TWENTY-FIVE YEARS OF RESEARCH AND SERVICE BY THE SEATTLE TECHNOLOGICAL LABORATORY

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SUMMARY

In connection with marking the twenty-fifth anniversary of the founding of the Seattle Fishery Technological Laboratory in May 1958, the activities of the Laboratory are reviewed. In the prewar period, programs dealt largely with fishery industrial products. Many special activities were taken on during the war years including such work as finding substitutes for items in short supply that are used by the fisheries. Much work on vitamin A-containing fish oils also was carried out during this period. A diversified program resulted after discontinuation of wartime activities. In the current period, with Saltonstall-Kennedy funds available, the program has been broadened with somewhat greater emphasis on basic research.

Outstanding accomplishments over the past 25 years have been reviewed. A total of 267 publications were released by the Seattle Laboratory, about half of them being concerned with analytical methods, frozen fish, and processing of fish meal and fish oil. One accomplishment alone saved the Government over $8 million, an amount several times the entire operating cost of the Laboratory over the 25-year period.

Current activities of the laboratory are reviewed. The functions of the Laboratory--basic research, applied research, and services to the fishing industry--are described, and details of the current programs, organization of the Laboratory, and Laboratory facilities are outlined.

INTRODUCTION

On May 2, 1933, the Seattle Fishery Technological Laboratory was opened at its present location on Montlake Boulevard. Thus 1958 marks the Laboratory's twenty-fifth anniversary. This report reviews the activities and accomplishments during the 25 years of operation and describes the current organization and programs.

ACTIVITIES

The activities of the Seattle Laboratory can be considered under four periods of time: the prewar period (1933-1941), the war period (1942-1946), the postwar period (1947-1954), and the current period (1955-1958).

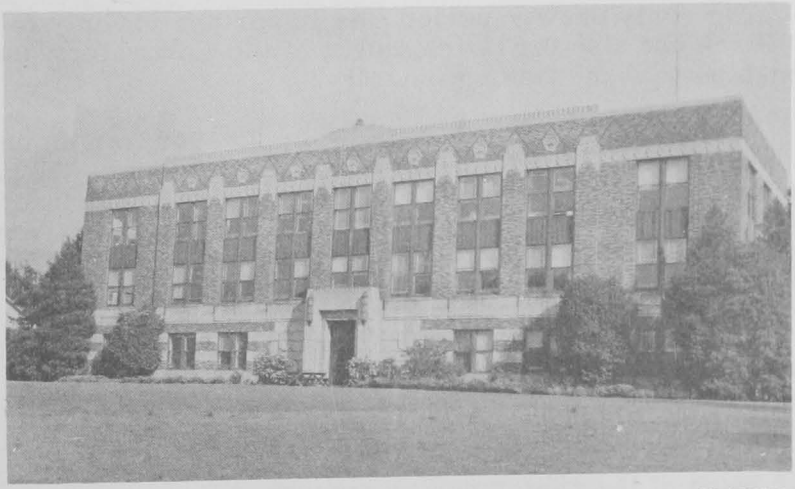

FIG. 1 - BUILDING THAT HOUSES SEATTLE TECHNOLOGICAL LABORATORY, U. S. BUREAU OF COMMERCIAL FISHERIES.

PREWAR PERIOD (1933-1941): At the inception of the program in 1933, with only two employees on the staff, the program had to be limited to a few narrow fields. During the first several years, the program dealt exclusively with utilization of salmon waste and fish livers for production of fishery industrial products.

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In 1937 the assignment of several W. P. A. chemists to the Laboratory and, later, in 1939 and 1940 the addition of two regular staff members made it possible to broaden the program somewhat to include limited investigations on composition and preservation.

FIG. 2 - THE PILOT PLANT OF THE SEATTLE FISHERY TECHNOLOGICAL LABORATORY OCCUPIES THE FIRST SMALL BUILDING TO THE LEFT OF THE MAIN BUILDING.

Extensive programs were carried out on utilization of salmon waste. Temporary field laboratory operations were carried out both in Alaska and on the Columbia River. Rendering methods for producing an edible salmon oil to be added to canned salmon were developed. Considerable basic information on chemical properties of salmon oils was obtained. Investigations were carried out on the heating of fish meals that occurs after they leave the driers. Improvements were made in methods for rendering oils from fish livers, and collaborative work was carried out with the U. S. Food and Drug Administration in connection with preparation of standardized samples of halibut-liver oil. Research was begun to improve the analytical methods for determining the oil content of fish meals.

Studies were carried out on the freezing and cold-storage life of commercially-important species of fish in the Pacific Northwest. It was shown that frozen fish can be stored in food lockers without damage to other frozen foods. Research was carried out on freshness tests for fish, including tests for oxidative rancidity. The proximate composition of some Pacific Northwest species of fish was determined.

An investigation was carried out over a 2-year period on the utilization of king crab in Alaska.

The early prewar period was important not only for the accomplishments of the research but also for development of the Laboratory and for setting up good relationships with the fishing industry.

WARTIME PERIOD (1942-1946): In 1942, the emphasis of the program was directed toward solving special wartime problems. Six programs concerned with wartime problems were undertaken. In order that these programs could be carried out adequately, the activities of the Laboratory were expanded. Professional-grade personnel were increased from the maximum of 4 reached during prewar to 15, and the budget was more than trebled.

The war projects included work on dehydration of fish, substitute containers for tinplate, seaweed substitutes for agar, assistance to the Army Quartermaster Corps, assistance to other wartime agencies such as the War Production Board, and better utilization of certain species of fish.

Much of the assistance to government agencies consisted of developing standards and analytical methods to facilitate Government purchases of vitamin A oils and livers, and the vitamin A project became, during this period, the largest one in the Laboratory. Work was carried out on stability of vitamin A, analytical methods for vitamin A, vitamin A content of fish livers, and conservational aspects of the shark fishery.

In connection with better utilization of certain species of fish, the Reconstruction Finance Corporation was assisted in designing and outfitting the vessel Pacific Explorer, which was built for freezing fish fillets at sea.

FIG. 3 - LABORATORY IN PILOT PLANT BUILDING.

POSTWAR PERIOD (1947-1954): The beginning of the postwar period was marked by a drastic reduction in budget and personnel as wartime projects were terminated. In 1947, a 50-percent cut in operating funds necessitated dropping 8 employees.

Considerable emphasis during this period was placed on aiding industry to solve problems encountered in the freezing and cold storage of fish. Special emphasis was placed on cold storage of king crab, the output of which had been expanded markedly, and on rockfish, the production of which had increased greatly during the war and for which civilian demand had not kept pace. Efforts were made to increase markets for this fish. Work was carried out to demonstrate the feasibility of freezing fish at sea in the round, thawing them ashore, and filleting and refreezing them. Work was also carried out on problems encountered in freezing salmon for later canning.

A large program sponsored in part by the Industrial Research and Development Department of the U. S. Department of Commerce was carried out toward better utilization of Alaskan salmon waste. As an extension of this work, Federal and State fish hatcheries were assisted in the utilization of fish waste for hatchery feeds.

Considerable work was done to determine the content of vitamin B_{12} and unidentified growth factors in fish meal. As an extension of a prewar project, a new method was developed for the determination of oil in fish meal.

Certain problems involving the storage life of halibut and salmon steaks cut from the frozen, stored fish were worked on cooperatively with industry. A fellowship from Continental Can Company financed a study of the causes of discoloration in tuna cans. A study of the protein-water relationship in fish, including the development of methods for measuring drip, was carried out.

An investigation was made of the composition and cold-storage life of freshwater fish. Because no technological laboratory is located in the Central States, very little was known concerning the technology of fish taken in that area. Analyses and cold-storage examinations were carried out on a large number of species of fish from the Great Lakes and Mississippi River areas.

Two projects dealing with fish meal and fish oil were started late in the postwar period. Results of investigation by research workers at the Poultry Husbandry Department of the University of California indicated a wide variation in nutritive value among different batches of fish meal. Work was started at Seattle to study the causes of this variation and to develop a chemical method of determining fish-meal nutritive value. In another project, work was started to investigate the possibilities of preparing potentially valuable chemical derivatives from fish oils.

CURRENT PERIOD (1955-1958): The current period is featured by the increase of funds provided for technological research by the Saltonstall-Kennedy Act of 1954. Initially, the main expansion in programs was in the form of contract research at various university laboratories and other laboratories. Later, some expansion in Bureau laboratory programs took place. Programs carried out under Saltonstall-Kennedy funds, either at the Seattle laboratory or on contracts elsewhere and coordinated from Seattle, have been in the following fields: fish meal, fish oil, standards, irradiation, tuna handling, and rockfish utilization. The first two on meal and oil were started as limited Seattle Laboratory investigations. Now with Saltonstall-Kennedy funds they have been broadened into comprehensive nationwide programs. At the express recommendation of fishery-industrial-products representatives, a substantial portion of these investigations has been basic research. Programs on contract with Hormel Institute, University of Minnesota, deal with the chemistry and nutrition of fish-oil fatty acids; other programs at the University of California, Food Technology Department, deal with oxidative deterioration in fish oils and in fish tissue. A program at the Seattle Laboratory carried out by organic chemists is concerned with the preparation of chemical derivatives of fish-oil fatty acids. This basic approach is producing the fundamental information needed for solving practical problems at an applied level. Some applied problems were undertaken simultaneously with the basic research. These deal, for example, with the use of fish oils in animal feeds and in ore flotation.

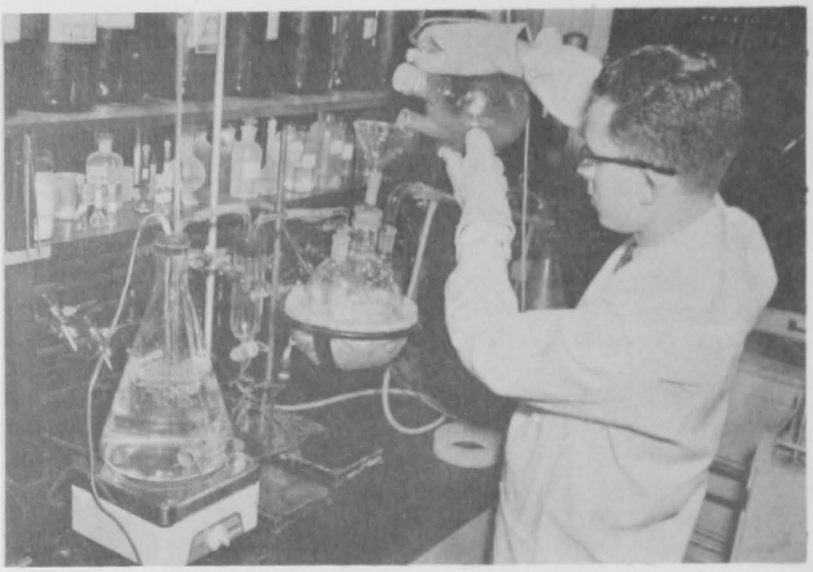

FIG. 4 - A MIXTURE OF FISH-OIL GLYCERIDES BEING HYDROLYZED BY SODIUM-REDUCTION REACTION TO PREPARE FATTY ALCOHOLS.

Fish-meal programs are being carried out at the Seattle Laboratory and on contracts at the Poultry Husbandry Department of the Universities of California and Wisconsin. These programs are investigating causes of variation in nutritive value of different batches of fish meals.

Other current programs at the Seattle Laboratory deal with the determination of chemical composition and with the freezing and storage of fish. These programs are supported, in part, by grants from The Refrigeration Research Foundation. Proximate composition and sodium content of both fresh-water and marine fish are being investigated. Cold-storage studies are being carried out on fresh-water fish, and marine fish, and Pacific oysters.

Special emphasis is given to assisting the fishing industry in solving its problems. Efforts are made to disseminate results of these research programs rapidly to the fishing industry both by the publishing of digest reports and by the giving of direct reports at meetings attended by members of industry.

ACCOMPLISHMENTS OF SEATTLE LABORATORY

PUBLICATIONS: One way of reviewing the accomplishments of the laboratory is to analyze the research reports that have been published. Table 1 lists by subject the number of publications issued each year. Table 2 lists the total number of

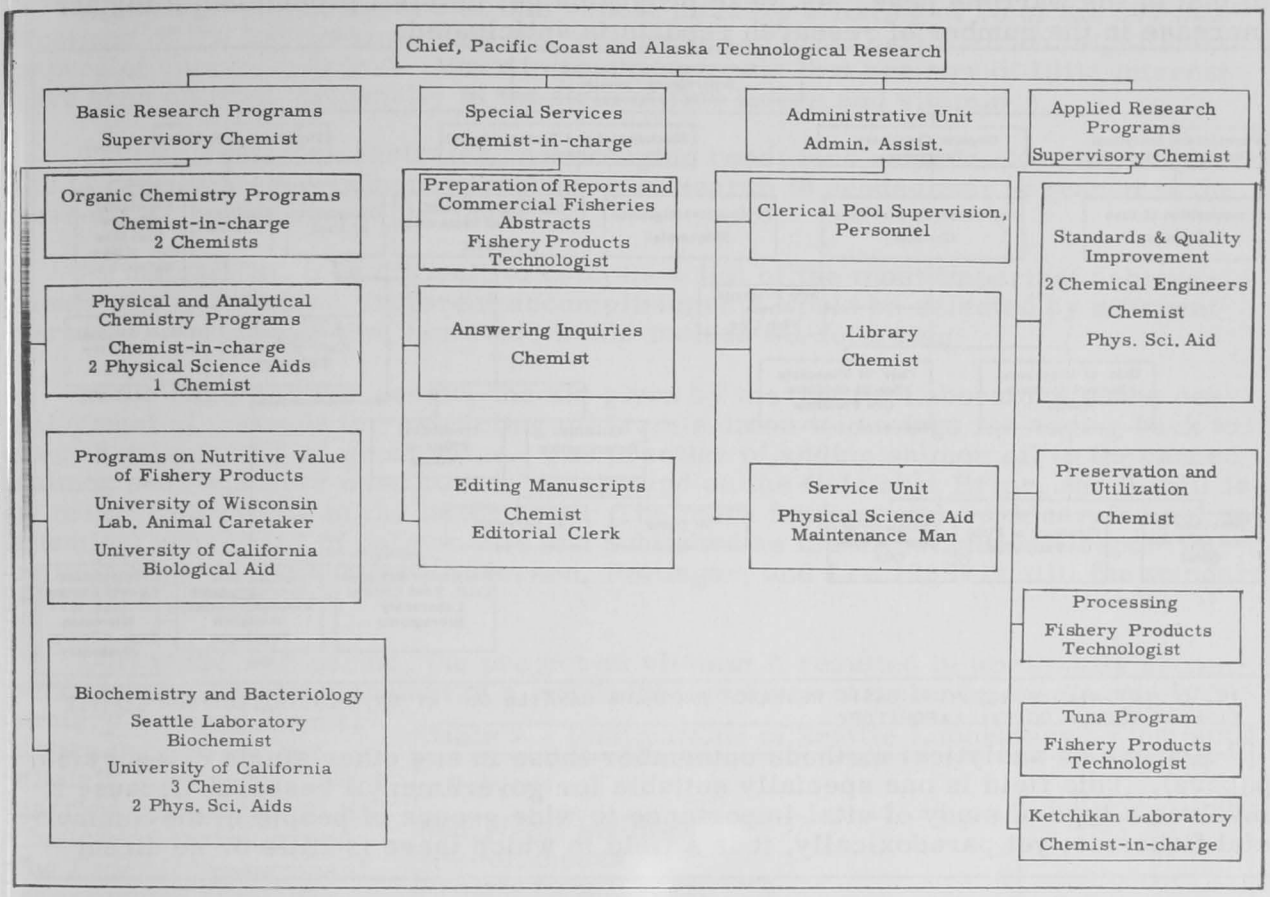

FIG. 5 - ORGANIZATION CHART OF SEATTLE FISHERY TECHNOLOGICAL LABORATORY.

publications on each subject. A total of 267 papers has been published from the time the Laboratory was established through 1957. The number of papers rose from 1 or 2 per year during the early prewar years to a maximum of 26 in 1945; the numbers then declined during the postwar years when the size of the Laboratory staff diminished. Since the start of the Saltonstall-Kennedy programs, the number of papers has increased to 26 in 1957. Thus the number published last year is equal

Table 1 - Seattle Laboratory Publications by Subject and Year

Year	Analytical Methods	Canned Fish	Chemical Composition	Fish Oil Chemistry	Fish Meal and Oil Processing	Frozen Fish	Handling Fresh Fish and Spoilage	Miscellaneous	Utilization of Fish and Waste	Total
1957	4	1	3	8	1	1	2	5	1	26
1956	1	3	2	3	1	7	1	1	-	19
1955	2	1	4	3	1	7	-	1	1	20
1954	1	1	3	-	-	3	1	3	-	12
1953	1	1	-	-	3	3	-	-	2	10
1952	2	-	-	1	3	-	-	1	2	9
1951	1	2	-	2	3	-	-	4	1	13
1950	3	1	3	-	4	-	-	2	1	14
1949	5	-	3	1	1	1	-	2	-	13
1948	2	2	-	1	1	3	-	4	-	13
1947	7	1	1	-	2	3	4	3	1	22
1946	7	1	1	-	2	2	-	4	2	19
1945	5	1	3	4	3	3	2	3	2	26
1944	7	-	-	1	2	1	-	3	2	16
1943	1	-	-	-	-	-	1	1	1	4
1942	2	-	-	-	1	1	-	4	-	8
1941	1	-	-	2	1	1	-	-	-	5
1940	-	-	-	-	3	2	-	-	-	5
1939	1	-	-	1	1	-	-	-	-	3
1938	1	-	-	-	1	-	-	-	-	2
1937	1	-	-	2	1	2	-	-	-	6
1936	-	-	-	-	1	-	-	-	-	1
1935	-	-	-	-	1	-	-	-	-	1
Total	55	15	23	29	37	40	11	41	16	267

to that of the wartime peak. As these programs get into full production, a further increase in the number of research reports is anticipated.

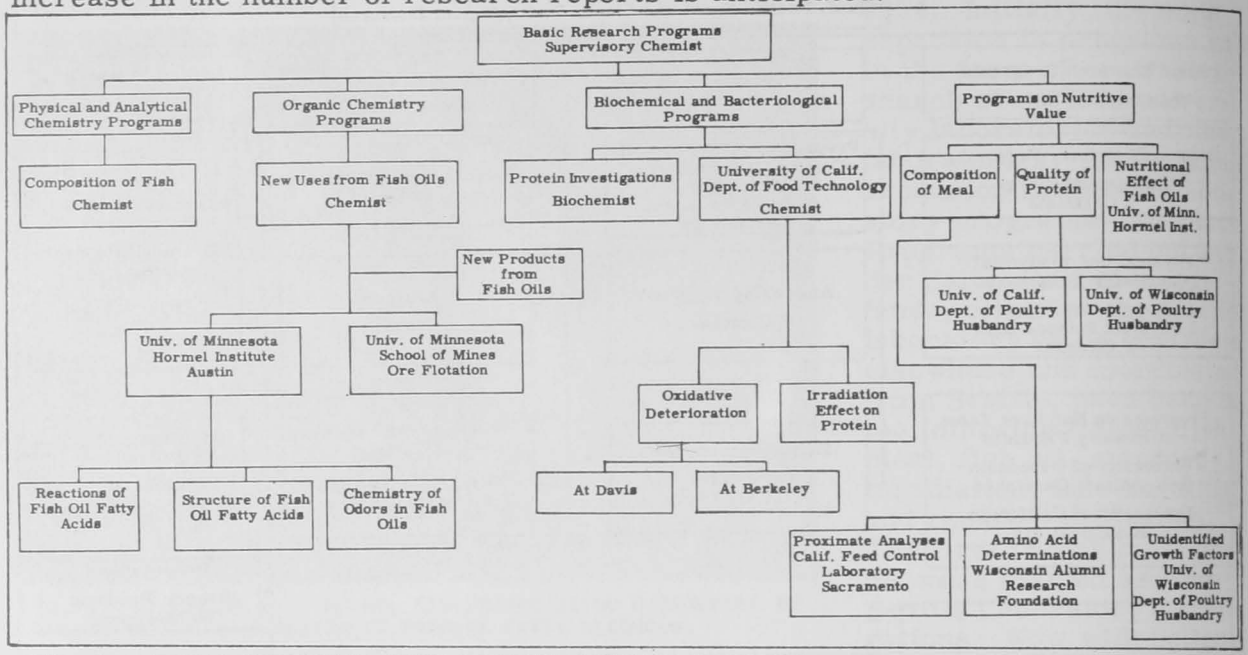

FIG. 6 - DETAILS CONCERNING BASIC RESEARCH PROGRAMS CARRIED OUT AT OR COORDINATED FROM SEATTLE FISHERY TECHNOLOGICAL LABORATORY.

Papers on analytical methods outnumber those in any other single category (55 papers). This field is one specially suitable for governmental research because it involves a type of study of vital importance to wide groups of people in the commercial fisheries; yet paradoxically, it is a field in which there is little or no direct

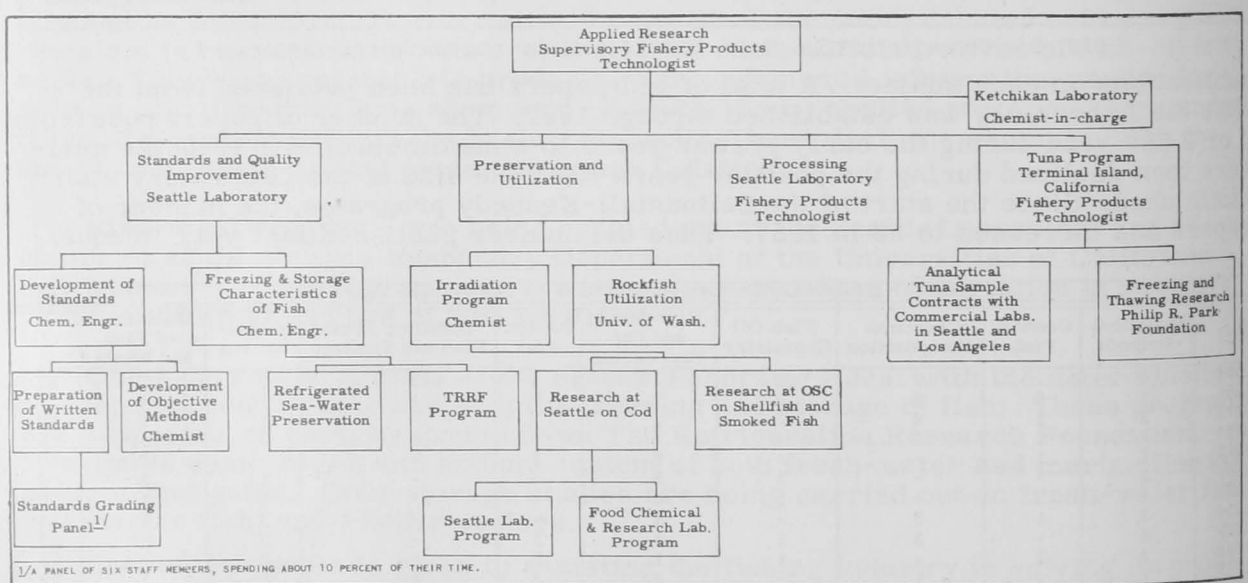

FIG. 7 - DETAILS CONCERNING APPLIED RESEARCH PROGRAMS CARRIED OUT AT OR COORDINATED FROM SEATTLE FISHERY TECHNOLOGICAL LABORATORY.

profit motive for private enterprise to undertake the work. Analytical methods are needed for use with a wide variety of fishery products for which special adaptations of standard analyses are required. Such methods are used by fishery technologists and chemists at all levels of the fishery industry, such as in processing fishery industrial products, in preservation, and in quality control. Reports on frozen fish is the next largest category of papers, followed by fish-meal and oil processing, fish-oil chemistry, and composition of fish.

A bibliography at the end of this report includes a listing of 75 of the 267 publications of the Laboratory. This list was compiled to include the most significant papers of current interest. Many important reports that are now of little interest have been omitted, especially in the field of fish livers and vitamin A.

This situation demonstrates how changing conditions require changing emphasis in research. A continuing program of research is needed that is geared to the ever-varying problems of the industry.

HIGHLIGHTS: It is difficult to compile a list of the most important achievements of a Laboratory. Different accomplishments would be selected by different persons. Almost any list, however, would include the following:

In the early prewar period, the aid given by the Seattle Laboratory in the development of methods for extracting oil from salmon trimmings for adding back to canned salmon was of great value. The practice of adding salmon oil to the canned salmon pack has been used both in Alaska and on the Columbia River, and it still is of major importance in the latter area. The more fundamental work carried out on chemical properties of salmon oils and published as the investigational report Pacific Salmon Oils (Harrison, Anderson, Pottinger, and Lee 1939) is still the standard reference in this field.

During the war period, the project on vitamin A resulted in worthwhile accomplishments. The development of a practical fish-liver sampler by the Seattle Laboratory changed the marketing pattern for the vitamin A industry. Work carried out for the U. S. Customs Service saved the Federal Government an estimated $8 million. This saving alone repaid, several times over, the total cost of operating the Seattle Laboratory during its entire past life.

Table 2 - Publications of Seattle Laboratory by Subjects

Subject	No. of Publications
Analytical methods	55
Miscellaneous	41
Frozen fish	40
Fish meal and oil processing	37
Fish oil chemistry	29
Composition of fish	23
Utilization of fish and waste	16
Canned fish	15
Handling fresh fish and spoilage	11
Total	267

In the postwar period, several major achievements have resulted. The conception, setting up, and preparation on a continuing basis, by the Seattle Laboratory staff, of the monthly periodical Commercial Fisheries Abstracts have been of great value. This method of getting results of technological and scientific research to the fishing industry proved so successful that it served as an incentive to the Food and Agriculture Organization to set up, for worldwide coverage, a parallel journal World Fisheries Abstracts, published in three languages and abstracting many foreign-language fishery articles not covered in Commercial Fisheries Abstracts.

The work carried out by Seattle Laboratory staff members on utilization of Alaska cannery waste has resulted in commercial utilization of such waste in two Alaskan areas where, previously, all salmon waste had been discarded. The work carried out on fresh-water fish provides the first comprehensive information available on proximate composition and cold-storage life of these fish. The work, started in the prewar period and completed after the war, on determination of oil in fish meal resulted in adoption by the Association of Official Agricultural Chemists of a new official method for analyzing the oil content of fish meal.

It is perhaps too early in the current period, which started in 1955, to appraise the relative importance of current accomplishments. It seems likely that the

setting up of programs to carry out basic research, particularly in the field of fish-oil chemistry, will rank of highest importance. More basic information is needed by the Pacific Coast fisheries not only for use in processing fish oil but even more in connection with problems concerning oxidative rancidity and discoloration. Pacific Coast species of fish are more susceptible to this type of change than are principal species in other areas. Important limitations to the utilization of salmon, tuna, and halibut are caused by oxidative changes occurring during processing and storage. The principal New England species--haddock, cod, and ocean perch--are relatively immune to such deterioration. Already, important results have been obtained toward establishment of the chemical structure of fish-oil fatty acids. Much has been done to elucidate the mechanism of oxidation of fish oils. The structures of pigments in tuna have been identified, and means for controlling discoloration during the processing of this species have been worked out. Studies under way promise eventually to result in more complete knowledge of the role of enzymes in deterioration of fish oils and fish tissue.

CURRENT ACTIVITIES OF LABORATORY

FUNCTIONS: The Seattle Fishery Technological Laboratory is primarily a research Laboratory. Unless the results of its research can be brought to the attention of those who need them, its work will not be effective. A very important function, therefore, is the dissemination of information. This is done through preparation of written bulletins and papers, answering written inquiries, consulting personally with individuals in the fishing industry, and holding occasional meetings to discuss research findings and problems of the industry. The Special Services Unit stationed at the Laboratory edits papers from the other Branch of Technology Laboratories on the Atlantic, Gulf, and Pacific Coasts.

FIG. 8 - SCENE IN PILOT PLANT. HERRING BEING PREPARED TO PRODUCE A MEAL FOR USE IN ANTIOXIDANT STUDIES.

ORGANIZATION AND PERSONNEL: The organization of the Seattle Laboratory is shown in figure 5. All staff members who are Bureau of Commercial Fisheries employees whose technological program is supervised or coordinated from Seattle are shown in this figure. Thus, employees stationed at the University of California are included. The contract research programs are not shown in this figure. Such contracts are listed in figures 6 and 7.

The personnel are divided among four sections: basic research, applied research, special services unit, and administrative unit. The basic research section is divided into subsections according to the field of scientific specialization: organic chemistry, physical and analytical chemistry, nutrition, and biochemistry and bacteriology. The applied research section also is divided into subsections. These are as follows: standards and quality improvement, preservation and utilization, processing, and tuna programs. The Ketchikan Laboratory program is coordinated with that of the Seattle Laboratory through the Applied Research Section.

All staff members participate in performing services for the fishing industry. In addition, certain activities involving written material, including preparation of Commercial Fisheries Abstracts, are handled by the Special Services Unit.

FACILITIES: The Seattle Fishery Technological Laboratory operates its basic research and administrative functions in the main building of the Bureau of Commercial Fisheries Montlake Laboratory. Three chemical Laboratories and an instrument room are available for this work.

The applied research activities are carried out in an adjacent, smaller building known as the Pilot Plant. A large room is available for processing fish meal and canned fish, another for handling fresh fish for filleting, packaging, and similar activities. A cold-storage section provides rooms at three temperatures, and an icing room also is available. A general chemical laboratory, two offices, and an organoleptic examination room are located on the second floor of the pilot-plant building.

The Special Services Unit occupies rented space in the basement of the Montlake Apartment Building located adjacent to the Montlake Laboratory property.

CURRENT PROGRAM: The activities of the Laboratory are organized under the following general headings: (1) control of chemical alterations in fish and fishery products during storage and processing (includes all basic research projects), (2) preservation and processing of fish and shellfish, (3) development of voluntary standards of grade for fish and fishery products, (4) services of Special Services Unit, (5) direct assistance to industry, and (6) assistance to contract research.

Details concerning basic and applied research programs are shown in figures 6 and 7. Included in these figures are details concerning (1) programs carried out at the Seattle Laboratory, (2) programs carried out by Bureau employees of the Seattle Laboratory stationed at cooperating universities, and (3) programs carried out on contracts with the Bureau of Commercial Fisheries and coordinated by the Seattle staff.

PARTIAL SUBJECT BIBLIOGRAPHY OF CURRENTLY-IMPORTANT PAPERS OF SEATTLE LABORATORY

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