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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 of 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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A REVIEW OF THE 1951 ALBACORE SEASON

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Introduction

The eastern Pacific fishery for albacore tuna, *Thunnus germo,* is primarily one fishery extending across both state and national boundaries from Mexico northward, occasionally into Alaska. It is not uncommon for boats to range the full length of the fishery in one season. The fishery began in California about 1910 (Brock, 1944), and in Oregon the first commercial landings were made in 1936. Limited research was started on this species in Oregon in 1938. This has continued except for the years 1943 to 1946, inclusive. Unfortunately, the missing years were important ones in the fishery. In 1944, the Oregon landings reached a peak of 22.5 million pounds (Cleaver, 1951). Two years later the catch dwindled to less than 4 million pounds. Bait fishing accounted for much of the catch during this period, while in the last few years this method of fishing has not been very effective north of Point Conception, California.

The history of the albacore fishery has been characterized by large fluctuations in the total landings. This is partially explained by the fact that there are but two important size (and, presumably, age) groups in the fishery, both of which appear to be composed of immature fish. If for any reason one or both of these groups do not appear in the catch in appreciable numbers, the landings for the year may be considerably less than average. Fisheries which exploit several year classes tend toward greater stability.

The reason for fewer fish of an age group to be available to the fishery may be correlated with oceanographic or meteorological conditions. Another cause for fewer fish to be caught might be a too-intense fishery leading to depletion of the stocks of fish. However, we have no evidence at present to support the conclusion that the stocks of albacore are being fished too heavily.

Fishery

The albacore fishery in the region of the Bonitos Islands, Mexico, west to the region around Guadalupe Island, Mexico, has been reasonably stable since about 1940. It is in this southern region that albacore are first found each season in any quantity. Many of the northern trollers cruise south in the early season to take advantage of this fishing. The northern extent of the fishery appears to depend upon the ocean circulation. Each summer an extension of the eastern Pacific gyral (Sverdrup, Johnson, and Fleming, 1946, p.723), a mass of blue, oceanic water that is warmer (58° to 63° F.) than the green coastal water, appears offshore; and with its appearance the tuna are usually found. The fish are apparently limited in their northern migration to the distance that this water mass extends northward. In 1948, the ocean waters were warmed to the region of southeastern Alaska, and albacore were taken in that region. During the 1951 season no fish were known to be caught north of central Washington.

The albacore fishery usually starts in Mexican waters about the last week of June each year. Albacore have been taken as early as June 12 (by the fishing yacht *Hispanola* in 1950) in the region of Erben Bank, located approximately 800 miles west of Los Angeles, California. Off the mouth of the Columbia River the first catches are usually taken around July 15. The season starts progressively later northward along the coast. Storms in October usually bring an end to the northern season. In the last few years the northern troll fleet has ended the season in late October and early November by fishing off northern and central California. In this region considerable numbers of small fish, from 9 to 12 pounds, are caught. The Oregon landings late in 1951 came from the region southwest of Point Arena, which is 90 miles north of San Francisco. Fishermen delivered their catches in Newport and Astoria enroute to their home ports.

The tuna troll fleet is made up of very few exclusively tuna fishermen. The bulk of the fleet in northern waters consists of salmon trollers. Most of these fishermen would, by choice, rather fish for salmon, but turn to tuna when the latter become abundant enough to be caught at a rate which overbalances the price differential betweeen the two species. The salmon trollers, plying the inner coastal waters, are within easy reach of any large tuna schools located offshore. The change from the gurdy-hauled wire lines and deep-trolled lures used to catch salmon, to the linen or cotton hand-hauled lines and surface jigs needed for albacore is a relatively simple one. Fishermen often land both species from a single trip after changing gear at sea. Another large group of boats that consistently fish albacore are the halibut long-liners. These fishermen, forced by the short halibut season to exploit other fisheries, eagerly pursue the albacore. Lastly, it is not uncommon for the fishermen of the otter-trawl fleet to stow their drag nets during the height of the season in August and turn to albacore fishing.

The 1951 Season

Before the fleet started scouting for albacore in June, 1951, the market was weak, and fishermen did not know what price they would receive for their catches. Large holdings canned the previous year remained in the warehouses. Despite this, a group of trollers made its usual trek to southern waters in search of the early fishing. The fish did not appear until later than usual, and the schools of fish were small and scattered. These fishermen reported catching about one-half ton per boat. They then scouted back northward to take advantage of the expected northern runs.

The first report of albacore being taken along the Oregon coast by commercial fishermen was on July 16, from an area 125 miles southwest by west of the Columbia River lightship. Many boats were scouting all along the coast, especially in areas where tuna had been found in previous years. No appreciable catches were reported until July 25, when tuna in moderate numbers were found 65 miles southwest of the lightship. It was estimated by returning vessels that a fleet of 300 trollers converged upon this area. Catches were small, and many fishermen returned to salmon trolling, which continued good. Most of the remaining fleet went south again where good fishing was reported southwest of Point Sur, which is near Monterey.

On August 8, another flurry of excitement was caused by the report that a fisherman had taken 60 fish in one day at a position 40 miles southwest by south of the lightship; but fishing continued poor, except for a few scattered schools. Few fish were being taken at the end of August; but by the second week of September, fishermen reported catches of 80 to 100 fish a day from a spot 70 miles southwest of Cape Lookout, which is

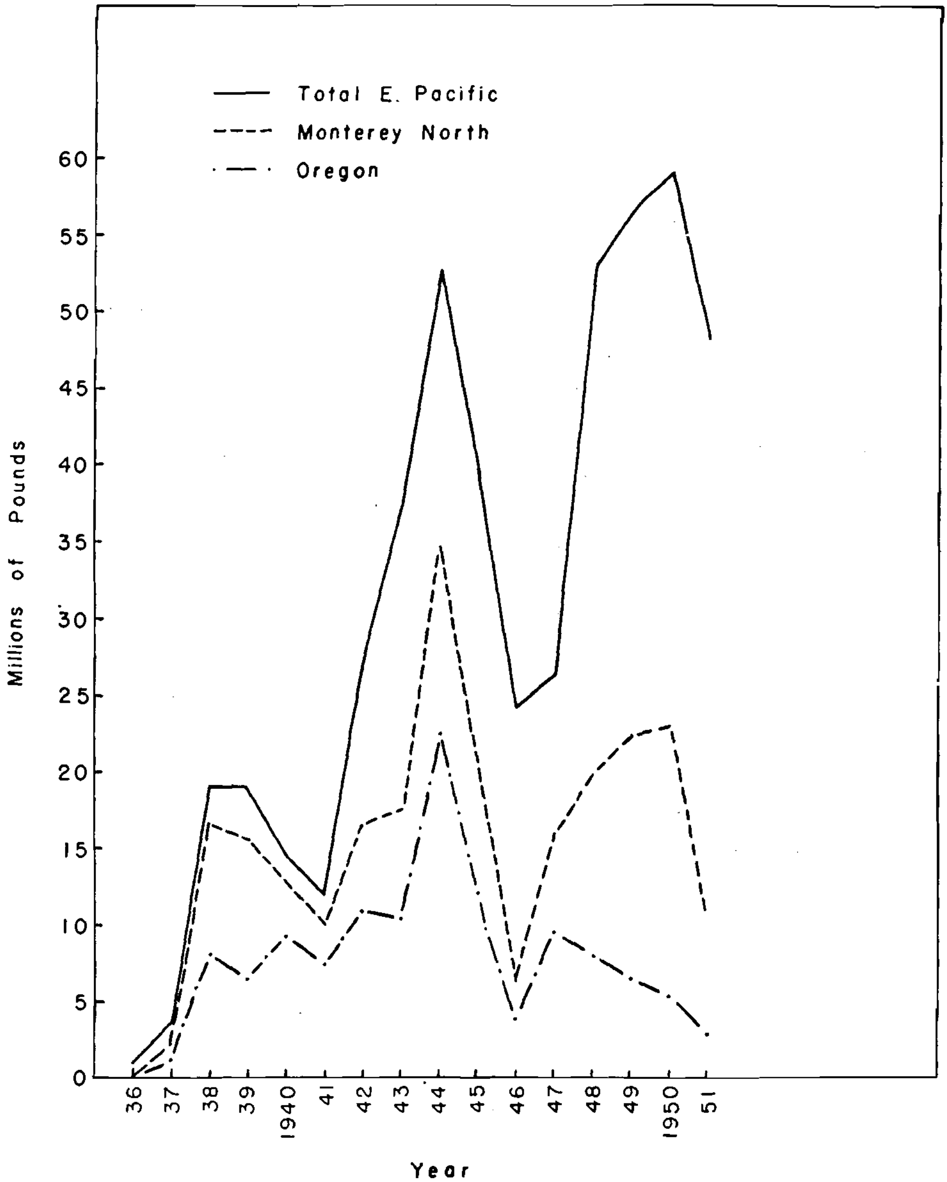

Figure 1. EASTERN PACIFIC ALBACORE LANDINGS.

55 miles south of the mouth of the Columbia River. By this time there were so few vessels left in the area that the remaining fishermen claimed to have experienced difficulty in tracing the movement of the schools. They

felt that more vessels could have scattered and located the lost schools with less difficulty. Stormy weather late in September and early October ended the Oregon fishery, and after mid-October all of the Oregon landings were made from catches taken off central and northern California.

In Oregon, 2,926,545 pounds of albacore were landed in 1951. Later corrections may change this figure slightly. This is the smallest yearly landing since 1937, when the Oregon fishery was still in its infancy. Previous to 1951, the smallest annual landing, which was made in 1946, was over one million pounds larger than the 1951 season. The poor catch in 1951 was the result, primarily, of a scarcity of albacore, and was only partially caused by poor market conditions. The low price and the reluctance of most canners to take fish occurred after the fish were found in increased abundance late in the season. Had fishing been good from the start of the season, it is felt that the effects of the market conditions would have become evident earlier in the season.

The landings of albacore in Oregon have declined since 1947, although the landings of the southern fishery, south of Pt. Conception, have increased. The 1951 season, however, resulted in a decline all along the coast. The trend of the Oregon statistics in later years is not representative of the total eastern Pacific catch, partly because of this shift in the catch toward the south (Figure 1).

Racial Studies

The albacore racial studies were continued this year as recommended by the Pacific Marine Fisheries Commission. The sampling in 1951 was done in a manner which would allow segregation and comparison of the factors within the local albacore population that were thought to be causing some significant differences between local samples as large as those found between the local and Japanese samples. Seasonal growth, sex, age, local races, and deviations between samplers were factors considered. To check the variation caused by seasonal growth, two samples of approximately 100 fish were taken. The first was made August 2 to 16, soon after the season had started. A second sample was taken September 17 to 20, toward the end of the season. The fish were sexed, and scale samples were collected for age determination. These data are now being analyzed.

Market Sampling

Body length measurements and scale samples were collected this season as in the past. The length-frequency samples were weighted to the monthly catch to obtain a more nearly correct size composition of the catch. To weight the samples by the catch, the samples were grouped into monthly periods. The monthly length-frequency distribution was converted to a weight-frequency distribution by multiplying the frequency in each class interval of the distribution by the average weight of the fish in the class interval. The average weight at each class interval was determined from the general formula $W=0.000042689\ L^{3.016}$ found from previous length-weight studies. A factor was then established by dividing the total weight landed for the month by the weight of the sample taken in the month. Because the same relationship exists between sample weight and landing weight as between numbers sampled and numbers landed, each interval of the length-frequency distribution was multiplied by the common factor. The numbers in each weighted length-frequency interval were reduced by multiplying by 0.01 for convenience in calculations. The weighted monthly samples were then combined into a total distribution for the season.

These calculations permit comparison of the size distributions of albacore, by month and year, in terms of absolute, rather than relative, numbers of fish.

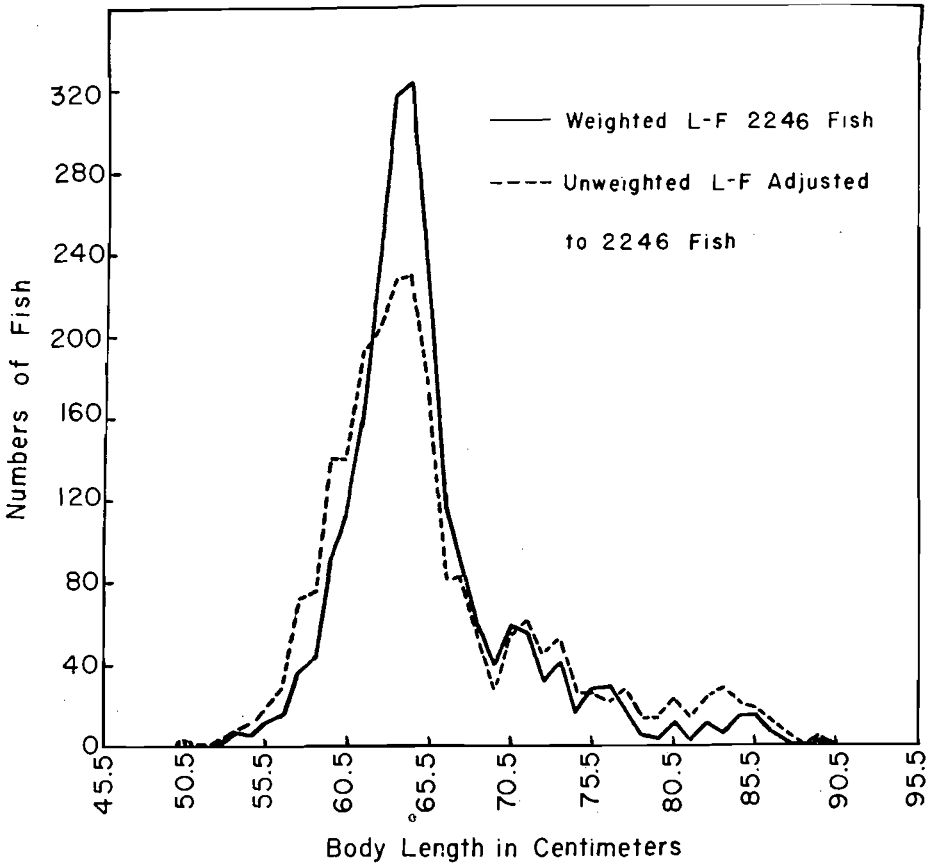

Figure 2. COMPARISON OF WEIGHTED AND UNWEIGHTED 1951 ALBACORE LENGTH-FREQUENCY DISTRIBUTION.

The weighted and unweighted curves are compared in Figure 2. Because of relatively heavier sampling at the start of the season when the fish were large, the unweighted curve minimizes the effect of small fish later in the season. Weighting the samples helps to overcome this tendency, although a further refinement into weekly intervals would probably give more accurate results. The 62 cm. size group predominated in the 1951 catch, but the number of fish landed was small compared with most previous years.

Summary

In 1951, the landings of albacore in Oregon reached a new low just under 3 million pounds. Landings of albacore in Oregon have been erratic, ranging from a peak of 22.5 million pounds in 1944 to the 1951 low. After the peak of 1944, the annual landing dropped to 4 million pounds in 1946. The 1947 total was up to 9.5 million pounds, but a steady decline has occurred since then. The landings in Oregon do not reflect the trend of the coastwise landings since 1947; however, the 1951 decline was apparent throughout the fishery.

There are only two principal size groups (presumably also age groups) in the fishery. Fisheries exploiting a small number of age groups have a greater tendency toward large fluctuations in the catch. The effects of oceanographic and meteorological conditions on the abundance of albacore are not known.

The northern tuna fleet is composed of vessels which also fish for halibut, ocean salmon, and bottom fish. There are a few vessels which fish exclusively for albacore.

Albacore were scarce off Oregon in the 1951 season, but some good catches were made off central California. In early November, landings were made in Oregon by vessels returning to their home ports from California.

Racial population studies are being continued in Oregon.

The length-frequency samples have been weighted by the catch.

Literature Cited

Brock, Vernon E.
1944 Contribution to the biology of the albacore, *Germo alalunga*, of the Oregon coast and other parts of the North Pacific. Contribution No. 10, Fish Comm. of Oregon, pp. 199-248, 19 figs., 18 tables.

Cleaver, Fred C.
1951 Fisheries statistics of Oregon. Contribution No. 16, Fish Commission of Oregon, 176 pp., 41 figs., 108 tables.

Sverdrup, H. U., Martin W. Johnson, and Richard H. Fleming
1946 The oceans, their physics, chemistry, and general biology. Prentice-Hall, Inc., New York, 1087 pp.

HOW MAY FISH HATCHERY FOODS NEEDS BE MET [1]

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The problem of finding a suitable diet for raising salmon is an old one, and much time and effort have been spent toward its solution. Let us look for a moment at some of the requirements which must be fulfilled in an ideal diet.

First, and most important, is that the diet contains all necessary food materials such as proteins, fats, carbohydrates, ash, and fiber, in proper balance; and that the various vitamins and other nutritional needs are present in sufficient amounts. Also, the size of the food particles and the amount fed should be in proper relationship to the size of the fish and the temperature of the water. The physical nature of the food and the method of presentation should allow maximum utilization.

As a result of the work of Gordon and Embody (1924) and other later workers on the chemical and biological analyses of the food constituents in trout stomachs, a proximate formula suitable for hatchery food may be developed. At the present time, the Fish Commission of Oregon, in cooperation with the Seafoods Laboratory, is engaged in similar pursuits toward the formulation of a suitable salmon diet. An attempt is being made to match the constituents found in natural salmon food with a diet composed of readily available, inexpensive materials which are suitable for raising salmon. The work on vitamin B_{12} and the antibiotics, as well as the recent advances in the study of other food factors and vitamins, will require a review of the use of the food materials that heretofore have been regarded as poor or unsatisfactory for raising fish. Many of the conclusions of former experiments describing the merits of one food over another must also be reviewed. Analyses of the natural food of young salmon are being continued by the Fish Commission of Oregon to determine more accurately the proportion of the various food constituents, and to use these analyses as a guide for the production of sound, healthy fish. Hatchery diets are often likely to be high in protein and low in fiber, ash, and carbohydrate materials, in comparison with natural foods. Since fiber, ash, and carbohydrates cost relatively little compared to liver or horsemeat, the possibility of a more economical diet presents itself.

In Oregon and Washington during 1947, approximately 10 million pounds of food was used for feeding hatchery reared fish. It is conservatively estimated that if the proposed dam programs go into effect, some 25 million pounds of food will be required each year to take care of the existing and proposed hatcheries. The cost and competition for such a large quantity of hatchery food will present imposing problems to all of the agencies concerned, especially since the hatchery demands are in direct competition with those of the fish reduction plants, which are engaged in the business of producing protein food for animal feeding. Competition for food also

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[1] Published as Technical Paper No. 671 with the approval of the Director of the Oregon Agricultural Experiment Station. Contribution of the Seafoods Laboratory, Astoria, Oregon, of the Dept. of Food Technology. Talk given at the 1950 meeting of the Western Div. of the Amer. Fish. Soc.

comes from fox and mink feeders who are also searching for a substitute for beef liver and additional sources of animal protein food. The manufacturers of pet foods and those industries which use the by-products of the fishing industry for the production of fish bait, special protein products, fertilizers, and oils are also searching for new sources of raw materials.

Hatchery personnel and fur farmers urgently need a substitute for beef liver. As veterinarians expand their knowledge on the control of animal parasites, condemned livers for feeding fish become more difficult to obtain and the price increases with the competition for the remaining supplies. It is the opinion of the author that eventually a suitable equivalent will be found for this important food which is so desirable in fish diets. Work in this direction is under way in Oregon; but at present no suitable equivalent has been found, although the amount of beef liver necessary in a suitable feed has been reduced to a low level.

It is doubtful if any single food will ever meet all the requirements of a good hatchery diet. The diets of the future will probably be supplemented with various factors and vitamins which are not found in readily obtained materials. The following is a list of materials which are available at low cost. This list, however, is in no sense complete; but is an attempt to include mainly fish and other materials from the Pacific Northwest. Fish waste and scrap fish are two of the largest potential sources of animal protein which are available at a relatively low cost. A few of the species on this list are being at least partially used for human consumption.

Protein material:

Scrap Fish:—

Common name	Scientific name
Arrow-toothed sole	*Atheresthes stomias*
Rex sole	*Glyptocephalus zachirus*
Bellingham sole	*Isopsetta isolepis*
Skates	*Raja* sp.
Hake (Pacific)	*Merluccius productus*
Shad	*Alosa sapidissima*
Carp	*Cyprinus carpio*
Chubs	*Mylocheilus caurinus* and others
Squawfish	*Ptychocheilus oregonensis*
Jack mackerel	*Trachurus symmetricus*
Sharks	*Squalus suckleyi* and others
Sand dabs	*Citharichthys* sp.

Fish wastes:—

Salmon viscera, liver, and trim
Tuna viscera, liver, and scraps
Fish stickwater and condensed fish solubles
Shrimp waste
Halibut scrap
Shad waste
Fillet scrap

Other sources of Protein:—

- Fish meal
- Crab meal
- Horsemeat
- Beef blood
- Dried liver meal
- Poultry by-products

Carbohydrate material containing protein:—

- Alfalfa meal
- Soy bean meal
- Corn meal
- Wheat shorts
- Peanut meal
- Linseed meals
- Wheat germ meal

Fiber:—

- Wood cellulose
- Fruit pomaces
- Vegetable wastes

Minerals:—

Considerable amounts are present in fishery wastes and the diet may be supplemented by readily available materials.

Fat:—

Present in many fishery waste products, and the diet may be supplemented by cheaper marine oils.

Vitamin and Food Factor supplements:—

- Yeast
- Beef livers, as well as those from horse, hog, and sheep
- Fish livers and viscera
- Condensed fish solubles
- Synthetic materials for supplementation

This list may serve to indicate some of the sources of foods which may help to meet hatchery needs. Since protein is the largest single component making up the natural diet of salmon, the use of fish waste and scrap fish seems to be the partial answer to the problem of the protein, and perhaps the fat and mineral, requirements.

In conclusion, the fish hatchery diet of the future will be variable and subject to many additions and modifications. The ideal diet might consist of a basal combination of balanced food materials, probably in dry form, which might be supplemented by such food as is available. This final food should bind well, be readily consumed, and yield sound, healthy fish at a low cost.

Literature Cited: Embody, G.C., and M. Gordon, 1924. A comparative study of natural and artificial foods of brook trout. Trans. Amer. Fish Soc., Vol. 54, pp. 185–200.

RESULTS OF PRELIMINARY SHRIMP EXPLORATIONS OFF THE OREGON COAST

ALONZO T. PRUTER [1]

GEORGE Y. HARRY, JR.

Introduction

Fishing for shrimp along the Pacific Coast started as early as 1869 in San Francisco Bay (Bonnot, 1932) and commercial fishing for shrimp has long been conducted in Alaska, British Columbia, and Puget Sound, Washington. However, no commercial shrimp fishery of any size has yet developed off the Pacific Coast of North America between the Gulf of California and the Straits of Juan de Fuca.[2] It has long been known, however, that shrimp of commercial size do occur in these waters. There are numerous records of such shrimp being taken by government vessels engaged in scientific work, and commercial otter-trawlers often catch small numbers of shrimp along with the various species of fish which form the basis of their livelihood.

Until recently, no serious attempts had been made to answer the question of whether shrimp were present in commercial quantities in the waters between Point Conception and the Columbia River. During the fall of 1950 and the spring and summer of 1951, the Bureau of Marine Fisheries of the California Department of Fish and Game conducted explorations off the coast of California for the purpose of determining if shrimp were present in commercial quantities. The results of these explorations were very encouraging, and as a result a commercial fishery for shrimp has been started in California waters.

Shrimp were located in California waters as far north as the Oregon border. This suggested that shrimp should also be found in Oregon waters. Through the efforts of William Ellis Ripley, who directed the shrimp exploratory work off California, one of the shrimp trawls belonging to the California Bureau of Marine Fisheries was secured on loan by the Fish Commission of Oregon, and explorations for shrimp were started during the fall of 1951. During the winter of 1951-52, the Fish Commission of Oregon purchased gear almost identical to that used by California. There were two major objectives in the explorations off Oregon. First was the opportunity to render a direct service to the fishing industry; and second was the desire to obtain information concerning the virgin shrimp populations as they exist before being subjected to a possible commercial fishery.

Acknowledgement

We wish to express our gratitude to the Department of Fish and Game of California, and to acknowledge the many helpful suggestions received from William Ellis Ripley concerning our exploratory work. We also wish to express our thanks to Dr. James E. Lynch of the School of Fisheries, University of Washington, for his help in the identification of the shrimp

[1] Now employed by the Washington State Department of Fisheries.

[2] Recent reports from California indicate that approximately 200,000 pounds of pink shrimp were landed in 1952 by two boats operating from Morro Bay, California.

obtained during our exploratory work. Hugo Lillienthal, owner of the *Nel Ron Dic*, donated his services and the use of his boat for the last two trips off Coos Bay. Robert Rulifson, biologist with the Fish Commission of Oregon, accompanied the *Nel Ron Dic* on these last two trips. George Miller, former temporary biologist with the Fish Commission of Oregon, and Eldon Korpela, former biologist with the Fish Commission, accompanied the vessel on several trips and helped to organize the data here presented. Jack Van Hyning and Kenneth Waldron, biologists with the Fish Commission, each made one exploratory trip.

Methods and Materials

The beam trawl used in the exploratory work consists of two horseshoe-shaped runners connected by two beams, and a funnel-shaped net with the open end of the net connected to the ends of the runners. The beams consist of two pieces of heavily galvanized pipe each 10 feet in length and 3½ inches outside diameter. The runners are constructed of steel strap 3½ inches wide and ½ inch thick. The runners on the beam used in 1952 were increased to 8 inches in width on the bottom half. The bridle used to tow the trawl is 10 feet long and made of ⅜-inch diameter steel wire rope. Two swivels were attached between the head of the bridle and the single cable running from a winch on the fishing vessel.

The beams were filled with steel slugs to increase the weight of the trawl from its normal weight of approximately 320 pounds to a weight of about 700 pounds. This was necessary in order to sink the trawl to the bottom when fishing in deep water.

The body of the net used in the 1951 explorations was made of 3½-inch stretched mesh, including one knot, and the cod end was of 1-inch mesh, 12-thread twine. In 1952, a 1-inch mesh net throughout was used on the first trip of the season aboard the *Destiny*. This 1-inch mesh net was lost on the first drag of the next trip made aboard the *Nel Ron Dic* in April. For the remainder of this latter trip, the net used in 1951 was placed in operation. This net was modified for the remainder of the trips by changing the fyke in the net to 1-inch mesh. The mouth of the net was completely encircled by a lead line, and the top of the lead line was lashed to the front beam of the trawl so as to furnish an overhang.

Although more shrimp would have been caught with a net constructed of 1-inch mesh throughout, such a net was not available in 1951 when the explorations were first conducted. Tentative results obtained by the Department of Fish and Game of California, however, indicate that a net of 1-inch mesh construction throughout fishes from five to seven times as effectively as the type with a 3½-inch mesh in the body and a 1-inch mesh cod end.

The beam trawl was towed by a single cable running from a winch on the starboard side of a commercial otter-trawl vessel. The trawl was placed in the water and brought aboard the vessel by means of a hook line running from the boom on the vessel. The trawl framework was usually placed on the stern of the vessel inside of the gunwales. The net was ordinarily pulled aboard by hand, except when a large haul was obtained, at which time it was brought aboard by means of a hook line running from the vessel's boom.

Because of the limited facilities and time, it was evident that the areas of exploration would have to be rather restricted. The areas to be explored were chosen on the basis of two factors. Since the experience of the California Department of Fish and Game indicated that shrimp were found on a green mud bottom, areas with such a bottom were given primary consideration. In addition, many commercial otter-trawl fishermen were interviewed in order to determine the areas in which they found the largest quantities of shrimp.

Following California's example, drags were made at right angles to the coast from shallow to deep water until the center of abundance of the shrimp was located. This contour was then followed up and down the coast when possible, until shrimp were no longer taken. Drags were then again made at right angles to the coast as a check against the possibility of the shrimp being located at different depths in the different areas.

Each drag was of 15 minutes duration, with the exception of those made off Coos Bay on the last two trips aboard the *Nel Ron Dic* which lasted for 30 minutes. The time counted was that actually spent by the net on the bottom. The net was considered to be on the bottom between the time the winch stopped after letting the cable out and the time the winch started up again to pull in the beam trawl. Although the net does not actually leave the bottom when the winch starts to wind in the cable, no simple method was found to compensate for this factor.

Although the primary objective of the exploratory work was to determine if shrimp were present in commercial quantities off Oregon, efforts were also made to learn something of the life history of the pink shrimp. Samples from most of the drags containing shrimp were accordingly saved and examined in the laboratory at the conclusion of each exploratory trip. While at sea, the shrimp were placed on ice in the vessel's hold; and upon return of the vessel to port, the shrimp were frozen or preserved in formalin for future use. In the laboratory, the lengths of the shrimp were recorded. Berkeley (1930) found variation in the length of the rostrum of the same size shrimp, and for that reason she recommended that the rostrum be omitted from body length measurements. Another reason for the omission is that a large percentage of the shrimp have broken rostrums as a result of handling.

The measurements given in this paper include the distance, in millimeters, from the posterior base of the eyestalk to the tip of the telson when the shrimp is straightened out so that the longest possible measurement is obtained.

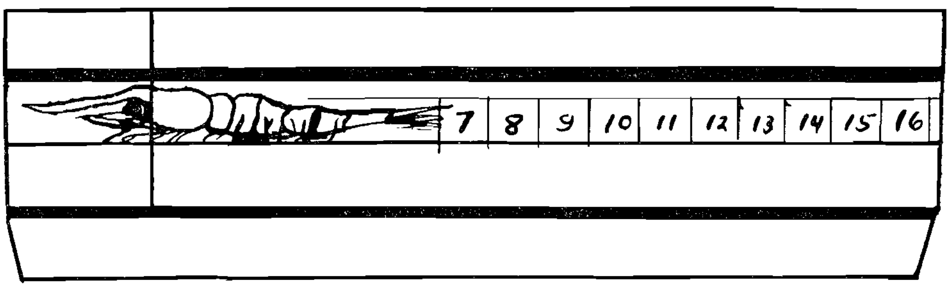

Figure 1. DIAGRAM OF DEVICE USED TO MEASURE SHRIMP.

In order to facilitate the measurement of the shrimp, a simple measuring device was constructed (Figure 1). A steel tape graduated in millimeters

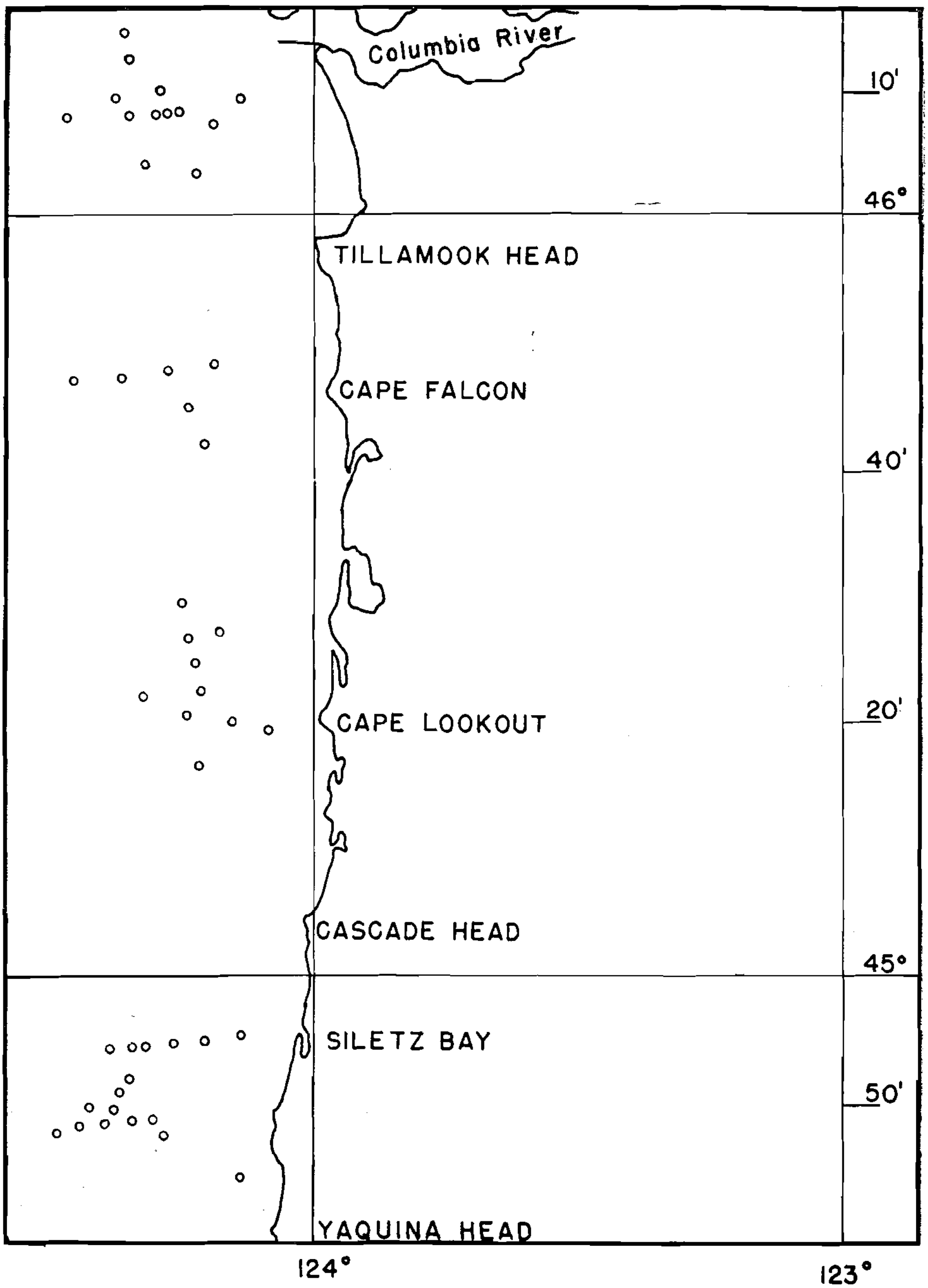

Figure 2. LOCATION OF EACH DRAG MADE IN 1951.

was glued in the groove of the measuring board, and a steel wire of small diameter was attached to the board so that the wire was superimposed over the 0-mm. mark on the tape. Each shrimp to be measured was placed on its side in the groove of the board with its ventral surface pressed against the side of the board, and then slid forward until the wire was directly over the posterior base of the eyestalk. The length in millimeters to the tip of the telson was then recorded.

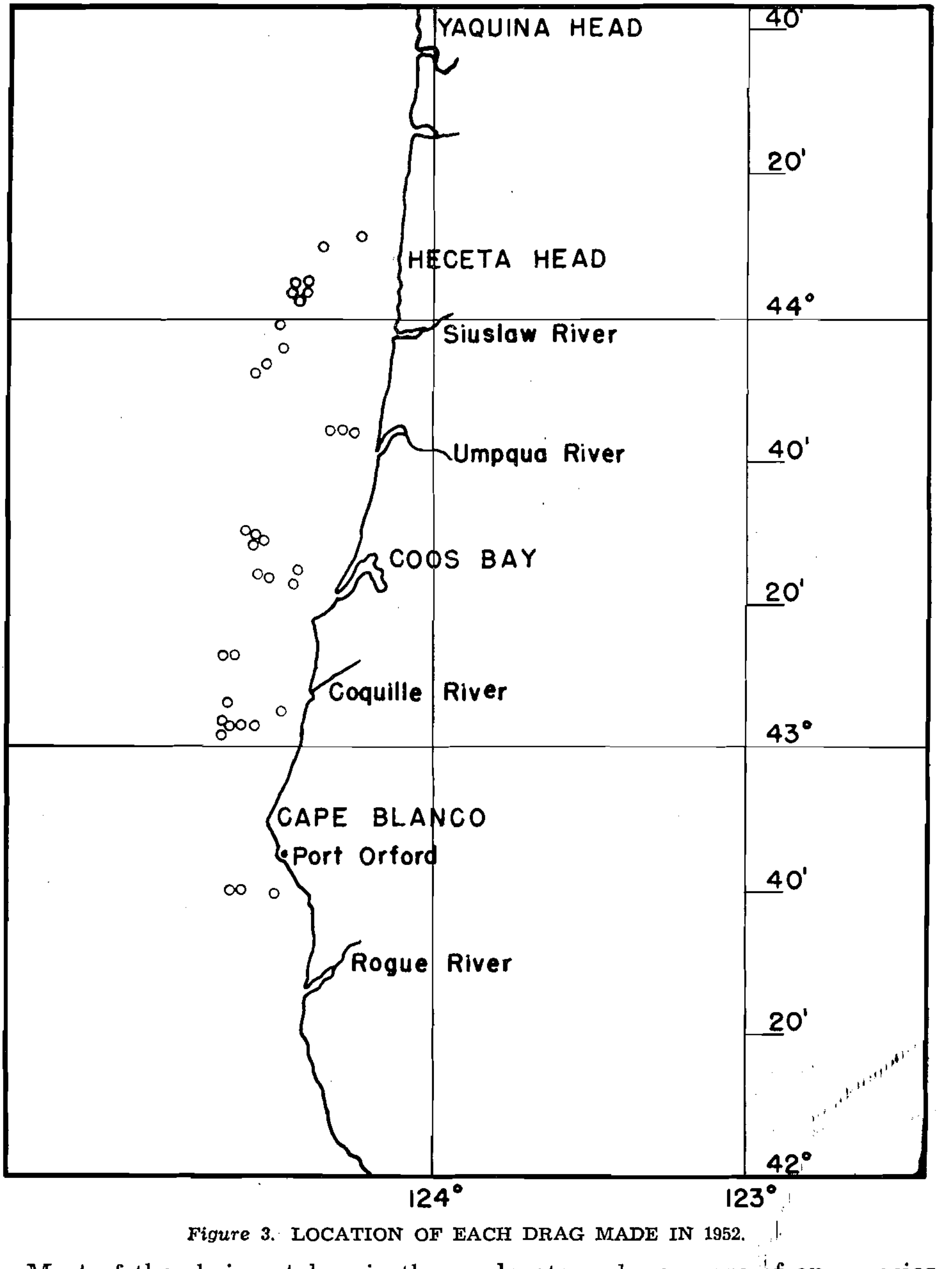

Figure 3. LOCATION OF EACH DRAG MADE IN 1952.

Most of the shrimp taken in the exploratory drags were of one species, *Pandalus jordani*. The sex of *Pandalus jordani* may be determined from an examination of the structure of the inner ramus of the first pleopod, or abdominal leg. A small rounded body, the organ of copulation, is present on the inner ramus of the males. The females do not have this organ of copulation, and the tip of the ramus is more pointed than in the male.

In addition, the males have a structure known as the appendix masculina on the inner side of the inner ramus of the second pleopod. This structure is absent on the females.

The first pleopod was examined under the magnification of approximately 2 diameters. In most cases, such an examination was sufficient to determine the sex. In doubtful cases, however, the second pleopod was examined for the presence of an appendix masculina.

Results

Drags were made between the Columbia River and Yaquina Bay in October, 1951, (Figure 2) and between Yaquina Bay and the Rogue River in 1952 (Figure 3). Each dot represents one drag.

Species other than the pink shrimp were frequently taken, but they at no time accounted for more than a small percentage of the total catch. For example, samples taken from two separate hauls included 1,556 shrimp, of which 88 per cent were *Pandalus jordani,* 9 per cent were *Crago* species, and 3 per cent were *Spirontocaris* species.

Shrimp were taken in practically all the areas explored where the bottom was green mud and the depth between 60 and 80 fathoms (Table 1). The pounds listed in the table refer to the actual amounts caught in the net, but it should be mentioned again that if a net of 1-inch mesh construction throughout had been used in 1951 an estimated five to seven times as many shrimp would have been caught.

TABLE 1.

AMOUNTS OF PINK SHRIMP *(Pandalus jordani)* TAKEN IN THE INDIVIDUAL AREAS OF EXPLORATION.

Area	Number of drags	Number of drags containing shrimp	Total pounds of shrimp caught	Pounds of shrimp per drag ①
3½-inch mesh net with 1-inch bag, 15-minute drags				
Off Columbia River	13	8	81.0	10.1
Off Cape Falcon	6	3	18.0	6.0
Off Cape Lookout	10	8	69.0	8.6
Off Siletz Bay	17	11	58.5	5.3
Off Coquille River	9	6	34.5	5.8
Off Port Orford	3	0	0.0	0.0
1-inch mesh throughout, 15-minute drags				
Off Siuslaw River	11	5	79.5	15.9
Off Umpqua River	3	3	5.5	1.8
3½-inch mesh with 1-inch bag and fyke, 30-minute drags				
Off Coos Bay	8	7	1,075	153.6

Almost all of the shrimp were taken in waters between 60 and 80 fathoms in depth (Table 2). Because of gear limitations, it was not possible to explore in water of a depth greater than 100 fathoms.

① Includes only those drags in which shrimp were caught.

TABLE 2.

AMOUNTS OF PINK SHRIMP ***(Pandalus jordani)*** **CAUGHT BY DEPTH OF WATER IN THE INDIVIDUAL AREAS OF EXPLORATION.**

Area	Depth in fathoms	Number of drags	Pounds of shrimp caught	Pounds of shrimp caught per drag
3½-inch mesh net with 1-inch bag, 15-minute drags				
Off Columbia River	31–50	1	0	0
	51–60	6	49	8
	61–70	5	33	7
	71–80	1	0	0
Off Cape Falcon	51–60	1	0	0
	61–70	1	0	0
	71–80	2	14	7
	81–90	1	4	4
	91–100	1	1	1
Off Cape Lookout	31–50	1	0	0
	51–60	2	1	½
	61–70	3	37	12
	71–80	3	28	9
	81–100	1	5	5
Off Siletz Bay	31–50	2	0	0
	51–60	2	0	0
	61–70	2	3	2
	71–80	5	41	8
	81–90	3	12	4
	91–100	3	4	1
Off Coquille River	31–40	1	0	0
	41–50	0	0	0
	51–60	1	0	0
	61–70	2	6	3
	71–80	4	28	7
	81–90	1	0	0
Off Port Orford	31–40	1	0	0
	41–50	0	0	0
	51–60	0	0	0
	61–70	1	0	0
	71–80	1	0	0
1-inch mesh throughout, 15-minute drags				
Off Siuslaw River	31–40	1	0	0
	41–50	1	0	0
	51–60	0	0	0
	61–70	6	77	13
	71–80	2	0	0
	81–90	1	1	1
Off Umpqua River	41–50	1	0	0
	51–60	2	5	3
3½-inch mesh net, 1-inch bag, 1-inch fyke; 30-minute drags				
Off Coos Bay	51–60	3	350	117
	61–70	2	325	163
	71–80	0	0	0
	81–90	2	350	175
	91–100	1	175	175

The results of the explorations suggest that shrimp are present in sufficient numbers off the Oregon coast to support a commercial fishery. As opportunity permits, further explorations will be made along the Oregon coast.

The number of shrimp (whole and headed) per pound varies considerably in the different areas (Table 3). The tails of the shrimp, including the shells, made up almost 54 per cent of the total weight (Table 3, Per cent yield).

TABLE 3.

NUMBER OF PINK SHRIMP *(Pandalus jordani)*—**WHOLE AND HEADED—PER POUND IN THE INDICATED AREAS OF EXPLORATION.**

Area	Number of whole shrimp per pound	Number of headed shrimp per pound	Percent yield (including shell on tail)
Off Columbia River	103	192	54
Off Cape Falcon	123	231	53
Off Cape Lookout	105	194	54
Off Siletz Bay	140	260	54
Off Siuslaw River	190	......	....
Off Coquille River	140	......	....
Off Coos Bay	108	......	....

The varying number of shrimp per pound in the different areas is accounted for mostly by the change in the sex ratio from one area to another. Because the males are smaller than the females, in the areas where there was a greater percentage of males there were also more shrimp per pound. Even within a generalized area, such as off Coos Bay, the number of shrimp per pound varied from drag to drag. For example, in 70 fathoms off Coos Bay there were 178 shrimp per pound; but at 90 fathoms, 81 shrimp per pound. Commercial fishermen would undoubtedly seek out these particular areas where the larger shrimp are found.

Observations Concerning the Life History of *Pandalus jordani*

Berkeley *(ibid)* in her paper on the commercially important shrimps of British Columbia, found that all the species examined of the genus *Pandalus* underwent a change of sex. The species studied by Berkeley start their lives as males, function as males once or twice, and then change to the female phase and remain females for the balance of their lives.

Unfortunately, Berkeley did not present any information in her paper concerning *Pandalus jordani,* but the following discussion of our observations demonstrates that this species probably has a life history similar to those worked out by Berkeley.

Length-frequencies (smoothed by a moving average of three) obtained during 1951 in the four general areas of exploration illustrate that there were two well-defined size groups present in the catches (Figure 4). The smaller of the two consists of males, which have a modal length of about 62 mm., and the larger consists of females with a modal length of about 78 mm. Occasionally small males belonging to a third group of about 35 mm. in length are captured. A suggestion of this smallest group is found in the length-frequencies of the shrimp taken off Cape Falcon and Siletz Bay.

Length-frequencies of *Pandalus jordani* were obtained off Siletz Bay on October 28, 1951, about three weeks later than those illustrated in Figure 4 (Figure 5). The general features of the two figures are the same. but Figure 5 is shown because it includes a fairly large sample of the smallest size group of shrimp. Whereas the two largest size groups of shrimp were measured after being frozen and allowed to thaw, the fragile nature of the smallest size group required that they be hardened in formalin before being measured. No correction factor has been applied to the data to compensate for any unequal shrinkage which may have resulted from the two different methods of preservation.

The shrimp taken in March, 1952, off the Siuslaw River were mostly males (Figure 6). The mode of their length-frequencies falls between the

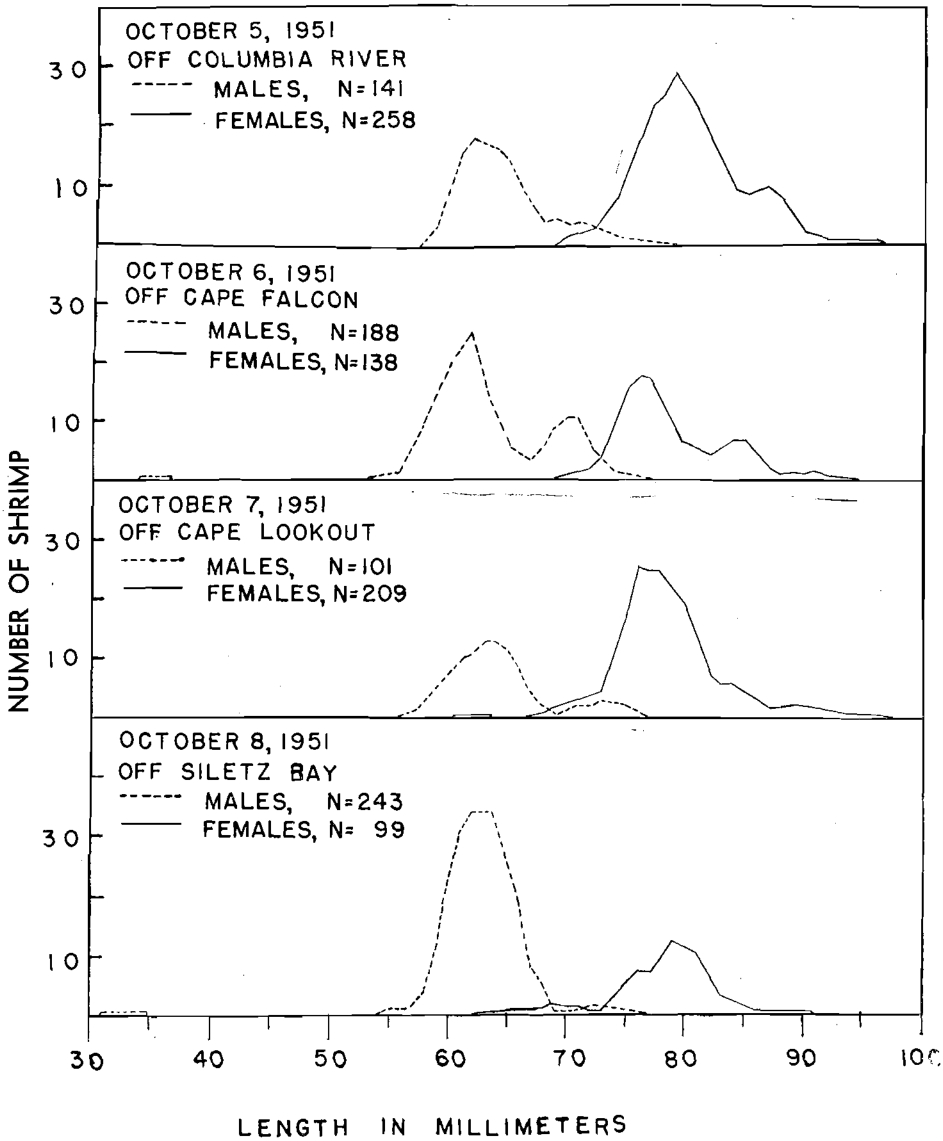

Figure 4. **LENGTH-FREQUENCIES OF SHRIMP CAUGHT OFF THE OREGON COAST IN 1951.**
(All figures smoothed by threes)

two modes for males shown in Figure 5, and may represent growth of the shrimp in the smaller mode. The males taken in April, 1952, southwest of Bandon, were similar in size to the majority of the males taken in 1951. The length-frequency mode of the females taken in this area was at a size greater than the modes of 1951. This suggests the possibility of another age group at a larger size than those found in 1951. Males predominated in water from 57 to 70 fathoms off Coos Bay in late May. The size mode of these males was similar to the principal mode found in 1951. However, in the deeper water, from 84 to 97 fathoms, the sex ratio changed and relatively more females were present. The length-frequency mode of these females was again at a size greater than any of the 1951 modes which adds evidence

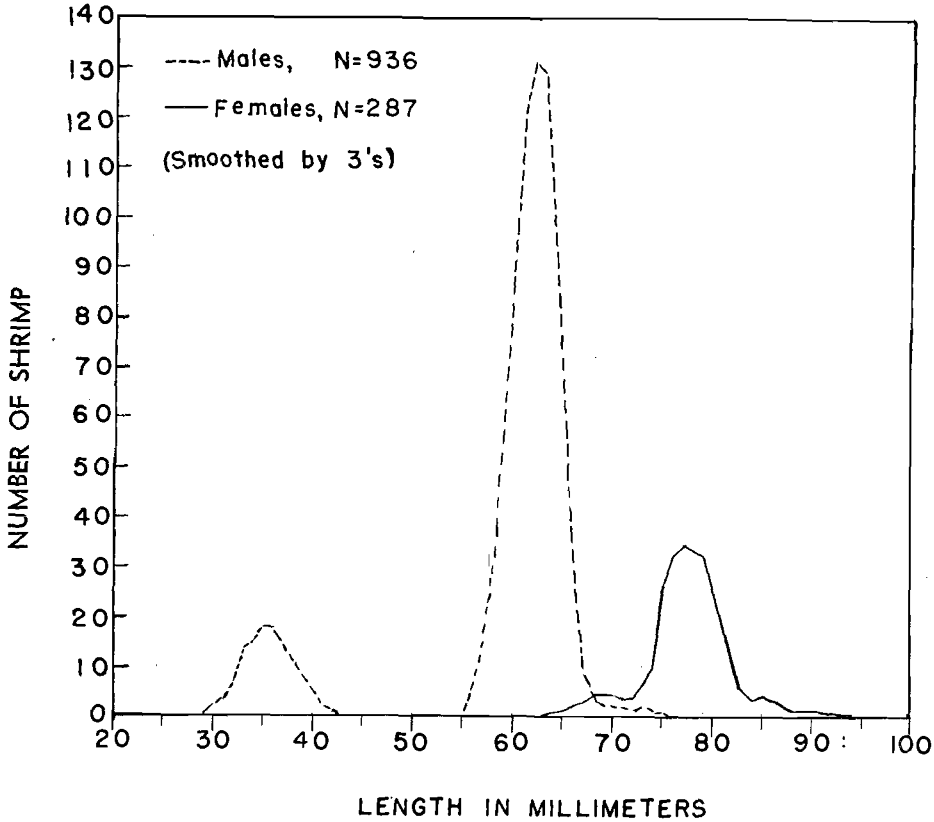

Figure 5. LENGTH-FREQUENCY OF SHRIMP TAKEN OFF SILETZ BAY OCTOBER 28, 1951. (Smoothed by threes)

to the theory that there is an age group of larger females present. All of the 1952 shrimp were preserved in formalin before being measured.

Several of the figures indicate the presence of males among the size groups of smaller females. These may be males which are in the process of changing sex to become females.

Although it would be necessary to follow the progression of the length-frequency modes throughout a period of 1 year before any conclusions concerning the age of the shrimp could be justified, it may be theorized that each distinct mode illustrated represents a separate age group of shrimp. If such is the case, probably four separate age classes of *Pandalus jordani* are found in the catches. The two youngest are males and the two oldest consist of females.

Less than 3 per cent of the females obtained in the various areas of exploration from October 5 through October 8, 1951, were carrying eggs, but 42 per cent of the females examined about 3 weeks later on October 28 bore eggs. When the explorations started again the following year, the

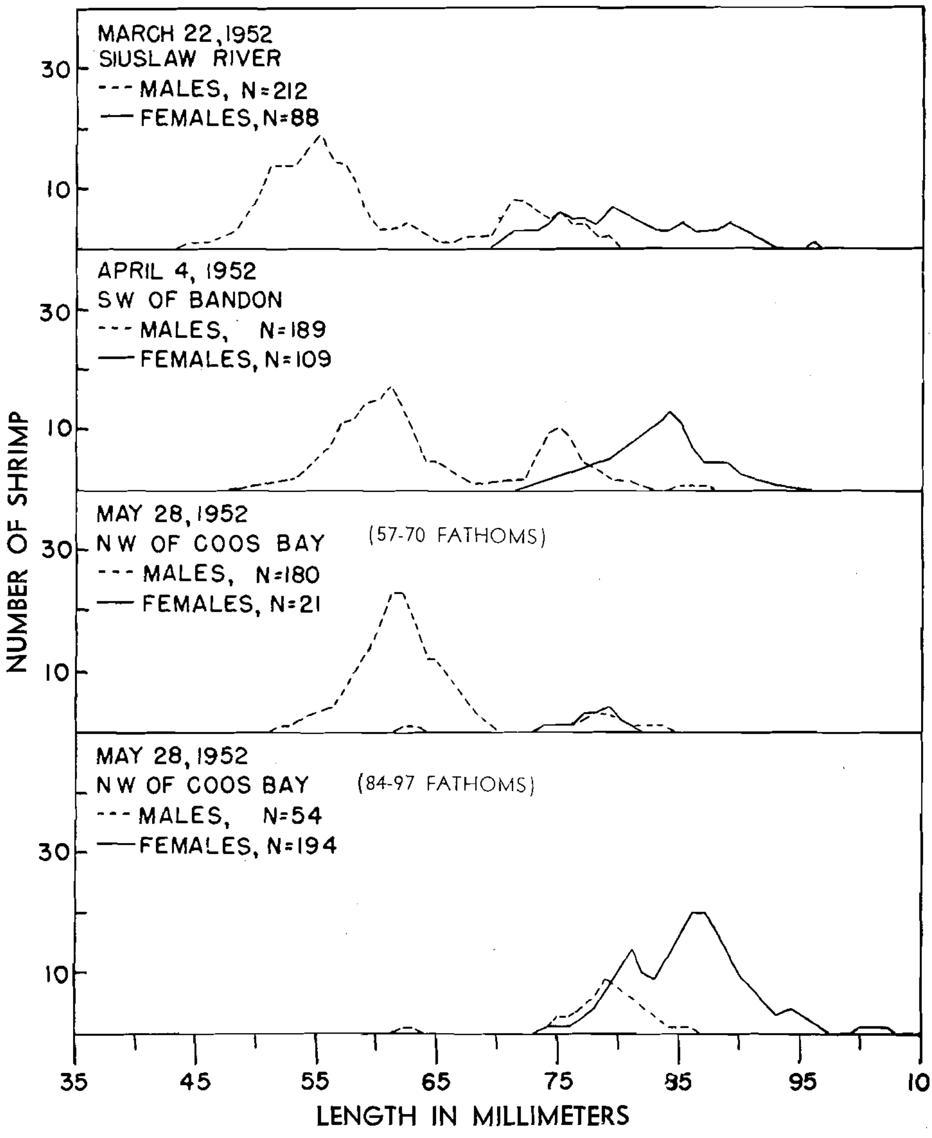

Figure 6. LENGTH-FREQUENCIES OF SHRIMP CAUGHT OFF THE OREGON COAST IN 1952. (All figures smoothed by threes)

females sampled on March 22 were 11.4 per cent egg-bearing. On April 4, 23.8 per cent of the females were egg-bearing, and on May 28 none of the females sampled carried eggs.

The length-frequencies of both egg-carrying and non-egg-carrying females taken on October 28 are similar, indicating that both the large and small females attain the egg-carrying stage at about the same time (Figure 7).

If a commercial fishery for the pink shrimp should develop off Oregon, an important item of consideration in the management of such a fishery would be the effect of the small mesh nets upon the stocks of commercially important fish and shellfish found in the same areas as the shrimp. During the exploratory work, therefore, a careful tabulation was

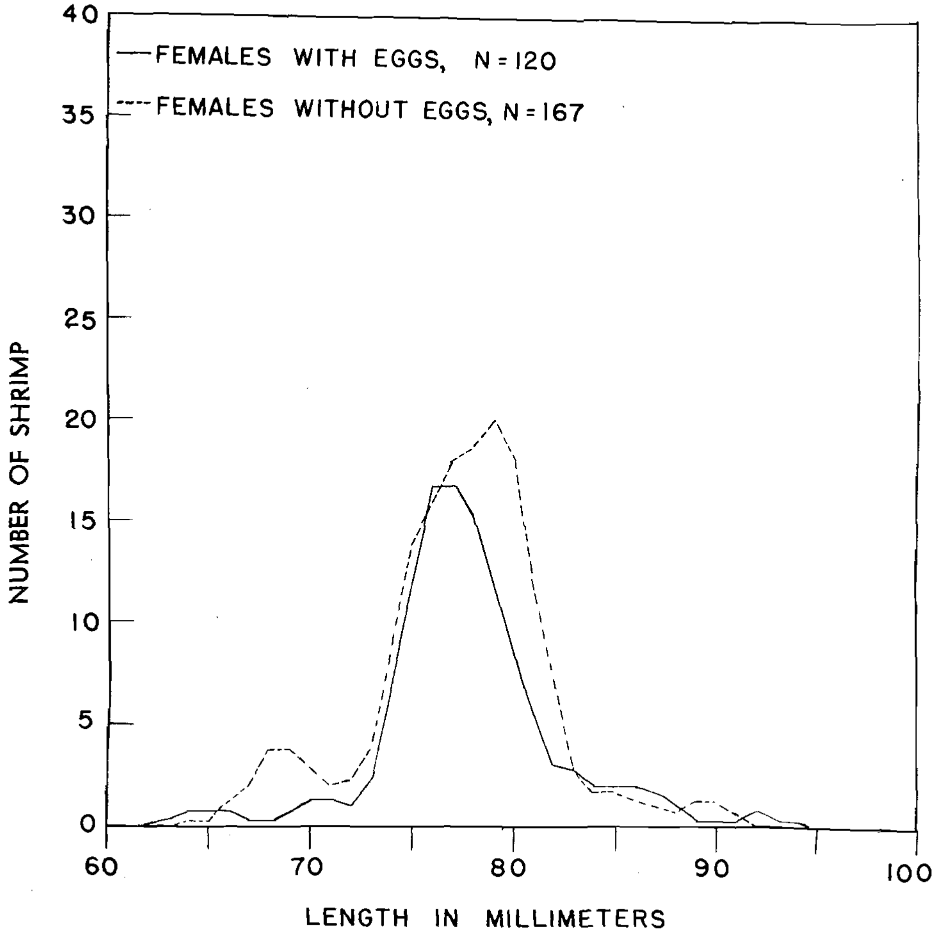

Figure 7. LENGTH-FREQUENCIES OF EGG-BEARING AND NON-EGG-BEARING SHRIMP TAKEN OCTOBER 28, 1951. (Smoothed by threes)

made of all species of fish and shellfish taken in the shrimp net. In addition, lengths and sex ratios of the commercially important species of fish and shellfish taken in the shrimp hauls were obtained.

In general, an inverse relationship was found to exist between the number of shrimp and the number of fish taken in the drags. Drags producing the most shrimp usually yielded the smallest number of fish.

By far the most numerous species of fish taken in the shrimp hauls were small specimens of slender sole *(Lyopsetta exilis)*, rex sole *(Glyptocephalus zachirus)*, and mottled sand dabs *(Citharichthys sordidus)*. Dover sole

(Microstomus pacificus) of a commercial size were regularly taken in small numbers along with the shrimp. In addition, negligible numbers of petrale sole *(Eopsetta jordani)*, turbot *(Atheresthes stomias)*, hake *(Merluccius productus)* and various species of rockfish (Scorpaenidae), sea poachers (Agonidae), and ell pouts (Zoarcidae) were taken along with the shrimp.

With the exception of a very small number of scallops (Pectinidae), snails (Gastropoda), and anomurans (chiefly *Munida quadrispina)*, virtually no shellfish were taken along with the shrimp.

At depths between 90 and 100 fathoms sea urchins (Echinoidea) were taken consistently in the net in quite large numbers. Although no attempt was made to count the sea urchins, it is quite possible that they may be present in such large numbers as to prevent a successful fishery at such depths. Fortunately, the center of abundance of the shrimp was found to occur in waters of a depth less than 90 fathoms where the number of sea urchins is not believed to be sufficiently large to hinder seriously fishing operations.

Summary

During the months of October, 1951, and March, April, and May, 1952, a total of 80 exploratory shrimp drags were made off the Oregon coast betwen the Columbia River and the Rogue River. Pink shrimp *(Pandalus jordani)* were taken in sizeable quantities in most of the areas explored.

The largest concentrations of shrimp were taken in areas with a green mud or mixed mud and sand bottom.

No pink shrimp were taken in less than 50 fathoms, and the center of abundance was found to occur at depths between 60 and 80 fathoms.

Four definite size groups of pink shrimp are present in the catch; two are males and two females.

Less than 3 per cent of the females taken on October 5 through October 8, 1951, were carrying eggs, but 42 per cent of the females examined about three weeks later were egg-bearing. On March 22, 1952, eleven per cent of the females were egg-bearing; on April 4, twenty-four per cent were egg-bearing; and on May 28, no females in the samples carried eggs.

The larger females apparently do not attain the egg-carrying stage before the smaller females.

An inverse relationship was found between the number of shrimp and the number of fish taken: drags producing the most shrimp usually yielded the smallest number of fish.

The Fish Commission of Oregon will continue the shrimp explorations as opportunity permits.

Literature Cited

Berkeley, Alfreda A.

1930 The post-embryonic development of the common pandalids of British Columbia. Contributions to Canadian Biology, Biological Board of Canada, 6 (6): 81-163.

Bonnot, Paul

1932 The California shrimp industry, State of California, Division of Fish and Game, Bureau of Marine Fisheries, Fish Bull. (38): 5-22.

SECOND PROGRESS REPORT ON SPRING CHINOOK SALMON DIET EXPERIMENTS [1]

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Introduction

The diminishing supply and rising cost of condemned beef liver, universally recognized as a valuable fish hatchery food, has necessitated a search for satisfactory substitutes. The Oregon Agricultural Experiment Station Seafoods Laboratory and the Fish Commission of Oregon are cooperating in a series of experiments at Bonneville Hatchery to develop economical substitutes as nutritional food for young salmon. Included in these test diets are by-products of the Pacific Northwest seafoods industry.

A purified diet is being developed for use in evaluating possible beef liver substitutes. McLaren *et al* (1947) successfully fed a purified diet to rainbow trout. This McLaren, or Wisconsin, diet was composed of 18 per cent Dextrin, 52 per cent vitamin-free casein, 8 per cent crab meal, 6 per cent supplemental salts IV, 1 per cent calcium carbonate, 2 per cent cod liver oil, 13 per cent corn oil, plus crystalline B vitamins and ascorbic acid, with 10 parts of gelatin added to 100 parts of the above mixture.

However, McKee, Sinnhuber, and Law (1951) found that this purified diet proved inadequate for growth and development of spring chinook salmon fingerlings using Tanner Creek and Columbia River water. The fish fed on the above diet developed severe anemia, with a resultant heavy mortality.

Procedure

Twelve diets were prepared and fed under controlled conditions. Five of the diets were based on the Wisconsin purified ration modified by the addition of Vitamin B_{12} and procaine penicillin. Salmon liver, beef liver, yellowfin tuna liver, condensed herring solubles, and salmon eggs were compared as substitute ingredients for a portion of each of the five modified Wisconsin rations.

Two lots were prepared to compare the effects of Argentine beef liver meal and fresh frozen beef liver.

Further studies were made to compare the effects on the fish of table salt and supplemental salts IV (Phillips and Hart, 1935) as binding agents in combination with beef liver.

Other lots were prepared to compare certain modified diets with the beef liver control diet and to evaluate hake *(Merluccius productus)* as a

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[2] Mr. Donald L. McKernan is now Assistant Director, Pacific Oceanic Fisheries Investigations.

fish food component. Burrows, Robinson, and Palmer (1951) found in their experimental feeding studies with blueback salmon *(Oncorhynchus nerka)* that hake showed promise of being a good hatchery food.

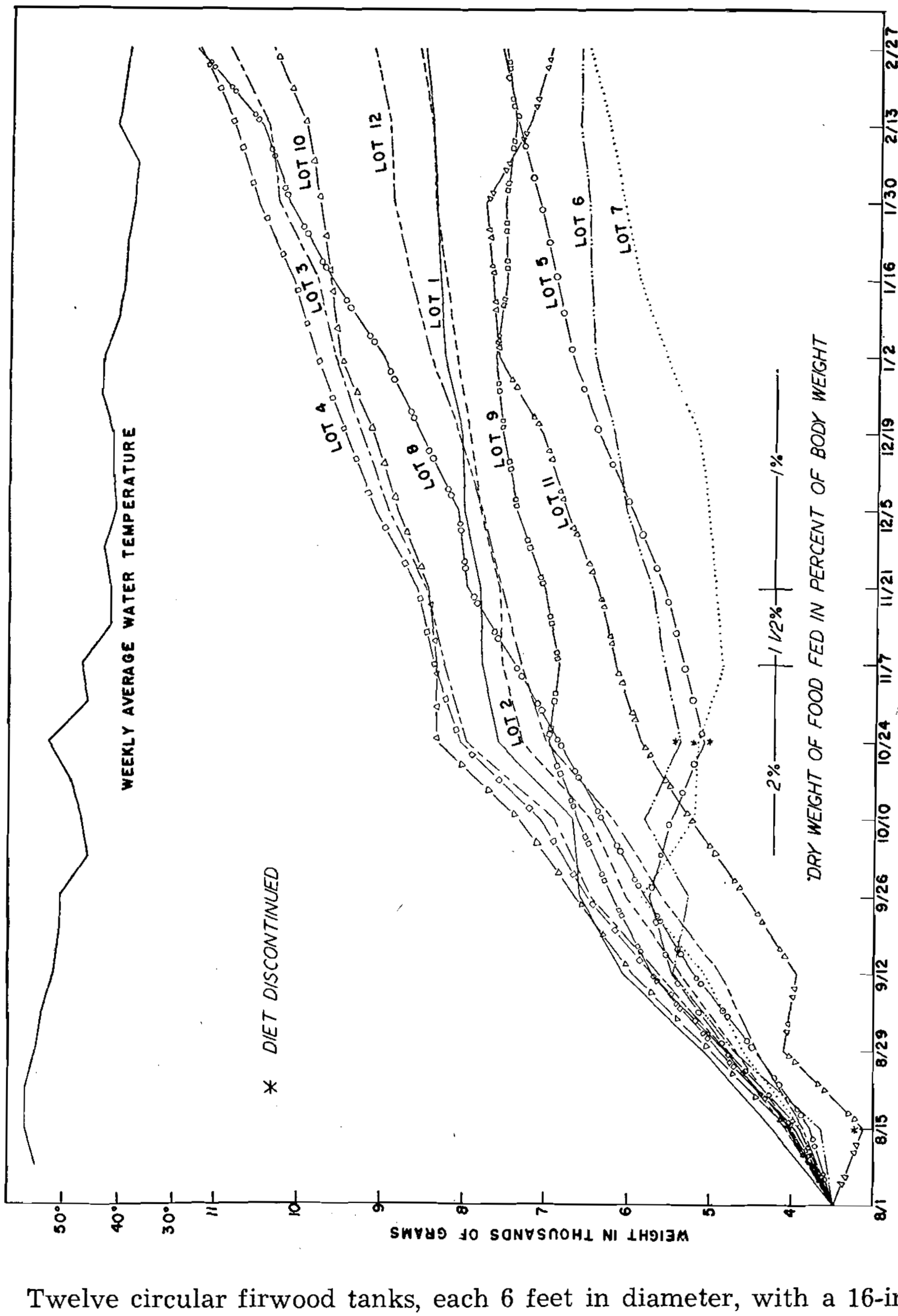

Figure 1. TOTAL WEIGHT OF LOTS AT 2-WEEK INTERVALS.

Twelve circular firwood tanks, each 6 feet in diameter, with a 16-inch water depth, were initially stocked with 3,500 grams of fish, or approximately 950 fish. Water intakes of all tanks were calibrated to deliver the same amount of water to each tank. The fish were randomly selected for the experiment in the same manner described previously by McKee, Sinnhuber, and Law (1951). Only one tank was used for each diet.

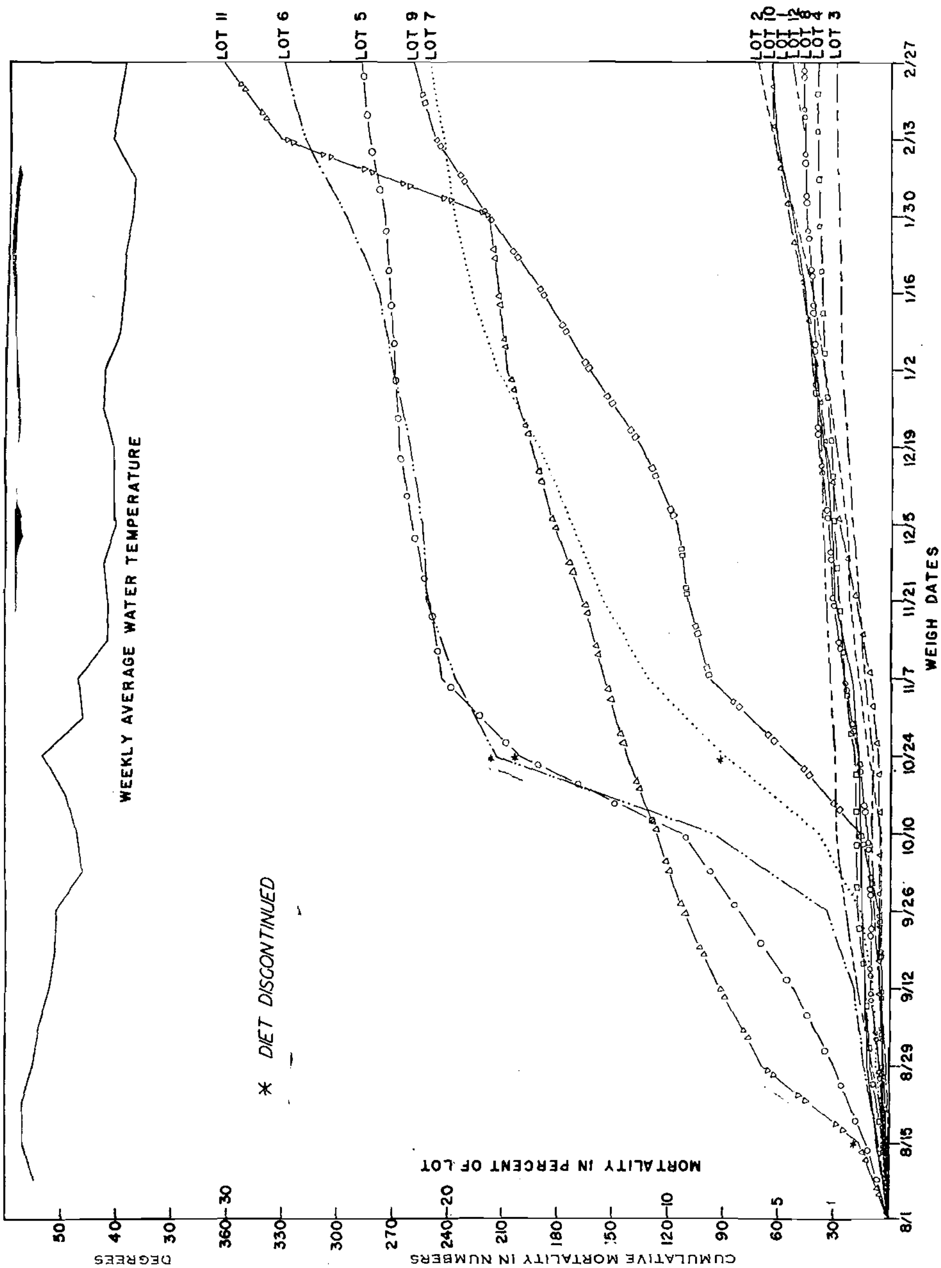

Figure 2. CUMULATIVE MORTALITIES OF LOTS.

The experiment was started on August 1, 1950, and was discontinued on February 26, 1951, after a total of 30 feeding weeks. The fish were fed six days of each week, and from two to four times daily, depending upon how well they took their food. All foods were fed on a dry weight basis since it is believed that this is the best method for evaluation of food components.

From the beginning of the experiment to November 7, the amount of food fed daily was equal to 2 per cent of the body weight; from November 7 to 21, it was 1½ per cent; and from November 21 to the end of the experiment, 1 per cent. Each entire lot of fish was weighed at 2-week intervals.

Results

The component percentages by weight of each of the 12 diets are given in Table 1, and the results obtained from each diet are described.

Figure 1 shows in chart form the results obtained. The weight for each period is the total weight of the lot.

Figure 2 shows in chart form the mortalities of each lot.

TABLE 1.

DESCRIPTION OF DIETS AND OBSERVATIONAL RESULTS

Lot Number	Diet	Observations
1	Control diet: beef liver 98%, salt 2%	Poorly balanced diet. Fish gained weight slowly and exhibited nervous condition.
2	Beef liver 96%, supplemental salts IV 4%	Except for elimination of nervous condition, no improvement was noted as result of substitution of supplemental salts IV for table salt.
3	Beef liver 76%, corn oil 10%, commercial salmon meal 10%, supplemental salts IV 4%	Superior to the control diet, probably because of added calories furnished by corn oil.
4	Equal parts of fresh frozen beef liver, hog liver, and salmon viscera plus salt 2% [1]	Superior to the beef liver control diet.
5	Dry Wisconsin ration, modified [2], 90 parts; frozen tuna liver, 10 parts. Water added to yield the same moisture content as Lot 4.	Unsatisfactory. Discontinued after 12 weeks and fish put on rehabilitation diet.
6	Dry Wisconsin ration, modified [2], 90 parts; salmon liver, 10 parts. Water added to yield the same moisture content as Lot 4.	Unsatisfactory. Discontinued after 12 weeks and fish put on rehabilitation diet.
7	Dry Wisconsin ration, modified [2], 95 parts; herring condensed fish solubles, 5 parts. Water added to yield the same moisture content as Lot 4.	Unsatisfactory. Discontinued after 12 weeks and fish put on rehabilitation diet.

8	Hog liver, 32.7%; salmon viscera, 32.7%; Argentine beef liver meal equivalent to 32.6% liver on a wet basis; plus 2% salt.	Superior to the beef liver control. Growth was comparable to Lot 4 in which fresh frozen beef liver was used.
9	Dry Wisconsin ration, modified ②, 90 parts; salmon eggs, 10 parts. Water added to yield the same moisture content as Lot 4.	Very unsatisfactory. Growth was poor and losses heavy.
10	Dry Wisconsin ration, modified ②, 90 parts; fresh frozen beef liver, 10 parts. Water added to yield the same moisture content as Lot 4.	Superior to the beef liver control, indicating that the purified diet plus beef liver is adequate for spring chinook salmon fingerlings.
11	Beef liver, 40%; meals, 60% (tomato meal 10%, alfalfa meal 10%, wheat germ 5%, brewers yeast 10%, salmon meal 10%, crab meal 10%, kelp meal 5%, salmon egg meal 10%, commercial fish meal 30%)	Discontinued after two weeks because fish would not eat food. Fish put on rehabilitation diet.
12	Hake 79%, beef liver 19%, salt 2%	Moderately successful diet. Inability to bind the diet caused much of the food to leach into the water and be unavailable to fish.

① This is one of the production diets used by the U. S. Fish and Wildlife Service at their Leavenworth, Washington station.

② The composition of this diet includes the Wisconsin diet (given in the introduction of this paper) plus Merck's Vitamin B_{12} and procaine penicillin supplement, 2 grams per 500 grams of dry diet.

Conclusions

A purified ration with a small quantity of beef liver yields good weight gains when fed to spring chinook salmon fingerlings.

Salmon liver, yellowfin tuna liver, condensed herring solubles, and salmon eggs were not satisfactory substitutes for beef liver in this experiment.

Argentine beef liver meal was an adequate substitute for fresh frozen beef liver in this experiment.

An all-meat ration composed of equal parts of beef liver, hog liver, and salmon viscera plus 2 per cent salt gave good growth.

Acknowledgements

We are indebted to Hoffman-LaRoche, Inc., Nutley, New Jersey; and to Merck & Co., Inc., Rahway, New Jersey, for the vitamins to carry on this study. We wish to thank the Columbia River Packers Association, Astoria, Oregon, for the salmon livers, viscera, eggs, and tuna livers; and

Bioproducts Oregon, Ltd., Warrenton, Oregon, for crab meal. Gopi Nath Gupta did the many moisture determinations at the Seafoods Laboratory, Astoria, Oregon.

Literature cited

Burrows, Roger E., Leslie A. Robinson, and David D. Palmer
1951 Tests of Hatchery Foods for Blueback salmon *(Oncorhynchus nerka)* 1944-1948. Special Scientific Report, Fisheries No. 59, U. S. Department of the Interior, F.W.S.

McKee, T. B., R. O. Sinnhuber, and D. K. Law
1951 Spring Chinook Salmon Diet Experiments at the Bonneville Hatchery. Fish Commission Res. Briefs, *3* (2): 22-31, August 1951.

McLaren, Barbara A., Elizabeth Keller, D. John O'Donnell, and C. A. Elvehjem
1947 The Nutrition of Rainbow Trout. I. Studies of Vitamin Requirements. Archives of Biochemistry, *15* (2): 169-178, November 1947.

Phillips, P. H. and E. B. Hart
1935 The Effect of Organic Dietary Constituents upon Chronic Fluorine Toxicosis in the Rat. Journal of Biochemistry, 109 (2): 657-663, 1935.

RECOVERY OF A CHINOOK SALMON IN TILLAMOOK BAY TAGGED IN ALASKA

A 29.5 inch chinook salmon was tagged in Cross Sound, Southeastern Alaska on July 12, 1951 by biologists of the Alaska Department of Fisheries. On the night of August 19, 1951, Messrs. Robert Sotto and Ned Nicholi caught this fish off the Garabaldi light in Tillamook Bay. After migrating some 900 miles in 39 days this 4-year old chinook had gained one-half inch in length. It is believed that this fish was reared in a Tillamook Bay tributary, went north to Alaska on a feeding migration and returned to spawn in a Tillamook Bay tributary.

Ray Willis
Fish Commission of Oregon

THE 1950 WILLAMETTE RIVER SPRING CHINOOK SPORT FISHERY

CHESTER R. MATTSON
Fish Commission of Oregon

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Oregon State Game Commission

Introduction

During the spring months of 1950, the chinook salmon *(Oncorhynchus tshawytscha)* sport fishery in the Willamette River was investigated for the seventh season. Studies were conducted during the periods 1941-1942 and 1946-1950. The investigations of 1941-1942 were carried out by Craig and Townsend of the U. S. Fish and Wildlife Service. The results of their studies have been published in Special Scientific Report No. 33. From 1946 through the 1950 season, annual investigations have been undertaken as a cooperative project of the Fish Commission of Oregon and the Oregon State Game Commission.

The Fishery

The Willamette River spring chinook fishing area consists of two principal sections of the main stream below the Willamette Falls at Oregon City. The upper section is comprised of the waters from the Ross Island bridge in Portland upstream to a fishing deadline established below the Willamette Falls. In this section the water currents are generally of sufficient velocity to operate trolling gear from anchored or slowly moving boats. In the vicinity of the Willamette Falls and the mouth of the Clackamas River, casting with lighter equipment is practiced with varying degrees of success.

The lower river section of the fishery extends from opposite Swan Island in northwest Portland downstream to the mouth of the main river. In addition to the above portion, the entire length of the Multnomah Channel from Portland to St. Helens is included in the lower river area. The principal type of angling practiced here is that of trolling from slowly moving boats.

Figure 1 depicts the main fishing areas together with the approximate locations of various boat moorages.

Methods of Computations

The method employed to determine the total catch of the 1950 season was identical to that used previously by McKernan and Jensen in 1946. This method is dependent upon a reliable estimate of the daily fishing intensity and catch in the two fishing areas throughout the spring season.

Basic information utilized in determining the total catch consisted of daily catch records kept by the various moorage operators. This record consisted of the daily catch of fish and the total number of boats fishing from boat concessions. In addition, on several occasions an airplane was used to count the boats fishing and two all-day moorage checks were made to determine the fishing intensity during the various hours of the day. Such all-day moorage checks were made during the study years of

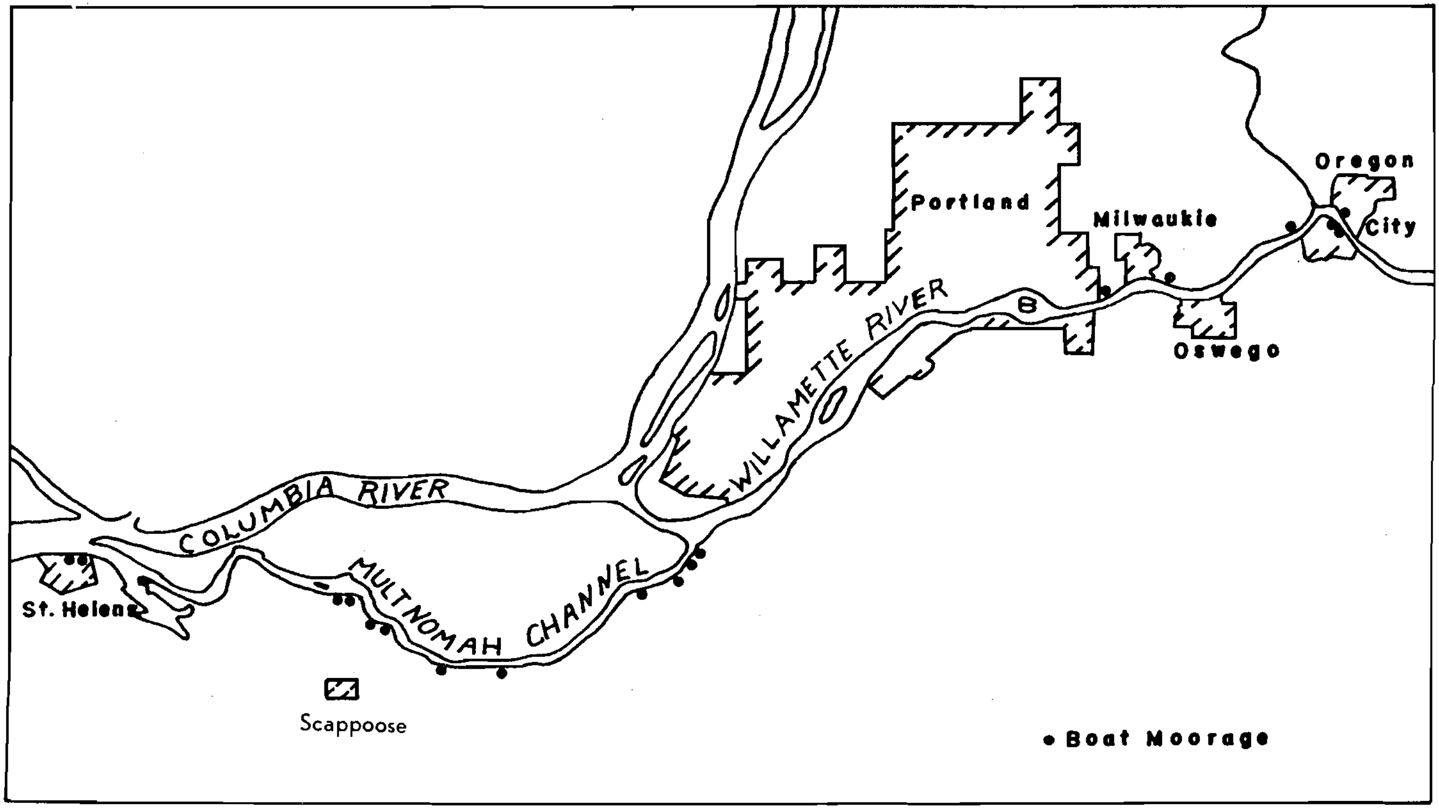

Figure 1. SPORT FISHING AREAS FOR SPRING CHINOOK SALMON IN THE LOWER WILLAMETTE RIVER AND MULTNOMAH CHANNEL.

1946, 1947, and 1948. In calculating the 1950 sport catch, all useful day-long moorage observations (Figure 2) were used in conjunction with the

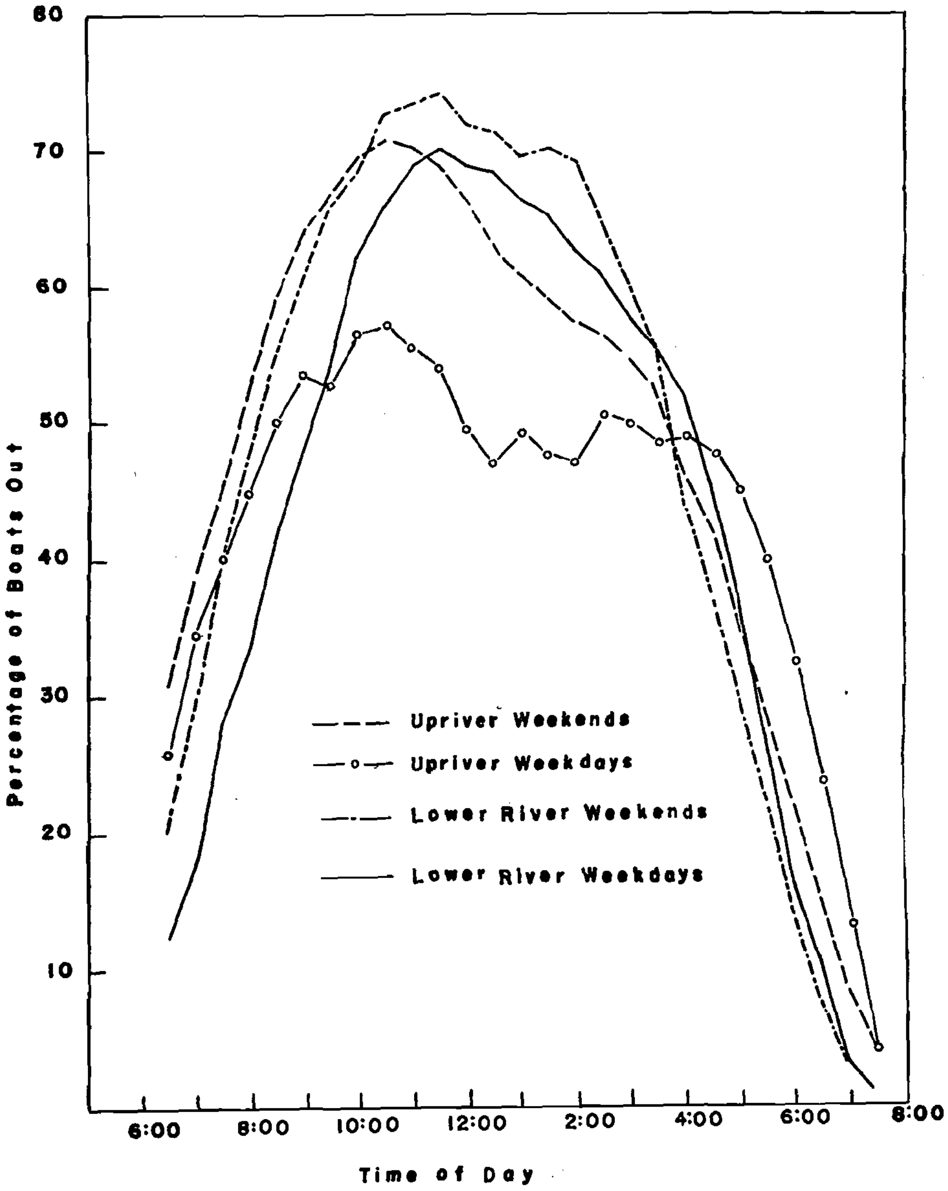

Figure 2. THE DISTRIBUTION OF FISHING EFFORT THROUGHOUT THE DAY, WILLAMETTE RIVER SALMON SPORT FISHERY, AVERAGE OF ALL USEFUL OBSERVATIONS, 1946, 1947, 1948, AND 1950.

moorage records and airplane boat counts. The latter were used to determine the percentage of boats on the river reported by the moorage operators (Tables 1 and 2).

Results

The total spring chinook salmon catch for 1950 was calculated to be 8,839 fish. A division of the total catch between the two fishing areas revealed that the lower river contributed 4,903 fish. The upper river catch was computed to be 3,936 fish (Table 3).

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, 1950

Date	Day	Time	Aerial Observer Counts	Percent Available ①	Total Boats Calculated	Reported by Moorages	Percent Reported
			Saturdays and Sundays				
April 8	Sat.	11:48	335	67.3	498	62	12.5
April 15	Sat.	11:59	298	66.2	450	74	16.4
April 16	Sun.	11:56	323	66.6	485	83	17.1
April 22	Sat.	11:53	371	66.8	555	90	16.2
April 23	Sun.	11:59	536	66.2	810	98	12.1
				Total	2,798	407	14.6
			Weekdays				
April 13	Thurs.	11:50	216	50.9	424	38	9.0
April 18	Tues.	12:50	201	48.7	413	61	14.8
May 3	Wed.	12:36	159	47.6	334	54	16.2
May 11	Thurs.	12:24	111	47.6	233	38	16.3
				Total	1,404	191	13.6

① Percentage of total boats for day that were on the river at the 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, 1950

Date	Day	Time	Aerial Observer Counts	Percent Available ①	Total Boats Calculated	Reported by Moorages	Percent Reported
			Saturdays and Sundays				
April 15	Sat.	12:18	560	71.5	783	366	46.8
April 16	Sun.	12:12	561	71.7	784	439	56.0
April 22	Sat.	12:12	679	71.7	947	452	47.7
April 23	Sun.	12:17	791	71.5	1,107	533	48.2
				Total	3,620	1,790	49.5
			Weekdays				
April 13	Thurs.	12:07	270	68.9	392	206	52.6
April 18	Tues.	12:25	289	68.5	422	183	43.3
May 3	Wed.	12:19	62	68.6	90	101	112.0
May 11	Thurs.	12:09	13	68.9	19	10	57.9
				Total	923	500	54.2

① Percentage of total boats for entire day that were on the river at time of count (Figure 2).

TABLE 3.

CATCH OF CHINOOK SALMON IN THE WILLAMETTE RIVER BY WEEKLY INTERVALS CALCULATED FROM MOORAGE REPORTS

1950

Date	Below Portland	Portland to Oregon City	Total
March 5-11	0	0	....
March 12-18	0	8	8
March 19-25	0	15	15
March 26-April 1	35	29	64
April 2-8	310	231	541
April 9-15	851	441	1,292
April 16-22	1,093	809	1,902
April 23-29	1,780	825	2,605
April 30-May 7	755	750	1,505
May 8-14	75	554	629
May 15-21	4	149	153
May 22-28	0	95	95
May 29-June 4	0	20	20
June 5-10	0	10	10
Total	4,903	3,936	8,839

The 12 cooperating moorages reported a catch of 3,107 fish, or 35 per cent of the total calculated catch. Of the 3,107 fish reported, the weights

Figure 3. FREQUENCY POLYGON OF WEIGHTS OF WILLAMETTE RIVER SPRING CHINOOK SALMON SHOWING THE WEIGHT VARIATIONS OF 2,157 FISH TAKEN IN THE SPORT FISHERY, 1950.

of 2,157 were obtained and were found to average 16.6 pounds. The range in weights was from 1 to 42 pounds (Figure 3). The calculated catch of 8,839 fish resulted in an aggregate weight of 146,700 pounds.

Discussion

The first spring chinook salmon was caught at the mouth of the Clackamas River on February 23, and the last fish was taken at Oregon City on June 11. Before April 1, few fish were caught, but the catch rapidly increased. The peaks for the upper and lower river sections occurred during the period of April 22-28. After the peak period, an abrupt decline was experienced in the lower river catch in contrast to the gradual decline in the catch of the up-river section (Figure 4).

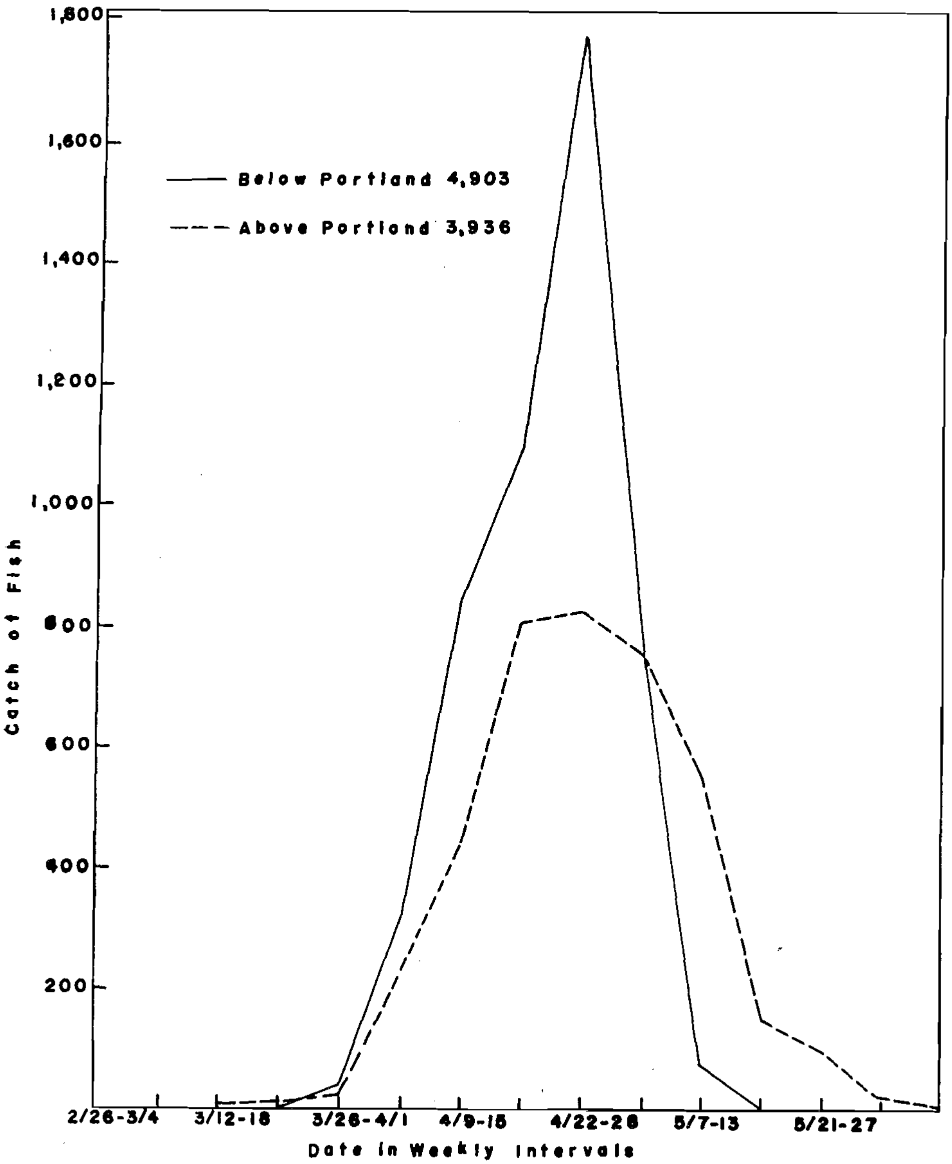

Figure 4. CATCH OF CHINOOK SALMON IN THE WILLAMETTE RIVER BY WEEKLY INTERVALS, CALCULATED FROM MOORAGE REPORTS, 1950

There were 69,868 man days expended in fishing, with a maximum of 3,842 anglers fishing on April 30. The mean catch per angler per day was 0.13 fish, which represented a mean catch of one salmon per angler in 7.7 days of angling effort. The catch per angler per day was 0.15 salmon in the lower river, or one fish in 6.7 days of angling. For the upper river, the catch per angler was 0.11 salmon or one fish in 9.1 days of angling (Table 4).

TABLE 4.

COMPARISON OF THE SPRING CHINOOK SALMON SPORT FISHERY OF THE WILLAMETTE RIVER IN 1946, 1947, 1948, 1949, AND 1950

Year	Fishing Intensity ①	Catch in No. of fish ②	Catch per Boat per day	Catch per Angler per day
1946	58,966	12,342	0.42	0.21
1947	87,456	11,855	0.27	0.14
1948	79,574	8,328	0.21	0.11
1949	81,438	9,064	0.22	0.11
1950	69,868	8,839	0.23	0.13

① 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.

② Catch from boats.

In Table 5 and Figure 5 are found the weekly catches for the 7 years in which the studies of the fishery have been conducted. The 1950 catch was the second lowest on record; only the 1948 catch of 8,300 fish was smaller.

The 1945 parent run of Willamette River chinook salmon, from which most of the 1950 salmon originated, was not evaluated due to the war conditions resulting in a lack of personnel. Therefore, the parent and progeny runs cannot be compared.

In general, the fishing conditions during the 1950 season were consistently favorable after March 25. Prior to this time, frequent rains and muddy water discouraged most anglers.

TABLE 5.

SALMON CATCH IN THE WILLAMETTE RIVER BY WEEKLY INTERVALS ① AS CALCULATED FROM MOORAGE REPORTS FOR THE YEARS 1941, 1942, 1946, 1947, 1948, 1949, AND 1950.

Date	1941 ②	1942 ②	1946	1947	1948	1949	1950
Feb. 8	....	....	1	....	....	....	....
Feb. 9–15	....	....	3	....	....	....	....
Feb. 16–22	....	....	41	3	....	....	....
Feb. 23–March 1	....	14	21	20	....	....	....
March 2–8	202	128	16	17	....	....	....
March 9–15	804	290	68	0	4	16	8
March 16–22	1,615	544	38	367	10	82	15
March 23-29	3,753	1,732	572	480	34	37	64
March 30–April 5	5,518	2,080	1,573	342	341	468	541
April 6–12	6,392	2,536	2,125	341	715	1,695	1,292
April 13–19	5,823	1,278	2,740	4,106	1,359	1,805	1,902
April 20–26	4,382	1,610	3,173	3,799	1,352	1,093	2,605
April 27–May 3	1,183	1,417	1,308	1,672	1,568	1,121	1,505
May 4–10	267	305	506	373	1,011	441	629
May 11–17	61	66	181	112	1,068	906	153
May 18–24	....	....	25	152	497	1,081	95
May 25–31	....	....	1	71	321	270	20
June 1–7	....	....	....	....	48	49	10
③ Total	30,000	12,000	12,630	12,000	8,330	9,060	8,839

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 as much as three days.

② Catches of 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.

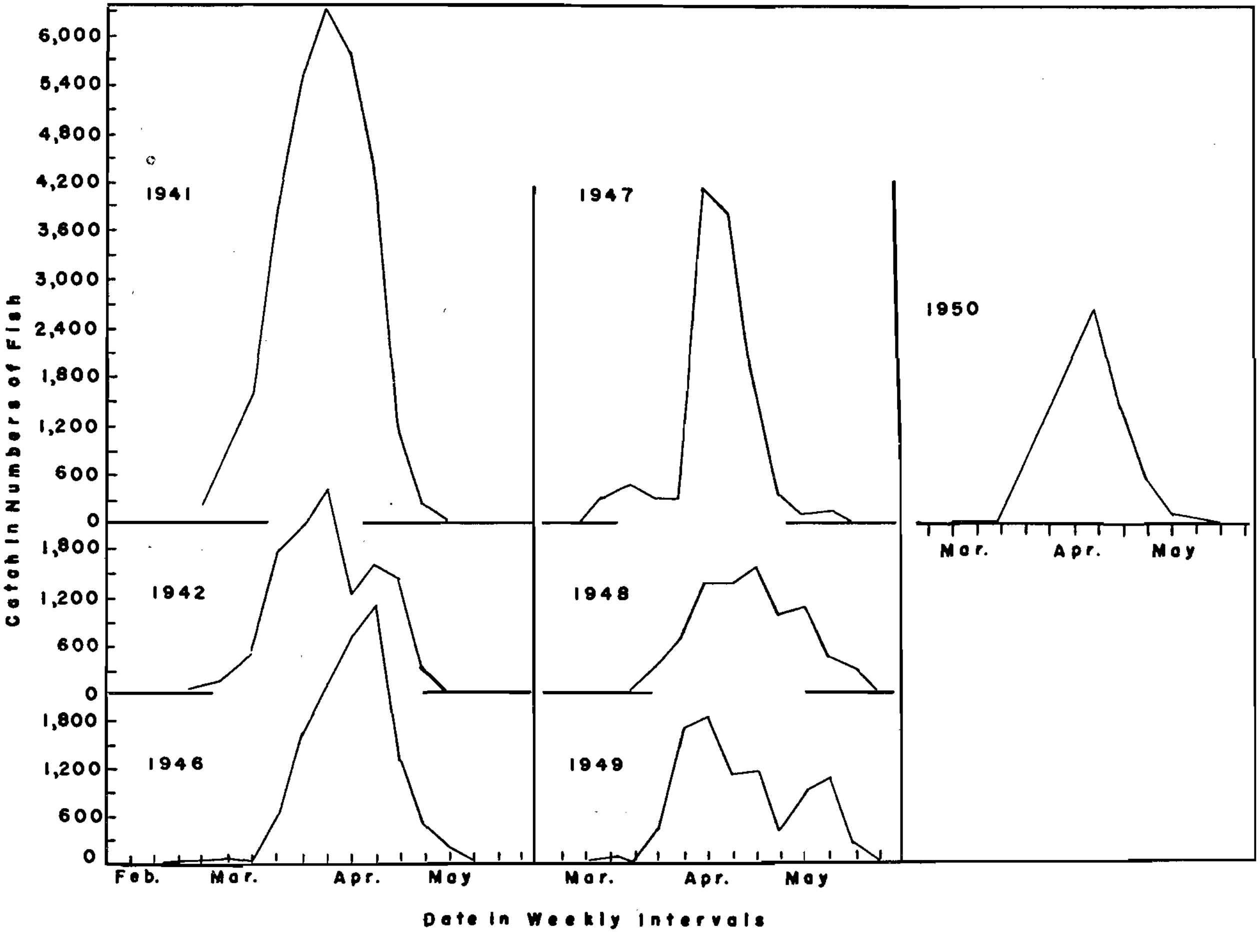

Figure 5. SALMON CATCH IN THE WILLAMETTE RIVER BY WEEKLY INTERVALS AS CALCULATED FROM MOORAGE REPORTS FOR THE YEARS 1941, 1942, 1946, 1947, 1948, 1949, AND 1950.

Summary

1. The 1950 sport catch of Willamette River spring chinook salmon was computed to be 8,839 fish. The average weight was found to be 16.6

pounds; and the total weight of the catch, 146,700 pounds or 73.5 tons.

2. Salmon were caught during the period from February 23 to June 11. The peak catches for both the upper and lower river were made during the period of April 22-28.

3. The fishing effort in terms of angling days was 69,868.

4. The catch per angler per day was calculated to be 0.13 fish, or an equivalent of 7.7 days angling to take one fish.

5. The 1950 sport catch was the second smallest on record—only the 1948 catch of 8,300 fish was smaller.

Literature Cited

Craig, J. A. and D. Townsend
1946 An Investigation of Fish Maintenance Problems in Relation to the Willamette Valley Project. U.S. Fish and Wildlife Service Special Scientific Report No. 33: 1-78, 10 figs., Chicago

McKernan, D. L. and C. C. Jensen
1946 '46 Willamette River Spring Chinook Sport Fishery. Oregon State Game Commission Bull. 1 (6): 3-6, Portland

Johnson, D. R. and C. R. Mattson
1949 Willamette River Spring Chinook Sport Fishery of 1948. Fish Comm. Research Briefs. Fish Comm. of Oregon. 2 (1): 10-17, 4 Figs., Portland

Troll Salmon Caught Twice by Same Fisherman

On September 21, 1951, Mr. Elmer Jennings caught the same chinook salmon for the second time. This fish had been tagged from Mr. Jenning's troller on July 13, 1951, off Coos Bay and he caught it again about 15 miles south of the tagging site.

Jack Van Hyning
Aquatic Biologist
Fish Commission of Oregon

Early Recovery of a Chum Salmon in the Columbia River

Mr. Isaac Jolma, fish buyer for the Point Adams Packing Company at Clatskanie, Ore., reported an unusually early appearance of a chum salmon on July 14, 1952, in the commercial catch at his station. This fish was a 7-pound female, bright in color and with only a faint trace of the normal calico coloring generally in evidence on these fish upon the approach of the spawning season. Ordinarily these fish begin to appear in the river gill-net fishery during late September, and the greatest catches are made in November.

Chester R. Mattson
Fish Commission of Oregon