduced by the small number of tags released and recovered. Several methods and sources of data were used to calculate population estimates. Data from commercial recoveries were used with a method suggested by Schaefer (1951) and also the Petersen method. The former method assumes that the population does not mix completely between tagging and sampling and the number of fish tagged and sampled may not be proportional to the number available. Schaefer developed this method to estimate the population from spawning ground recoveries. In the Petersen method either tagging or recovery samples must be random to give an unbiased estimate. Estimates with the Schaefer and Petersen methods were 4,700 and 5,600 chinook, respectively. A possible explanation of the higher estimate by the Petersen method is that it ignores stratification of tagged fish either by time or area. However, the relatively good agreement between the two estimates may have resulted from an undetermined amount of mixing of the population.

Estimates obtained from commercial fishery samples were compared with estimates of catches made in the tagging gear and from observations of live fish on the spawning grounds. The samples were small, and the estimates—3,000 and 2,800 fish, respectively—considerably lower than those made from samples of commercial landings. Tagging gear was operated below the main commercial fishery but above both Drift and Schooner Creeks. Because of the gear's position in the lower river, recoveries in the tagging gear may have been from fish destined for these lower tributaries. Tag recoveries of chinook on the spawning grounds were made primarily in Drift Creek. While the estimates from data obtained in the tagging gear and on the spawning grounds are lower than estimates from sampling data in the commercial fishery, they are similar and may be a better estimate of the chinook population entering the lower tributaries, primarily Drift Creek, rather than the number returning to the entire Siletz drainage. All estimates and 95 per cent upper and lower confidence limits are shown in Table 2.

Confidence limits were calculated by utilizing data in Chapman (1948, p. 76). For estimates obtained from samples in the commercial fishery and tagging data, the value for nt (181×768) was multiplied by the upper and lower limits (0.02552 and 0.0591) for $s = 25$ in Chapman's

TABLE 2. COMPARISON OF CHINOOK SALMON POPULATION ESTIMATES FROM DIFFERENT SOURCES OF DATA AND BY TWO METHODS AND UPPER AND LOWER 95 PER CENT CONFIDENCE LIMITS.

Source of Recovered Tags	Number Tagged	Number Sampled	Number Recovered	Population Estimate	Upper Limit	Lower Limit
Commercial Fishery	181①	768	25	-----	8,200	3,500
Schaefer Method	-----	-----	-----	4,700	-----	-----
Petersen Method	-----	-----	-----	5,600	-----	-----
Tagging Gear	194	200	13	3,000	5,200	1,600
Spawning Grounds (live fish)	194	115	8	2,800	5,700	1,200

① Excludes 13 fish tagged after the commercial season closed.

Table 1. The confidence limits shown in Table 2 for estimates from other sources were obtained in the same manner.

Fishing Intensity

The calculated number of chinook in the 1954 commercial catch (based on average weight data) was 1,688 fish. If 4,700 is used as the best estimate of the chinook population, the commercial fishery took 36 per cent of the fish entering the river. If the upper and lower 95-per cent confidence limits, 8,200 and 3,500 fish, are substituted, the commercial catch ranged from 48 to 21 per cent of the chinook entering the river. The sport and Indian fisheries took an estimated additional 4 per cent of the total chinook run.

SILVER SALMON

Condition of Tagged Fish

Sixty-three per cent of the 445 silvers tagged were classified in good condition when released. Fifty-two per cent of the 33 tagged fish recovered in the commercial catch had been labeled good when released. A value of chi-square calculated for the numbers recovered from the two categories of tagged fish released was not significant at the 5-per cent level and indicated that recovery of tagged silvers by the commercial fishery was independent of condition when released.

Seven tagged silvers were recovered from 211 taken in the trap at the Oregon Fish Commission hatchery on the South Fork of Rock Creek, about 40 miles upstream from the mouth of the Siletz. Of these, 3 had been labeled in good condition and 4 as weak when released (Table 3).

Time of arrival at the hatchery trap was not consistent with time of tagging or condition. Fish tagged first did not necessarily reach the trap first. Fish labeled weak did not require in most cases more time for the migration than those classed as good.

Commercial Fishery

Commercial fishery regulations for silver salmon in the Siletz River were the same as for chinook. The average annual catch of silvers was

TABLE 3. DATES OF TAGGING AND RECOVERY AT SILETZ HATCHERY OF 7 TAGGED SILVER SALMON, ACCORDING TO CONDITION WHEN RELEASED.

<i>Date Tagged</i>	<i>Date Recovered and Condition</i>	<i>Days Between Release and Recovery</i>
	Good	
Oct. 17	Nov. 22	36
Oct. 30	Nov. 22	23
Nov. 8	Dec. 17	39
	Weak	
Oct. 9	Dec. 7	59
Oct. 13	Nov. 16	34
Oct. 20	Nov. 22	33
Nov. 10	Dec. 14	34

about 81,700 pounds for the period 1939-46. After the 1946 season, when set nets were eliminated, the average annual catch dropped to about 24,600 pounds (1947-54). In 1954, about 18,900 pounds were landed.

Tag Recoveries in the Commercial Fishery

The first silvers were tagged on September 14. After this date, sampling commercial landings of silver salmon resulted in the recovery of 24 tags and 4 tag scars from 1,648 examined (Table 4). A total of 39 tagged silvers was recovered in the commercial fishery from all sources. During the 1954 season an average weight of 9.9 pounds was calculated for a sample containing 127 fish (range from 5 to 16 pounds).

Assuming the 28 tag recoveries were from samples with a Poisson distribution, the upper and lower 95-per cent confidence limits (40 and 19 tags) were calculated as described for chinook salmon. Extrapolating to the total catch after the tagged fish became available to the fishery (1,787 fish), it was found that the number of tags taken by the commercial fishery should have been between 43 and 21.

Tag Recoveries in the Sport Fishery

The sport catch was not sampled, but several tags were returned by sportsmen. Of 7 tags returned, 4 were from silvers caught in tidewater and 3 from the upper river. In addition, 1 tag was returned from a spent, dead silver.

It was estimated that the 1954 sport fishery in the Siletz River took 1,250 silvers. Using the following equations, with 95-per cent confidence limits, the number of tagged silvers taken in the sport catch should have been between 30 and 14:

$$\frac{1,648}{40} = \frac{1,250}{x}; x = 30 \quad \text{and} \quad \frac{1,648}{19} = \frac{1,250}{x}; x = 14$$

Tag Recoveries in the Indian Fishery

The Indians fished for silvers in the same locations as for chinook. No tagged silvers were reported or recovered from the 2 Indians known to be fishing near the upper commercial deadline. The 3 Indians who fished near Logsdan returned 3 tags from silver salmon. Two of these fishermen were interviewed and reported no other tags observed or knowledge of other Indians fishing in that area.

As shown in Table 4, the tagged-to-untagged ratio for silvers in the commercial catch was calculated at about 1:59. While no tags were returned from the Indian fishery in the lower river, an estimated 60 silvers were taken by this fishery.

TABLE 4. NUMBERS OF SILVER SALMON SAMPLED, TAGS AND SCARS OBSERVED, AND FISH PER TAG IN THE COMMERCIAL CATCH.

Date	Number Sampled	Number of Recoveries		Fish (Including Scars) Per Tag
		Tags	Tag Scars	
Sept. 14-19	338	-----	-----	-----
20-25	207	3	-----	69.0
27-Oct. 2	111	-----	-----	-----
Oct. 4- 9	108	-----	2	54.0
11-16	510	5	-----	102.0
18-23	291	11	1	24.2
25-30	83	5	1	13.8
Total	1,648	24	4	58.8

In the upper river, the Indian fishery at Logsdan is near the mouth of the South Fork of Rock Creek, where the Fish Commission hatchery trap is located. The calculated tagged-to-untagged ratio for 211 silvers examined at the trap was 1:30. If it is assumed that the Indian fishery took 30 silvers for every tag returned, the upper river catch may be estimated at about 90. The minimum estimate of the total silver catch by the Indian fishery in the Siletz River was therefore about 150 fish.

Tag Recoveries From Spawning Grounds

A total of 174 live silvers was examined on the spawning grounds and 7 tagged fish were observed. In addition, 211 adult silvers were examined at the hatchery trap and 7 tags observed. By combining these observations, a tagged-to-untagged ratio of 1:27 was obtained for live silvers in the upper river.

A total of 82 spent, dead adults was examined and no tags observed.

Time was not available to survey major silver spawning grounds in remote areas of Drift Creek to compare tagged-to-untagged ratios with other parts of the Siletz drainage. During a survey for spawning chinook on November 4, 14 live silvers were observed in one resting hole of which

2 were tagged. No other samples were obtained. The observed tagged-to-untagged ratio of 1:7 is probably low and not representative of the total Drift Creek spawning population.

Tag Recoveries in Other River Systems

Tags were recovered from 3 silvers that were tagged in the lower Siletz, returned to the ocean, and migrated to other streams. In addition, 1 tagged silver was observed by Oregon Game Commission biologists during spawning ground surveys of Rock Creek, a tributary of Devils Lake. The 3 tags recovered included 1 from the Salmon River, 1 from Fogarty Creek, and 1 from the commercial fishery in the Yaquina River. Two of the straying fish were tagged on October 16 and the other on October 9.

Migrations in the Siletz River System

Of 38 tagged silvers recovered in the commercial fishery, 10 had made negative or downstream migrations, 9 were recovered in the tagging area, and the remaining 19 made positive or upstream migrations. Two tagged silvers recovered from spawning grounds in Schooner Creek had migrated downstream from Coyote Rock and Shirttail Point to the mouth of Schooner Creek near the entrance of Siletz Bay. One fish was tagged November 1 and the other November 5. Two live tagged silvers observed in Drift Creek migrated downstream to reach the mouth of that stream. The rate of migration appeared to be somewhat more rapid for fish tagged in November than earlier tagged fish. One fish tagged in September traveled 1.1 miles per day, compared to an average of 1.3 miles per day for fish tagged in October, and 1.5 miles per day for fish tagged in November (Figure 3).

Very little data were obtained on time elapsed between tagging and spawning. Three live fish recovered on the spawning grounds had been tagged 28 (November 10-December 8), 49 (November 1-December 20), and 72 (October 16-December 27) days previously. These 3 fish appeared at the hatchery trap in reverse order to the time they were tagged. This is not thought to be typical of fish behavior in the Siletz run, although there is probably considerable mixing on the spawning grounds of fish that had passed through the lower river at different times. Of the 16 stream recoveries made in the Siletz drainage, 1 had been tagged in September, 9 in October, and 6 in November.

Estimate of the Silver Salmon Population

Estimates of silver salmon population were made using the same methods as for chinook except that additional data were available from hatchery recoveries. Estimates are 19,400 fish obtained by the Petersen method and 15,200 by the Schaefer method (Table 5). The former is probably an overestimate. The estimate of 13,350 fish obtained with the Petersen method from tagging gear recoveries is almost identical with that made from hatchery recoveries nearly 40 miles upstream. The estimate of 11,100 made from observations of live fish on spawning grounds is lower

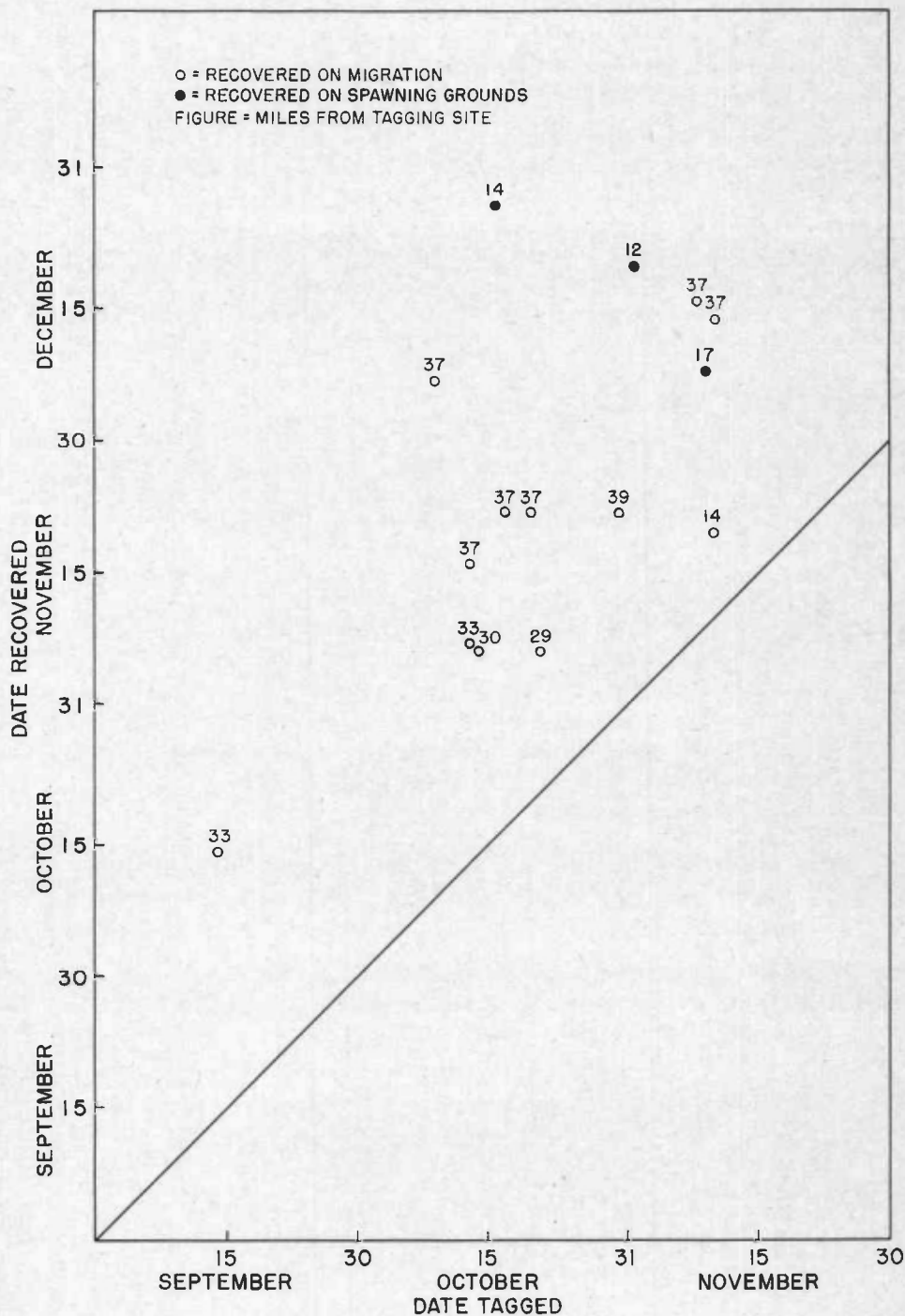


FIGURE 3. RECOVERIES OF TAGGED SILVER SALMON ACCORDING TO DATE TAGGED AND RECOVERED.

TABLE 5. COMPARISON OF SILVER SALMON POPULATION ESTIMATES FROM DIFFERENT SOURCES OF DATA AND BY TWO METHODS AND UPPER AND LOWER 95 PER CENT CONFIDENCE LIMITS.

Source of Recovered Tags	Number Tagged	Number Sampled	Number Recovered	Population Estimate	Upper Limit	Lower Limit
Commercial Fishery	330 ^①	1,648	28	-----	28,100	12,700
Schaefer Method	-----	-----	-----	15,200	-----	-----
Petersen Method	-----	-----	-----	19,400	-----	-----
Tagging Gear	445	480	16	13,350	23,500	8,100
Hatchery Trap	445	211	7	13,400	29,000	5,300
Spawning Grounds (live fish)	445	174	7	11,100	24,000	4,300

① Excludes 115 fish tagged after the commercial season closed.

than from other sources, but is relatively close in spite of the small number of fish in the samples.

Fishing Intensity

Based on average weights and landing records, the commercial fishery took 1,787 silvers in the Siletz River in 1954, or 12 per cent of the 15,200 estimated to have entered the river. If the 95 per cent upper and lower confidence limits calculated from tags recovered from the commercial fishery are substituted, the percentage caught ranges from 6 to 14.

This low fishing intensity was partially due to the fact that many fishermen continued to use the larger mesh nets for chinook even though the smaller silvers and chums were more abundant later in the season. Some fishermen discontinued fishing when chinook moved out of the area.

The sport and Indian fisheries took an estimated 9 and 1 per cent, respectively, of the silver run. All gear combined took approximately 3,100 fish or 22 per cent of the silver salmon that entered the Siletz River in 1954.

CHUM SALMON

Commercial Fishery

Chum salmon caught in the Siletz River commercial fishery were taken incidentally to chinook and silver salmon. The same regulations applied to all three species.

The average annual catch of chum salmon in the Siletz River was about 10,800 pounds during the period 1939-46 and then dropped to about 800 pounds. The largest catches prior to 1947 were made during November. From 1947 to 1956 the commercial fishery closed on October 31 and set nets could not be used. As a result, most of the chum salmon were not available to the fishery.

Tag Recoveries in the Commercial Fishery

There were 58 chum salmon tagged during the period October 16-November 15. Only 11 chums were examined in samples of the commercial catch, and 1 tag was observed. This fish had been tagged near Coyote Rock, and was recovered 4 days later about 1 mile above the tagging site.

Tag Recoveries From Spawning Grounds

Since there was no sport fishery (except possible "snagging" on the spawning grounds), the next source of chum tag recoveries was spawning ground surveys. No specific surveys were made for chums, but those observed during chinook and silver surveys were examined. The principal areas found to be utilized by chums were Bear Creek and Cedar Creek (Figure 2). Scare Creek was reported by residents to have had a fair run also.

During the season, 114 live and 109 dead chums were examined for tags. One tag was recovered from a dead fish—42 days after tagging—in Bear Creek, about 4 miles from the tagging point.

STEELHEAD

Commercial Fishery

Steelhead trout were caught by the commercial fishery incidental to chinook and silver salmon. Prior to 1947, the largest catches were made from November through January. Since 1947, the season has been closed on October 31, and set nets have been eliminated. The average annual catch of steelhead was about 11,200 pounds during the period 1939-46, and less than 1,000 pounds in 1947-54.

Tag Recoveries in the Commercial Fishery

Only 11 of the 63 steelhead tagged were available to the commercial fishery. During the season, 13 steelhead were examined in the catch, but no tags were observed. One tag was returned voluntarily. This fish had been tagged 3 days and migrated downstream from Coyote Rock about 1 mile before it was recovered.

Tag Recoveries in the Sport Fishery

Steelhead are fished by sportsmen primarily in the upper Siletz drainage. No effort was made to estimate the steelhead sport catch or sample it. Several tags were reported, and 2 were recovered. One of the tagged fish was caught approximately 40 miles up the Siletz from the tagging point 44 days after it was tagged; the other about 8 miles up Drift Creek 19 days after tagging. To reach the mouth of Drift Creek, the latter fish migrated 4 miles downstream from the tagging site at Coyote Rock.

SUMMARY

During a tagging study conducted in 1954 on salmon and steelhead migrating into the Siletz River, 194 chinook salmon, 445 silver salmon, 58 chum salmon, and 63 steelhead trout were tagged.

At the time of tagging, the fish were classified in two condition categories—"good" and "weak". Under the hypothesis that recovery of fish in the commercial fishery was independent of condition when released, a value of chi-square was obtained which was considered not significant at the 5-per cent level for both chinook and silver salmon.

The commercial catch was sampled intensively for tagged fish; tags were recovered from 25 chinook, 28 silvers, and 1 chum salmon.

The sport catch was not sampled but, by using the tagged-to-untagged ratio from samples of the commercial catch, it was calculated that the sport fishery took between 3 and 7 tagged chinook and between 15 and 32 tagged silvers although only 7 tags were actually returned by sport fishermen.

A small fishery was conducted in the Siletz River by about 5 members of the Siletz Indian Tribe. Their total catch was estimated at 40 chinook and 160 silver salmon. Nothing is known about the chum salmon or steelhead catch by the Indians.

Some chinook and silver salmon and steelhead moved at least 3 to 4 miles up the Siletz River, then returned downstream to enter lower tributaries to spawn. Voluntary returns were made of 4 tagged silvers that left the Siletz River and entered other drainages to spawn.

The tagged-to-untagged ratios of chinook found dead on the spawning grounds in Drift Creek indicated that chinook destined for Drift Creek received more tags than chinook going to other tributaries. Samples of silver salmon from Drift Creek spawning grounds were too few to be compared to other parts of the Siletz drainage. Only 1 tagged chum salmon and no tagged steelhead were recovered from spawning ground surveys.

Several estimates were made of the chinook and silver salmon population. The best estimate of the chinook population was 4,700 fish, using data obtained from the commercial fishery. The upper and lower 95 per cent confidence limits for this estimate were 8,200 and 3,500 fish, respectively. The best estimate of the silver salmon population, obtained from tags recovered in the commercial fishery, was 15,200 fish with confidence limits of 28,100 and 12,700 fish. Insufficient data were available for estimating chum salmon or steelhead populations.

It was calculated that the commercial fishery took 36 per cent of the chinook and about 12 per cent of the silvers that entered the Siletz River in 1954. The combined sport and Indian fisheries took an additional 4 and 10 per cent, respectively. The total harvest by all gear amounted to 40 per cent of the chinook and 22 per cent of the silvers.

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