

Troll Salmon Investigation Progress Report

January - December 1958

Oregon Fish Commission Research Division  
Clackamas, Oregon

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## INTRODUCTION

The period January through March was devoted to analysis of data and report writing. The 1957 Oregon troll sampling and mark recovery compilation was completed during January; this had been reported on in the previous progress report of this series (November 1956 to December 1957). In addition to the 1957 Oregon mark recoveries being summarized in the above progress report they have all been coded and punched for IBM processing. These data are available to interested parties in an IBM report "Tabulation and Marks Recovered by, or Reported to, OFC, Calendar Year 1957".

The 1957 recoveries of Oregon marks by other agencies (California, Washington, British Columbia, and Alaska) were received and processed during this period. These will be the subject of a supplement to the above mentioned IBM report and will be discussed briefly in the following pages. Oregon recoveries of other agencies' marks were processed, assigned, and sent to the marking agencies.

Random chinook scales from samples of the 1957 ocean sport and commercial fisheries were read and analyzed during the early part of the year. This has also been covered in the November 1956 to December 1957 progress report.

With the opening of the troll season on April 15, sampling of the landings began. The highlights of the 1958 sampling and mark recovery will be discussed later in this report. Prior to and during the course of the sampling a considerable amount of time was spent in collaboration with George Hirschhorn and the IBM section of the Portland office on the adoption of IBM processing principles to the troll salmon sampling material. The 1957 mark recoveries were put on IBM cards but not the sampling itself. The 1958 sampling as well as the mark recoveries, will be punched and processed similar to the Columbia River material and will be available in various summary forms from the Mark Analysis and IBM statistical sections.

In late May the summer's hooking mortality work began which will be discussed in this report.

Sampling the troll fishery for marks, average weights, and catch per unit effort continued throughout the summer. Miscellaneous work also performed during the period consisted of: (1) budget preparation; (2) studying and assigning 1958 Alaska mark recoveries; (3) coding of sampling and assigning marks as received for IBM analysis; (4) preparing a progress report on the past season's work; and (5) working up 1957 catch statistics.

Work after the fishing season closed on October 31 consisted of: (1) finishing up the sampling coding and assigning of marks; (2) preparation for and attendance at meetings; and (3) writing papers on past troll chinook tagging experiments and a nursery area study based on fishermen interviews.

#### MEETINGS ATTENDED

Major meetings attended and participated in during the year included: the Pacific Marine Fisheries Commission research meeting at Seattle; the Pacific Fisheries Biologists and Albacore Steering Committee Meeting at Harrison Hot Springs; the Fish Commission Research Division staff meeting at Portland; and the Pacific Marine Fisheries Commission meeting in November 1958 at Seattle.

Talks were given to the Columbia River Gill-Netters Union, the Astoria Kiwanis Club (twice), and a delegation of Japanese fisheries experts.

The State Conservation Week program was participated in including a downtown Astoria window display of Fish Commission activities in cooperation with the Information and Education Section. The Astoria Laboratory also cooperated with the I. and E. Section and the Seafoods Laboratory in setting up an exhibit at the Astoria Fish Festival. The fisheries class from Oregon State College visited the area and were shown the fishing industries and given a review of Fish Commission research work.

REPORTS SUBMITTED

Miscellaneous minor reports and briefs dealt with the contribution to the troll fishery of fish above various dam sites on the Umpqua River; the contribution of Columbia River chinook above the Nez Perce Dam site to the troll fishery; information on the 1958 troll fishery to the Washington Department of Fisheries for presentation at the Pacific Marine Fisheries Commission meeting; the biennial report of activities and accomplishments for the period July 1, 1956 to June 30, 1958; size limits and seasons on silver salmon; and prospects for the 1958 fall chinook run.

A second draft of a report on offshore silver salmon tagging was submitted for further editorial comment.

Considerable time was spent in preparing the justification for the 1959-61 biennial budget for marine fisheries.

A summary of all that we have learned about salmon in the ocean was submitted to the Pacific Marine Fisheries Commission in response to a resolution of the Western Association of Fish & Game Commissioners.

PERSONNEL

Robert Ellis joined the troll salmon staff in February 1958 on a permanent basis. He engaged in all the various projects mentioned, but will specialize in the hooking mortality work and the small fish problem in the troll fishery with all its ramifications.

Fred Vincent reported for work in June and began sampling the troll fishery for marks. He was paid largely from Federal Columbia River Fishery Development Program funds. He terminated in September to return to school.

SAMPLING AND MARK RECOVERY

1957 Troll Recoveries of Oregon Marked Fish in Other Areas.

California

The California Department of Fish and Game sampled salmon for marks in 1957. They reported the following double marks of possible Oregon origin in their samples (Table 1).

Table 1. Recovery of Oregon Marked Salmon in the California Troll Fishery in 1957.

Species	Mark	Brood Year	Origin	Number Recovered	Comments
Silver	Ad-LV	1954	Sandy River or Minter Creek	6	Crescent City, Fort Bragg, and San Francisco
Silver	Ad-RV	1954	Sandy River or Minter Creek	2	---
Silver	BV	1954	Oregon Coastal Streams	24	May include some naturals
Chinook	BV	1953	Umpqua River	7	May include some naturals
Chinook	BV	1954 or 55	Duplicated	2	May include some naturals
Chinook	RV-RM	1953 or 54	Umpqua River	20	Springs
Chinook	BV-LM	1953 or 54	Rogue River	32	Springs
Chinook	Ad-LM	1953 or 54	Rogue River	30	Springs
Chinook	RV-LM	1953 or 54	Rogue or Chetco River	21	Springs
Chinook	LV-LM	1955	Willamette or Klickitat River	1	-----



About the only noteworthy feature of the California sampling this year is the considerable numbers of Rogue and Umpqua River spring chinook taken. In the Oregon sampling the same year 25 Rogue and 24 Umpqua River springs were found (see Troll Salmon Investigation Progress Report, November 1956 to December 1957) and in Washington, only 5 were found. An interesting characteristic of spring chinook from these rivers is to migrate predominately southward rather than northward as for the Columbia River stocks.

#### Washington

The Washington Department of Fisheries examined 95,750 chinook out of a catch of 350,556, or 27 per cent, and 116,545 silvers out of a catch of 661,587, or 18 per cent, at Grays Harbor and Puget Sound ports.

Table 2 shows the double marks of possible Oregon origin recovered.

The only outstanding recovery of Oregon marks in the 1957 Washington sampling was the 31 recoveries of 1953-brood Ad-RV marks. This mark was duplicated on the Willamette River and the Mad River of California, but, as will be pointed out later, in all probability the majority were from the Willamette. If so, this number of troll recoveries far exceeds any other from the Willamette and stands out as one of the few successful marking experiments on Willamette River spring chinook. This is especially significant considering that only 65,000 were marked. Only 4 were taken in the Oregon troll fishery in 1957, but quite a large number was taken in Alaska (see later section). This experiment was also successful from the standpoint of river recoveries: 25 actual recoveries from the gill-net fishery in 1957 and 62 in 1958; 66 hatchery recoveries in 1957 (including 11 from the McKensie River) and 41 in 1958.

#### British Columbia

Little information has been received on the results of the 1957 British Columbia sampling. They apparently recovered 10 Ad-LV, 7 Ad-RV, and 7 Ad-BV marks

Table 2. Recovery of Oregon Marked Salmon in the Washington Troll Fishery in 1957.

Species	Mark	Brood Year	Origin	Number Recovered	Comments
Silver	Ad-LV	1954	Sandy River or Minter Creek	38	--
Silver	Ad-RV	1954	Sandy River or Minter Creek	27	--
Silver	BV	1954	Oregon Coastal Streams	38	--
Chinook	D-LV	1954	Willamette River	1	Falls
Chinook	Ad-LV	1953	Sandy River	5	Springs
Chinook	Ad-RV	1953	Willamette River or Mad River	31 <u>1/</u>	Springs
Chinook	Ad-RP	1953	Willamette River	1	Falls
Chinook	Ad-RP	1954	Bonneville Hatchery	1 <u>2/</u>	Falls
Chinook	BV	1952	Umpqua River	1	Falls
Chinook	--	1953	Umpqua River	18 <u>2/</u>	Falls
Chinook	--	1954	Duplicated	2	--
Chinook	RV-RM	1953 or 5/4	Umpqua River	5	Springs

1/ Includes 3 selected.

2/ Includes 1 selected.

from 27,758 chinook sampled off the West Coast of Vancouver Island, but they were all believed to have been from Washington experiments. No silver marks were recovered from the 15,943 examined.

Alaska

No sampling for marked fish in 1957 was done by the Pacific Marine Fisheries Commission. However, a fish buyer at Pelican noticed a number of marked chinook and recorded data on 35; they consisted of 23 Ad-RV, 6 Ad-LV, 1 Ad-UV, 1 Ad-BV, and 4 single clips. At first it was believed that these were from the large 1954-brood Klickitat River experiments, but later scale analysis indicated that they were mostly 1953-brood fish. The 1953-brood Ad-RV mark was duplicated on the Willamette and Mad Rivers, while the 1953-brood Ad-LV was from the Sandy River (spring chinook). Previous PMFC sampling in Alaska has been somewhat discouraging in that only a mere handful of marks has been recovered. For the first time in several years that no sampling was done, apparently large numbers of marked fish were available.

In an effort to resolve the duplication and attempt to assign the duplicated marks to the proper experiment a modest scale study was undertaken. The Willamette fish were spring chinook which should have shown a year of fresh-water growth and in fact were held in the hatchery for a full year. The Mad River runs are fall-run fish which typically should have shown the ocean type of nucleus. The scale reader of the Washington Department of Fisheries classified the 4-year fish as 15 ocean type and 5 stream type (one was a 3-year fish and 2 were without scales). The Oregon reader classified them on the first reading in an identical manner. A set of marked fish from the 1953-brood Willamette experiment from the Columbia River gill-net fishery was also studied and a reading of 14 stream and 3 ocean type obtained. There was undoubtedly a bias introduced here as the reader was familiar with the known early life history of the fish; more would have been called ocean type if it had not been known. A second reading of the Alaska troll scales are

study of the Columbia River sample changed the reading to 8 stream type and 12 ocean type. It was obvious that these fish had exceptionally good growth in fresh water and our criteria for separating ocean and stream growth in wild fish were not applicable to the marked fish.

Circuli counts and scale measurements were then made on the Alaska and Columbia River samples. A comparison of the first year or fresh-water circuli counts is shown in Figure 1. The two distributions have almost the same range and it appears that the Alaska troll marks could have come from the Willamette Hatchery. Scale measurements to the first and second annuli also show a pattern of being almost super-imposed. It appears that the fish of known origin from the Columbia River gill-net fishery had a similar early life history to that of fish of unknown origin taken in the Alaska troll fishery. Little information is available on the Mad River fish. Apparently none were obtained from the Mad River itself and 3 were sent for examination from the California troll fishery and presumed to be from the Mad River. First-year circuli counts were 16, 34, and 36. The 16-count fish was almost certainly a stream-type of nucleus and could have been from the Willamette (taken at Crescent City) while the other 2 were at the highest range of circuli counts of the Alaska and Columbia River samples. The first-year growth was comparable to the other samples, but the 2nd-year growth was considerable higher in the California recoveries than in the northern recoveries. Only 3 scale samples, however, leaves much to be desired for comparison purposes.

The conclusion was that most of the 1953-brood Ad-RV marks taken in the Alaska fishery in 1957 were of Willamette River origin based on the following facts:

1. The early life history, as shown by scale patterns, was very similar for marked fish taken in the Columbia River, of known origin, and those taken in the Alaska troll fishery, of uncertain origin.

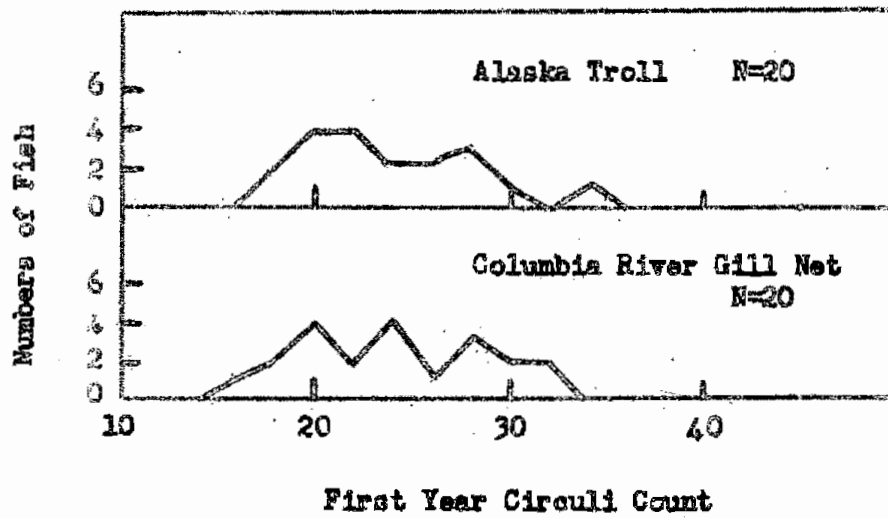


Figure 1. Circuli Counts of 1953-Brood Ad-RV Chinook Marks From the Alaska Troll Fishery and the Columbia River Gill-Net Fishery.

2. Previous tagging and marking experiments have shown Willamette fish to be present in this area while California fish have not been found.
3. The Willamette Hatchery 1953-brood experiment was very successful and contributed large numbers of marked fish to the river fishery and also returning to the hatchery. Few fish of known Mad River origin were reported as being caught.

This is the only case of any significant numbers of marked fish appearing in the Alaskan fishery, even though it is known that Columbia River stocks are an important component of this fishery, and one of the two Willamette marking experiments that produced a return of any consequence.

#### 1958 Oregon Sampling

Sampling was done on a rather small scale in 1958. Only one full-time sampler was available; he was paid largely from federal funds. He was stationed at Astoria and sampled fish that were landed there as well as those trucked in from Newport. Only scattered observations were made in the Coos Bay area except for the intense fishery in early June. Prior to the arrival of the sampler in June and after his departure in September, permanent personnel conducted the sampling.

Tables 3 and 4 summarize the average weight and mark recovery information for 1958 for silvers and chinook, respectively. Since the individual marks and more detailed sampling information are available in IBM tabulations to those interested, no more detail need be given here. These data refer only to double marks.

#### THE 1958 TROLL FISHERY

The troll season opening was again delayed to April 15 to give protection to the Columbia River fall chinook run. Vigorous enforcement and a gentleman's agreement among the fishermen resulted in no pre-season fishing this year and a storm prevailing at the season's opening did not allow any fishing until April 21. Even after the boats got out however, there were few fish to be caught. Catches of from 0 to 5 fish per day were the rule, with the average

Table 3. Oregon Troll Chinook Sampling, 1958.

Port	April	May	June	July	August	Sept.	October	Total
Columbia								
No. Weighed	306	180	237	251	239	45	5	1,263
Weight	2,951	1,819	2,031	2,147	2,862	656	48	12,514
Average	9.64	10.1	8.56	8.55	11.97	14.57	9.60	9.90
No. Examined	350	254	417	597	520	61	8	2,207
No. Marked	0	4	3	0	5	0	0	12
Newport								
No. Weighed	--	7	306	666	1,296	403	--	2,678
Weight	--	56	2,403	5,808	14,809	4,346	--	27,422
Average	--	8.0	7.85	8.72	11.42	10.78	--	10.23
No. Examined	--	7	726	1,266	2,114	706	--	4,819
No. Marked	--	0	0	4	5	1	--	10
Coos Bay								
No. Weighed	--	2	1,788	2	237	--	--	2,029
Weight	--	12	15,195	20	2,285	--	--	17,512
Average	--	6.0	8.49	10.0	9.64	--	--	8.63
No. Examined	--	15	4,221	198	282	10	--	4,726
No. Marked	--	0	8	0	1	0	--	9

Table 4. Oregon Troll Silver Sampling, 1958.

Port	June	July	August	Sept.	October	Total
Columbia						
No. Weighed	865	688	351	1,026	49	2,979
Weight	4,088	4,031	2,694	6,036	365	17,215
Average	4.72	5.85	7.67	5.88	7.44	5.77
No. Examined	3,255	1,752	522	2,636	102	8,267
No. Marked	10	7	1	19	0	37
Newport						
No. Weighed	--	93	120	41	--	254
Weight	--	601	815	274	--	3,690
Average	--	6.46	6.79	6.68	--	6.65
No. Examined	4,472	1,167	1,418	214	330	7,601
No. Marked	20	6	8	1	2	37
Coos Bay						
No. Weighed	142	40	2	--	--	184
Weight	753	231	12	--	--	996
Average	5.30	5.77	6.00	--	--	5.41
No. Examined	142	47	2	--	--	191
No. Marked	0	0	0	--	--	0

only 4.5 fish per day. Only a little over 10,000 pounds of chinook were landed at Astoria during April 1958 compared with April 1957 of 46,000, and 290,000 pounds as recently as 1956. It appeared that the late opening had effectively protected the spring run from the trollers and the fall run is still in a depleted condition.

May was even worse in the Columbia River area with less than 5,000 pounds landed at Astoria and less than 3,000 pounds at Ilwaco. The picture seemed equally dismal in most of the other Pacific coast areas from British Columbia to California. The fishing this year seemed to bear out our prediction of an impending failure in the troll chinook fishery coincident with the extremely poor escapements of Columbia River fall chinook in the brood years of 1954 and 1955. The situation was most critical in the areas most dependent on Columbia River fish such as off the Columbia and the lower Washington coast. The fishermen, however, tended to blame the warm water and unquestionably it also had some effect on the availability of the fish. What few fish that were caught were found in the deeper colder water. During the last few days of May a run of chinook developed offshore from Cape Blanco. Due to the widespread scarcity of salmon on other grounds a very large fleet of trollers from San Francisco to Ketchikan appeared and the salmon soon disappeared, but not until some very large landings had been made at the new Fisherman's Cooperative Association plant at Coos Bay. Approximately 637,000 pounds of chinook were landed at ports in the Coos Bay area during May and June which far exceeded any other landings during the year. The early Cape Blanco fishery has been characteristically one for large fish, but this year small and medium sizes predominated. After the Cape Blanco run, few chinook were to be found and most of the boats waited at the docks for the silvers or albacore to appear.



Silvers were scarce during June either before or after the season opened. Except for a few days around Memorial Day the fisherman interviewed reported catching virtually no silvers prior to June 15. Approximately 397,000 pounds were landed at all Oregon ports during June 1958 compared to 734,000 in June 1957.

The shortage of salmon, particularly the larger and choice grades, pushed the price to an all-time high. Fishermen received an average of \$.71 a pound for large dressed chinook, and \$.39 and \$.33 for small chinook and silvers, respectively. At Seattle the price was even higher, with an average price in August of \$.82 per pound for the larger grade. The price in 1958 was from \$.10 to \$.20 per pound higher for all species and grades than in 1957. Some loads sold for as much as \$1.00 per pound.

Salmon fishing continued poor through the rest of the season with the majority of the trollers turning to albacore after July. In addition to the scarcity of fish, the weather remained generally poor with strong northwest winds blowing much of the time. This was in contrast to 1957 when ocean conditions were ideal most of the time.

Large numbers of jack silvers were found off the mouth of the Columbia River in September. Some fairly good silver fishing was found by a few boats just inside the mouth of the Columbia in September when it was too stormy to go outside. About 141,000 pounds of silvers were landed in September 1958 at Astoria and Ilwaco, compared to 85,000 pounds in 1957.

An interesting feature of fishery this year was the taking of a few chum salmon early in the season. One was observed caught off Winchester Bay on June 6 that weighted 11.8 pounds dressed. Fishermen reported catching a few others. The testis on the one observed was in a fairly advanced state of maturity, suggesting possibly that it was destined for one of the early

runs of Puget Sound or Canadian Waters. Large blue sharks were noted frequently also during the early season. They are associated with warm water and are usually not seen inshore until late summer. Numbers of California white sea bass were again taken this year.

Total landings at Oregon ports in 1958 approximated only 3,074,000 pounds compared to 7,600,000 in 1956 and 6,800,000 in 1957. The breakdown in 1958 was 1,831,000 pounds of chinook and 1,244,000 pounds of silvers. Tables 5 and 6 show the catch statistics for the Oregon troll fishery for 1958.

#### THE 1958 TAGGING AND HOOKING MORTALITY STUDY

##### Introduction

The purpose of this study was to obtain an estimate of the mortality of troll-caught salmon which must be released because of size limits (chinook salmon) or season restrictions (silver salmon). These mortalities are thought to be of two kinds: (1) drowning or severe tissue damage and/or bleeding and is usually apparent when the fish is removed from the hook; and (2) fatigue and accumulation of lactic acid in the fish's body as a result of fighting the hook--a delayed mortality. It was also planned to develop an improved tagging method using an anesthetic.

##### Background

Milne and Ball (1956) reported a mortality of about 30 per cent in small (15- to 24-inch) troll-caught coho salmon landed in good condition, tagged, and held in tanks or a live pond for 33 days. The total mortality, including those landed dead or in poor condition and those tagged and held was 42 per cent.

Parker and Black (1959) reported an estimated delayed mortality of 71 per cent (95 per cent confidence limits of 40 to 86 per cent) for troll-caught chinook salmon held on board a troller in a live tank. These data do not include fish landed in poor condition due to severe hooking or drowning.

Table 5. Troll Chinook Statistics for 1958 by Month and Area Landed:  
Numbers of Landings, Pounds Round, and Numbers of Fish.

Month	Columbia <sup>1/</sup>		Newport		Coos Bay		Total	
	Nos. of Landings	Pounds Round Nos. of Fish	Nos. of Landings	Pounds Round Nos. of Fish	Nos. of Landings	Pounds Round Nos. of Fish	Nos. of Landings	Pounds Round Nos. of Fish
April	198 ---	16,601 1,497	53 ---	9,011 765	8 ---	284 29	259 ---	25,896 2,291
May	79 ---	7,147 616	199 ---	36,658 3,103	627 ---	106,574 10,739	905 ---	150,379 14,458
June	306 ---	31,273 3,177	672 ---	58,881 6,523	2,038 ---	530,263 54,313	3,016 ---	620,417 64,013
July	582 ---	45,356 4,613	1,587 ---	234,559 23,391	2,111 ---	260,240 26,223	4,280 ---	540,155 54,227
August	1,415 ---	103,412 7,512	1,514 ---	268,887 20,457	895 ---	63,798 5,755	3,824 ---	436,094 33,724
September	421 ---	11,453 684	951 ---	73,468 5,927	573 ---	46,231 4,658	1,945 ---	131,152 11,269
October	111 ---	2,367 215	186 ---	14,696 1,248	200 ---	12,789 1,289	497 ---	29,852 2,752
Total	3,112 ---	217,609 18,314	5,162 ---	696,160 61,414	6,452 ---	1,020,176 103,006	14,726 ---	1,933,945 182,734

<sup>1/</sup> Oregon and Washington landings combined.

Table 6. Troll Silver Statistics for 1958 by Month and Area Landings:  
Numbers of Landings, Pounds Round, and Numbers of Fish.

Month	Columbia 1/		Newport		Coos Bay		Total	
	Nos. of Landings	Pounds Round Nos. of Fish	Nos. of Landings	Pounds Round Nos. of Fish	Nos. of Landings	Pounds Round Nos. of Fish	Nos. of Landings	Pounds Round Nos. of Fish
June	503	135,876 — 25,033	443	171,506 — 31,007	1,134	123,366 — 20,241	2,080	430,748 — 76,281
July	899	167,660 — 24,922	1,518	230,468 — 31,024	2,009	191,576 — 28,872	4,426	589,704 — 84,818
August	1,531	131,116 — 14,866	1,680	161,792 — 20,720	955	44,172 — 5,156	4,166	337,080 — 40,742
September	1,051	141,188 — 20,881	1,343	116,821 — 15,208	781	40,540 — 5,965	3,175	298,549 — 42,054
October	253	12,769 — 1,492	189	9,105 — 1,064	182	5,376 — 628	624	27,250 — 3,184
Total	4,237	588,609 — 87,194	5,173	689,692 — 99,023	5,061	405,030 — 60,862	14,471	1,683,331 — 247,079

1/ Oregon and Washington landings combined.

Both of the aforementioned studies entailed holding the fish in live tanks on board ship. The mere condition of holding fish in live tanks is known to increase the levels of metabolism (Black, Fry, and Scott, 1939; Black and Barrett, 1957) and is therefore likely to increase the probability of mortality by adding to or slowing the recovery from the fatigue products accumulated while fighting the hook.

The present study of the effect of fatigue was patterned after that of Parker and Black except that an attempt was made to measure the effects of holding the fish in live tanks. In addition, an effort was made to measure the effects of handling after boating on the survival of fish by comparing returns of fish tagged with two different degrees of struggling through the use of rapid anesthesia.

#### Tagging Methods

During the 1958 season 18 day-trips were made on commercial trolliers to obtain fish for tagging and hooking mortality studies. Eight trips were made from Winchester Bay on the trollier "Patricia T." and ten off the Columbia River on the "Dreamer", "Quassia", and "Agnes".

The objectives of the tagging program were to obtain data on the movements and future contribution of the early season silver salmon off Winchester Bay and to compare tag returns from fish handled with and without anesthesia. It was also planned to hold fish in tanks on the boat and obtain blood samples for lactic acid determinations to measure fatigue due to being captured on the troll-fishing gear.

Considerable effort was directed at the early season fishing off Winchester Bay in an attempt to tag a large number of the silver salmon which commonly appear in the area before June 15. A combination of bad weather and failure of the silvers to appear resulted in the tagging of only 13 silver salmon

and 25 sub-legal (under 26 inches total length) chinook salmon. The work was discontinued in this area after July 24.

The tagging and fatigue studies were continued off the Columbia River from August 9 to September 26. It was thought that the large numbers of jack silvers being caught off the Columbia during this period, many of them being marked and of Klaskanine Hatchery origin, offered an opportunity to tag fish many of which would be headed for hatcheries and almost sure recovery. This theory was not borne out for only one tagged jack silver was recovered from a hatchery and that from Eagle Creek, a tributary of the Clackamas River. Twenty-three silver salmon between 14 and 21 inches in total length were tagged off the Columbia River, one of these was marked indicating a Klaskanine Hatchery origin.

One of the objectives of the field studies was to develop improved tagging methods for future population and mortality investigations. It was thus thought desirable to develop a handling technique which would minimize the struggling of the fish from the time it was landed on the boat until released. The use of MS 222 (Tricaine Methanesulfonate) as a rapid anesthetic was attempted and proven successful.

After considerable trial and error it was found that a concentration of MS 222 of 1:5,000 in sea water would rapidly anesthetize troll-caught fish. The anesthetic was contained in an 11-gallon wash boiler. The small salmon could be dropped into the anesthetic while still on the hook and the cover put on immediately. The fish would become quiet after the cover was put in place and anesthesia would take from 30 to 90 seconds. It was thought that the darkness in the covered boiler may have helped quiet the fish. This method of anesthesia was proven effective on both chinook and silver salmon (up to about 26 inches) and on two 26-inch halibut.

It was observed that anesthetized salmon often would not have regained their equilibrium by the time measuring, scale sampling, and tagging had been completed and would float away when returned to the ocean. Two methods were used to hasten recovery: (1) a hose delivering fresh sea water under low pressure was directed into the fish's mouth for about one minute; or (2) the fish were placed in a tub of fresh sea water until they righted themselves. Fish treated in this manner usually recovered in about 1 to 5 minutes and swam away when released. Most rapid recovery resulted from bathing the gills with fresh sea water from the hose.

As a check on the effectiveness of using an anesthetic on increasing the tag returns--lowering the mortality attributable to handling--fish were also tagged using no anesthetic. The hook was removed from these fish as rapidly and carefully as possible, but often it was necessary to use the fisherman's gaff to invert the hook and "shake" the fish onto the deck. The fish was then picked up and placed on the tagging board, scale sampled, tagged, and released by dropping over the side of the boat. These fish would occasionally float away. The unanesthetized fish often lost many scales while flopping about on the deck and tagging board. It was attempted to alternate the use of the two methods of handling the fish but this did not always occur.

#### Tagging Results

The tagging off Winchester Bay and the Columbia River will be treated separately.

In the Winchester Bay area a total of 27 chinook and silver salmon was tagged with the aid of rapid anesthesia and 11 salmon without anesthesia. One return was made from the anesthesia group and 1 from the no anesthesia group. These figures do not warrant further comment because of the small numbers of fish involved.

A total of 22 salmon was tagged in the Columbia River area with the aid of rapid anesthesia and 15 without anesthesia. Five returns were reported from the anesthesia group (23 per cent recovery) and one from the no anesthesia group (7 per cent recovery). The tag returns are few in number but do seem to indicate an advantage in favor of the use of rapid anesthesia in terms of tag recoveries.

The location of the tag recoveries are of some interest. Two chinook recoveries, apparently both jacks (24 inches total length), were tagged and released within a few hundred yards and a few minutes of each other in the mouth of the Columbia River. One of these fish was recovered in a gill net at Clifton on the Columbia River and the other was taken on sport gear in the Wilson River, a tributary to Tillamook Bay. Three jack silver salmon recoveries were: one from the Eagle Creek Hatchery, one from Saavie Island, and one from the Washougal River.

The single silver return from the Winchester Bay tagging occurred the day of tagging and was made by a sport fisherman. The single chinook salmon tag return from the Winchester Bay tagging came from Yaquina Head by commercial trolling in July 1959.

It should be noted in evaluating the returns from the Columbia River tagging in terms of hooking mortalities that all the silvers and some of the chinook were sexually mature jacks when tagged.

The tagging off Winchester Bay was probably early enough in the season so as to remove the effects of sexual maturity from the hooking mortality. Perhaps part of the difference in tag returns from the two areas may be due to differences in hooking mortality resulting from differences in sexual maturity. It is thought that immature fish may be more vulnerable to hooking mortality via fatigue products. This subject is discussed further in the section on the hooking mortality study.



Observations were made on the physical condition of the sub-legal or out-of-season salmon which were caught. Of the 39 sub-legal chinook and 40 pre-season silvers boated on the eight 1-day trips off Winchester Bay, 7 chinook (18 per cent) and 1 silver (2 per cent) were either dead when landed or so severely hooked as to be very probable mortalities. During the ten 1-day trips off the Columbia River 5 of the 24 sub-legal chinook boated were counted as mortalities (21 per cent). The 166 silver salmon were not considered as to condition. These figures do not include the possible delayed mortality or unobserved physical damage.

Table 7 summarizes the 1958 tagging and Figures 2 and 3 show the length frequency distributions of all the salmon caught. A total of 54 chinook and 46 silvers was taken off Winchester Bay and 32 chinook and 166 silvers off the Columbia River.

### Hooking Mortality Study

#### Materials and Methods

The general plan was to make observations on physical damage due to hooking present when boated and to obtain experimental fish from the catch of a commercial troller at sea. The subjects of the holding experiments were held in live tanks on the boat.

Sub-legal chinook and small silver salmon, landed in apparently good condition were placed in live tanks in the hold. One tank was a 110-gallon hogshead and the other a rectangular box of 85-gallon capacity. One live tank contained sea water and the other sea water with enough MS 222 to act as a tranquilizer (1 part in 150,000). It was hoped that the use of the two holding methods would make possible the measurement of the effects of holding the fish via differences in the blood levels of lactic acid. A blood sample was taken from the fish after a known period of time in the tank for measurement of the level of lactic acid, an established correlate of fatigue and death

Table 7. Results of Tagging Off Winchester Bay and off the Columbia River, 14 1-day Trips from May 20 to September 26, 1958.

	Anesthesia	No Anesthesia	Total
Numbers tagged:			
Chinook	29	10	39
Silver	<u>20</u>	<u>16</u>	<u>36</u>
Total	49	26	75
Numbers recovered: $\frac{1}{2}$			
Chinook	4	0	4
Silver	<u>2</u>	<u>2</u>	<u>4</u>
Total	6	2	8
Per Cent Recovery	12	8	11

$\frac{1}{2}$  Through October 30, 1959

Numbers of Fish

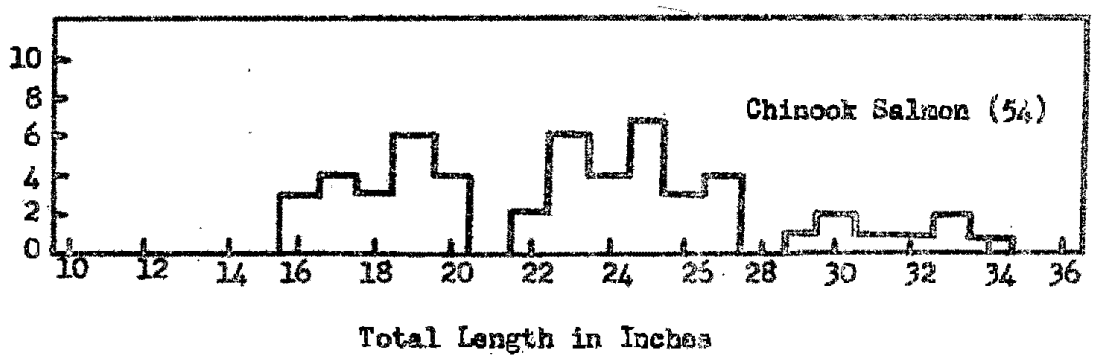
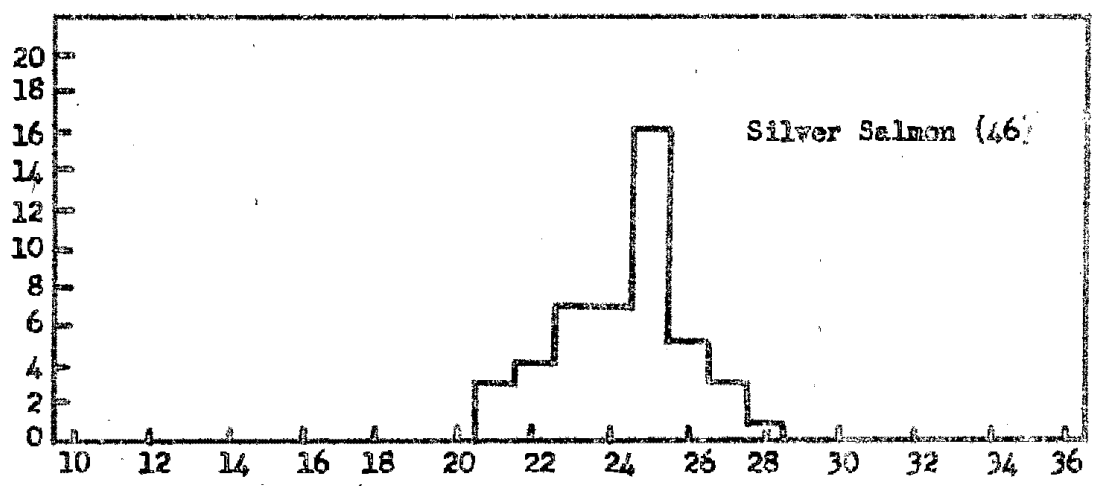


Figure 2. Length-Frequency Distribution of Troll Catch for Eight One-Day Fishing Trips off Winchester Bay, May 20 to July 26, 1958.

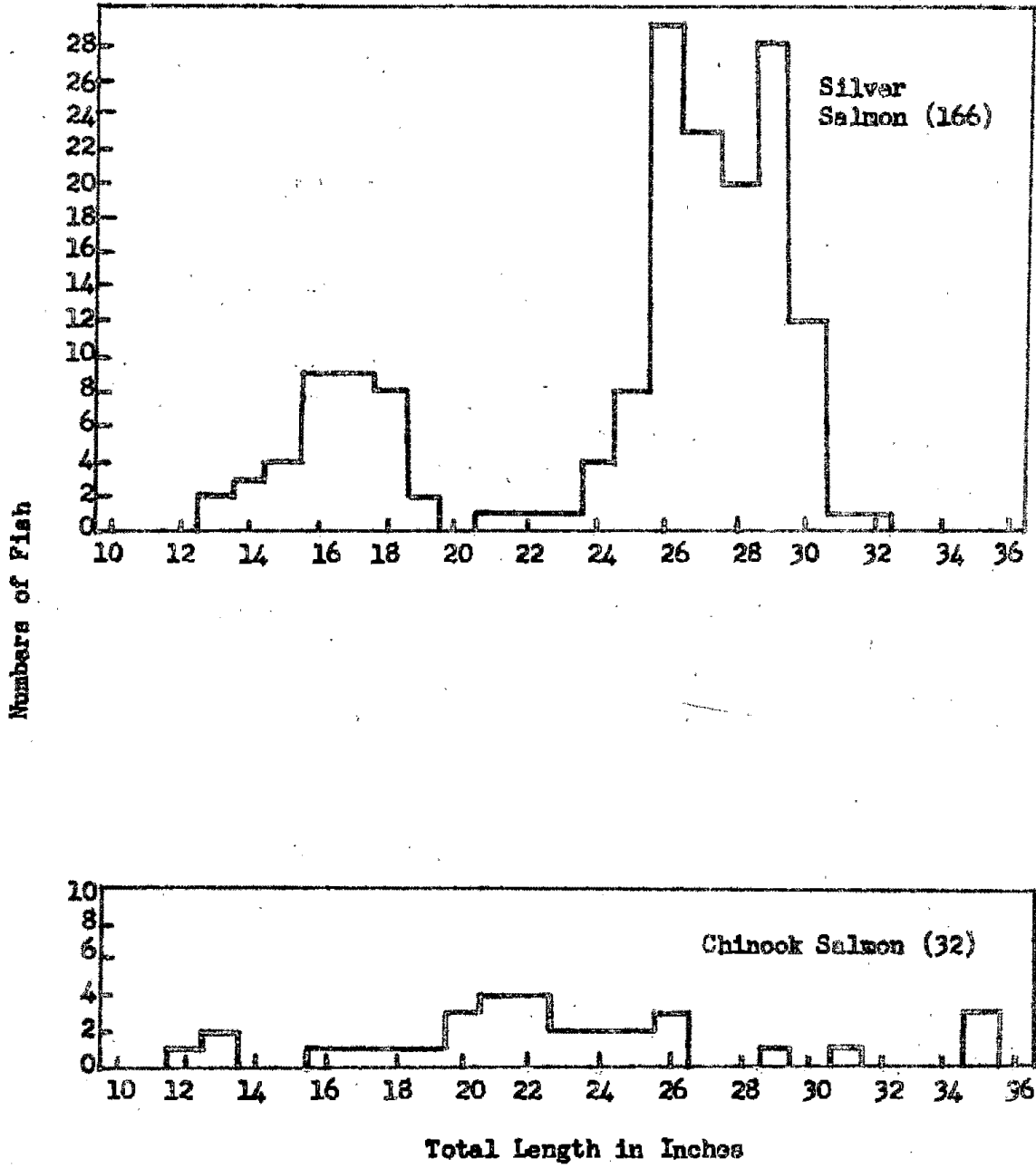


Figure 3. Length-Frequency Distribution of Troll Catch for Ten One-Day Fishing Trips off the Columbia River, August 9 to September 26, 1958.

(Black, 1957, a, b, and c). The blood samples were obtained by inserting a 1-1/2-inch hypodermic needle through the ventral body wall and into the heart. A 1.0 ml. sample of the blood was transferred to a polyethylene bottle containing 9.0 ml. of 10 per cent trichloroacetic acid and filtered through No. 41 Whatman filter paper into another polyethylene bottle. The filtrate was kept on ice until freezing facilities were available.

By October it was apparent that too few troll fish were being obtained for any comparison of the effects of holding tranquilized and untranquilized fish. At that time many jack silver salmon were appearing at the Klaskanine Hatchery and permission was obtained to experiment with some of these fish.

It was thought that possible differences in lactic acid levels in these sexually mature silver salmon would give at least an indication of the effects of holding fish in tanks.

These fish had been intercepted on their upstream migration and were in a concrete holding basin. Hatchery personnel had chased the fish about in the process of capturing adult fish for spawning. The experimental fish were captured with a dip net and carried to the holding tanks in a 5-gallon pail. All fought violently when captured and during the approximately 1-minute transport to the holding tanks.

The two holding tanks (those used in the troll studies) were moved to the lower end of the pond used for holding mature fish. Four jack silver salmon were placed in each tank, one tank with tranquilizer and one without. The fish were removed after 1 to 4 hours and blood samples obtained. On October 22 not enough jack salmon were available so migrating cutthroat trout were used.

It was determined by direct observation, and subsequently confirmed by the blood levels of lactic acid, that one gram of MS 222 in 85 gallons (1:300,000)

of fresh water was not sufficient to "tranquelize" these fish, i.e., did not noticeably reduce their activity. Therefore two grams per 85 gallons (1:150,000) was tried on the second and third days and four grams per 85 gallons (1:75,000) on the fourth day. Thereafter the number of jacks appearing at the hatchery was too few to make further work profitable.

The blood samples from these jack silver salmon were processed as described earlier for the troll-caught fish. The determinations of lactic acid were made at the Astoria Seafoods Laboratory of Oregon State College. Duncan Law gave freely of his time and laboratory experience in helping learn the techniques. The method used was that outlined in Hawk, Oser, and Summerson, 1954.

#### Results

Very few troll-caught fish suitable for holding were obtained and many of these were utilized in determining the proper concentration of MS 222 for rapid anesthesia for tagging. Several fish being held in the tanks were killed by rough water conditions. The determination of a "tranquilizing" concentration of MS 222 "consumed" others.

The net result in samples of blood from troll-caught fish was 9 samples. Of these 2 were from chinook salmon sampled when boated, 1 from a silver salmon when boated, 3 from chinook salmon held in sea water, 1 from a silver salmon held in sea water, and 2 from chinook salmon held in tranquilizing concentrations of MS 222.

A concentration of 2 grams of MS 222 per 85 gallons of sea water (1:150,000) was tentatively accepted as a tranquilizer for ocean-dwelling chinook and silver salmon. This tentative figure was based on the apparently tranquilized state of 4 chinook salmon held in this concentration. Unfortunately these fish were dead after crossing a very rough bar entering the bay, but the death of these fish was attributed to the physical damage incurred during the crossing.

The results of the blood analyses are presented in Table 8 for the troll-caught fish. The results in terms of milligram per cent of lactic acid are within the range reported by other workers. The range found here is from 37 to 271 mg. per cent.

Considerable variation was found to be present in the levels of lactic acid within a treatment in the mature fish handled at the hatchery; i.e., within the tranquilized or untranquilized groups at equivalent time periods (Table 9). This variation in blood levels of lactic acid is consistent with results reported by other workers (Parker and Black, 1959). Differences in range of lactic acid levels from one trial day to another may have been due in part to differences in amount of chasing about in the traps due to removal of spawning stock before the experimental fish were removed. Also on the first trial (October 20) MS 222 was used at the rate of 1:300,000 which did not seem to quiet the fish. In this trial the levels of lactic acid were higher in the 4 "tranquilized" fish than in the 2 held in fresh water (there were originally 4 fish in fresh water but two jumped out).

The use of MS 222 at the rate 1:75,000 in fresh water did not appear to decrease the levels of lactic acid below that of fish held at a concentration of 1:150,000. It appeared that under the experimental conditions, that is in fresh water at about 50° F., 1 part MS 222 in 150,000 parts of water was affective in reducing the activity, physical and/or psychological, of sexually mature silver salmon confined in small tanks and, in effect, acted as a tranquilizer.

The levels of lactic acid found in the blood of jack silver salmon captured during upstream migration were considerably lower (on the order of 60 per cent less) than those found in the troll-caught chinook and silver salmon. This observation has also been made by Parker (verbal communication) for chinook salmon captured on their spawning migration versus troll-caught chinook in Alaska. The differences observed being of about the same magnitude as found here.

Table 8. Blood Levels of Lactic Acid in Troll-Caught  
Chinook and Silver Salmon, 1958.

Fish Number	Date	Sp.	Total Length in Inches	Sex	Maturity	Mg. % Blood Lactic Acid	Treatment
1	May 20	Ch.	26	F	M	55.5	Killed when boated
2	June 4	Ch.	29	M	M	54.8	Killed when boated.
3	June 4	Ch.	23	F	I	116.5	52 min. on boat, never recovered from anesthetic in tranquilizer
4	June 4	Ch.	25	M	I	131.2	Held 4 hrs. 48 min. in fresh sea water, death thought due to rough seas.
6	June 25	Ch.	--	-	-	150.2	2 hrs. 10 min. in fresh sea water. Blood taken when the fish was observed to be floating.
17	June 25	S.	25	-	-	72.2	50 min. in fresh sea water. Floated belly-up for a long time. Breathing when sampled
24	July 25	Ch.	9	M	I	143.5	1 hr. 27 min. anesthetized and tranquilized. Nearly dead when sampled.
90	Aug. 9	S.	16	M	M	271.0	Put directly into sea water. 1 hr. 35 min. on boat. Swimming when removed for sampling
102	Aug. 14	S.	26	M	M	36.7	Killed when landed. Blood taken immediately, 2 min. 25 sec. on hook.



Table 9. Blood Levels of Lactic Acid in Jack Silver Salmon and Cutthroat Trout Handled at Klaskanine Hatchery, 1958.

Fish Number	Date	Sp.	Total Length in Inches	Sex	Maturity	Mg. % Blood Lactic Acid	Treatment
2 6	Oct. 20	S.	—	M	M	22.7	1 hr. 25 min. in tranquilizer at the rate of 1 gram MS 222 in 85 gallons (1:300,000).
2 7	Oct. 20	S.	—	M	M	20.9	1 hr. 40 min. in fresh water.
2 8	Oct. 20	S.	—	M	M	25.9	1 hr. 45 min. in tranquilizer.
2 9	Oct. 20	S.	20	M	M	44.1	2 hrs. in tranquilizer
2 0	Oct. 20	S.	17	M	M	26.1	2 hrs. in fresh water
2 1	Oct. 20	S.	18	M	M	28.2	2 hrs. 15 min. in tranquilizer.
2 2	Oct. 21	S.	20	M	M	31.3	2 hrs. 45 min. in tranquilizer at the rate of 2 grams MS 222 in 85 gallons (1:150,000).
2 3	Oct. 21	S.	19	M	M	23.7	2 hrs. 30 min. in fresh water.
2 5	Oct. 21	S.	19	M	M	14.1	3 hrs. 15 min. in tranquilizer.
2 7	Oct. 21	S.	17	M	M	3.9	4 hrs. in tranquilizer.
2 8	Oct. 21	S.	18	M	M	13.5	4 hrs. 15 min. in fresh water.
2 9	Oct. 22	Ct.	12	-	-	52.7	1 hr. 10 min. in fresh water.
2 0	Oct. 22	Ct.	14	-	-	49.4	1 hr. 20 min. in tranquilizer at the rate of 2 grams MS 222 per 85 gallons (1:150,000).
2 1	Oct. 22	S.	15	M	M	31.8	1 hr. 55 min. in fresh water.

Table 9. Blood Levels of Lactic Acid in Jack Silver Salmon and Cutthroat Trout Handled at Klaskanine Hatchery, 1958 (cont'd).

Fish Number	Date	Sp.	Total Length in Inches	Sex	Maturity	Mg. % Blood Lactic Acid	Treatment
292	Oct. 22	Ct.	17	-	-	55.7	1 hr. 55 min. in tranquilizer.
293	Oct. 22	S.	19	M	M	71.5	2 hr. 20 min. in fresh water.
294	Oct. 22	Ct.	13	-	-	17.3	2 hr. 35 min. in tranquilizer.
295	Oct. 22	Ct.	17	-	-	9.3	3 hrs. in fresh water.
296	Oct. 22	Ct.	17	-	-	12.7	3 hr. 15 min. in tranquilizer.
297	Oct. 22	Ct.	15	-	-	29.1	3 hr. 10 min. in fresh water.
299	Nov. 7	S.	18	M	M	32.3	1 hr. in tranquilizer at the rate of 2 grams MS 222/85 gallons (1:150,000).
300	Nov. 7	S.	20	M	M	40.7	1 hr. 10 min. in fresh water.
301	Nov. 7	S.	19	M	M	20.0	2 hr. 15 min. in tranquilizer.
302	Nov. 7	S.	17	M	M	31.3	2 hr. 40 min. in fresh water.
303	Nov. 7	S.	20	M	M	12.3	3 hr. 5 min. in tranquilizer.
304	Nov. 7	S.	20	M	M	35.6	3 hr. 5 min. in fresh water.
305	Nov. 7	S.	19	M	M	54.5	4 hr. 10 min. in fresh water.
306	Nov. 10	S.	19	M	M	11.6	1 hr. 25 min. in tranquilizer at the rate of 4 gm. MS 222/85 gallons (1:75,000).

Table 9. Blood Levels of Lactic Acid in Jack Silver Salmon and Cutthroat Trout Handled at Klaskanine Hatchery, 1958 (cont'd).

Fish Number	Date	Sp.	Total Length in Inches	Sex	Maturity	Mg. % Blood Lactic Acid	Treatment
307	Nov. 10	S.	17	M	M	57.2	1 hr. 25 min. in fresh water.
308	Nov. 10	S.	20	M	M	35.2	1 hr. 35 min. tranquilizer.
309	Nov. 10	S.	17	M	M	54.5	1 hr. 55 min. fresh water.
310	Nov. 10	S.	17	M	M	48.2	3 hr. in tranquilizer.
311	Nov. 10	S.	18	M	M	71.8	3 hr. 5 min. in fresh water.
312	Nov. 10	S.	19	M	M	14.8	3 hr. 5 min. in tranquilizer.
313	Nov. 10	S.	20	M	M	43.2	3 hr. 30 min. in fresh water.

Figure 4 demonstrates graphically the results of the holding trials for November 7 and 10. It is interesting to note that the untranquilized (control) fish had consistently higher lactic acid values (with 1 exception) that tend to remain at a high level while the tranquilized (test) fish had lower values that tended to decrease with time.

A calculation of the blood levels of lactic acid for the tranquilized silvers gives an average of 24.8 mg. per cent and for the untranquilized 40.5 mg. per cent. No further statistical treatment is offered because of the small numbers of trials involved, but the thought is presented that control fish (untranquilized) increased their lactic acid levels due to the psychological excitement of confinement in a small live box while the test fish (tranquilized) decreased in lactic acid values corresponding to what may occur in nature when a fish is released with no further stress. If this hypothesis is true, then it follows that confinement in a small live box is in itself conducive to higher lactic acid values. It is hoped to follow through on this study in 1959 with more samples-at-sea and also at the hatchery.

This type of work may also have applications in the procedures of hauling fish at high dams and would appear to be a profitable line of research. It is conceivable that the mortality due to hauling could be materially reduced by the use of a tranquilizer to calm the fish.

#### Summary

1. A modest work program at sea continued in 1958 in an attempt to determine the hooking mortality of the small salmon released by the troll fishery and to devise an improved tagging technique utilizing an anesthetic.
2. The use of MS 222 at 1:5,000 proved to be an effective and efficient anesthetic to aid in the tagging of salmon; the recovery rates of the tagged fish has been encouraging compared with the unanesthetized fish.

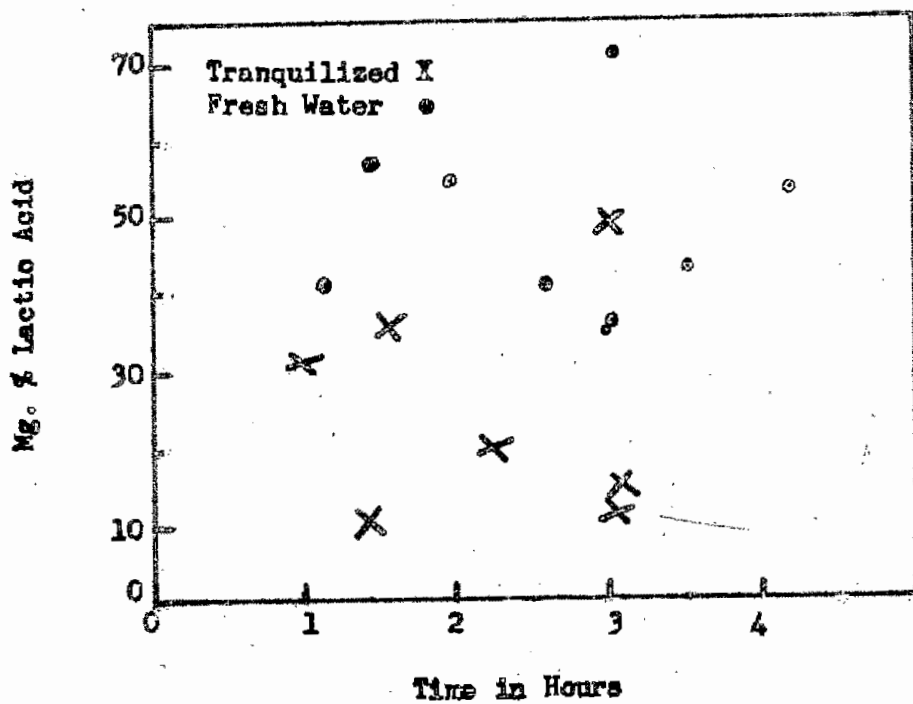


Figure 4. Results of Holding Jack Silver Salmon in Fresh Water and a MS 222 Tranquilizing Solution in Terms of Blood Lactic Acid, November 7 and 10, 1958.

3. Plans were made to study the lactic acid levels of the blood from the ocean-caught fish using different holding methods but too few samples were obtained to afford any conclusions. The complex technique of lactic acid determination was mastered as well as obtaining some information and ideas on future improvements in the study.
4. Since so few samples were obtained at sea, further work on jack silver salmon at the Klaskanine Hatchery was attempted. A concentration of M-22 of 1:150,000 appeared to be effective as a tranquilizer for these fish in reducing their activity and excitement. The lactic acid blood levels for the hatchery fish were considerably lower than for the ocean-caught fish. The hypothesis is presented that confinement in a live box in itself helps to increase, or at least maintain, high lactic acid values due to the excitement involved, and fish that are artificially calmed or released return to the resting stage much faster. The limited data obtained suggests that the control fish (untranquilized) had higher lactic acid values and maintained them over a longer period than the test fish (tranquilized) and that part of the high lactic acid values and subsequent delayed or fatigue mortalities observed by other workers may be attributed to the excitement caused by confinement. This work may also have application in the fish-hauling procedures at dams.

#### Literature Cited

Black, Edgar C.

1957. a. Alterations in the blood level of lactic acid in certain salmonid fishes following muscular activity. I. Kamloops trout, Salmo gairdneri. Journ. Fish. Res. Bd. Can., Vol. 14, No. 2, pp. 117-134.
- b. Alterations in the blood level of lactic acid in certain salmonid fishes following muscular activity. II. Lake trout, Salvelinus namaycush. Ibid., Vol. 14, No. 4, pp. 465-469.
- c. Alterations in the blood level of lactic acid in certain salmonid fishes following muscular activity. III. Sockeye salmon, Oncorhynchus nerka. Ibid., Vol. 14, No. 6, pp. 807-814.

Black, Edgar C. and Isidore Barrett.

1957. Increase in levels of lactic acid in the blood of cutthroat and steelhead trout following handling and live transportation. The Canadian Fish Culturist, No. 20, pp. 13-24.

Black, E. E., F. E. J. Fry, and W. J. Scott.

1939. Maximum rates of oxygen transport for certain fresh-water fish. Anat. Record 75, Supp. 80. This reference not seen, results read in The Physiology of Fishes, Vol. I.

Hawk, Philip B., Bernard L. Oser, and William H. Sommerson.

1954. Practical physiological chemistry. Ed. 13. The Blakiston Co., Philadelphia.

Milne, D. J. and E. A. R. Ball.

1956. The mortality of small salmon when caught by trolling and tagged or released untagged. Fish. Res. Bd. Can., Prog. Rept. Pac., No. 106, pp. 10-13.

Parker, Robert R. and Edgar C. Black.

1959. Muscular fatigue and mortality in troll-caught chinook salmon (Oncorhynchus tshawytscha). Journ. Fish. Res. Bd. Can., Vol. 16, No. 1, pp. 95-106.

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