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FOREWORD

These short reports are intended to inform the public, industry, and other interested parties of the current studies of the Commission's staff and the basis for conservation measures. Reports will be published from time to time when studies are sufficiently complete to provide reliable biological evidence for conclusions upon which regulations are based. Research Briefs are free and may be obtained upon request from the Fish Commission office.

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THE DEVELOPMENT OF ARTIFICIAL PROPAGATION OF SALMON IN THE WEST

Prior to 1872 there had been no artificial propagation of salmon in the west. In that year United States Commissioner of Fisheries Baird sent Mr. Livingston Stone from the east to California to establish a salmon station on the Sacramento river, "if possible". Mr. Stone, upon his arrival in August 1872, inquired in Sacramento and San Francisco as to the whereabouts of the spawning grounds of the Sacramento salmon. In one of his reports Mr. Stone says: "Reared in New England, where almost every square foot of ground has been explored, I supposed that almost anyone who had given attention to the matter could tell where the salmon spawned. To my very great astonishment, not a man could be found in California who could give the desired information.

"The fishermen at Sacramento, and between Sacramento and San Francisco, knew all about catching salmon, but none of them knew where the salmon spawned. The state fish commissioners, although they had collected valuable information of other kinds, had not yet learned the location of the spawning grounds of the Sacramento salmon."

Finally he was introduced to the chief engineer of the Pacific Railroad who showed him surveys of the upper waters of the Sacramento and pointed out a place on the map, near the junction of the McCloud and Pit rivers, where he assured Mr. Stone that in the fall of the year, he had seen Indians spearing the salmon on their spawning grounds.

"Our attempt to locate a camp on the river bank was received by the Indians with furious and threatening demonstrations. They had, until this time, succeeded in keeping white men from the river, with the exception of one settler, a Mr. Crooks, whom they murdered a few weeks after our arrival. Their success thus far in keeping white men off had given them a good deal of assurance."

Mr. Stone, after convincing the Indians that their protests were futile, went even so far as to have them help him in the constructing of his station and came to find them good-natured, hardy, honest but indolent.

"On the darkest nights the scene on the river bank was exceedingly wild and picturesque. Behind us was the tall, deep shadow of Persephone Mountain, and before us at our feet ran the gleaming, rapid current of the McCloud, while the camp-fire threw an unsteady light upon the forest, mountain and river, suddenly cut off by the dense darkness beyond. The flaming pitch-pine torches, stuck into the sandy beach at intervals of twenty feet to guide the boatman, the dusky forms of the half-dozen Indians coiled around the fire or stoically watching the fishing, the net, the fishing boat, and the struggling fish added to the effect, and made a picture which, especially when the woods were set on fire to attract the salmon, was one of surpassing interest. It was quite impressive, in the midst of these surroundings, to reflect that we were beyond the white man's boundary, in the home of the

Indian, where the bear, the panther, the deer, and the Indian had lived for centuries undisturbed."

That first year about 50,000 eggs were taken, of which 30,000 survived and were shipped to the Atlantic coast.

In July 1879, Mr. Stone received instructions from the United States Commissioner of fisheries to establish a station on the McCloud river for the purpose of taking and distributing the eggs of the black spotted McCloud river trout. A place at the mouth of a creek on the west side of the river four miles above the salmon station was selected and by December 1880, a large collection of live, full-grown trout averaging three pounds had been made. Most of the eggs taken here were shipped east.

The Baird station, as this one on the McCloud was known after 1879 when a post office was established there, grew to be one of the leading salmon stations in the west, employing from forty to fifty men. During the first eleven years alone of the sixty-four it was operated, 67,000,000 eggs were taken. Approximately 15,000,000 were planted in the McCloud; the remainder were shipped to the Atlantic coast or to foreign countries.

In 1877 Mr. Stone was sent to Oregon to establish a salmon station. He inspected many of the rivers of the state, especially the tributaries of the Columbia, and found the Clackamas, which is a tributary of the Willamette, which is, in turn, a tributary of the Columbia, to be the most suitable for salmon work. He discovered that the cold, rushing water of this stream attracted many fish. He located his station at the mouth of Clear creek, about twenty-five miles up the river.

Here the government alone operated until the Oregon Board of Fish Commissioners began its work earnestly enough in 1887, when it leased a site on the Clackamas from the Oregon and Washington Fish Propagation Company. But the state apparently was disinterested or unaware of the need of such stations, for, beginning in 1888, the legislature failed for many sessions to appropriate funds for furthering the work. Had it not been for the government and such men in Oregon as F. C. Reed and Hollister McGuire (Members of the Board of Fish Commissioners) and a group of far-sighted men who formed the Oregon and Washington Fish Propagation Company, "the purpose of which was to propagate salmon and other fish in the Columbia and its tributaries, and do a general fish cultural business and maintain hatcheries," there would probably not be many fish in the streams of Oregon today.

In 1888 the state turned this station on the Clackamas over to the government The members of the Board of Fish Commissioners realized the worth of artificial propagation. They had considered the value of the Columbia, Nehalem, Tillamook, Nestucca, Yaquina, Alsea, Siuslaw, Umpqua, Coquille and Rogue rivers and Coos Bay as suitable for hatchery work. They felt that in turning their Clackamas station over to the government, they would be assured of its continued operation.

The United States government, in fact, is actually responsible for the development of artificial propagation of salmon in the West. It alone seemed to realize the necessity of this work, even as early as 1872, and so efficient was the man sent to the West to investigate, locate, and operate the first stations there, that we find that the methods used today in the capturing and propagating of fish are much the same as those originated and used so successfully in California by Livingston Stone.

In early days of fish culture but very little was known of the habits and life of the salmon. It was believed that could the fish return to salt water after spawning, they would revive instead of die in the rivers as they were known to do. Nor was the number of times that a fish was capable of spawning known. There were no methods of checking, as have been instituted today, which show that the life cycle of the salmon is generally two years for the humpback, three years for the silver and four years for the chinook and blueback. One year an attempt was made to take eggs at Willamette Falls during May, and the workers were surprised to find that the fish had not yet reached the spawning period. It was not yet known that the spring run was headed for destinations far inland and, consequently, had begun its long journey earlier in the season than those of the fall run.

There is, actually, little of interest to be said about salmon work in Oregon between 1888 and 1910, for, although the state did begin to take an interest about 1900, its stations, as well as those of the government, were going through a type of trial and error period in which the worth of the various streams was being tested. Many stations were opened and soon closed when they were found to be poorly located.

The number of stations was increased gradually, however, and in 1915 the Oregon Fish and Game Commission was organized. Through the efforts of this Commission "the improved hatchery system" was developed. The continued falling off of the pack from year to year aroused the packers, and an effort was made to discover the reason for the gradual but steady decline in the size of the runs. It was decided that the fish were being liberated too early, so this new system was installed. It included, among other things, the use of feeding ponds, in which the fish were held until of sufficient age to better protect themselves when liberated. Better results were achieved, as was seen when the returns from liberations arrived in the rivers in 1917-1918-1919. The United States government stations, seeing the profitable results of this method, began immediately to use the same system. This system of feeding ponds naturally demanded large supplies of perishable fish food, which, in turn, necessitated the erection of cold storage plants in or near the station.

By 1921, the work being done by this commission became so extensive that it was deemed best to form two separate commissions. And so there were brought into existence the Game Commission, which took charge of the raising, distributing and protecting of game birds and fishes, and the Fish Commission, which handled the commercial fishes and shellfish.

The Columbia is one of the few salmon streams in the civilized world where the supply has been maintained over a long period of years in spite of more intensive fishing and greater inroads being made constantly upon the source of supply for the future. In the early stages of commercial fishing, the natural spawning beds at their various points along the rivers were free and unmolested. Slowly, but certainly, the advance of civilization crept upon this territory, and man began to destroy these natural spawning beds.

After much of the natural spawning ground became ruined, it was apparent to interested observers that the runs of salmon were gradually playing out. This led up to the development of the present extensive and scientific work with artificial propagation.

Years of work spent in developing artificial propagation have shown that it is a scientific process which requires knowledge, skill and patience which are gained only through years of experience. After watching the workings of a station, the process may appear simple to the visitor; such is not the case, however. From the moment that the eggs are taken from the fish until the resulting six-inch fish are liberated into the rivers, they require certain definite attention and care.

Continuous study is being carried on by State and Federal agencies. New problems are arising and old ones becoming more acute. Diseases are now being recognized and treated with a variety of products. The sulfa drugs have come into wide use for curing ailing fish. Prophylactic materials for treating the fish and the ponds in which they live have been developed and improved markedly within the last decade. Malnutrition in young fish is now recognized and research designed to develop cheap, balanced diets for the various species is under way. Fish culture has developed markedly since the day of Livingston Stone. Judging by present trends it will advance as much during the next half century as it has during the past fifty years and may well be the instrument necessary to maintain the salmon resources in the face of encroaching civilization.

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Special Representative
Fish Commission of Oregon

Leopard Shark Reported from Yaquina Bay

On September 21, 1948, while gill-net fishing for salmon in Yaquina Bay, Mr. J. C. Shermer, a gill-net fisherman of Yaquina, Oregon, removed a shark from his gear some five miles upbay from the ocean. This shark, which was landed at Yaquina Bay Fish Company, Newport, Oregon, was identified at the Oregon Fish Commission Research Laboratory at Newport as a male leopard shark, *Triakis semifasciatum* Girard. It measured 44 inches from the tip of the snout to the tip of the upper lobe of the caudal fin and weighed 11.5 pounds.

Although found in California in considerable numbers this is the second known record of the leopard shark being present in Yaquina Bay. Professor R. E. Dimick, Oregon State College, Corvallis, Oregon, published the first record under Icthyological Notes in Copeia, 1944.

APPLICATIONS OF ULTRAVIOLET LIGHT TO FISHERIES TECHNOLOGY[1]

Technology is constantly on the lookout for new tools or new applications of old instruments to the particular field or problem with which they are dealing. Ultraviolet light has frequently been a vital factor leading to the solution of many technological and scientific problems that formerly were solved only by lengthy and laborious analyses. In the field of mineralogy the use of ultraviolet or "black light" has one of its more important applications and prospectors consider the use of this instrument one of the notable advances in their field of endeavor.

In the food industries the use of ultraviolet has been largely confined to sanitation problems. Application of ultraviolet light in the bakery industry to irradiate the air and prevent contamination of products by air borne mold spores has been generally accepted, especially in hot, humid climates. In the cold storage and aging of meat, ultraviolet lamps have received considerable application in the inhibition of growth of micro-organisms enabling storage at higher humidities and temperatures.

Other applications of long wave length light that have been described are the sterilization of clear filtered water; detection of mercury, tungsten and molybdenum ores; detection of petroleum shale; and in the field of criminology and military science.

In the field of fisheries technology the use of ultraviolet light has had rather limited use as a bacteriostatic or bactericidal agent. The applications with which this paper deals in the field of fisheries is not one of sanitation but rather of quality control.

Detection of Parasites in Fish Flesh

At certain times of the year and with certain species of fish, parasitic infection is frequently noticed. Probably many of the parasites in marine fish are derived from their food sources. As far as the authors are aware, no parasites present in ocean fish in this section have ever been known to infect man. However, the detection and removal of parasites from frozen and fresh fish fillets is an important factor in quality control. A method that has been used to some limited extent for the detection of parasites has been called the candling procedure. By this technique the fish fillets, before marketing and packaging, are examined by means of strong artificial light. The fillets are held up to or allowed to pass over a glass plate beneath which is an intense electric light. The parasites, generally nematodes, are often visible and can then be removed by the inspector. This procedure has certain limitations; the operator must look into a strong light causing

[1]Published as Technical Paper No. 571 with approval of the Director of the Oregon Agricultural Experiment Station as a contribution of the Seafoods Laboratory of the Department of Food Technology.

considerable strain and discomfort. Moreover, in the thicker fillets the parasites are often not visible. Occasionally this laboratory has been called upon to make parasite counts on fish fillets. In carrying on this work all the difficulties inherent in the candling procedure and the discrepancies between counts were noticed. It was then decided to try the effect of ultraviolet light in this regard. In one particular lot of 10 pounds of frozen fillets consisting of 26 individual fillets of various sizes, 8 nematode-like parasites were counted by the candling method, using a 300 watt incandescent bulb. This same lot of fillets was then subjected to examination under ultraviolet light. Eighty-one nematode-like parasites were then revealed. In another sample, 10 pounds of fillets consisting of 30 pieces of a different variety of fish, 5 nematode-like parasites were counted by the candling procedure. Ultraviolet light exposed 57 parasites.

The procedure for examination of fillets with ultraviolet light is briefly as follows: The ultraviolet lamp used is known as Glo-Craft Model 106 (formerly Conti-Glo) portable black light Model 106, flood type bulb 100 watt manufactured by Switzer Brothers Inc., Cleveland, Ohio. The lamp, used in a darkroom, was mounted in such a way as to prevent direct illumination from the lamp entering the eyes of the operator, and at such an angle to minimize the effect of reflected ultraviolet light. In some cases and if many samples are to be examined, it has been found advantageous to employ dark glasses of the complete coverage type. The nematode-like parasites are noticed by their bluish-white fluorescence. It is helpful to examine the fish against a black background. The fillets are examined first on one side and then on the other and the parasites counted and removed. Occasionally on thin fillets or with certain species of fish the parasites are completely visible without examining both sides. This method has served to detect parasites in fish that are fresh as well as those that have been months in frozen storage. Other effects are noticed as one examines fish fillets with the aid of black light. The bones that may have not been removed in the filleting operation are quite plainly visible under ultraviolet light and may be removed to make a boneless fillet. Fish scales occasionally are present and may be eliminated with the aid of an ultraviolet light.

The fishing industry is doing its utmost to place before the consumer a high quality product and the ultraviolet procedure may be added to the ever growing list of methods and instruments which are used by the meat and fish industry to prevent and eliminate any foreign material from its products. It is well known that these and other extraneous materials are apt to occur in meat and fish but a rigid inspection program combined with the latest scientific developments are giving the consumers the quality which they demand.

Separation of Crabshell from Crabmeat

It was noticed that certain material in canned Pacific crab meat, *(Cancer magister)*, fluoresced bluish-white under ultraviolet light. On closer examination of this material it was found that the fluorescent material was crab shell that had not been removed in the picking and cleaning operations. Crab meat that had been freshly picked and had been examined by inspectors to remove as much shell as possible was taken to the laboratory dark room for examination. A considerable additional amount of crab shell was found with the aid of ultraviolet light. The outer exoskeleton as well as the colorless or white inner endoskeleton was found to fluoresce and could be readily removed. The procedure for examination and the light employed was the same as for the detection of parasites.

At the present time one of the commercial procedures for the separation of crab shell from the meat is based on a brine flotation principle. There are several limitations to this brine flotation method, among them being the cost of installation of brine equipment, incomplete removal of the shell, loss of meat, necessity for accurate control of brine concentration, and the effects of the carry-over of the brine solution on the remaining steps involved in the canning process. The use of an ultraviolet light separation method may simplify and eliminate many of the limiting factors found in the brine separation process.

A can of Atlantic blue crab *(Callinectes sapidus)* was examined with ultraviolet light and approximately a tablespoon of crab shell was removed from a single can.

Subsequently a literature search was made and an article was found published in 1937 by A. G. Giese and P. A. Seighton which described the phosphoresence of chitinous material and in the same year E. C. Gibson was granted a patent for a method of freeing crustacean flesh from the shell or chitin with the aid of ultraviolet light.

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Drag Boat Damage on Crabs

Considerable controversy exists between various fishing groups as to the damage done to crabs when brought up in drag gear. Accordingly observations were made while tagging crabs on the drag boat "Captain Ludvig" out of Astoria during December and January, 1947-1948. Of 588 crabs brought up in regular commercial operations from depths ranging from 20 to 80 fathoms which were purposely examined for injury, only 25 or 4.2 per cent were found to be damaged in any manner considered to be serious enough to cause the death of the crab. Further evidence of lack of damage is shown by the fact that tagged drag-caught crabs have been recoverd in about the same proportion as those tagged from regular commercial crab pots.

WILLAMETTE RIVER SPRING CHINOOK SPORT FISHERY OF 1948

Introduction

The year 1948 was the fifth in which the sport fishery for Willamette spring chinook was studied, previous years being 1941, 1942, 1946, and 1947. Studies during 1941 and 1942 were made by Craig and Townsend of the U. S. Fish and Wildlife Service and were published in a Special Scientific Report No. 33. Beginning in 1946 the studies have been carried on jointly by the Oregon Fish Commission and the Oregon Game Commission. Messrs. C. J. Campbell and C. C. Jensen of the Game Commission contributed materially to the project as did D. L. McKernan of the Fish Commission.

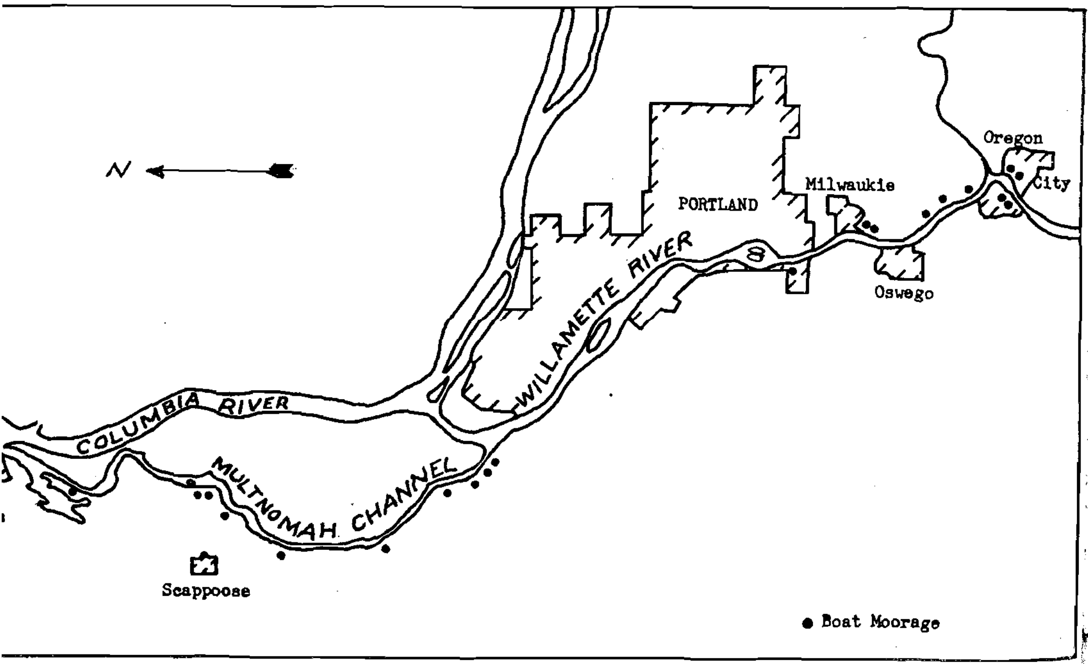
The Fishery

The sport fishery is carried on for the most part by anglers trolling from boats, and takes place from the lower end of Multnomah Channel to St. Johns Bridge, including a reach of the main Willamette River extending to its mouth; a second and important fishing area in the main Willamette River is that from Ross Island to Willamette Falls at Oregon City. Figure 1 shows the fishing areas and the approximate locations of the various moorages.

Methods

The method of arriving at the catch is the same as that used previously (McKernan and Jensen, 1946) and is based on obtaining an accurate esti-

FIGURE 1
SPORT FISHING AREAS FOR SPRING CHINOOK SALMON IN THE LOWER WILLAMETTE RIVER AND MULTNOMAH CHANNEL



mate of the catch per boat per day and the number of boats fishing each day for the entire season.

Basic data were obtained from record books kept by moorage operators, day-long studies of the fishery at moorages to learn the daily distribution of fishing effort, and counts of boats fishing (obtained from an airplane).

Daily distribution of fishing effort, averaged for all useful observations during the years 1946, 1947, and 1948, are shown in Figure 2. The basis for catch computations is indicated in Tables 1 and 2.

Results

The total sport catch of Willamette spring chinook salmon in 1948 was estimated to be 8,330. Of these, roughly 3,600 were taken below Portland

TABLE 1

COUNTS OF BOATS FROM AIRPLANE ON WILLAMETTE RIVER FROM PORTLAND TO OREGON CITY FALLS,

With Computation of Total Number of Boats on River During Day and Percentage Reported by Moorages, 1948

Date	Day	Time	Observer Counts	Per Cent Available*	Total Boats Calculated	Reported by Moorages	Per Cent Reported
			SATURDAYS AND SUNDAYS				
April 10	Sat.	1:03	295	60.2	490	78	15.9
April 11	Sun.	12:51	414	61.1	678	132	19.5
April 18	Sun.	12:00	599	66.2	905	127	14.0
			Total..........		2,073	337	16.3
			WEEK DAYS				
April 20	Tues.	12:35	185	43.0	430	81	18.8
April 27	Tues.	11:55	144	46.4	310	42	13.5
			Total..........		740	123	16.6

*Percentage of total boats for day that were on the river at time of count. (Figure 2).

TABLE 2

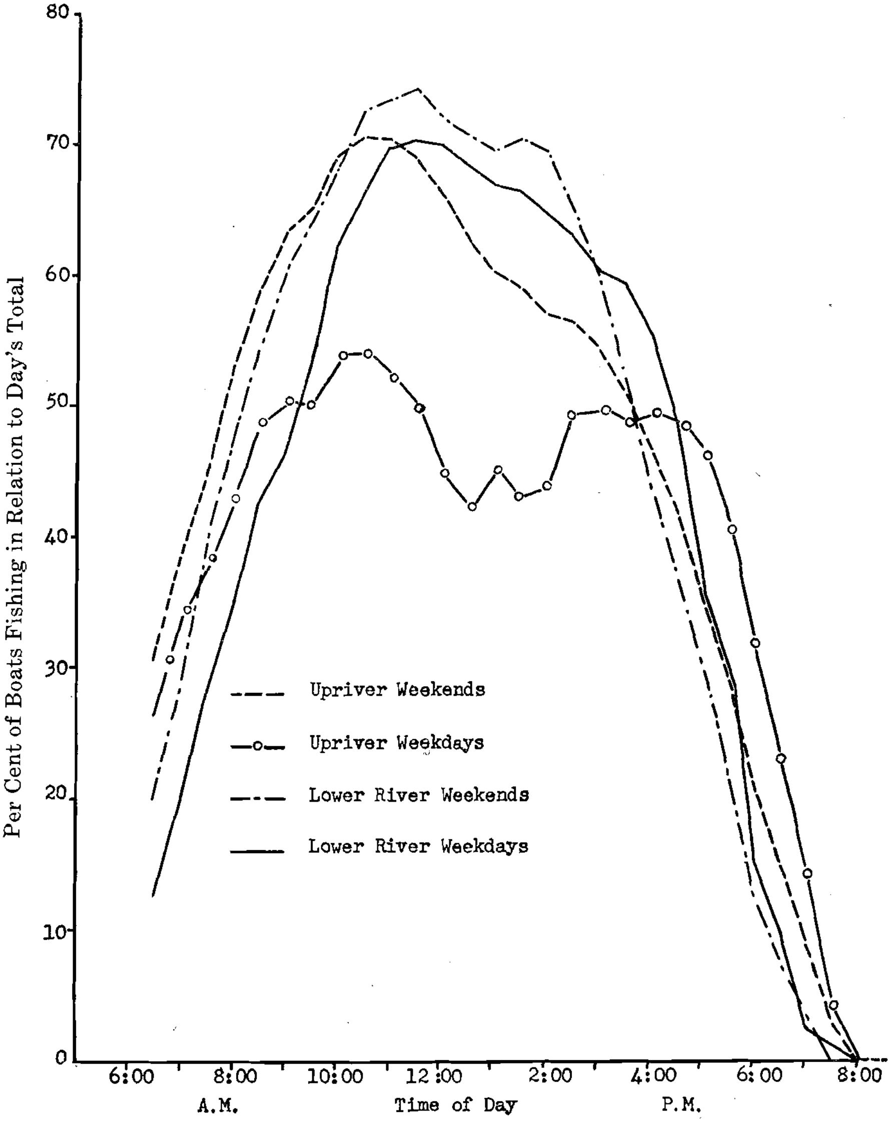
COUNTS OF BOATS FROM AIRPLANE ON MULTNOMAH CHANNEL AND THE WILLAMETTE RIVER BELOW PORTLAND,

With Computation of Total Number of Boats on River During Day and Percentage Reported by Moorages, 1948

Date	Day	Time	Observer Counts	Per Cent Available	Total Boats Calculated	Reported by Moorages	Per Cent Reported
			SATURDAYS AND SUNDAYS				
April 10	Sat.	12:03	566	71.9	787	497	63.2
April 11	Sun.	1:19	705	70.1	1,001	651	65.0
April 18	Sun.	12:22	832	71.4	1,165	722	62.0
			Total..........		2,953	1,870	63.3
			WEEK DAYS				
April 20	Tues.	12:54	320	67.3	475	355	74.7
April 27	Tues.	12:18	184	67.6	272	176	64.7
			Total..........		747	531	71.1

FIGURE 2

THE DISTRIBUTION OF FISHING EFFORT THROUGHOUT THE DAY, WILLAMETE RIVER SALMON SPORT FISHERY, AVERAGE OF ALL USEFUL OBSERVATIONS, 1946, 1947, and 1948



and 4,370 above (Table 3). The number of fish actually reported by cooperating moorages was 3,196. The estimate does not include a portion of the relatively small numbers of spring chinooks taken by anglers casting from shore and by others fishing within the Clackamas River and in the Willamette above the falls at Oregon City.

Attention is drawn to Figure 3 and Table 3 which show the weekly catches above and below Portland. Peak catches were made on the lower river in the final week in April and in the upper river during the second week in May. The first chinooks of the season were taken in the lower river, i.e. below Portland, in the second week of March. The latest known catch was taken near Oregon City during the first week of June.

TABLE 3
CATCH OF CHINOOK SALMON IN THE WILLAMETTE RIVER BY WEEKLY INTERVALS, CALCULATED FROM MOORAGE REPORTS, 1948

Date	Below Portland	Portland to Oregon City	Total
Feb. 29-March 6	0	0	0
March 7-13	4	0	4
14-20	10	0	10
21-27	3	31	34
28-April 3	226	115	341
April 4-10	545	170	715
11-17	597	762	1,359
18-24	826	526	1,352
25-May 1	1,004	564	1,568
May 2- 8	385	626	1,011
9-15	2	1,066	1,068
16-22	0	497	497
23-29	0	321	321
30-June 5	0	48	48
Total	3,602	4,726	8,328

TABLE 4
SALMON CATCH IN THE WILLAMETTE RIVER BY WEEKLY INTERVALS[1] AS CALCULATED FROM MOORAGE REPORTS FOR THE YEARS 1941, 1942, 1946, 1947, and 1948

Date	1941[2]	1942[2]	1946	1947	1948
Feb. 8	.....	.....	1	.....	.....
9-15	.....	.....	3	.....	.....
16-22	.....	.....	41	3	.....
23-March 1	.....	14	21	20	.....
March 2- 8	202	128	16	17	.....
9-15	804	290	68	0	4
16-22	1,615	544	38	367	10
23-29	3,753	1,732	572	480	34
30-April 5	5,518	2,080	1,523	342	341
April 6-12	6,392	2,536	2,125	341	715
13-19	5,823	1,278	2,740	4,106	1,359
20-26	4,382	1,610	3,173	3,799	1,352
27-May 3	1,183	1,417	1,308	1,672	1,568
May 4-10	267	305	506	373	1,011
11-17	61	66	181	112	1,068
18-24	.....	.....	25	152	497
25-31	.....	.....	1	71	321
June 1- 7	.....	.....	.....	.....	48
Total[3] (rounded)	30,000	12,000	12,630	12,000	8,330

[1]Weeks are defined to begin on a Sunday and end the following Saturday. Consequently weeks indicated here do not agree precisely and may be off by as much as three days.

[2]Catches for 1941 and 1942 were derived from Craig and Townsend.

[3]Total includes estimate of catch by anglers casting from shore (unassigned as to week) for 1946 and 1947.

It will be noted on Table 4 and Figure 4 that the 1948 catch was by far the lowest yet recorded for the Willamette sport fishery. This low catch was partially occasioned by a light run and partially by high and muddy water during much of the fishing season.

The average weight of 1,985 fish was 16.5 pounds. Recorded weights ranged from 2 to 42 pounds, the most common weight being 18 pounds. The total catch amounted to more than 137,400 pounds.

It was noted that there were 728 anglers in 365 of the boats observed at moorages, an average of about two anglers per boat (Table 5).

The number of angler-days spent fishing spring chinook on the Willamette in 1948 was calculated to be 79,574 (Table 6) with the greatest number of anglers in a single day being about 3,840. These sport fishermen caught 0.105 fish per day. In other words it required an average of about 10 days to catch a salmon on the Willamette River in 1948.

FIGURE 3
CATCH OF CHINOOK SALMON IN THE WILLAMETTE RIVER BY WEEKLY INTERVALS, CALCULATED FROM MOORAGE REPORTS, 1948

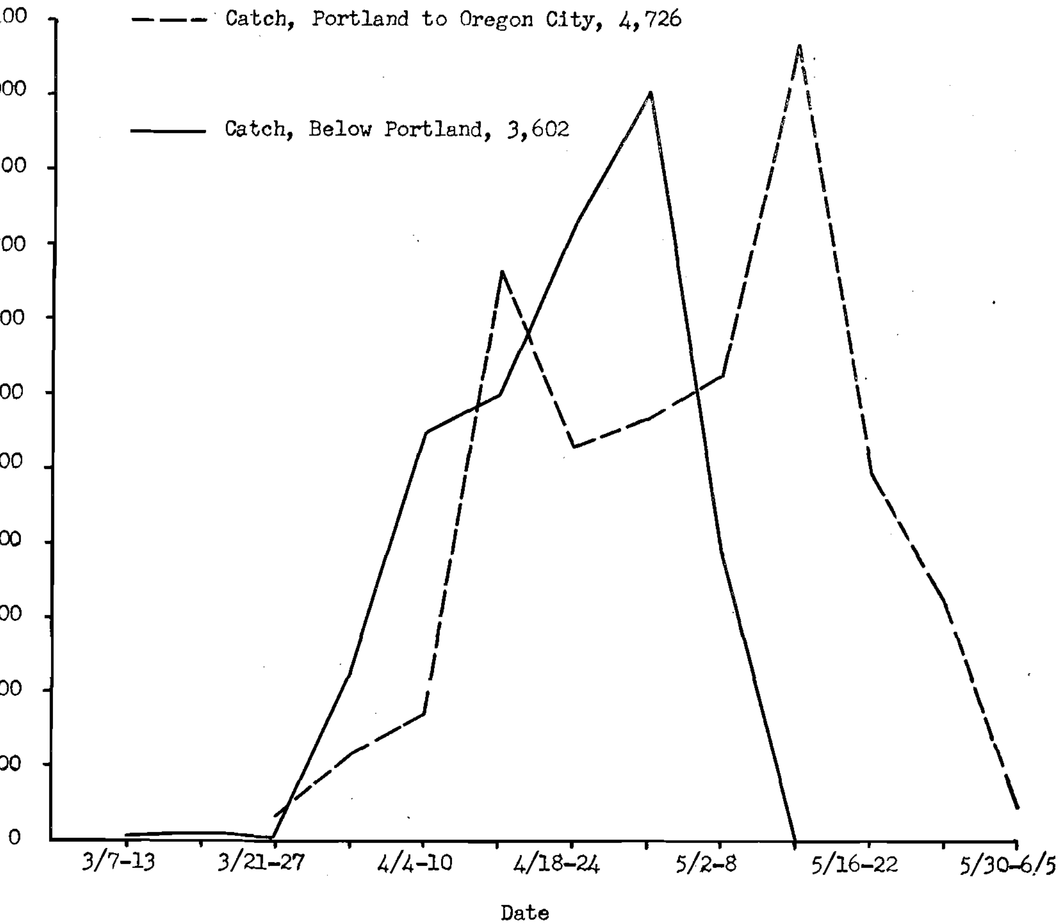


FIGURE 4

COMPARISON OF TOTAL CATCHES
OF WILLAMETTE RIVER SPRING CHINOOKS, BY WEEKLY INTERVALS,
FOR THE YEARS 1941, 1942, 1946, 1947, and 1948

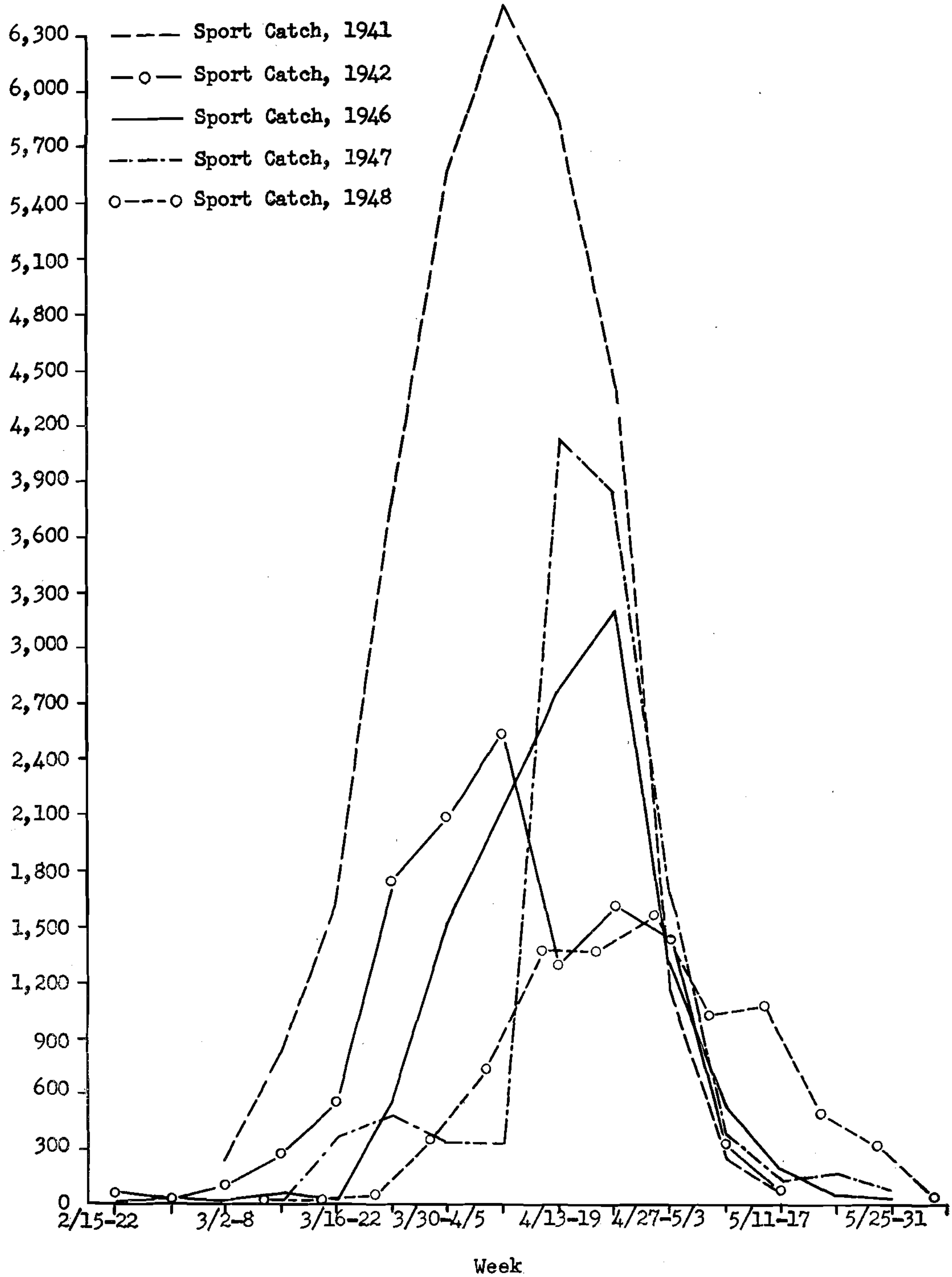


TABLE 5

AVERAGE NUMBER OF FISHERMEN PER BOAT AS OBTAINED BY OBSERVATIONS AT MOORAGES, WILLAMETTE RIVER, 1948

	Date	No. of Boats	No. of Fishermen	Fishermen per Boat
Portland to Oregon City....	April 11	116	255	2.20
	15	31	56	1.81
	21	74	134	1.81
	20	52	92	1.77
Below Portland.............	April 15	62	134	2.16
	20	30	57	1.90
Total..............	....	365	728	2.00

TABLE 6

COMPARISON OF THE SPRING CHINOOK SALMON SPORT FISHERY OF THE WILLAMETTE RIVER IN 1946, 1947, and 1948

Year	Fishing Intensity*	Catch in No. of Fish**	Catch per Boat per Day	Catch per Angler per Day
1946............	58,966	12,342	0.418	0.209
1947............	87,456	11,855	0.271	0.136
1948............	79,574	8,328	0.209	0.105

*Man-days of fishing on the part of anglers fishing from boats; calculated on basis of total boat-days of angling for season and 2.0 anglers per boat.

**Catch from boats.

Discussion

No study of the sport fishery was conducted in 1943, so it is impossible to relate the 1948 catch to that of the previous cycle.

Table 4 shows the weekly catches for 1941, 1942, 1946, 1947, and 1948. It will be noted that the 1948 catch occurred later than all the other years in all respects. The first, last, and peak catches occurred later. Peaks have occurred as early as the second week in April (1941). The 1948 peak for all sections of the river combined occurred during the last of April and first part of May. The very late catches of salmon at Oregon City Falls are in part related to the fact that salmon appeared to have difficulty surmounting the falls under the water flow conditions prevailing in the spring of 1948. Both salmon and steelhead appeared to suffer considerable difficulty and delay, and were abundant in the fishing areas below the falls much later than usual. Both this study of the sport fishery and the Fish Commission's studies at the falls indicate that that barrier seriously delays the migrations of salmon under unfavorable water flow conditions.

Summary

1. The total sport catch of Willamette spring chinook salmon amounted to about 8,330 fish in 1948. At an average weight of 16.5 pounds per fish this amounted to 137,400 pounds.

2. The 1948 catch was the smallest on record, catches in 1941, 1942, 1946, and 1947 being 30,000, 12,000, 12,630, and 12,000 fish, respectively.

3. Fishing in 1948 was poor because of a light run and more than usual high, muddy water.

4. Chinooks were taken from early March into June. Best catches were made in late April and early May.

5. The fishing intensity in terms of angler-days was computed to be 79,574 in 1948. This was higher than 1946 (58,966) but lower than 1947 (87,456).

6. The catch per angler per day was 0.105 fish in 1948. This was lower than either of the two previous years, the catch per man per day being 0.209 fish in 1946 and 0.136 in 1947.

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1946 '46 Willamette River Spring Chinook Sport Fishery. Oregon State Game Com. Bull. *1* (6):3-6, Portland.

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Crab Larvae as Food for Silver Salmon at Sea

Of 67 silver salmon stomachs examined in the troll fishery off Newport, Oregon, June 29, 1948, all except two that were empty contained the larvae of the Pacific edible crab, *Cancer magister*. One of these silver salmon stomachs examined, taken 4½ miles off the Yaquina Light, contained 809 identified larvae. The other 64 stomachs were also gorged with early stage larvae and occasional amphipods, a small shrimp-like animal.

Fishermen who fished the area between Cape Lookout and the Yaquina Light, June 25, to July 1, 1948 reported that most of the silvers caught had crab larvae in their stomachs.

Ocean Tagging Program

In an attempt to learn more of the ocean life of the salmon, the State of Oregon, along with California, Washington, British Columbia and Alaska, is undertaking an ocean salmon tagging program. The fish are caught from commercial trollers, tagged with a numbered disc and released. From the returned tags the migration of the fish from the point of tagging is traced; also information about the growth, fishing intensity and mortality may be secured. It is especially important that the river of origin of the various stocks of salmon in the ocean be understood in order to properly evaluate the stream and ocean fisheries. Fishermen and others handling salmon are requested to watch for these tags, record the locality and date taken and send them to the Fish Commission Research Laboratory, Route 3, Box 3, Astoria, Oregon. The success of this program depends upon the cooperation of the fishermen, and the tags sent in will be gratefully acknowledged.

Tagged Fish Makes Interesting Migration in Willamette River

A spring chinook salmon tagged at Oregon City Falls on May 26, 1948 was taken at the mouth of Eagle Creek in the Clackamas River on September 7 of the same year. This fish had dropped out of the fishway at the falls, moved down the Willamette more than a mile, and then migrated up the Clackamas River. While it may have dropped out of the fishway at the falls because of being handled while tagging, it had survived for more than three months while its sexual products were maturing and was ready to spawn when captured at an egg taking site by men of the Fish and Wildlife Service.

Tagged Columbia River Spring Chinook Taken at Sea

A chinook salmon tagged at Clifton, which is roughly 30 miles above the mouth of the Columbia River, was recaptured at sea six miles west of Willapa Harbor eight days later. The fish in question was caught in a gill net, measured (length, 35 inches), tagged, and released on April 10. On the eighteenth an offshore troller took the same fish on a plug.

Although salmon generally do not feed in fresh water during their upstream migration, it is not uncommon to find chinooks in the lower Columbia with stomachs containing smelt *(Thaleichthys pacificus)* during the spring of the year. The smelt annually enter the Columbia in the winter and spring and their vast numbers probably attract the feeding salmon. In view of the fact that the tagged fish in question returned to the sea and was caught on a plug, it seems possible that it too was in the Columbia to feed on the smelt, and that the feeding fish in the river in the spring may not belong with this year's spring run.

OBSERVATIONS ON THE EFFECT OF INTERTIDAL BLASTING ON CLAMS, OYSTERS AND OTHER SHORE INHABITANTS

Introduction

An opportunity recently arose to observe the effects of blasting on certain beach-dwelling animals. On April 12, 1949 the Port Commission of Bayocean, Oregon made two test blasts directly out from Bayocean on Tillamook Bay. The purpose was to determine the feasibility of blasting a channel in that area to permit small boats to dock closer inshore. Although no consequential shellfish, except oysters (beds 500 feet from blast), were present in the immediate area that might be damaged, observations and tests were made to determine what effect such blasting might have were it done in clam or crab producing areas. Sincere thanks are due to the Bayocean Port Commission, and Mr. Donald Toye of Atlas Powder Company who did the actual blasting, for their excellent cooperation in the matter, and to Messrs. D. Handley and C. Smith for their donation of oysters for testing in the blast.

The area involved was a sandy mud bottom ranging from about plus one to plus three foot tide level. The center line for the blasting was drawn up through a small depression, or channel, through which a "creek" of drainage water was running. Both blasts were set and fired during the afternoon low tide of April 12 (Low water plus 0.3 feet at 6:26 pm, corrected for Garibaldi).

The first charge consisted of an upper string 70 feet long joined by a lower portion 25 feet long. Three cases of 50 per cent strength dynamite (ditching type) were uniformly set along the upper 70 foot string with one additional case being set in three closely spaced rows along the lower 25 foot portion. The second charge consisted of one case set along a 70 foot line extending down from the lower end of the first charge. The mean depth of planting of the dynamite was about three feet below the surface in both instances (Figure 1).

Results

Although the results varied with the manner of setting the charge, in general the effect of the blasts was to blow a ditch approximately 10-15 feet wide at the top, or 5-8 deep from the center to the sides, and about 4-6 feet deep. Immediately following the blast the water began to "boil" up very strongly through the surrounding area out to about 75 feet on the lower (test) side of the channel. A large sector extending out about the same distance began to loosen up and settle down towards the ditch. A large amount of mud was scattered about, in places deposited up to a foot deep, but for the most part merely scattered about in masses. The general effect on the surrounding flat was to loosen and soften it up, muddying the surface. However, it is believed that such effect will be very rapidly erased with the soil returning to normal in perhaps but a few runs of tides.

CLAMS CRABS, AND OYSTERS

To test the effect on shellfish, a line was drawn out to one side perpendicular to the center of the upper 70 foot strip in the first blast. Stations were then paced off along this line at various intervals and specimens

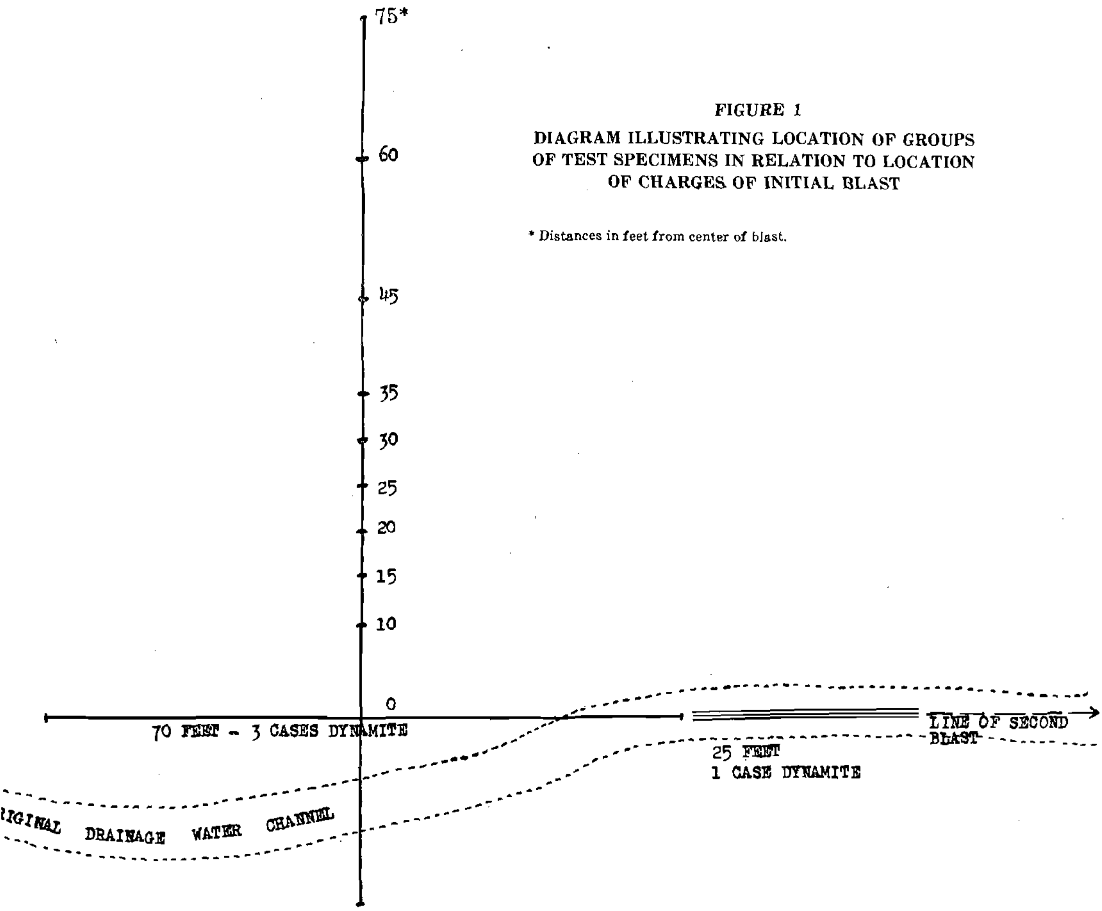

FIGURE 1

DIAGRAM ILLUSTRATING LOCATION OF GROUPS OF TEST SPECIMENS IN RELATION TO LOCATION OF CHARGES OF INITIAL BLAST

* Distances in feet from center of blast.

placed at each as listed below. The table also gives the final effect of the blast on each specimen.

Distance from center of blast in feet	Specimen	Results (Through April 22)
0	2 cockles—buried	Blown 150 ft., destroyed
	2 cockles—on surface	Presumed destroyed, not found
	1 cluster oysters	Presumed destroyed, not found
	1 crab (*Cancer productus*)	Blown 150 ft., destroyed
10	2 cockles—buried	Shells smashed, destroyed
	2 cockles—on surface	No effect
	1 cluster oysters	No effect
	1 crab (*C. magister*)	Dead—April 22
15	2 cockles—buried.	No effect.
	2 cockles—on surface.	No effect.
	1 cluster oysters.	No effect.
	1 crab (*C. magister*).	No effect.
20	2 cockles—buried.	No effect.
	2 cockles—on surface.	No effect.
	1 cluster oysters.	No effect.
	1 crab (*C. magister*).	Small crack in carapace, still alive and active April 22.
25	2 cockles—buried.	No effect.
	2 cockles—on surface.	No effect.
	1 cluster oysters.	No effect.
	1 crab (*C. productus*).	Dead—April 18.
30	2 cockles—buried.	No effect.
	2 cockles—on surface.	No effect.
	1 cluster oysters.	No effect.
	1 crab (*C. magister*).	No effect.
35	2 cockles—buried.	No effect.
	2 cockles—on surface.	No effect.
	1 cluster oysters.	No effect.
	1 crab (*C. productus*).	No effect.
45, 60, 75	Clams and oysters as above.	No effect.

The cockles, *Cardium corbis,* were specimens brought up from Yaquina Bay, secured a week previously and held in an aquarium tank until taken to Tillamook. They ranged in size from 60 to 79 mm. in rib length with an average rib length of 70.0 mm. They were randomly distributed to each station.

The oysters were clusters of one and two year old Pacific oysters, *Ostrea gigas,* taken at the time from the adjacent beds of Handley and Smith at Bayocean. They ranged from 4-12 oysters per cluster with an average of 8.4 oysters per cluster.

The crabs were small miscellaneous specimens brought up from the Newport laboratory where they had been held for several months or more. All but one were males. They ranged in back width from 115 to 144 mm., average width 129 mm.

All specimens, except the oysters, which were set at 20 feet or less from the center of the blast were first placed in separate canvas sample bags with appropriate labels to facilitate locating and prevent any mixing of specimens following the blast. It is not believed that this would have exerted any appreciable cushioning effect. The buried cockles were set about four inches under the surface.

Following the experiment all specimens were brought back to the Newport laboratory where they were examined and taken care of that same night. All specimens still alive were placed in aquaria and observed through April 22 at which time the experiment was closed.

In addition to the foregoing, one miscellaneous group of left-over cockles was placed on the surface 20 feet from the blast center on the opposite side of the regular test. Eight clams were put out, five of which were recovered, the missing three being buried or picked up by other parties present. These were also brought back to the Newport laboratory and put in the aquaria. One of these was found dead on April 22, the other four showed no ill effects.

Immediately following the firing of each charge, the area was examined for other specimens which might be present in the area affected. Five small crabs *(C. magister)* were found within the 25 foot zone. They ranged from 77 to 97 mm. back width, averaging, 90.2 mm. Three had broken or cracked carapaces and were dead on recovery. One showed no external signs of damage but was also dead. The remaining one showed no ill effects whatsoever through April 22.

GHOST SHRIMP

A considerable number of "ghost shrimp" were found within the 25 foot zone. Although all living specimens were also placed in an aquarium at Newport, the final observation on these was made the following day, April 13. Since past experience has shown it to be difficult to hold any of these forms very long in aquaria it was felt that this was about the limit of reliability of such observations.

A total of 76 of those collected were *Upogebia pugettensis.* Fourteen of the 76, or 18.4 per cent, were broken up or otherwise obviously mutilated by the blast. Including the above, a total of 39 were dead by April 13, or 51.3 per cent mortality. Nine specimens of *Callianassa sp.* were found; three, or 33.3 per cent, being broken or killed by being mutilated. Four others died, giving a total mortality of 77.8 per cent.

The average body length of the dead *Upogebia* was 88.2 mm. against 65.3 for those surviving. For *Callianassa* the average lengths were 109.6 mm. for the dead and 102.5 for the surviving. This may indicate a differential mortality depending upon size of the individual with the larger ones more susceptible to injury.

FISH

Three salmon fingerlings (tentatively identified as chums) were found within the 25 foot zone. Fork lengths were 36, 38, and 46 mm. Eight gobies

(Clevelandia ios) were also found, ranging in length from 58 to 65 mm. averaging 61.3 mm. All the fish were either dead or dying when collected. Since the tide was out, it was not surprising that only three salmon fingerlings were killed, as very few were present in the tide pools in the vicinity of the blast.

MISCELLANEOUS INVERTEBRATES

A small snail *(Thais sp.)*, 15 mm. in height, was found unharmed within 25 feet of the center.

A specimen of mud clam *(Macoma sp.)* 38 mm. in length was also found uninjured.

Three large sand worms *(Nereis sp.)* were found. Two were torn in half and the third had the body cavity ruptured.

Several ribbon worms *(Nemertinea)* were found in dead and broken condition.

One of the ghost shrimp *(Upogebia pugettensis)* was found with the small commensal clam *(Pseudopythina rugifera)* attached to its abdomen on the ventral surface. The clam was still alive and attached on April 13.

Summary

Four cases of 50 per cent dynamite were fired as a single shot along a 95 foot line in a sandy mud bottom of plus 1.0 to plus 3.0 foot tide level at Bayocean, April 12, 1949. A second smaller charge was also fired and observed.

Specimens placed at known distances from the center of the blast showed:

1. Little or no damage to surface cockles located 10 feet or further from the center.
2. No damage to sub-surface cockles located 15 feet or further from the center.
3. No damage to crabs located 30 feet or further from the center.
4. No damage to oysters located 10 feet or further from the center. (The foregoing does not consider any possible after-effects such as silting.)
5. A 50 to 75 per cent mortality of ghost shrimp was found within 25 feet of the center.

6. In the case of the invertebrates involved it is likely that almost all damage done by blasting is grossly physical in nature, that there is little shock or other after effects.

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The Ghost Shrimp Fishery

In the larger bays of Oregon, and in many of the smaller ones, there can be found in the mud flats at low tide the ghost shrimp, *Callianassa californiensis.* An excellent bait for flounders, perch, kelp, etc., it is much in demand by sportsmen. Another use it has been put to is crab bait for the ring-netting of crabs.

To meet increasing demands a shrimp pump was developed and first used in the Alsea Bay in 1936. It is simply a gasoline powered water pump that pumps water from the bay and forces it through a four foot nozzle attached to a fire hose of varying length. The nozzle is then used to wash the sandy-mud away and isolate the shrimp by washing. An area of 25 square feet can be "washed" in about an hour with a yield of one to two gallons of shrimp in selected areas.

An estimate of the acreage of shrimp beds for the bays of Oregon is 9135 acres, each having a calculated 1700 gallons of shrimp per acre.

Two bays, the Alsea and Siletz, showed the seasonal yield of ghost shrimp to be 400 gallons. At $3.00 per gallon (approximate present price) the total value of shrimp in these two bays would be $1200.

Damage to clams due to the pumping operation is negligible, for at present operations are limited to areas away from the clam beds.

Cockle Dredging — Tillamook Bay

A recent investigation of "cockle-dredging" at Tillamook Bay found the total take of clams by this method to be small and the damage to associated forms (horseclams, crabs, oysters) due to this operation negligible.

The dredge, a sled type, is drawn slowly along the bottom (approximately four feet per minute) behind a boat in from 7 to 15 feet of water, depending upon the tides and areas dredged, digging from three to four inches into the sand. An average drag is 15 to 20 minutes in length, traveling in this time 70 to 100 feet.

On a test trip with one of the cockle dredgers, May 11, 1949, the catch was five gallons of cockles for 86 minutes of dredging. Earlier this year, catches were reportedly better, averaging five gallons in 60 minutes. In contrast, an experienced man raking for cockles can rake 2 to 3 five gallon cans per hour in a good area.

The operation is limited to sand bottom only, the dredge rapidly buries itself and becomes clogged when dragged in mud. The operation is further limited by the accumulation of old shells in areas on the bottom; these old shells fill the dredge sack and stick between the teeth rendering the dredge inoperative. Dredges are most useful during the winter months when the tides are not right for raking.

AN INCIDENT OF FURUNCULOSIS IN SALMON AT A COASTAL HATCHERY

Introduction

Year old spring chinook salmon being held at the Commission's Trask Hatchery were experiencing severe mortalities in October of 1948, and it proved advisable to closely examine both the fish present and the hatchery arrangement. Mr. Bolle, the hatchery superintendent, had about 98,000 yearling spring-run chinooks on hand in mid-October. According to him, the losses among this lot of fish were remarkably low prior to September 1, being about five or six fish per day. These fish had been examined in early August and found to be in relatively good condition. At that time several specimens were examined microscopically. The gills were normal and of good color with no parasites. The liver and spleen of all fish examined were normal. Despite the plump appearance of the yearlings, no fat deposits were noted along the intestinal tract. The diet fed the fish at this time was salmon viscera and varying amounts of fluky beef liver when available. About September 1, a shipment of tuna viscera was received at the hatchery and fed for about four days.

Observations

In mid-October several of the weaker fish near the outlet screens were netted for examination. The gills of these fish were pale in color but without parasites. Some "clubbing" of the gill filaments was noted. Some evidences of fungal growth were also noted in the caudal and gill areas. Upon opening the body cavity a pinkish fluid material flowed from near the vent. The posterior portion of the kidney was three to four times as large as normal with white rosette-shaped lesions in the dorsal peritoneum. Upon probing the kidney it was found to be of a soft pulpy nature and semi-fluid. Smears of this fluid under the high dry power of the microscope showed disintegrating kidney tissue and small rod-shaped bacteria in profusion. The spleens of examined fish were a bright cherry red color. The heart and liver appeared normal. In only one fish of the several examined were there pinkish spots along the lateral areas. These were in clusters of 3 or 4 about the size of a pin head. The underlying muscles in this area were of a mushy consistency.

A tentative diagnosis of furunculosis was made and further study initiated. A group of the infected fish was taken to the laboratory at Reed College and prepared slides were made of kidney smears. Both Gram positive and Gram negative bacilli were found on the slides.

SULMET (SULFAMETHAZINE) TREATMENT

References of Wolf and Gutsell on treatment of furunculosis with sulfa drugs were perused. Mr. Burrows of the U. S. Fish and Wildlife Service station at Leavenworth stated that he found in his experimental work that sulfamerazine proved more satisfactory than sulfamethazine in treatments. Several drug companies in Portland were contacted and "Sulmet" powder was all that was obtainable at the time. To get sulfamerazine would necessitate a ten-day delay in treatments, so the sulfamethazine powder was decided upon. The veterinary grade powder was ordered.

A live box was then constructed and placed in the pond. In late October three hundred of the weakest appearing fish were placed in the live box and given medicated food over a period of eight days with seemingly good results.

TABLE 1

Date	Number Mortalities	Mortalities in per cent of remaining fish	Water Temperatures in degrees F. High	Water Temperatures in degrees F. Low	Water Temperature °F Average	Comments
Dec. 18	312	.61	43	39	41	....
19	612	1.21	44	39	41.5	....
20	701	1.41	46	42	44	....
21	471	.96	45	42	43.5	....
22	395	.81	44	41	42.5	....
23	392	.81	44	40	42	....
24	400	.83	42	39	40.5	....
25	328	.68	41	39	40	....
26	458	.97	41	39	40	....
27	432	.92	42	39	40.5	....
28	430	.93	43	40	41.5	....
29	375	.81	43	40	41.5	....
30	295	.64	44	42	43	....
31	316	.69	44	40	42	....
Jan. 1	279	.62	43	40	41.5	....
2	321	.71	43	40	41.5	....
3	358	.80	42	40	41	....
4	206	.46	41	38	39.5	....
5	302	.69	40	38	39	....
6	326	.75	42	39	40.5	....
7	318	.73	43	39	41	....
8	317	.74	43	39	41	....
9	310	.70	41	38	39.5	....
10	312	.70	40	36	38	....
11	292	.60	38	36	37	....
12	285	.60	38	35	36.5	....
13	276	.60	38	35	36.5	....
14	282	.68	38	35	36.5	....
15	306	.75	39	35	37	....
16	312	.77	41	37	39	....
17	215	.53	42	38	40	....
18	340	.85	40	39	39.5	....
19	359	.91	40	38	39	....
20	426	1.10	42	37	39.5	....
21	167	.43	40	36	38	....
22	349	.90	39	36	37.5	....
23	212	.55	40	35	37.5	....
24	215	.56	38	34	36	....
25	158	.42	37	34	35.5	....
26	158	.42	38	33	35.5	....
27	47	.12	41	34	37.5	Medicated food—1st day.
28	79	.20	41	36	38.5	Medicated food—2nd day.
29	93	.24	40	36	38	Medicated food—3rd day.
30	Sunday	....	40	37	38.5	Medicated food—4th day.
31	90	.23	39	37	38	Medicated food—5th day.

TABLE 1—(continued)

Date	Number Mortalities	Mortalities in per cent of remaining fish	Water Temperatures in degrees F. High	Water Temperatures in degrees F. Low	Water Temperature °F Average	Comments
Feb. 1	72	.19	39	37	38	Medicated food—6th day.
2	112	.29	40	36	38	Medicated food—7th day.
3	102	.27	39	36	37.5	Medicated food—8th day.
4	92	.24	39	36	37.5	Medicated food—9th day.
5	91	.24	38	35	36.5	Medicated food—10th day.
6	81	.22	38	35	36.5	Medicated food—11th day.
7	97	.26	39	34	36.5	Medicated food—12th day.
8	77	.20	40	38	39	....
9	90	.24	40	38	39	....
10	82	.22	40	38	39	....
11	144	.39	39	38	38.5	High, muddy water.
12	144	.39	42	38	40	High, muddy water.
13	145	.39	38	35	36.5	Liver in diet increased to approximately 10% from here on out to liberation date.
14	147	.40	39	34	36.5	....
15	140	.38	40	38	39	....
16	147	.40	40	38	39	....
17	171	.47	40	38	39	High, muddy water.
18	172	.48	39	38	38.5	High, muddy water.
19	172	.48	42	38	40	High, muddy water.
20	172	.48	46	41	43.5	High, muddy water.
21	343	.97	46	42	44	....
22	290	.83	45	43	44	High, muddy water.
23	290	.84	46	43	44.5	High, muddy water.
24	290	.85	46	42	44	High ,muddy water.
25	171	.50	47	43	45	....
26	....	....	....	....	....	Liberated via Gold Creek.

FURTHER DIAGNOSIS

On November 1, Dr. R. R. Rucker of the U. S. Fish and Wildlife Service took culture smears of kidney lesions from six infected fish which had not been previously treated. These fish all had fungal growths beneath the opercle and two had fungus patches in the caudal area.

Subsequent findings by Dr. Rucker showed that two of the six cultures taken showed the presence of *Bacterium salmonicida*, the causative agent of furunculosis.

SULFAMERAZINE TREATMENT

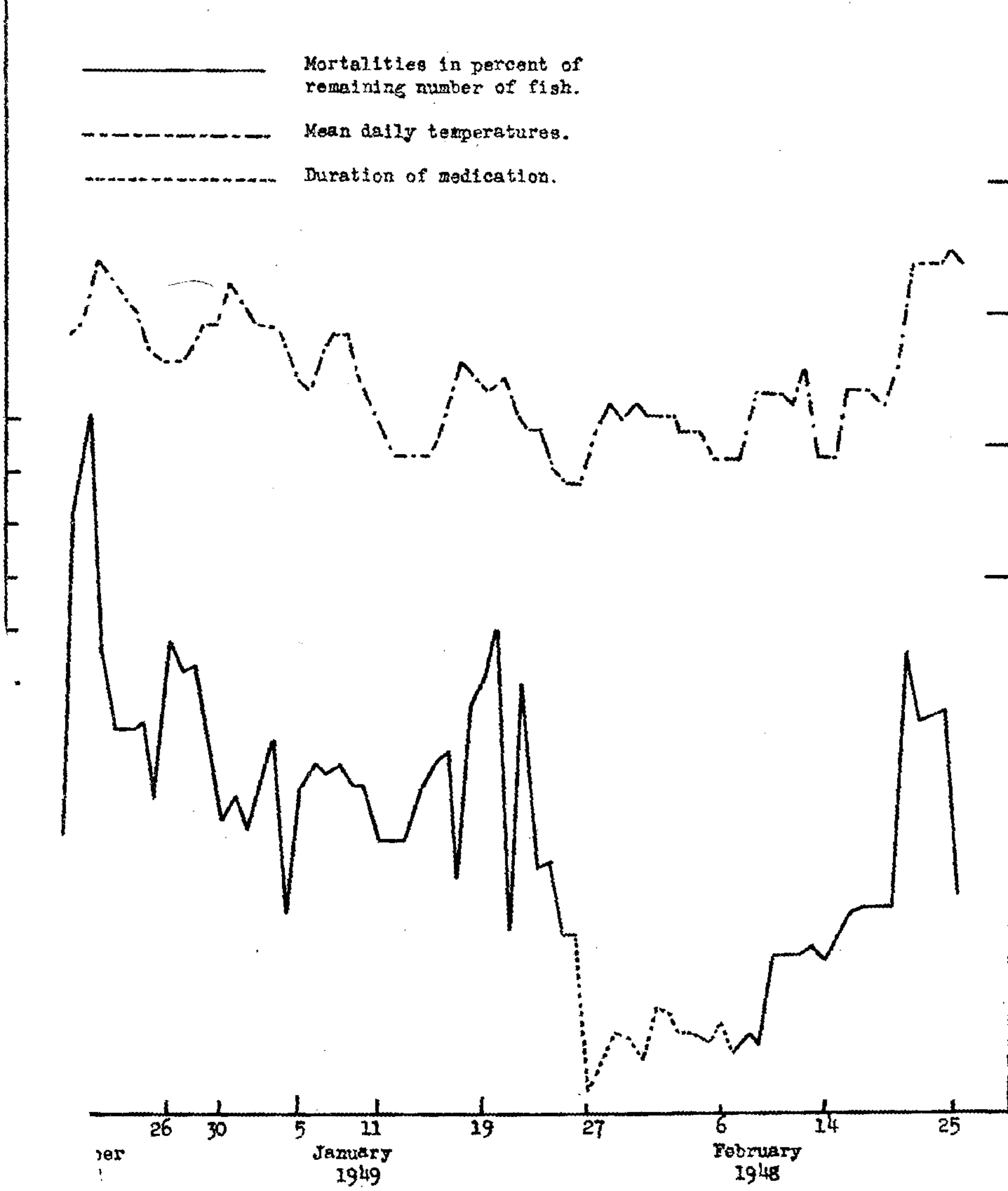
Further treatments were started in late January. Two pounds of sulfamerazine powder were procured. The infected spring chinooks were seined from ponds in series at the hatchery and placed in the spring creek fed pond across the roadway from the series ponds.

There were 37,833 fish with a total weight of 1,184 pounds placed in this pond and sulfamarazine was fed at the rate of three grams per pound of food per day. This amounted to 75 grams of sulfa powder fed per day, and was fed over a period of 12 days.

Discussion

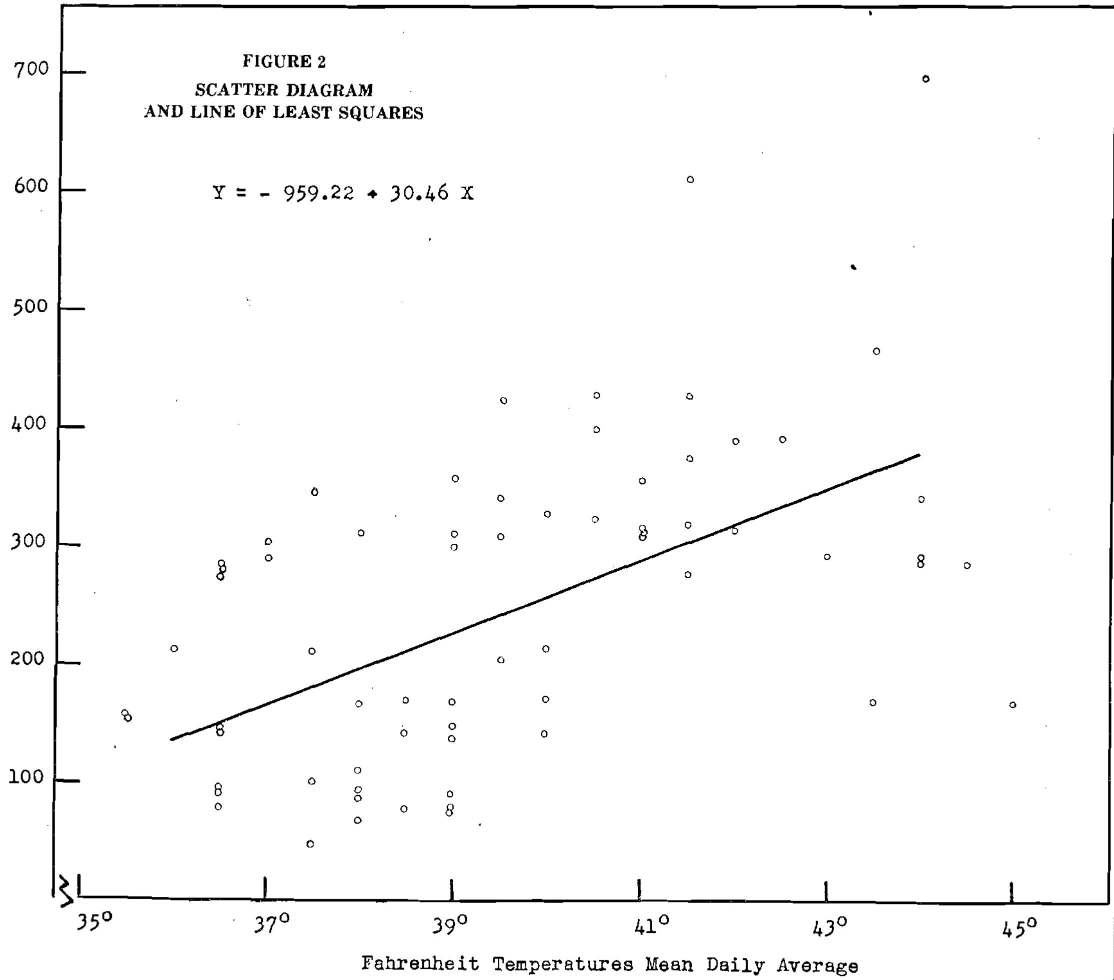
Figure 1 and Table 1 show the mortalities in per cent of remaining numbers of fish and mean daily water temperatures taken from December 18 through February 25. The period of medication is indicated by the dotted

FIGURE 1
MORTALITIES IN PERCENT
OF
REMAINING NUMBER OF FISH



line. It may be observed that the mortalities, while fluctuating considerably throughout the period of observation, dropped sharply upon initiation of treatment with sulfamerazine. After the 12-day period of treatment the mortalities again rose, indicating that under the prevailing conditions this period of medication was not sufficient to eliminate the causative bacteria.

It is interesting to note that high temperature peaks and mortality peaks roughly coincide. A scatter diagram relating mortality and temperature was plotted and the line of least squares calculated. (Figure 2). A coefficient of correlation of 0.55 was obtained which proved highly significant. Thus, water temperature plays an important part in the ultimate effect of a disease such as furunculosis on hatchery fish.



Summary

1. An outbreak of disease accompanied by rising mortalities was observed at the Trask River Hatchery on the Oregon Coast in yearling spring chinook salmon. A tentative diagnosis of furunculosis was given. Later bacteriological study by Dr. R. R. Rucker, U. S. Fish and Wildlife Service, confirmed the diagnosis.
2. Three hundred of the weakest fish were segregated and treated with "Sulmet", a sulfamethazine compound. Some promising possibilities of this sulfa drug were observed.
3. To test the relationship between the water temperatures and the mortality the coefficient of correlation was calculated between these two variables; it was found to be 0.55 which was highly significant. Increasing water temperatures increased the death rate of fish infected with furunculosis, and decreasing water temperatures decreased the death rate of the infected fish.
4. The 12-day period of medication using sulfamerazine at the temperatures occurring (35° F. to 45° F.) was insufficient to eradicate the disease. Following the cessation of treatment the mortalities again rose.
6. The average daily mortality for the ten days preceding treatment was 260 fish per day; during the treatment the average daily mortality was 87 per day; and during the ten days immediately after treatment the daily mortality rose to 129 fish per day.

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Marked Fingerling Chinook Retaken in Willamette River

A fingerling chinook salmon marked at the McKenzie River salmon hatchery, a tributary of the Willamette River, and liberated on February 22 was retaken at Oswego about 159 river miles downstream on April 28. This fish had travelled downstream at an average rate of 2.9 miles per day. Inasmuch as it is important that fish in their second year pass out of the Willamette River before pollution becomes acute in the late summer this recovery was of considerable interest. This fish migrated out of the river with the normal migrants and apparently was not held too long at the hatchery. It is hoped that the 31,270 fish liberated the same day from the hatchery also moved rapidly toward the ocean.