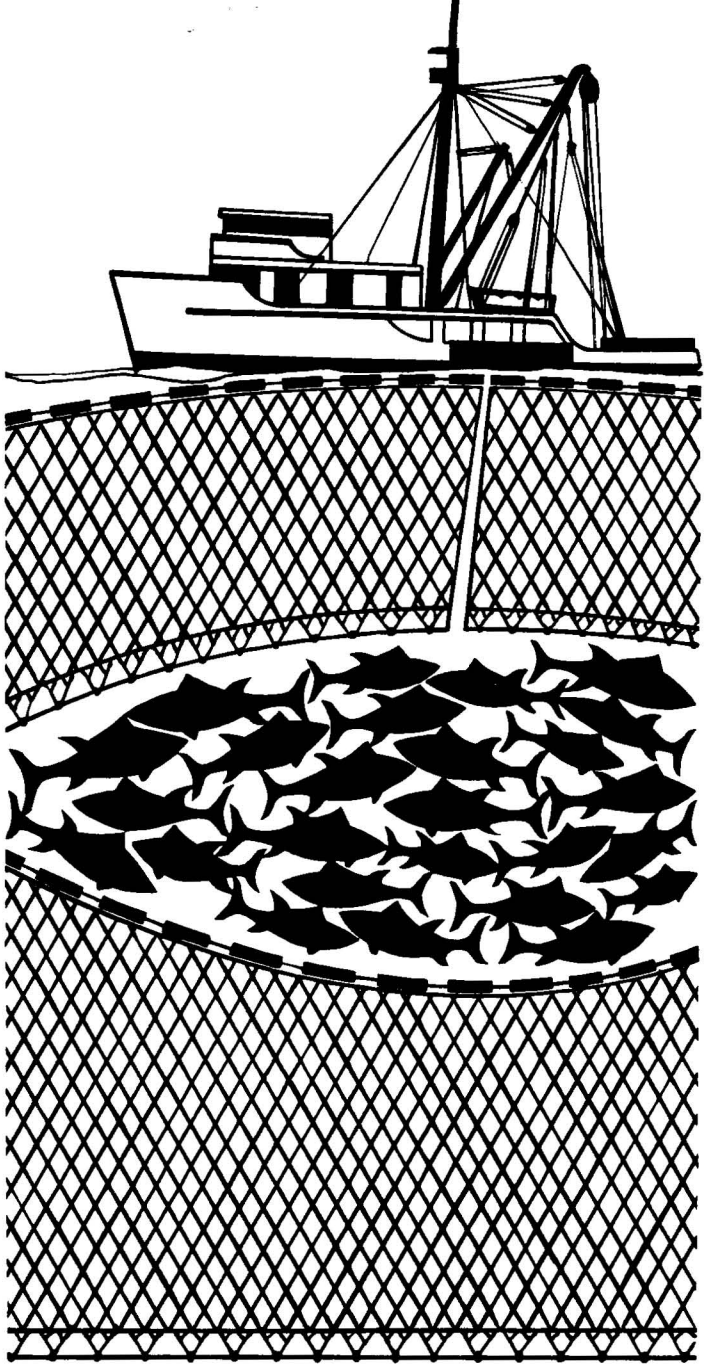

FISHERY INDUSTRIAL RESEARCH

VOLUME 5 NO. 5

United States
Department of the Interior
U.S. Fish and Wildlife Service
Bureau of Commercial Fisheries

Members of the fishing industry and allied interests who wish to receive FISHERY INDUSTRIAL RESEARCH should write to:

Bureau of Commercial Fisheries
Division of Publications
Bldg. 67, U.S. Naval Air Station
Seattle, Washington 98115

UNITED STATES DEPARTMENT OF THE INTERIOR
Walter J. Hickel, *Secretary*
Russell E. Train, *Under Secretary*
Leslie L. Glasgow, *Assistant Secretary*
for Fish and Wildlife, Parks, and Marine Resources
Charles H. Meacham, *Commissioner, U.S. FISH AND WILDLIFE SERVICE*
Dayton L. Alverson, Acting Director, BUREAU OF COMMERCIAL FISHERIES

FISHERY INDUSTRIAL RESEARCH
Volume 5 -- Number 5

Washington, D. C.
DECEMBER 1969

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States — now and in the future.

ALASKA PINK SHRIMP, *Pandalus borealis*: EFFECTS OF HEAT TREATMENT ON COLOR AND MACHINE PEELABILITY

by

Jeff Collins and Carolyn Kelley

ABSTRACT

For the improvement of the quality of canned pink shrimp, particularly its color, a process is needed so that fresh shrimp, rather than aged shrimp, can be peeled by machine.

In our work on this problem, the retention of color was improved during peeling if the shrimp were first given a heat pretreatment. During in-plant trials, 60- to 500-pound lots of shrimp were given various one-stage and two-stage heat treatments before they were machine peeled and routinely canned.

The precook method of preparing fresh shrimp for peeling by machine resulted in a canned product that had more color and had better texture and flavor than shrimp prepared for peeling by being held in ice or in refrigerated sea water. In some samples, gelling occurred in the liquor, and some cans had more sulfide blackening than usual.

CONTENTS

Authors: Jeff Collins and Carolyn Kelley, *Chemists*, Bureau of Commercial Fisheries Technological Laboratory, 622 Mission Street, Ketchikan, Alaska 99901.

Issued: November 1969.

Contents--Con.

INTRODUCTION

Alaska shrimp, Pandalidae species, are difficult to peel on machines when fresh (Collins, 1960a). Shrimp are commonly held in ice for at least 2 days so they can be peeled by machine. Research and commercial experience has indicated that refrigerated sea water and ice are about equivalent as holding methods to facilitate machine peeling. The use of either of these methods results in products of similar quality.

Holding shrimp increases cost and results in lower yield because of physical damage and leaching. Also, quality decreases because of leaching of soluble components and development of off flavors and odors. The longer that shrimp are held in refrigerated sea water or ice, the more leaching occurs throughout the processing operation (Collins, Seagran, and Iverson, 1960; Seagran, Collins, and Iverson, 1960; Collins, 1960b; Collins, 1961).

We have found that the carotenoid content of shrimp is a good index of quality, inasmuch as a product that has poor color ordinarily is poor in other quality factors. The desirable red-orange color occurs as a carotenoid-protein complex closely associated with oil and is located primarily at the interface between the meat and the shell. In raw shrimp, the color complex is quite soluble but is easily denatured to a less-soluble state by heat or by treatment with acid. As a result of holding the shrimp in ice or in refrigerated sea water, significant amounts of carotenoid complexes, flavor components, and proteins are leached from the shrimp during both storage and subsequent processing. These changes result in products that have less color and flavor and that have poorer texture than have those prepared from fresher shrimp. The products of best quality are obtained when shrimp are processed as soon as possible after they are captured.

This paper reports on the development of a process in which precooking is substituted for holding the shrimp in ice or in refrigerated sea water to precondition the shrimp for peeling on machines. In laboratory experiments, we obtained information on the effects of size of shrimp and heat treatments on the carotenoid content. In in-plant experiments, we gave small lots of shrimp various heat treatments prior to peeling them mechanically and canning them in the usual manner.

I. LABORATORY EXPERIMENTS ON VARIABLES POSSIBLY AFFECTING COLOR

Variables studied were (A) size of shrimp and distribution of color and (B) relation of temperature of heat treatment to carotenoid content of shrimp.

A. SIZE OF SHRIMP AND DISTRIBUTION OF COLOR

In the experiments reported in this section, we were concerned with (1) carotenoid analyses, (2) size of shrimp, and (3) distribution of color.

1. Carotenoid Analyses

a. Procedure.—For the estimation of color, we used an exhaustive chloroform-acetone extraction of blended samples, with the color being finally partitioned into petroleum ether and then evaluated spectrophotometrically (Ravesi).[1] We analyzed all samples at least in triplicate and used a Gilford modification of a Beckman DU spectrophotometer for the spectrophotometric work.[2] The carotenoid content, expressed as the carotenoid index (Rousseau, 1960), is a calculated value based on dry weight. For some samples, we could not obtain the dry weight, so the results are reported as total absorbancy per sample. The carotenoid index represents the a. (absorbancy) in 100 milliliters of PE (petroleum ether) of the carotenoids from 1 gram of dry sample. It is calculated as follows:

$$E\,\frac{1\%}{1\text{ cm.}} = \frac{\text{(a. at 468 m}\mu\text{ in 100 ml. PE) (100)}}{\text{(50-gram wet sample) (\% dry weight)}}$$

b. Results.—The relation between carotenoid index and visual color was as follows: Hand-picked, cocktail-style, frozen shrimp that were of superior color had a carotenoid index of 0.120 or higher; highly colored canned products had an index of 0.060 or higher; very poorly colored and "washed out" products had an index of 0.040 or lower. Observers familiar with the judgment of color could readily detect differences of 0.005 in carotenoid index in all ranges and could detect differences of 0.002 in the lower ranges.

2. Size of Shrimp

a. Procedure.—Raw pink shrimp were divided into various classes according to size and were analyzed for their content of carotenoids.

We determined the classes by weighing each shrimp individually. Those weighing 1.00-1.99 grams were placed in one group, those weighing 2.00-2.99 grams were placed in another, and so on. When all the shrimp were weighed, the groups containing too few shrimp for analysis were combined with the next preceding or succeeding group to form a group of adequate size.

In each size class, the samples were analyzed as whole shrimp, as headed shrimp, and as hand-peeled meat.

b. Results.—Table 1 shows that the larger shrimp had less color. For the peeled meats a commercially significant drop in color occurred, on a percentage basis, with increasing size of shrimp. Less than half of the color in the headed shrimp was retained by the meats.

Table 1.—Carotenoid content as affected by size and form of raw shrimp

Whole count	Carotenoid index		
	Whole shrimp	Headed shrimp	Peeled meats
No. shrimp per lb.	$E\,\frac{1\%}{1\text{ cm}}$	$E\,\frac{1\%}{1\text{ cm}}$	$E\,\frac{1\%}{1\text{ cm}}$
262	0.639	0.264	0.135
180	627	269	122
128	628	270	118
101	602	265	096
84	571	269	091
71	597	258	096

[1] Elinor Ravesi. 1965. Effect of processing and frozen storage on the carotenoid pigments of Alaska king crab. Unpublished manuscript, filed at Bureau of Commercial Fisheries Technological Laboratory, Ketchikan, Alaska.

[2] The use of trade names is merely to facilitate description, no endorsement of product is implied.

3. Distribution of Color

a. Procedure.—To determine how much of the color lost during peeling is due to residue tissue remaining with shells, we analyzed headed shrimp, peeled meats, and the shells separately.

We analyzed some of the headed shrimp, hand peeled the remaining headed shrimp, and analyzed the peeled meats for carotenoid content without washing them. Before analyzing the shells, we removed the tissue from them by washing them with a 5-percent NaCl solution. We made the usual carotenoid analyses and calculated the total absorbancy for the actual weight of the form being analyzed. The amount of carotenoid found in the meats and washed shells was subtracted from that found in the headed shrimp, and the difference was assumed to be the amount of carotenoid lost with the residue tissue.

b. Results.—The analyses on the headed shrimp and the two parts were:

Headed shrimp		15.94 a./100 ml.PE/337 g.	headed shrimp
Hand-peeled meats	6.79	a./100 ml.PE/257 g.	meats
Washed shells	3.13	a./100 ml.PE/ 80 g.	unwashed shells
	9.92		
Meats and shells		9.92 a./100 ml.PE/337 g.	meats and shells
Carotenoid lost from residue tissue		6.02 a./100 ml.PE/337 g.	headed shrimp

These data show that about one-half of the theoretically available carotenoid content is lost during peeling. Retention of color on the peeled meats, rather than loss of it through leaching or with the shell as unremoved tissue, is our primary aim in trying to improve the method of processing.

B. RELATION OF TEMPERATURE OF HEAT TREATMENT TO CAROTENOID CONTENT OF SHRIMP

In the study reported in this section, we were interested in (1) the effect of heat on the color itself and (2) the effect of heat on the retention of color in the shrimp.

1. Effect of Heat on Color

a. Procedure.—To determine if the carotenoid is itself affected by heat, we placed blended samples of raw meat in individual glass containers, which we heated in a water bath. The meat was heated to the desired internal temperature and was held at that temperature for 30 minutes. It then was immediately cooled by our placing the container in cold water. The carotenoid index was then determined.

b. Results.—Table 2 shows that heat had no measurable effect on the carotenoid content.

Table 2.—Carotenoid content as affected by the temperature of heating blended shrimp meats

Temperature	Carotenoid index
°F.	$E\,\frac{1\%}{1\ cm.}$
38	0.130
100	.129
115	.133
130	.135
145	.136
160	.134
175	.133
190	.130
210	.130

2. Effect of Heat on Color Retention

a. Procedure.—To determine if temperature would affect the amount of carotenoid retained when the shrimp are peeled, we cooked whole shrimp for 5 minutes at various temperatures, hand-peeled them, and analyzed the unwashed meats for their carotenoid content.

b. Results.—Carotenoid analyses (Table 3) show that more color was retained when the

Table 3.—Effect of the temperature of cooking whole shrimp on the color retention of hand-peeled meats

Temperature of cooking whole shrimp	Carotenoid index of hand-peeled meats
°F.	$E\,\frac{1\%}{1\ cm.}$
110	0.085
150	.100
180	.108
212	.137

shrimp were cooked at the higher temperatures. Although color itself was not affected by heat, its retention during peeling was increased when the whole shrimp were heated.

II. IN-PLANT EXPERIMENTS USING VARIOUS PRECOOKING CONDITIONS BEFORE MACHINE-PEELING AND CANNING

The preceding laboratory experiments showed that cooking before peeling does improve the retention of color. We next needed to see whether heat-treated fresh shrimp could be machine-peeled and whether the improved color observed after hand-peeling would be retained during machine-peeling.

We did the experiments in Part A (preliminary in-plant study) to determine peelability and color retention. We did those in Part B (establishing precook conditions) to learn the best conditions of time and temperature for precooking.

A. PRELIMINARY IN-PLANT STUDY

1. Procedure

The study was made in Wrangell, Alaska, in October 1965.

About 60 pounds of whole pink shrimp caught 3 to 5 hours before being processed was used for each lot. Although such a short time would be impractical on a commercial basis, we wanted to see if we could machine-peel shrimp so fresh that we could expect the ultimate possible quality. The shrimp were given various heat treatments before they were routinely machine peeled and canned. Precooking was done by dipping a wooden tray with a hardware-cloth bottom containing the shrimp into tanks of preheated fresh water. The shrimp were taken to the machine peelers and spread out on a conveyor belt leading to the peeler rolls. Table 4 gives the experimental conditions, the peeling properties of the shrimp, and their color. Regular-production shrimp, which had been held in ice for 2 days, were defined to have poor color and excellent peeling properties. These subjective ratings were used as a basis for comparative ratings of the experimental samples.

Color was rated subjectively at the inspection belt. Peeling efficiency, in turn, was rated subjectively at several stages in the process and was based on the completeness with which the shell was removed, the amount of residual shell, the amount of broken meats, and the amount of ragged meats. The yield of cans, which is the true measure of peeling efficiency at constant peeling rate, often did not agree with our subjective rating. Low yields of cans are obtained when small lots are run, because some shrimp are retained in the processing machinery. For these small lots, the subjective

Table 4.—Effect of precooking conditions on peeling properties and color of northern shrimp

Identification of sample and precooking conditions	Peeling properties	Color of peeled shrimp	Carotenoid index
			$E\ \frac{1\ \%}{1\ cm.}$
Shrimp processed after 2-day storage in ice:			
Control, no precook	Excellent	Poor	0.047
Shrimp processed 3 to 5 hours after capture:			
Heated in 110° F. water for 2 minutes	Fair	Fair	.050
Heated in 130° F. water for 2 minutes	Fair	Good	.054
Heated in 150° F. water for 2 minutes	Poor	Excellent	.058
Heated in 150° F. water for 30 seconds	Fair	Excellent	.069
Heated in 110° F. water for 2 minutes; then heated in 150° F. water for 15 seconds	Good	Good	.069
Shrimp processed 18 hours after capture:			
Heated in 110° F. water for 3 minutes	Excellent	Good	.051

rating therefore was more meaningful than the yield of cans as a measure of peeling efficiency.

2. Results

In principle, precooking at a higher temperature apparently is necessary for good color, but it results in broken shrimp. Lower temperature of cooking enables fresh shrimp to be peeled but has little effect on color. Peeling properties were not satisfactory in any of the single-stage precooks except at low temperature, where the color was not satisfactory. The two-stage precook, however, resulted in a product that had both good color and good peeling characteristics and was therefore preferred to the single-stage precook. Holding shrimp overnight improved their peeling properties.

B. ESTABLISHING PRECOOK CONDITIONS

Because the two-stage precook resulted in a product that had both good color and good peeling properties, we decided to give this method further attention. In the following sections, we report on our in-plant peeling study, can-cutting data, and organoleptic evaluation of the canned shrimp.

1. In-plant Peeling Study

a. Procedure.—This experiment was done in Wrangell, Alaska, in February 1966.

Often, the earliest that shrimp can be processed is 18 to 24 hours after they are captured. Accordingly, we used shrimp held overnight in the regular shrimp boxes at ambient temperatures of 30° to 35° F.

Shrimp in 100-pound lots were precooked in five different ways before being peeled and routinely canned. Two larger lots of 500 pounds each were processed to enable us to compare yields between shrimp that had been precooked with those held in ice for 2 days. Table 5 shows the experimental conditions and data on yield of cans, on color, and on peelability.

b. Results. — The lot processed at 180° F. contained an excessive amount of ragged meats. No further improvement in color was noted visually in the lots processed above 165° F. When reverse sequences were compared (150° F., 15 seconds; 110° F., 3 minutes vs. 110° F., 3 minutes; 150° F., 15 seconds), the data showed that the higher temperature should come first. Otherwise, yields were low, and meats were broken and ragged. Other precooked samples had nearly equal yields. From the 500-pound lots, the apparent yield of cans for the shrimp held on ice was greater than for the precooked shrimp.

2. Can-Cutting Data

a. Procedure. — Samples were opened after 1 year and after 2 years of storage. Drained weights and pH were determined, and samples were checked for iron sulfide blackening. Carotenoid index was determined only after 2 years of storage.

Table 5.—Can yield and subjective rating on color and peeling properties of precooked shrimp

Identification of lots and precooking conditions	Yield of cans	Color of peeled shrimp	Peeling properties
	Number		
100-pound lots of shrimp:			
Heated in 110° F. water for 3 min.	52	Fair	Excellent
Heated in 110° F. water for 3 min.; then heated in 150° F. water for 15 sec.	43	Good	Poor
Heated in 150° F. water for 15 sec.; then heated in 110° F. water for 3 min.	52	Fair	Fair
Heated in 165° F. water for 15 sec.; then heated in 110° F. water for 3 min.	51	Good	Good
Heated in 180° F. water for 15 sec.; then heated in 110° F. water for 3 min.	54	Good	Poor
500-pound lots of shrimp:			
Heated in 165° F. water for 15 sec.; then heated in 110° F. water for 3 min.	274	Good	Good
Held 2 days on ice	312	Poor	Excellent

Regular drained weights were obtained as follows: A No. 8 mesh sieve was tared, placed in an inclining position on a tray, and a can of shrimp was spread evenly over the screen. After the shrimp had drained for 2 minutes, the bottom of the screen was blotted with damp sponges to remove excess liquor, and the sieve and shrimp were weighed.

The liquor was poured from each can into a beaker, and the pH of the liquor was measured with a pH meter.

The cans were visually inspected for iron sulfide blackening as the shrimp were dumped onto the sieve.

The method of carotenoid analysis was previously described in Part I A 1.

b. Results. — Table 6 gives the data for the canned shrimp after they had been stored for 1 and 2 years.

In all analyses but one, pH values were lower in the samples that were stored for 2 years. Values of pH were about 0.2 units lower than normal.

The data on blackening were erratic and difficult to interpret, but they did indicate a tendency for precooked shrimp to develop iron sulfide discoloration, particularly after they had been stored for 2 years.

Gelling of the liquor in the can caused high drained weights in some precooked samples when the conventional 2-minute drain on a standard screen was used. To get comparable weights, we obtained a rinsed, drained weight by dipping the screen and its contents briefly in cold, fresh water after the regular drained weight was obtained. The much lower regular drained-weight values for the 2-year samples probably indicates a breaking of the gel. In the rinsed, drained weights, however, the values for the 1-year and 2-year samples were about the same.

3. Organoleptic Evaluation of Canned Shrimp

a. Procedure. — The canned shrimp after 1 year of storage were evaluated organoleptically by a six-member panel on a 9-point grading system (Table 7).

b. Results. — Shrimp held on ice had scores similar to those for the single-cook sample. All two-stage precook samples were rated higher than the iced or single-cook samples. Minor variations in scores occurred within the various two-stage samples but were not significant enough to warrant the choice of one condition over another.

Table 6.—Can cutting data after 1 and 2 years of storage

Precooking or holding conditions	pH		Blackening		Drained weights				Carotenoid index
					Regular		Rinsed		
	1 yr.	2 yr.	1 yr.	2 yr.	1 yr.	2 yr.	1 yr.	2 yr.	2 yr.
			[1]	[1]	*Oz.*	*Oz.*	*Oz.*	*Oz.*	$E\ \frac{1\%}{1\ cm.}$
100-pound lots of shrimp:									
Heated in 110° F. water for 3 min.	6.54	6.51	0.7	1.1	5.51	4.69	4.02	4.16	0.044
Heated in 110° F. water for 3 min; then heated in 150° F. water for 15 sec.	6.59	6.62	1.2	2.2	6.12	5.21	4.35	4.57	.056
Heated in 150° F. water for 15 sec.; then heated in 110° F. water for 3 min.	6.58	6.42	.7	.6	5.85	4.96	4.43	4.50	.051
Heated in 165° F. water for 15 sec.; then heated in 110° F. water for 3 min.	6.58	6.48	.5	1.2	5.91	5.12	4.33	4.46	.050
Heated in 180° F. water for 15 sec.; then heated in 110° F. water for 3 min.	6.56	6.44	.3	.4	5.75	4.96	4.28	4.53	.052
500-pound lots of shrimp:									
Heated in 165° F. water for 15 sec.; then heated in 110° F. water for 3 min.	6.54	6.50	.0	.7	5.93	5.13	4.55	4.54	.053
Heated in 165° F. water for 15 sec.; then heated in 110° F. water for 2 min.[2]	7.02	6.92	.5	2.0	5.99	5.16	4.69	4.67	.059
Shrimp held 2 days on ice	6.65	6.47	.0	.6	4.75	4.39	4.34	4.10	.041

[1] Scale used: 3 is objectionable, 2 is moderate, 1 is trace, 0 is none.
[2] The shrimp were from the same run as that immediately above, but they were canned without the normal addition of citric acid.
Note: Each datum is the average from six cans.

Table 7.—Organoleptic data on canned shrimp stored for 1 year

Precooking or holding conditions	Organoleptic evaluation of:				
	Appearance	Flavor	Odor	Texture	Overall
	9-point hedonic scale				
100-pound lots of shrimp:					
Heated in 110° F. water for 3 min.	6.3	6.9	7.8	7.7	6.9
Heated in 110° F. water for 3 min.; then heated in 150° F. water for 15 sec.	7.7	7.0	7.5	7.3	7.0
Heated in 150° F. water for 15 sec.; then heated in 110° F. water for 3 min.	7.3	8.0	7.9	8.0	7.9
Heated in 165° F. water for 15 sec.; then heated in 110° F. water for 3 min.	6.8	7.9	7.2	7.8	7.6
Heated in 180° F. water for 15 sec.; then heated in 110° F. water for 3 min.	8.0	8.2	7.8	8.2	8.0
500-pound lots of shrimp:					
Heated in 165° F. water for 15 sec.; then heated in 110° F. water for 3 min.	7.0	7.5	7.7	7.5	7.7
Heated in 165° F. water for 15 sec.; then heated in 110° F. water for 3 min.[1]	7.5	8.5	7.0	8.1	8.0
Held 2 days on ice	6.2	6.9	6.6	7.5	6.9

[1] The shrimp were from the same run as that immediately above, but they were canned without the normal addition of citric acid.

Note: The hedonic scale used was as follows:

9. Like extremely
8. Like very much
7. Like moderately
6. Like slightly
5. Neither like nor dislike
4. Dislike slightly
3. Dislike moderately
2. Dislike very much
1. Dislike extremely

SUMMARY AND CONCLUSIONS

Our purpose in this work was to find a way of improving the quality of machine-peeled Alaska pink shrimp, particularly its color, by developing a method for processing fresh shrimp. To do this, we had to develop a method of pretreating shrimp for machine-peeling that would substitute for holding shrimp on ice for 2 or more days before they are machine-peeled.

Several laboratory experiments involving a study of the carotenoid content of the shrimp showed that the color of raw whole shrimp, of headed shrimp, and of peeled meats tended to vary inversely with the size of the shrimp. In hand-peeling of raw shrimp, about one-half of the color was lost in the tissue that remained with the shell. Although the carotenoid content of samples of blended shrimp meat was not affected by heating, more color was retained in the peeled meats if the whole shrimp were precooked.

In two series of experiments carried out in a commercial canning plant, small batches of shrimp were precooked under various experimental conditions. They were then peeled by machine and canned by the normal processing method. We concluded the following from these in-plant experiments and from our analyses of the resulting canned products:

1. Lower yields resulted if the combined effects of time and temperature of precooking were excessive.
2. A two-stage precook resulted in good color and good peeling properties; it was preferred over a single precook.
3. In the two-stage precook method, the higher temperature must precede the lower temperature in order to reduce breakage of shrimp meats on the machine peeler.
4. Some gelling of the liquor in the canned product resulted from the use of fresh shrimp with the precook method.
5. Can-cutting data obtained after the cans had been stored 1 and 2 years suggested that precooked shrimp may show a greater amount of iron sulfide blackening than that produced by the normal process.
6. The precook method of preparing fresh

shrimp for peeling by machine resulted in a canned product that had more color and better texture and flavor than shrimp prepared for peeling by being held in ice.

ACKNOWLEDGMENT

Ben Engdal and Harry Sundberg, owners of the Harbor Seafoods Company at Wrangell, Alaska, made their facilities available for these experiments.

LITERATURE CITED

Collins, Jeff.

1960a. Processing and quality studies of shrimp held in refrigerated sea water and ice. Part 1 - Preliminary observations on machine-peeling characteristics and product quality. Commer. Fish. Rev. 22(3): 1-5.

1960b. Processing and quality studies of shrimp held in refrigerated sea water and ice. Part 4 - Interchange of the components in the shrimp-refrigerated-sea-water system. Commer. Fish. Rev. 22(7): 9-14.

1961. Processing and quality studies of shrimp held in refrigerated sea water and ice. Part 5 - Interchange of components in a shrimp-ice system. Commer. Fish. Rev. 23(7): 1-3.

Collins, Jeff, Harry Seagran, and John Iverson.

1960. Processing and quality studies of shrimp held in refrigerated sea water and ice. Part 2 - Comparison of objective methods for quality evaluation of raw shrimp. Commer. Fish. Rev. 22(4): 1-5.

Rousseau, J. E., Jr.

1960. Shrimp-waste meal: Effect of storage variables on pigment content. Commer. Fish. Rev. 22(4): 6-10.

Seagran, Harry, Jeff Collins, and John Iverson.

1960. Processing and quality studies of shrimp held in refrigerated sea water and ice. Part 3 - Holding variables and keeping quality of the raw whole shrimp. Commer. Fish. Rev. 22(5): 1-5.

MS. #1950

DEPTH-TIME SEQUENTIAL ANALYSES OF THE OPERATION OF TWO CALIFORNIA TUNA PURSE SEINES

by

Roger E. Green

ABSTRACT

Little information is available on the depth of a purse seine at different times during setting, though the timing of setting and pursing is important in the development of successful fishing tactics. The depth-time relation during setting was studied for two tuna purse seines of different size (7 strips deep, 470 fathoms long; 8 strips deep, 520 fathoms long) to which depth-time recorders were attached. From data gathered during 32 sets, composite sequence analyses and underwater net profiles were prepared for four basic stages (halfway through setting, end of setting, start of pursing, and halfway through pursing) of the setting and pursing operations.

CONTENTS

INTRODUCTION

Purse-seine fishermen often see tuna disappear from apparently well-set nets without understanding why. Long after purse seines became the major U.S. gear for tuna fishing, the proportion of successful sets averaged about 50 percent (Schaefer, 1962). Recent improvements in fishing tactics have raised this figure to a little over 60 percent (Craig Orange,[1] personal communication), which obviously is still too low.

[1] Senior Scientist, Inter-American Tropical Tuna Commission, Fishery-Oceanography Center, La Jolla, California 92037.

Author: Roger E. Green, *Fishery Biologist*, Bureau of Commercial Fisheries Fishery-Oceanography Center, P.O. Box 271, La Jolla, California 92037.
Published December 1969.
This article will appear in FISHERY INDUSTRIAL RESEARCH vol. 5, no. 5, a publication of the U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries.

A factor contributing to this inefficiency may well be the lack of information on the underwater behavior of purse seines. How many fishermen can answer such critical questions as: How deep is the first quarter of the net when the school is half encircled? How deep is the third quarter of the net when the skiff is reached? How much time is required for 70 percent of the leadline to reach a thermocline 60 feet below the surface? How is the depth of the net affected during pursing? How wide is the gap between the ends of the net at 20 fathoms depth when the net is half pursed? No doubt these questions bring many more to mind. Answers have been lacking because, heretofore, no one has placed suitable instruments along the bottom of the net to determine exactly what the leadline is doing along all its length and at all times.

Given complete information on sinking rates of the net, fishermen can time the setting operations on a rational basis. Guesswork and trial and error could be removed from such problems as how much to lead a traveling school of tuna to ensure that the fish will encounter a suitably deep wall of netting, how to take advantage of a favorable thermocline (Green, 1967), how to reach an effective fishing depth before beginning to purse, and how to improve the design of the purse seine (Ben Yami and Green, 1968).

The purpose of this paper is to help fill this gap in information by presenting analyses in time and space of the setting of two California tuna purse seines: one 470 fathoms long constructed of 7 body strips[2] and the other 570 fathoms long constructed of 8 body strips. I chose these lengths to offer a comparison between sinking characteristics of nets of different size. Both nets are near the mode of the size range used by the California fleet for tropical tunas.

I. ANALYSES OF SETTING OF 7-STRIP, 470-FATHOM PURSE SEINE

This net is similar to the purse seine described by McNeely (1961) except that the first 350-fathom section of leadline is $^{7}/_{16}$-inch chain and the rest is $^{1}/_{2}$-inch chain.

Data obtained in the use of this net were collected by Gary Sharp[3] on a regular fishing trip of the tuna seiner *Mary Barbara* during June and July 1967. He used the BKG (bathykymograph), an instrument developed by the Bureau of Commercial Fisheries for this purpose (Hester, Aasted, and Gilkey, 1963). The BKG, while submerged, produces a one-line graph of depth against time (Figure 1). This graph presents useful information but is limited to showing what happens at one point on the net. A series of such graphs is needed to show the profile of an entire net underwater, at different times during the set. The BKG's

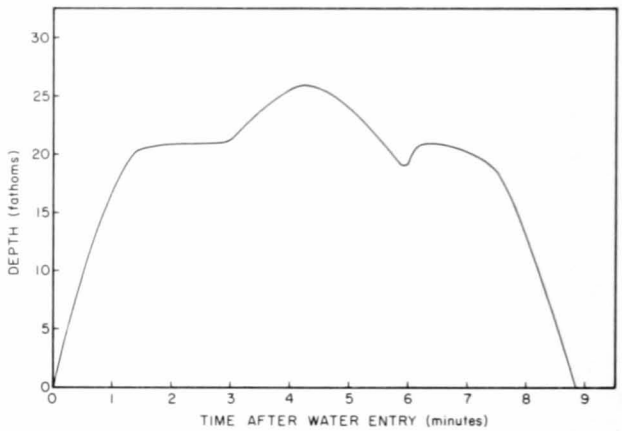

Figure 1.—Bathykymograph (BKG) trace transcribed as it appeared on the pressure sensitive paper of the BKG (coordinates added and vertical scale exaggerated).

were used during 22 of the 34 sets during the trip.

The time that fish may escape a net, once setting has started, is marked by three natural divisions of time: (1) the time the net is being set (Figures 2, 3, and 4), (2) the time

[2] Typical California tuna purse seines are constructed of horizontally laced body strips, each 100 meshes deep with 4¼-inch stretched mesh (McNeely, 1961). I use the number of body strips as an indicator of depth of the net rather than the depth measured in fathoms. The depth measured in fathoms depends on so many variables that it is a confusing and unreliable index. In addition to body strips, each net has a 50-mesh strip along the bottom and a narrower selvage strip at the top and bottom. I do not include these strips in the counts of the body strips.

[3] Biological Technician, Bureau of Commercial Fisheries Fishery-Oceanography Center, La Jolla, California 92037.

Figure 2.—"Let go!" At this command, marking the start of a set, a crewman strikes the pelican hook release, dropping the seine skiff into the water. (Photo taken aboard *Jeanne Lynn*.)

between the end of the set (when the skiff is reached, Figure 5) and the beginning of pursing, and (3) the time during pursing (Figures 6 and 7).

On the basis of these natural divisions, I show the underwater profiles of the net at four stages during setting: (A) halfway through setting (*half net*), (B) at the end of setting (*end net*), (C) at the start of pursing, and (D) halfway through pursing.

Before each of 22 sets, BKG's (usually three) were lashed to the leadline -- one at midnet, one in the front portion of the net, and one in the back portion. After the net was pursed and the purse rings were on deck, the BKG's were retrieved, and the data graphs were removed. After the net was stacked, the BKG's were repositioned on the leadline for the next set (Figure 8). The data were recorded according to purse-ring numbers, counting from the skiff, and later converted to fathoms of net length (the 69 purse rings are spaced at uniform intervals along the leadline).

Each setting operation was timed by stopwatches; times were recorded from (1) *let go* (the moment the skiff is dropped with one end of the net) to (2) *half net*, (3) *end net*, (4) start of pursing, and (5) *rings up* (end of pursing).

Because the recording mechanism of the BKG is started by the pressure of water when the instrument is immersed, the first step in interpreting the data was to determine how long each BKG had been in the water at each of the four times examined. Assuming constant vessel and pursing speeds, I derived equations for this purpose.

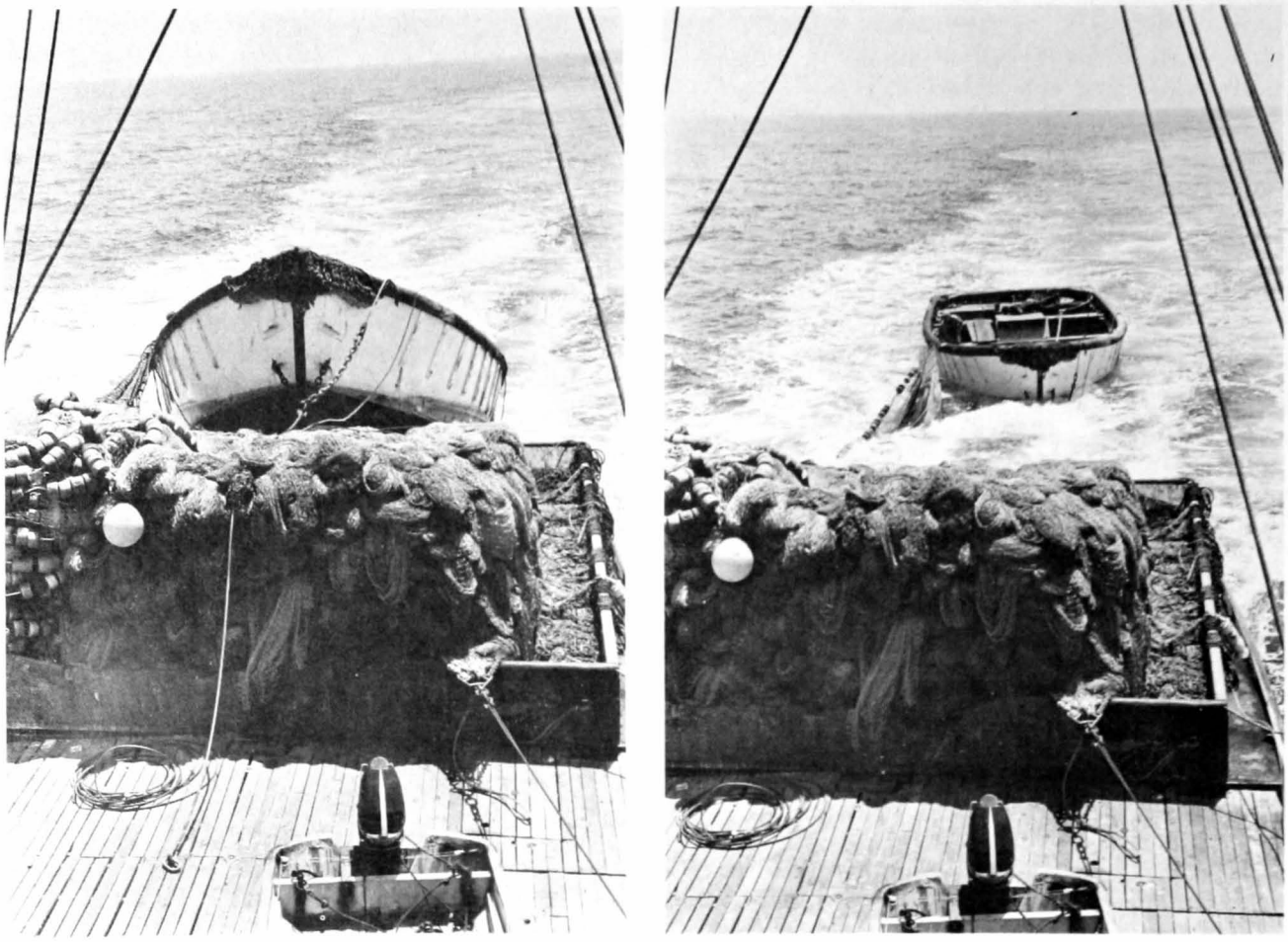

Figure 3.—A split second after *let go*, the 10-ton seine skiff slides backward off the net pile with one end of the net attached. (Photo taken aboard *Antoinette B.*)

A. HALFWAY THROUGH SETTING

The time that each BKG had been in the water at *half net* is given by the equation:

$$t_w = t_h \left(1 - \frac{a}{h}\right)$$

where t_w = time from water entry of BKG to *half net*

t_h = time from *let go* to *half net*

a = distance, in fathoms, of BKG from skiff

and h = one-half the length of the purse seine, in fathoms.

Referring to the original BKG graphs at the times thus determined gave the depths at the time *half net* for the points along the net where BKG's were attached.

The depths at *half net* are plotted against distance from one end of the net in Figure 9A. The line drawn through the data points represents my concept of the position of the leadline at a normal maximum sinking rate.

The points are somewhat scattered because the data were taken from different sets under different conditions. Some of the conditions that may affect sinking rate to this point in the set are winds, currents, and tension applied by either the power skiff or the pursing winch. In general, a net that lies rather loosely in the water sinks faster than one that is tightly stretched (Ben Yami and Green, 1968).

At the time *half net,* the maximum depth of all data points was only 12.5 fathoms, and only about one-fourth of the net approached this depth. For the 34 sets of this trip the

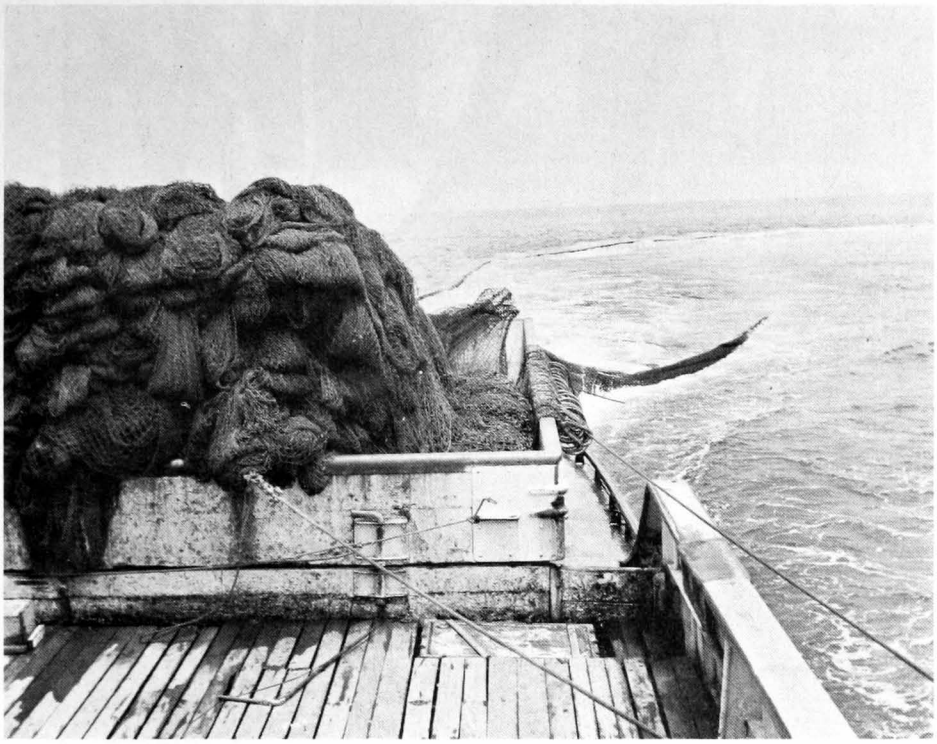

Figure 4.—"Half net!" This signal is given as the *half-net* marker (not shown) goes overboard to inform the helmsman of the set's progress. (Photo taken aboard *Jeanne Lynn.)*

Figure 5.—"End net". The skiff is reached and the heaving line is thrown. The skiff end of net must now be transferred to the vessel before pursing begins. (Photo taken aboard *Antoinette B.*)

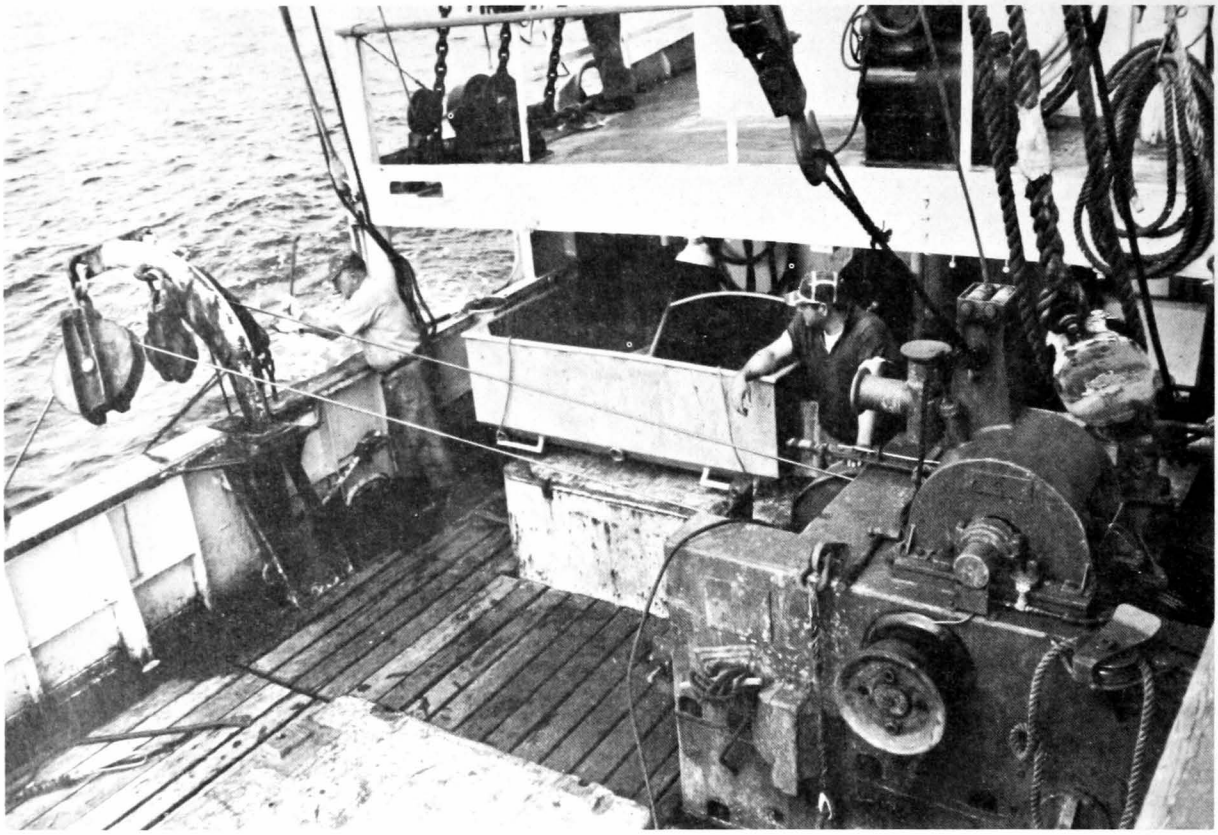

Figure 6.—Pursing in progress. Both ends of the pursing cable are hauled simultaneously. (Photo taken aboard *Jeanne Lynn*.)

mean time required to reach half net was 1 minute 41 seconds.

B. END OF SETTING

The time that each BKG had been in the water at *end net* is given by the equation:

$$t_w = t_s \left(1 - \frac{a}{s}\right)$$

where t_w = time from water entry of BKG to *end net*

t_s = time from *let go* to *end net*

a = distance, in fathoms, of BKG from skiff

and s = length of the purse seine, in fathoms.

Figure 7.—Pursing completed. Purse rings, in bight of pursing cable, are hauled to the surface. Subsequent operations, not treated in this paper, are net stacking, and, if fish are caught, sacking up and brailing. (Photo taken aboard *Antoinette B.*)

Figure 8.—Between sets, Thomas Hunter, *Biological Aid,* attaches bathykymographs (BKG's) to leadline. (Photo taken aboard *Antoinette B.*)

At *end net* (the time when the skiff was reached)--an average of 3 minutes 29 seconds since *let go*--most of the net was still not at fishing depth (Figure 9B). The maximum observed depth of the leadline was 24.5 fathoms at a distance of about 87 fathoms from the skiff end, or at a point slightly short of quarter net. Depth decreased steadily in both directions from this point. This maximum appeared to result from a loose set because the data point exceeds clusters of others to either side of it by 5 to 8 fathoms.

C. START OF PURSING

The time that each BKG had been in the water at start of pursing is given by the equation:

$$t_w = t_p - \frac{a}{s} t_s$$

where t_w = time from water entry of BKG to start of pursing

t_p = time from *let go* to start of pursing

t_s = time from *let go* to *end net*

a = distance, in fathoms, of BKG from skiff

and s = length of the purse seine, in fathoms.

At the start of pursing--an average of 5 minutes 15 seconds since *let go*--the net approached its maximum fishing depth along its entire length (Figure 9C). The maximum depth attained at start of pursing was 28.0

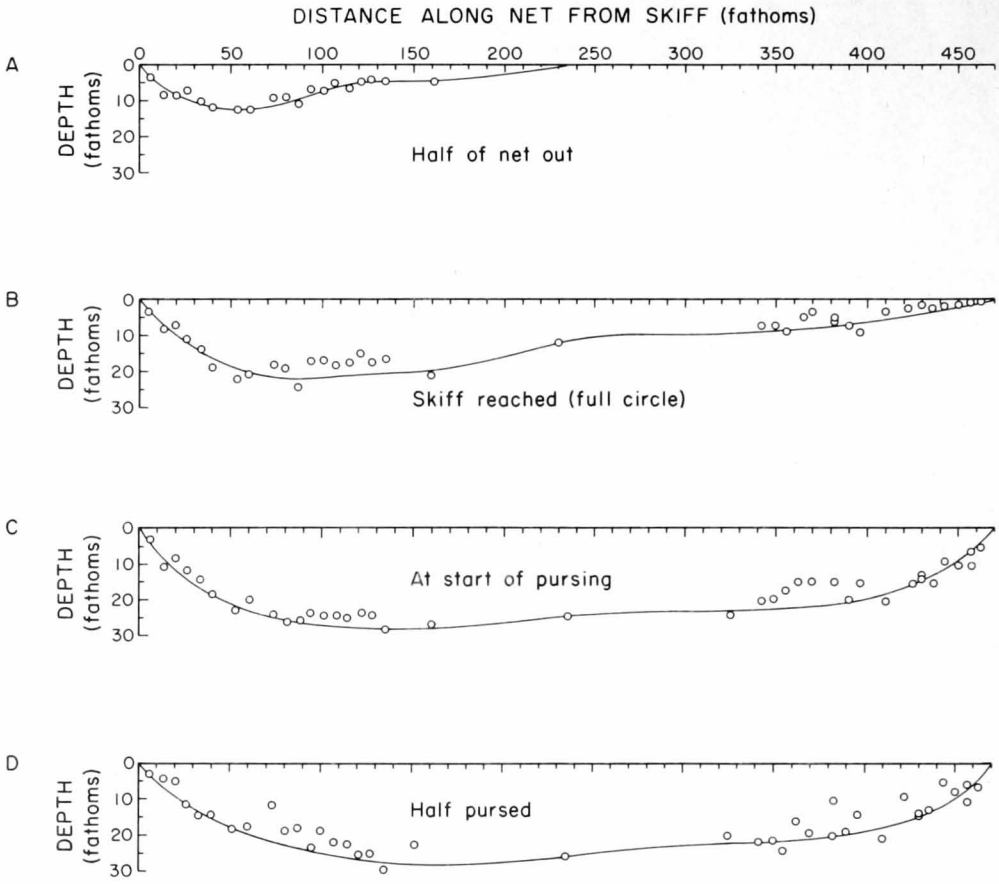

Figure 9.—Net profiles--470-fathom, 7-strip tuna purse seine. (Data points indicate individual observations except for midnet, which indicates the mean of nine observations.)

fathoms, 134 fathoms from the skiff end of the net. Because its stretched depth is 46.5 fathoms, the net would sink deeper if the pursing were postponed. Further sinking would be slow, however, and deform the shape of the mesh and reduce the circumference of the circular set (Ben Yami and Green, 1968). Neither this net nor the 520-fathom net showed any relation between the amount of towline used after *end net* and maximum depth.

D. HALFWAY THROUGH PURSING

The time that each BKG had been in the water at *half pursed* is given by the equation:

$$t_w = t_p - \frac{a}{s} t_s + \tfrac{1}{2} (t_e - t_p)$$

where t_w = time from water entry of BKG to *half pursed*

t_e = time from *let go* to *rings up* (end of pursing)

t_p = time from *let go* to start of pursing

t_s = time from *let go* to *end net*

a = distance, in fathoms, of BKG

and s = length of the purse seine, in fathoms.

Between the start of pursing and *half pursed*, the net reached a depth of 30.2 fathoms and started to rise. The maximum depth at *half pursed* was 29.0 fathoms (Figure 9D). Two more causes of variations of depth of net are introduced during pursing. The first is the sideways towing of the purse seiner by the skiff, which is done to keep the purse seiner from drifting back into the net toward the center of the set. This towing also imparts

a variable tightening strain on the entire net and prevents it from sinking farther. The second cause of variation in the depth of the net is the temporary hanging-up of purse rings, in bunches, on portions of the upward-hauled part of the pursing cable. When the friction-breaking strain is reached, the rings slide down the cable to a more level portion. Variations from this source were seen on nearly every BKG trace and are evident in Figure 1.

II. ANALYSES OF SETTING OF 8-STRIP, 520-FATHOM PURSE SEINE

The construction of this net is similar to that of the purse seine described by McNeely (1961) except for the larger size of net.

The data were collected by Thomas Hunter[4] on the tuna seiner *Antoinette B* in the same way as they were collected for the 470-fathom net. The data, consisting of 20 BKG observations from 10 sets, were also treated as in the preceding section.

[4] Biological Aid, Bureau of Commercial Fisheries Fishery-Oceanography Center, La Jolla, California 92037.

A. HALFWAY THROUGH SETTING

The mean time from *let go* to *half net* was 1 minute 42 seconds. The maximum depth reached at this time was 10.5 fathoms (Figure 10A)--2.0 fathoms less than that reached by the 470-fathom, 7-strip net. The time was too early in the set for the extra strip in this

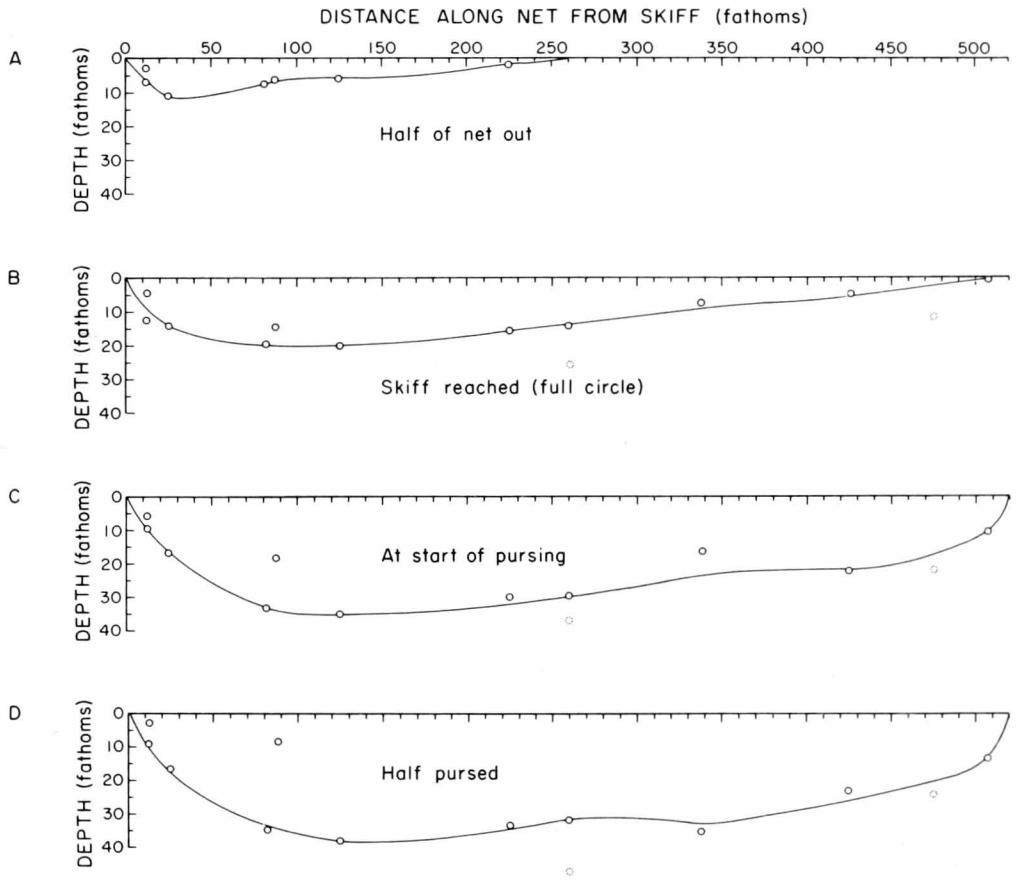

Figure 10.—Net profiles--520-fathom, 8-strip tuna purse seine. (See footnote 5 for explanation of the broken circles in panels B, C, and D.) (Data points indicate individual observations except for midnet, which indicates the mean of eight observations.)

net to give a depth advantage. Both nets, at this time, would be characterized by freely falling leadlines dragging down loose webbing. The extra webbing of the 8-strip net might cause increased drag and consequently slow the sinking velocity initially.

B. END OF SETTING

The mean time from *let go* to *end net* was 4 minutes 9 seconds. The normal[5] maximum depth was 20.0 fathoms (Figure 10B)--4.5 fathoms less than that reached by the 470-fathom, 7-strip net. Thus sinking velocity at this time still was slower than that of the smaller net.

C. START OF PURSING

The mean time from *let go* to start of pursing was 9 minutes 35 seconds. The normal maximum depth reached at this time was 35.0 fathoms (Figure 10C) -- nearly 9 fathoms deeper than that reached by the other net. The extra depth may be accounted for both by the effect of the added strip of webbing (5.9 fathoms stretched measure) and by the extra time (4 minutes 20 seconds) to reach this point. Figure 11 shows the average time for the setting for both of the vessels.

D. HALFWAY THROUGH PURSING

The mean time from *let go* to *half pursed* was 18 minutes 20 seconds. The normal maximum depth was 38.5 fathoms (Figure 10D) --9.5 fathoms deeper than that reached by the other net. Again, the extra webbing and extra time can account for the increase in depth. As with the other net, maximum depth (39.0 fathoms) was reached between start of pursing and *half pursed.*

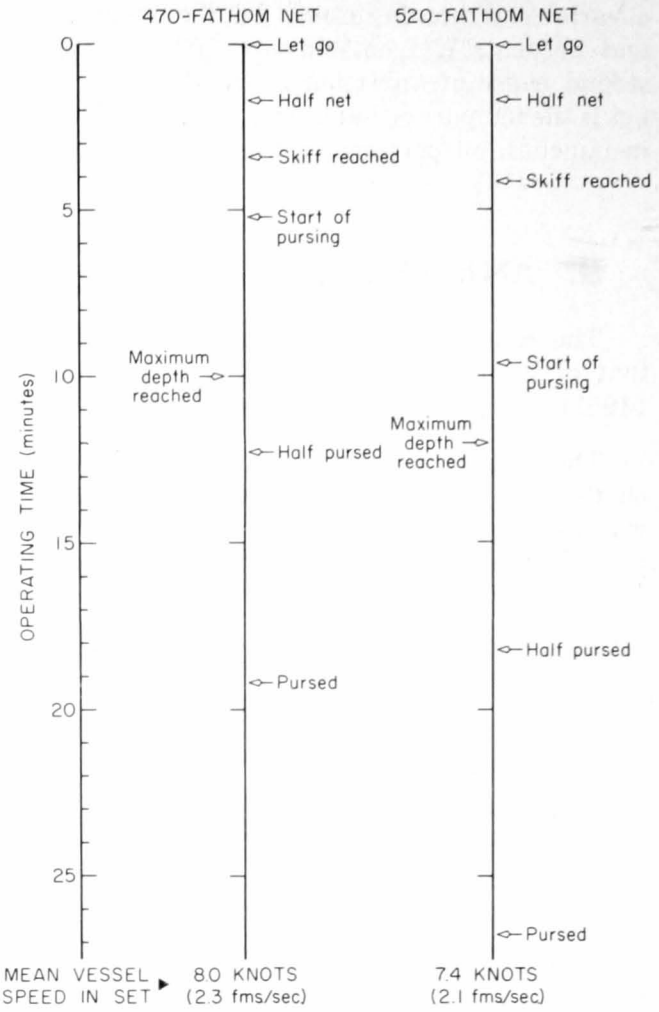

Figure 11.—Time sequence analysis of operations of vessels carrying the two nets. (Times are medians.)

SUMMARY

Two tuna purse seines of different sizes (7 strips deep, 470 fathoms long and 8 strips deep, 520 fathoms long) were equipped with depth-time recorders during fishing. Data from points along the leadline were obtained by means of bathykymographs for 32 sets to determine the depth of purse seines at four selected times: (1) halfway through setting, (2) end of setting, (3) start of pursing, and (4) halfway through pursing.

During a set--that is, at half net and end net--the fishing depths of both nets were

[5] The two aberrant points, encircled by dotted lines, at midnet and at 425 fathoms (Figure 10B, C, and D) resulted from one set made under unusual conditions. During this set, some time after midnet, a large pile of webbing, somewhat less than a quarter of the net, became tangled and slid off the net platform prematurely. Once overboard and sinking, the tangle cleared itself. The looseness in the net resulting from this accident produced the greatest depth of all the depths observed with either net. The aberrant points were not used in the construction of the net profiles.

shallow; they did not exceed 12.5 fathoms at *half net* and 24.5 fathoms at *end net*, and they fished much shallower along most of their lengths. Paradoxically, the extra strip of webbing added to the designed depth of the larger net reduced sinking speed during this time.

At the start of pursing the smaller net fished 28.0 fathoms; the larger, 35.0 fathoms. The difference in fishing depth is too large to be attributed entirely to the extra webbing in the depth of the larger net and may have resulted partially from the consistently slower pacing of the operations of the vessel fishing it. At *half pursed* the smaller net fished 29.0 fathoms; the larger, 38.5 fathoms.

The maximum depths of both nets were reached during the first half of pursing -- 30.2 fathoms for the smaller net and 39.0 fathoms for the larger one (excluding one set in which the accidental fall of a pile of loose webbing in the water caused the net to reach abnormally great depth).

CONCLUSIONS

1. Very little fishing depth was obtained from either net during the time they were being paid out (from *let go* to *end net*).

2. The depth advantage from an extra strip of webbing in the net is not achieved until after the skiff is reached.

3. Maximum depth was reached by both nets during the first half of the pursing operation.

4. Extra depth may be obtained by postponing or slowing the pursing operation.

ACKNOWLEDGMENTS

The owners, skippers, and crews of *Mary Barbara* and *Antoinette B* generously provided ship time, space, personal cooperation, and hospitality to the Bureau of Commercial Fisheries team gathering the data.

LITERATURE CITED

Ben Yami, M'nakhem, and Roger E. Green.
1968. Designing an improved California tuna purse seine. U.S. Fish Wildl. Serv., Fish. Ind. Res. 4: 183-207.

Green, Roger E.
1967. Relationship of the thermocline to success of purse seining for tuna. Trans. Amer. Fish. Soc. 96: 126-130.

Hester, Frank J., Donald C. Aasted, and Robert W. Gilkey.
1963. The bathykymograph, a depth-time recorder. U.S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 441, iii + 5 pp.

McNeely, Richard L.
1961. Purse seine revolution in tuna fishing. Pac. Fish. 59(7): 27-58.

Schaefer, Milner B.
1962. Report on the investigations of the Inter-American Tropical Tuna Commission for the year 1961. Inter-Amer. Trop. Tuna Comm. Annu. Rep. 1961, Append. A, pp. 44-103 (in Engl.) and pp. 104-171 (in Span.).

MS. #1971

RECOMMENDATIONS FOR IMPROVING THE QUALITY OF VESSEL-CAUGHT GROUNDFISH

by

J. Perry Lane

ABSTRACT

Because fish start to lose their quality as soon as they are taken from the sea and because the basic causes of the loss in quality are not readily observable to the eye, fishermen need guidelines for slowing the rate at which the quality of the fish is lost.

Recommended here are suggestions that will enable fishermen to slow the rate of quality loss. These recommendations provide guidelines that are designed (1) to reduce the initial numbers of bacteria on newly caught fish, (2) to prevent the fish from being crushed and otherwise physically damaged, (3) to protect the fish from being contaminated by bacteria from such sources as pughs, hand contact, and viscera, (4) to retard the activity of bacteria and enzymes by rapid and sustained chilling of the fish, and (5) to protect the fish from contamination from such sources as fuel oil and sour bilges.

Putting these recommendations into use will increase the demand for groundfish, will make groundfishing more profitable, and will help the U.S. groundfishing industry to meet foreign competition.

CONTENTS

Author: J. Perry Lane, *Supervisory Research Food Technologist*, Bureau of Commercial Fisheries Technological Laboratory, Emerson Avenue, Gloucester, Massachusetts 01930.
Published December 1969.

CONTENTS—Con.

INTRODUCTION

Fresh fish are highly perishable. When a fish dies, the natural protective mechanisms that have been active throughout its life stop functioning. The stage is then set for those deteriorative changes that, with varying degrees of rapidity, will transform a newly caught fish of highly desirable quality into a food that is soft in texture, dull in appearance, and high in odor-producing compounds. Over the years, consumers have recognized these odors as being the undesirable "fishy" odors that often are associated with seafoods.

The deteriorative changes that cause fish to lose quality are primarily chemical, bacterial, and enzymatic. The chemical changes of greatest significance are oxidative and cause rancidity. Under normal conditions of fresh-fish handling, these oxidative changes are masked, however, by the more rapid bacterial and enzymatic breakdown of the fish flesh. Also lessening the impact of chemical changes in fresh fish is the fact that those practices that retard bacterial and enzymatic deterioration also slow the onset of rancidity. For practical purposes then, maintaining the quality of fresh fish aboard a fishing vessel is primarily a matter of retarding both bacterial and enzymatic activity.

Unfortunately, the loss of quality in fish is cumulative and irreversible. The processor cannot improve the quality of the fish he receives from the fisherman, nor can the retailer improve the quality of the fish he receives from the processor. Even under ideal conditions, no one can halt the adverse changes caused by bacterial and enzymatic action. The best that can be done is to slow the rate of these undesirable changes. Because fish are at the peak of their quality when they are caught, fishermen need to be aware of techniques that will enable them to land fish that are as close to the peak of quality as possible.

Some of the following suggested guidelines for accomplishing this aim may seem idealistic when applied to our groundfishing vessels. Many of the suggested practices, however, could be implemented with little or no expenditure of capital and effort.

A clear understanding of the importance of handling fish at sea so that the quality of the fish will be protected is essential if the domestic fishing industry is to remain competitive with foreign fishing industries. The application of the guidelines suggested here will help fishermen to maintain quality during the all-important first link in the chain of distribution from the sea to the consumer.

Carrying out the recommended practices will involve both the vessel and the catch. For that reason, we look into both the vessel requirements and the catch requirements for the delivery of fish that are as near their peak in quality as is possible.

I. RECOMMENDATIONS FOR VESSEL DESIGN AND EQUIPMENT

In this part of our recommendations, we consider (A) the fish hold and (B) the deck equipment for handling the fish.

A. FISH HOLD

In considering the fish hold, we are concerned (1) with protecting the fish from a rise in temperature resulting from absorption of heat passing through the deck and the sides of the vessel and (2) with protecting the fish from physical damage due to crushing.

1. Protecting the Fish from Heat

Protecting the fish from heat requires the use of insulation. It also requires the use of a lining to protect the insulation from damage and contamination.

a. Insulation.

(1) Insulate between the hold and the area overhead.

(2) Insulate over the bulkhead of the engineroom to prevent heat leaks.

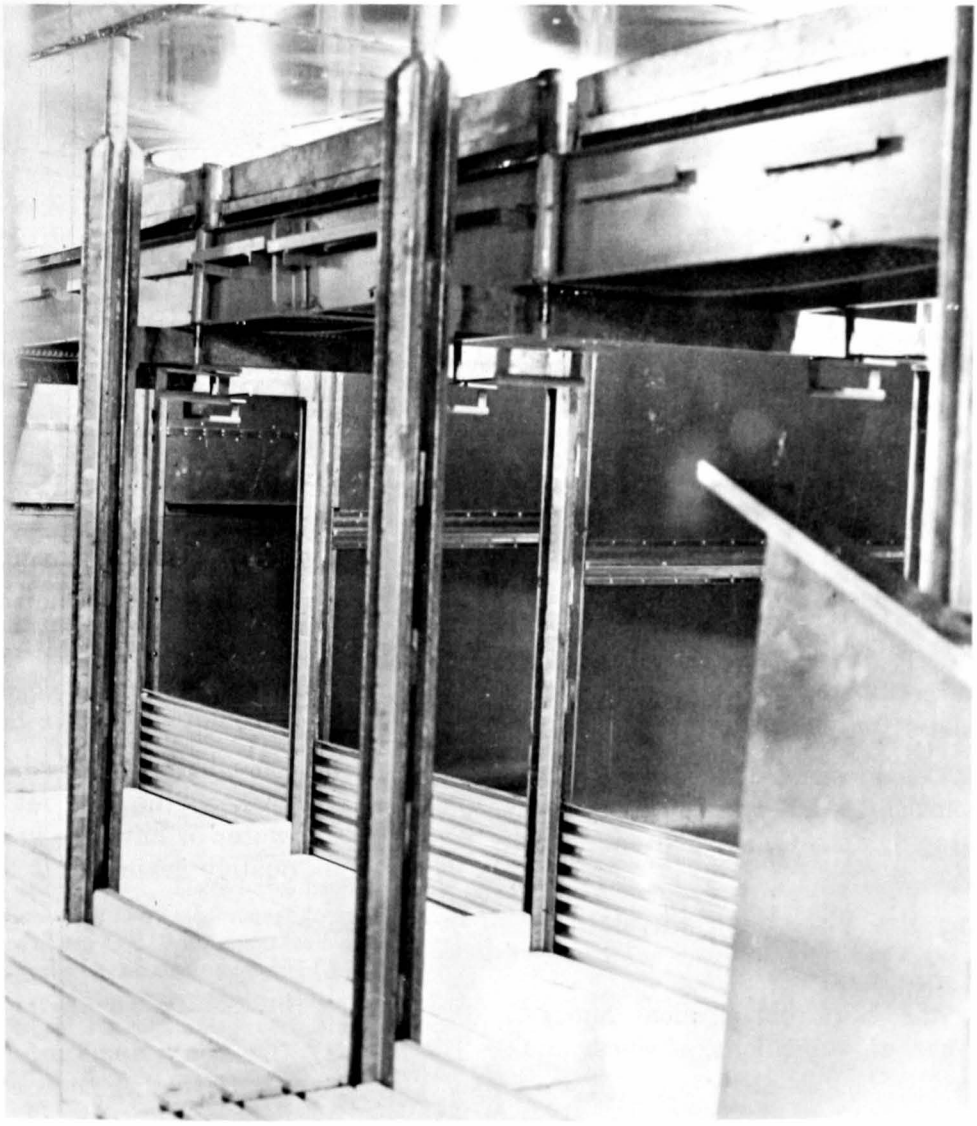

Figure 1.—Fish hold lined with stainless steel. Note overhead conveyor for delivering fish to pens, the use of aluminum pen boards, and the brackets between stanchions for shelving off (horizontal partition within the pen) the fish pens.

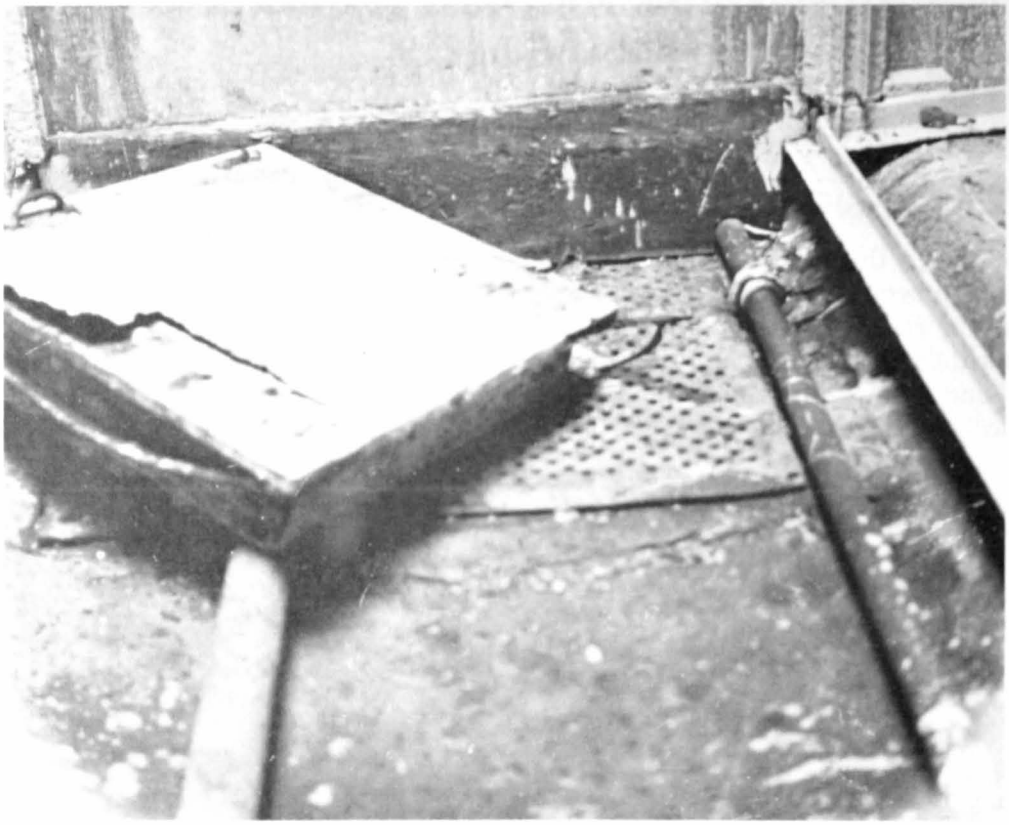

Figure 2.—A poorly maintained fish hold. Note the hatch cover with the cracked metal sheathing. This cover provides an excellent breeding ground for bacteria and is nearly impossible to clean.

(3) Insulate along all outside areas of the hull.

b. Lining.

(1) To make the hold easier to clean, line it either with aluminum that is resistant to salt water, with fiberglass, or with stainless steel.

(2) Make the lining watertight to prevent slime, blood, and water from seeping into the insulation.

2. Protecting the Fish from Physical Damage

Protecting the fish from physical damage involves the use of stanchions, shelves, and boxes.

a. **Stanchions.**—Locate stanchions so that the fish pens are not more than 4.5 by 4.5 feet on the bottom.

b. Shelves.

(1) Provide shelf brackets at intervals such that the combined depth of fish and ice will not exceed 3 feet without a shelf for support.

(2) Provide for drainage of melt water through the shelves.

(3) Elevate the lower shelf sufficiently to keep the fish out of the bilge water or have the vessel hold adequately drained into a bilge sump.

c. Boxes.

(1) Use boxes in preference to using bulk-storage pens.

(2) Use boxes made of aluminum or plastic rather than of wood.

(3) Choose boxes of the nesting type for ease of storage when the boxes are empty.

(4) Provide all boxes with drainage holes.

(5) Use boxes that are capable of being stacked in such a way that melt water from the upper boxes does not drip into those below.

B. DECK EQUIPMENT

In considering deck equipment, we are concerned with (1) the surface of the deck, (2) hoses, (3) stanchions, (4) pens and checker boards, (5) work areas, (6) wash boxes, and (7) chutes and conveyors.

Figure 3.—Stainless-steel fish boxes designed to stack one on top of another. Note drainage holes in bottom and top lip. This lip allows drainage from the top box to run down the outside of the box below. These boxes cannot be nested when empty.

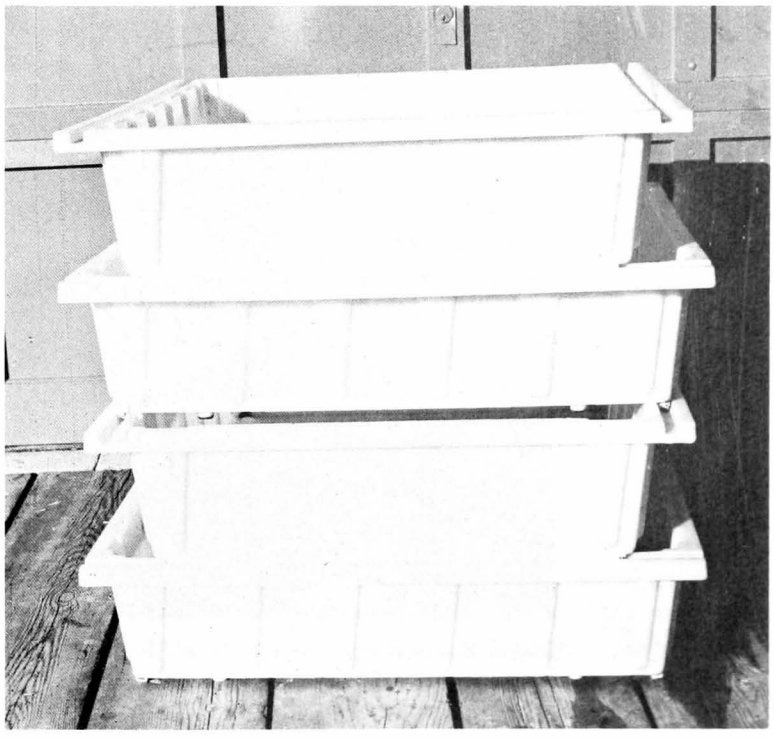

Figure 4.—Plastic fish boxes. These boxes have channels that carry off drainage from boxes above as well as permit loaded boxes to be stacked one atop of another. The empty boxes can be nested by simply turning each one 90 degrees.

1. Deck Surface

Cover the decks with hard-surface cork or composite rubber to make them less slippery and, therefore, safer to work on.

2. Hoses

Supply deck hoses with sea water under high pressure for use in washing decks and gear at sea (but not in harbors, where the water is contaminated).

3. Stanchions

a. Provide deck stanchions made of galvanized iron or of other corrosion-resistant material.

b. Provide an adequate number of stanchions, and position them to permit checkers to be located in such a way as to prevent fish from sliding on the deck.

4. Pens and Checker Boards

a. Equip checker boards with hand holds.

b. Make the checker board fit the stanchions properly for easy removal.

c. Notch the checker boards in the corners to facilitate drainage of water.

d. Paint deck pens and checker boards with epoxy resin or nontoxic paint to facilitate cleaning.

5. Work Areas

a. Provide an elevated work area for gutting the fish.

b. Make the work area of stainless steel, aluminum, or fiberglass.

c. Provide a water flume to carry off the viscera.

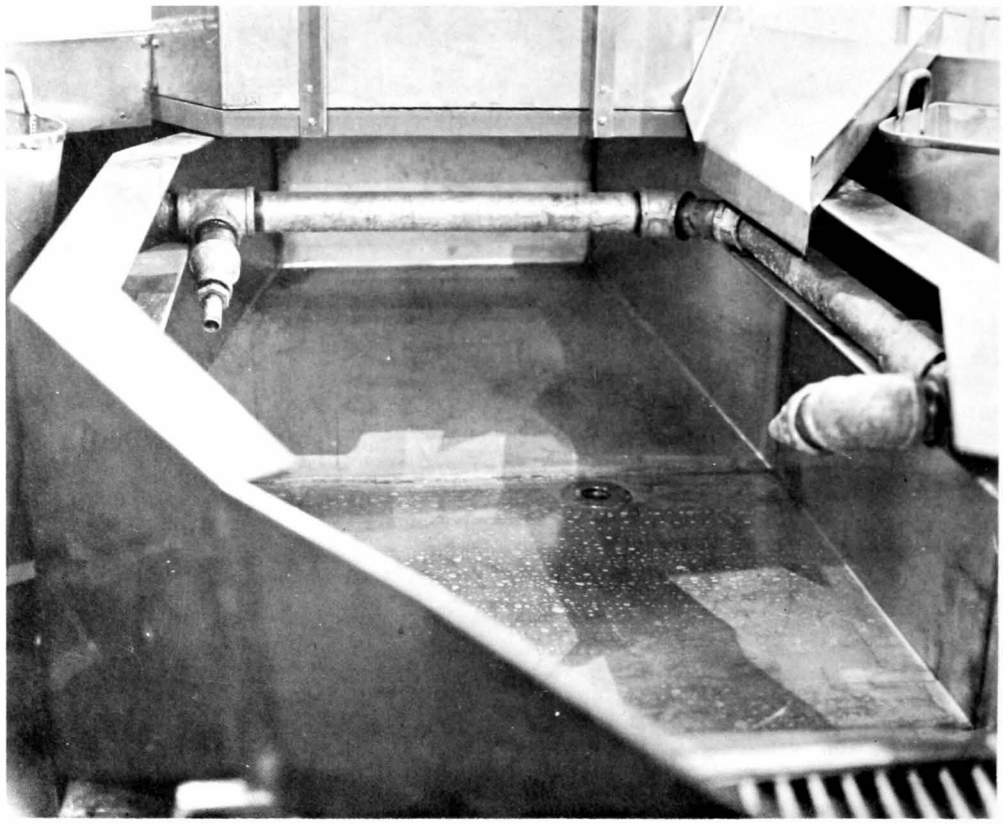

Figure 5.—Swirl-type Grimsby wash box. The swirling motion of the water is created by pumping in two jets of water at opposite corners (note nozzles) iof the box. This motion plus the normal motion of the vessel carries the fish out of the wash box from the chute in the upright foreground.

6. Wash Boxes

a. Construct the wash boxes of stainless steel or of aluminum that is resistant to salt water.

b. Use swirl-type washers preferably, so that the fish can be transported automatically from the washer into the chute leading to the hold.

7. Chutes and Conveyors

a. Construct, of stainless steel or of aluminum, the chutes leading into the hold, and use baffles so that the fish do not drop more than 3 feet into the hold.

b. If a nonswirling washer is used, provide a conveyor to transport fish to the hold.

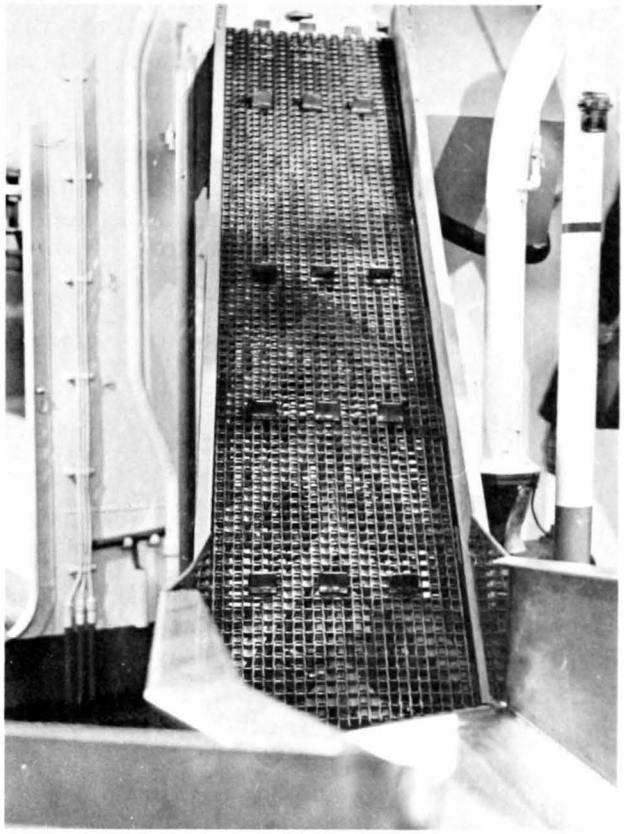

Figure 6.—Stainless-steel-mesh conveyor used to carry fish from wash box to a higher level for storage in the fish hold. This conveyor eliminates the need to fork the fish out of the wash box and prevents damage to fish caused by dropping them from the deck to the fish hold.

II. RECOMMENDATIONS FOR HANDLING THE CATCH

In the first part of our recommendations, we dealt with vessel requirements; in this, the second part, we deal with requirements for handling the catch. In dealing with the catch requirements, we consider (A) transporting the catch from sea to shore, (B) unloading the catch at the dock, and (C) preparing the vessel and equipment to handle the catch to be taken in the next trip.

A. TRANSPORTING THE CATCH FROM SEA TO SHORE

In transporting the catch from sea to shore, we are concerned with (1) preparing the catch for storage aboard the vessel, (2) storing and icing the catch, and (3) keeping the catch from becoming contaminated by bilge water.

1. Preparing the Catch for Storage Aboard the Vessel

Nearly all New England groundfish are caught by nets called otter trawls. A few small vessels use longlines to catch groundfish. Most of the requirements for general sanitation apply equally to otter trawlers and longliners, but one special requirement pertains to line-caught fish.

a. Trawl-caught fish.—When trawl-caught fish are first brought aboard the vessel, they are all handled in the same way, regardless of the form in which they are to be sold. Then, later, they are handled specially, depending upon whether they are to be sold as round fish or as dressed fish.

(1) General handling.

(a) Before each set is brought aboard, clean all surfaces that will come in contact with the fish.

(b) As soon as the cod end is dumped, remove any fish that are entangled in the net.

(c) Wash the fish thoroughly with a deck hose after they have been dumped in the checkers.

(d) Cull the trash fish, and store them separately or discard them overboard.

(e) Do not trample or crush the edible fish during the culling operation.

(f) Do not pile the fish more than 2 feet deep.

(g) Handle the fish rapidly.

(h) Protect the fish from exposure to the sun.

(2) Special handling.

(a) *Round fish.*

[1] Thoroughly wash the small fish that will be landed in the round.

[2] Immediately stow the round fish in the hold.

(b) *Dressed (drawn) fish (viscera removed but heads on.*— Dressing fish requires that they be ripped, gutted, and washed.

[1] Ripping.

[a] Begin ripping as soon as the catch has been washed by the deck hose.

[b] Cut main blood vessels or gills for proper bleeding.

[c] When ripping, do not extend the cut into the flesh beyond the vent.

[d] Place the ripped fish on the elevated work area for gutting.

[2] Gutting.

[a] Remove the viscera, taking particular care to remove all of the liver and the digestive tract.

[b] Preferably, remove the gills.

[c] Do not allow the ripped and gutted fish to come in contact with the viscera, which will contaminate them.

[3] Washing.

[a] Place the fish in the wash box immediately after they have been gutted.

[b] Make sure that the wash water is cold and clean.

[c] Do not reuse water that is contaminated with blood, viscera, and slime.

[d] After the fish leave the wash box, spray them with chlorinated sea water.

[e] Move the fish rapidly from the wash box to the hold.

b. Line-caught fish.—Stun line-caught fish to stop them from struggling. (Stopping the fish from struggling prevents their blood vessels from rupturing and, thereby, helps to keep blood out of the fillets.)

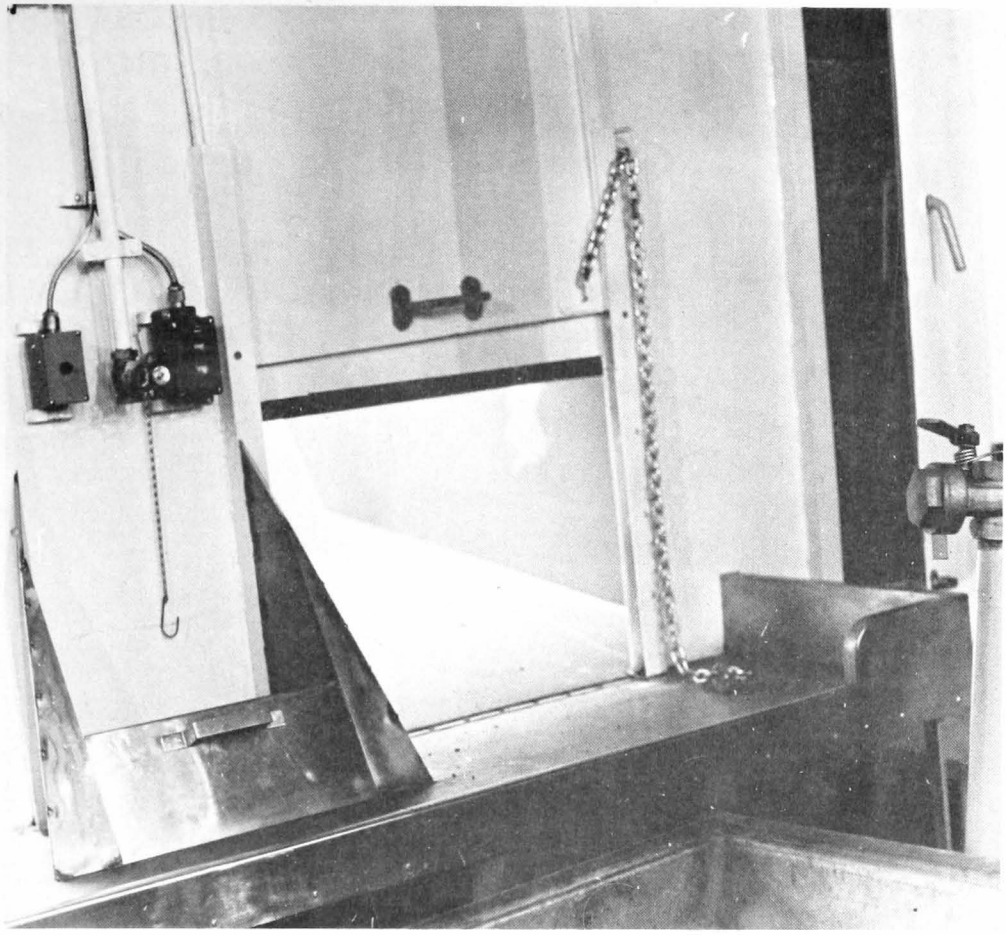

Figure 7.—Stainless-steel chute leading from deck to elevated work area for culling and ripping.

2. Storing and Icing the Catch

a. Storing.

(1) By means of a chute, move the fish directly from the wash box to the proper pen (or use a conveyor or baskets; do not use forks).

(2) Separate the fish by species and by day of catch--that is, do not mix successive days' catches in the same pen, section, or container.

(3) Mark the box or pen sections to indicate the species and the day of catch.

(4) Shelve the pens at 3-foot intervals.

(5) Keep the flow of fish from the deck steady so as to avoid gluts that would make difficult the mixing of ice and fish in the optimum ratio.

b. Icing.

(1) Use ice made only from potable water.

(2) Be sure that the ice is finely crushed and that it contains no large lumps that will bruise the flesh of the fish.

(3) Use each lot of ice during only one trip. At the end of each trip, discard the excess ice.

(4) Line the bottom and sides of pens (or of boxes) with a layer of ice before placing the fish in them.

(5) Use ice to prevent the fish from contacting any surface in the hold directly.

(6) Mix the fish and ice as the fish are stored.

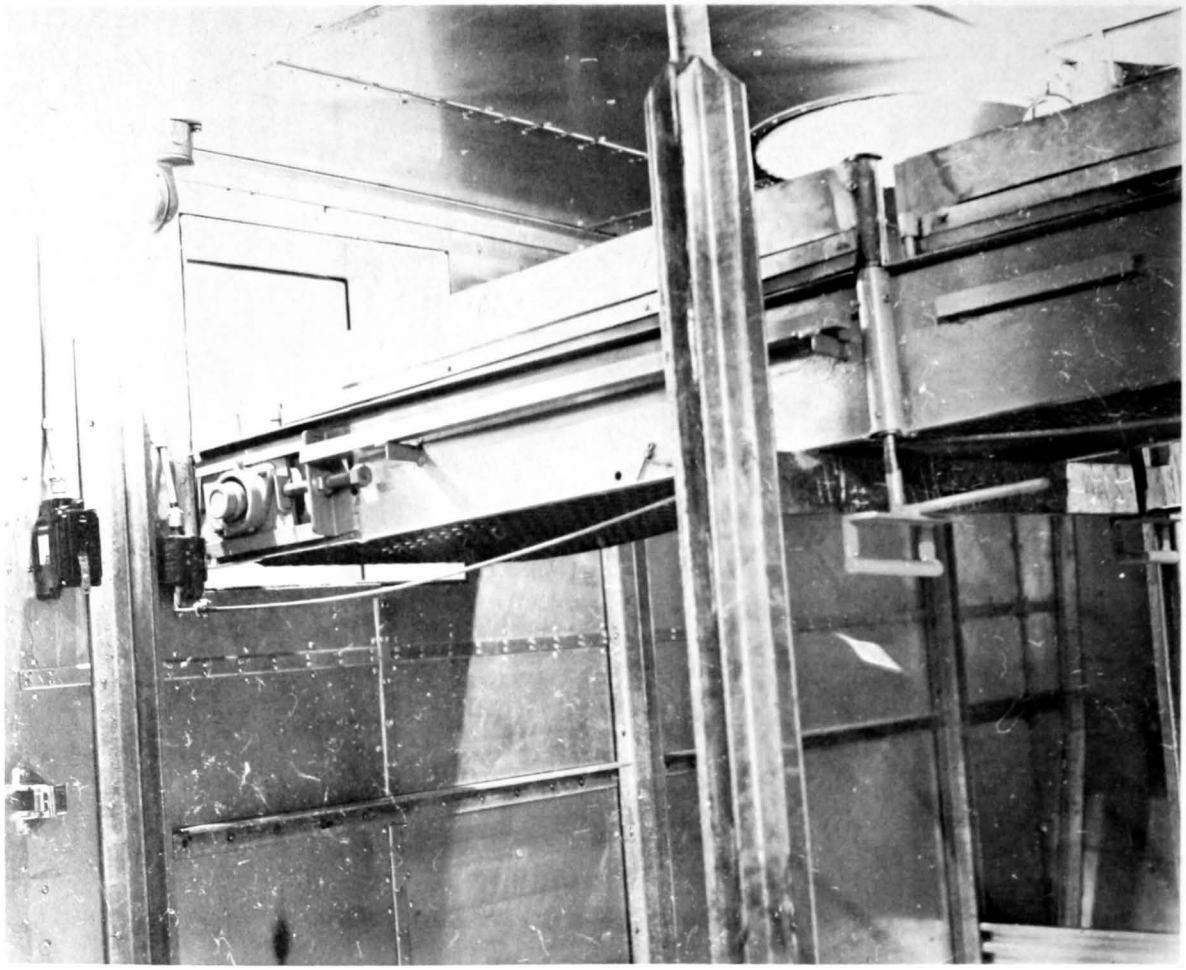

Figure 8.—Stainless-steel conveyor used to carry dressed, washed fish into the fish hold.

(7) In cold weather, use a ratio of at least 1 part of ice to 3 parts of fish. In hot weather, use a ratio of 1 part of ice to 2 parts of fish, or even of 1 part of ice to 1 part of fish.

3. Keeping the Catch Free from Bilge Contamination

Clean and pump out the bilge sump daily while the vessel is fishing.

B. UNLOADING THE CATCH AT THE DOCK

1. Unload the catch as rapidly as possible.
2. Use fish pumps to unload the smaller species; be sure, however, that the water used is potable.
3. Use conveyors or buckets to unload the larger species.
4. Separate the fish from the ice to facilitate their being weighed.
5. After the fish are weighed, re-ice them.
6. Use containers and carts made of stainless steel, aluminum, or fiberglass.
7. Cover the containers of fish, and move them rapidly to the processing plant.
8. If any delay occurs in moving the fish from the vessel to the plant, mix the fish with ice and store them under refrigeration.

III. RECOMMENDATIONS FOR PREPARING THE VESSEL AND EQUIPMENT FOR SUBSEQUENT CATCHES

1. Thoroughly clean and sanitize all containers after each use.
2. Thoroughly scrub holds, penboards, checkers, and deck, using potable water and a sanitizing agent.
3. Stack penboards to dry them completely before they are returned to the hold.
4. Do not allow the water from the bilge in the engineroom to mix with the water in the bilge in the fish hold.
5. Flush out the bilges, and clean the bilge sump.

Figure 9.—Washing penboards. Boards are stacked on deck after washing to permit drying before they are reused in the fish hold.

MS #1918

AUTHOR INDEX OF PUBLICATIONS AND ADDRESSES -- 1967

BUREAU OF COMMERCIAL FISHERIES BRANCH OF TECHNOLOGY AND BRANCH OF REPORTS (SEATTLE)

by

Helen E. Plastino and Mary S. Fukuyama

PUBLICATIONS

Authors: Helen E. Plastino, *Administrative Clerk*, and Mary S. Fukuyama, *Editor*, Bureau of Commercial Fisheries Branch of Reports, Building 67, U.S. Naval Air Station, Seattle, Washington 98115.

Issued December 1969.

Dyer, John A.
General industrial and potential uses of fish oils. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 270-279. Avi Publishing Co., Inc., Westport, Conn.

Eklund, M[elvin] W., and F[rank] Poysky.
Growth and toxin production of *Clostridium botulinum* type E, nonproteolytic B, and F in nonirradiated and irradiated fisheries products in the temperature range of 36° and 72° F. U.S. At. Energy Comm., 7th Annu. AEC Food Irradiat. Contract. Meet., Sum. Accomplishments, CONF-670945, pp. 46-53.

Incidence of *Cl. botulinum* type E from the Pacific Coast of the United States. *In* M. Ingram and T. A. Roberts (editors), Botulism 1966, Proc. 5th Int. Symp. Food Microbiol.: Moscow, July 1966, pp. 49-55. Chapman and Hall Ltd., London.

Eklund, M. W., F. [T.] Poysky, and D. [I.] Wieler.
Characteristics of *Clostridium botulinum* type F isolated from the Pacific Coast of the United States. Appl. Microbiol. 15: 1316-1323.

Demonstration and isolation of *Cl. botulinum* type F from the Pacific Coast of the United States. *In* M. Ingram and T. A. Roberts (editors), Botulism 1966, Proc. 5th Int. Symp. Food Microbiol.: Moscow, July 1966, pp. 443-445. Chapman and Hall Ltd., London.

Growth and toxin production of *Clostridium botulinum* type E, nonproteolytic B, and F in nonirradiated and irradiated fishery products in the temperature range of 36° to 72° F. U.S. At. Energy Comm. 1967 Annu. Rep., Div. Biol. Med., 86 pp.

Eklund, M. W., D. I. Wieler, and F. T. Poysky.
Outgrowth and toxin production of nonproteolytic type B *Clostridium botulinum* at 3.3 to 5.6 C. J. Bacteriol. 93: 1461-1462.

Fineberg, H., and A. G. Johanson.
Industrial use of fish oils. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 222-238. Avi Publishing Co., Inc., Westport, Conn. Also reprinted as U.S. Fish Wildl. Serv., Circ. 278.

Gadbois, D. F., J. M. Mendelsohn, and L. J. Ronsivalli.
Effects of radiation, heating and storage on volatile carbonyl compounds in clam meats. J. Food Sci. 32: 511-515.

Gauglitz, Erich J., Jr.
Properties and application of fish oils. Activ. Rep. 19: 104-108.

Reactions of the carboxyl group. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 107-118. Avi Publishing Co., Inc., Westport, Conn.

Green, J. H.
The potential and problems of food harvest from the oceans. J. Milk Food Technol. 30: 366-368.

Green, John H., Ismini George, and Warren Litsky.
Determination of carbohydrate pathway for *Clostridium botulinum* types A, B and E by interval radiorespirametric techniques. Bacteriol. Proc., 1967 Annu. Meet. Amer. Soc. Microbiol., N.Y., Paper A31, p. 6.

Grieg, R. A.
Extending the shelf life of frozen chub (*Leuchichthys hoyi*) fillets through the use of ascorbic acid dips. U.S. Fish Wildl. Serv., Fish. Ind. Res. 4: 23-27.

Extending the shelf life of frozen white bass (*Roccus chrysops*) through the use of ascorbic acid dips. U.S. Fish Wildl. Serv., Fish. Ind. Res. 4: 45-48.

Grieg, R. A., and J. R. Donahue.
Frozen storage capabilities of channel catfish. Amer. Fishes U.S. Trout News 12(3): 12-13.

Grieg, R. A., J. A. Emerson, and G. W. Fleihman.
Extending the shelf life of frozen cisco (*Coregonus artedii*) products through the use of water-soluble antioxidants. U.S. Fish Wildl. Serv., Fish. Ind. Res. 3(4): 1-10.

Groninger, Herman S.
See National Fisherman.

Gruger, Edward H., Jr.
Fatty acid composition. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 3-30. Avi Publishing Co., Inc., Westport, Conn. Also reprinted as U.S. Fish Wildl. Serv., Circ. 276, under the title, "Fatty acid composition of fish oils."

Reactions of the ethylenic bonds. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 119-137. Avi Publishing Co., Inc., Westport, Conn.

Hannewijk, J.
Use of fish oils in margarine and shortening. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 251-269. Avi Publishing Co., Inc., Westport, Conn. Also reprinted as U.S. Fish Wildl. Serv., Circ. 279.

Hobbs, G., Anita Stiebrs, and M. K. Eklund.
Egg yolk reaction of *Clostridium botulinum* type E in different basal media. J. Bacteriol. 93: 1192.

Holston, John A.
Presentation and processing of freshly caught fish: The practice and the potential. Activ. Rep. 19: 14-17.

Research in review. Fish. Gaz. 84(1): 8-9; 84(2): 6, 32; 84(3): 8-9; 84(4): 6, 11; 84(5): 6, 8; 84(6): 12-13; 84(7): 6, 8.

Houle, Clifford H.
Gas-liquid chromatography. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 52-62. Avi Publishing Co., Inc., Westport, Conn.

Huff, John B., and Joseph M. Lee.
Replacement of underwater bearings in a high radiation field. Isotop. Radiat. Technol. 5: 25-28.

Ito, K. A., Donna J. Seslar, W. A. Mercer, and K. F. Meyer.
The thermal and chlorine resistance of *Cl. botulinum* types A, B and E spores. *In* M. Ingram and T. A. Roberts (editors), Botulism 1966, Proc. 5th Int. Symp. Food Microbiol: Moscow, July 1966, pp. 108-122. Chapman and Hall Ltd., London.

Karrick, Neva L.
Nutritional value as animal feed. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 362-382. Avi Publishing Co., Inc., Westport, Conn. Also reprinted as U.S. Fish Wildl. Serv., Circ. 281, under the title, "Nutritional value of fish oils as animal feed."

Kifer, Robert Ray.
Effect of menhaden fish oil on flavor and fatty acid deposition of swine tissue—analysis by gas-liquid chromatography. Ph.D. thesis, Univ. Md., College Park, Md., 99 pp.

Knobl, George M., Jr.
The fish protein concentrate story—Here and there: Dragging the net. 4. World efforts toward FPC. Food Technol. 21(8): 56-59.

Kurtzman, C. H., and M. E. Ambrose.
Method for calculating the calcium and phosphorus in menhaden fish meal from the analysis of total ash. Poult. Sci. 46: 718-726.

Kwee, Wie Han.
Quality and nutritive value of pasta made from rice, corn, soya, and tapioca enriched with fish protein concentrate. M.S. thesis, Univ. Md., College Park, Md., 69 pp.

Learson, Robert J.
Electrophoretic methods for determining species identity and processing history of fishery products. Activ. Rep. 19: 33-37.

Licciardello, J. J., L. J. Ronsivalli, and J. W. Slavin.
Effect of oxygen tension on the spoilage microflora of irradiated and non-irradiated haddock (*Melanogrammus aeglefinus*) fillets. J. Appl. Bacteriol. 30: 239-245.

Love, Travis D.
Bacteriological controls for producing high-quality breaded seafoods. Commer. Fish. Rev. 29(1): 54-57.

The sun-dried-shrimp industry of Mexico's North Central Gulf. Commer. Fish. Rev. 29(4): 58-61.

Love, Travis D., and Mary H. Thompson.
Report, Technological Laboratory, Bureau of Commercial Fisheries, Pascagoula, Mississippi, for the fiscal year ending June 30, 1966. U.S. Fish Wildl. Serv., Circ. 262, 14 pp.

Malins, D[onald] C.
The biosynthesis of plasmalogens from glyceryl ethers. Biochem. J. 103(2): 29p.

The classes of lipids in fish. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 31-42. Avi Publishing Co., Inc., Westport, Conn.

Malins, Donald C., and John C. Wekell.
Chromatographic methods. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 63-72. Avi Publishing Co., Inc., Westport, Conn.

Medwadowski, B. F., J. van der Veen, and H. S. Olcott.
Nature of the residual lipids in fish protein concentrate (FPC). J. Food Sci. 32:361-365.

Miller, D[avid], E[dward] H. Gruger, Jr., K[am] C. Leong, and G[eorge] M. Knobl, Jr.
Dietary effect of menhaden-oil ethyl esters on the fatty acid pattern of broiler muscle lipids. Poult. Sci. 46: 438-444.

Effect of refined menhaden oils on the flavor and fatty acid composition of broiler flesh. J. Food Sci. 32: 342-345.

Miyauchi, D., J. Spinelli, G. Pelroy, and M. A. Steinberg.
Application of radiation-pasteurization processes to Pacific Coast fishery products. U.S. At. Energy Comm., 7th Annu. AEC Food Irradiat. Contract. Meet., Sum. Accomplishments, CONF-670945, pp. 10-20.

Radiation preservation of Pacific Coast fisheries products. Isotop. Radiat. Technol. 4: 135-141.

Miyauchi, David, John Spinelli, Gretchen Pelroy, Fuad Teeny, and John Seman.
Application of radiation-pasteurization processes to Pacific crab and flounder. U.S. At. Energy Comm., Div. Isotop. Develop., Annu. Rep. Nov. 1, 1966 through Oct. 31, 1967, 136 pp.

National Fisherman.
Food technologists develop notable advances in seafoods. Nat. Fish., Aug. 1967, p. 9-C. Prepared by Herman Groninger, *Research Chemist*, Bur. Commer. Fish. Technol. Lab., Seattle, Wash.

Nickerson, J. T. R., S. A. Goldblith, G. DiGioia, and W. W. Bishop.
The presence of *Cl. botulinum* type E in fish and mud taken from the Gulf of Maine. *In* M. Ingram and T. A. Roberts (editors), Botulism 1966, Proc. 5th Int. Symp. Food Microbiol.: Moscow, July 1966, pp. 25-33. Chapman and Hall Ltd., London.

Pariser, E. R.
BCF process aims to make product simply. Nat. Fish., April 1967, pp. 14-C, 16-C.

The fish protein concentrate story—U.S. scope, perspective and the voyage ahead. 2. The deep yarn of FPC. Food Technol. 21(7): 70-71.

Pelroy, Gretchen A.
New smells from spoiled fish. Packaging affects bacterial growth in radiation-pasteurized products. Canner/Packer 136(12): 22-23.

Pelroy, Gretchen A., John P. Seman, Jr., and Melvin W. Eklund.
Changes in the microflora of irradiated petrale sole (*Eopsetta jordani*) fillets stored aerobically at 0.5 C. Appl. Microbiol. 15: 92-96.

Pigott, George M.
Production of fish oils. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 183-192. Avi Publishing Co., Inc., Westport, Conn. Also reprinted as U.S. Fish Wildl. Serv., Circ. 277.

Plastino, Helen E., and Mary S. Fukuyama.
Author index of publications and addresses - 1965, Bureau of Commercial Fisheries Division of Economics and Branches of Reports (Seattle) and Technology. U.S. Fish Wildl. Serv., Fish. Ind. Res. 3(4): 47-58.

Ronsivalli, Louis J.
Problems in packaging radiopasteurized fish. Activ. Rep. 19: 42-45.

Shelf life of radiopasteurized fishery products. Activ. Rep. 19: 59-63.

Ronsivalli, Louis J., Lena Baldwin, and F. Bruce Sanford.
I—Preservation of fish by the use of gamma rays. Commer. Fish. Rev. 29(6): 56-60.

Roubal, W. T.
Oxidative deterioration of flesh lipids of Pacific cod (*Gadus macrocephalus*). J. Amer. Oil Chem. Soc. 44: 325-327.

Roubal, W. T., and A. L. Tappel.
Damage to ATP by peroxidizing lipids. Biochim. Biophs. Acta 136: 402-403.

Ryan, John J., and Joseph Clem.
See U.S. Fish and Wildlife Service, Inspectors' instructions.

Ryan, John J., and J. Perry Lane.
See U.S. Fish and Wildlife Service, Federal specifications.
See U.S. Fish and Wildlife Service, Interim Federal specifications.

Sanchez Torres, J. R.
Fish oil industry in South America. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 394-404. Avi Publishing Co., Inc., Westport, Conn. Also reprinted as U.S. Fish Wildl. Serv., Circ. 282.

Sanford, F. B[ruce].
Basic ideas in fishery science. Commer. Fish. Rev. 29(6): 56.

First subsidized fishing vessel built on Pacific Coast. Commer. Fish. Rev. 29(8-9): 35-36.

Organizing the research report to reveal the units of research. U.S. Fish Wildl. Serv., Circ. 272, 9 pp.

Seman, John P., Jr.
Improved multipoint inoculating device for replica plating. Appl. Microbiol. 15: 1514-1516.

Sidwell, Virginia D.
FPC in foods. Activ. Rep. 19: 118-124.

Snyder, Donald G.
The fish protein concentrate story—Bringing the product home. 5. Bureau of Commercial Fisheries program. Food Technol. 21(9): 70, 72, 76.

The fish protein concentrate story—U.S. scope, perspective and the voyage ahead. 1. Enter: FPC. Food Technol. 21(7): 70.

Spinelli, J., G. Pelroy, and D. Miyauchi.
Irradiation of Pacific Coast fish and shellfish. 6—Pretreatment with sodium tripolyphosphate. U.S. Fish Wildl. Serv., Fish. Ind. Res. 4: 37-44.

Spinelli, John.
Degradation of nucleotides in ice-stored halibut. J. Food Sci. 32: 38-41.

New tests assess quality changes in fish. Commer. Fish. Rev. 29(11): 69-70.

Stansby, M. E.
Fatty acid patterns in marine, freshwater, and anadromous fish. J. Amer. Oil Chem. Soc. 44(1): 64.

General analytical methods. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 43-51. Avi Publishing Co., Inc., Westport, Conn.

Misconception about nutritional properties of fish oils. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 283-288. Avi Publishing Co., Inc., Westport, Conn. Also reprinted as U.S. Fish Wildl. Serv., Circ. 280.

Odors and flavors. *In* M. E. Stansby (editor), Fish oils; their chemistry, technology, stability, nutritional properties, and uses, pp. 171-180. Avi Publishing Co., Inc., Westport, Conn.

Oxidative changes are being investigated at new Food Science Pioneer Research Laboratory. Commer. Fish. Rev. 29(10): 41.

Stansby, M. E. (editor).
Fish oils; their chemistry, technology, sta-

Stansby—Con.
bility, nutritional properties, and uses. Avi Publishing Co., Inc., Westport, Conn., 440 pp.

Stansby, Maurice E., and Alice S. Hall.
Chemical composition of commercially important fish of the United States. U.S. Fish Wildl. Serv., Fish. Ind. Res. 3(4): 29-46.

Stansby, Maurice E., Paul E. Zollman, and R. M. Winkelmann.
Efficacy of fish oils in healing wounds and burns. U.S. Fish Wildl. Serv., Fish. Ind. Res. 3(4): 25-27.

Stillings, Bruce R.
Nutritional evaluation of fish protein concentrate. Activ. Rep. 19: 109-117.

U.S. Department of the Interior and U.S. Department of Health, Education, and Welfare.
Sanitation standards for smoked-fish processing. Part 1. Fish-smoking establishment, 1967 recommendations. U.S. Dep. Interior, Fish Wildl. Parks, and U.S. Dep. Health, Educ., Welfare, Public Health Serv., Public Health Serv. Publ. No. 1587, 30 pp. (Prepared by the Bur. Commer. Fish. Technol. Lab., Ann Arbor, Mich.)

U.S. Fish and Wildlife Service.
Federal specifications for salmon, canned. PP-S-31e, March 27, 7 pp. Prepared by John J. Ryan, *Chemist,* and J. Perry Lane, *Research Food Technologist,* Bur. Commer. Fish. Technol. Lab., Gloucester, Mass. (Copies available from General Services Administration, Washington, D.C.)

Inspectors' instructions for grading frozen breaded shrimp. Bur. Commer. Fish. Div. Ind. Res., December, 2d issue, 24 pp. Prepared by John J. Ryan, *Chemist,* and Joseph Clem, formerly *Regional Supervisory Inspector,* Bur. Commer. Fish. Technol. Lab., Gloucester, Mass.

Interim Federal specifications for scallops, chilled and frozen, sea. PP-S-00120, February 8, 8 pp. Prepared by John J. Ryan, *Chemist,* and J. Perry Lane, *Research Food Technologist,* Bur. Commer. Fish. Technol. Lab., Gloucester, Mass. (Copies available from General Services Administration, Washington, D.C.)

Ward, B. Q., and B. J. Carroll.
Effects of sulfa drugs on spore germination, vegetative growth, and toxin formation of Clostridium botulinum type E. Can. J. Microbiol. 13: 107-108.

Production of toxin by Clostridium botulinum type E in defined media. Can. J. Microbiol. 13: 108-110.

Ward, B. Q., B. J. Carroll, and E. S. Garrett.
Presence of *Cl. botulinum* type E in estuarine waters of the United States Gulf Coast comparing fluorescent detection and mouse-toxin methods. *In* M. Ingram and T. A. Roberts (editors), Botulism 1966, Proc. 5th Int. Symp. Food Microbiol: Moscow, July 1966, pp. 503-507. Chapman and Hall Ltd., London.

Ward, B. Q., B. J. Carroll, E. S. Garrett, and G. B. Reese.
Survey of the U.S. Atlantic Coast and estuaries from Key Largo to Staten Island for the presence of *Clostridium botulinum.* Appl. Microbiol. 15: 964-965.

Survey of the U.S. Gulf Coast for the presence of *Clostridium botulinum.* Appl. Microbiol. 15: 629-636.

Ward, B. Q., E. S. Garrett, and G. B. Reese.
Further indications of *Clostridium botulinum* in Latin American waters. Appl. Microbiol. 15: 1509.

Wick, Emily L., Edward Underriner, and Evan Paneras.
Volatile constituents of fish protein concentrate. J. Food Sci. 32: 365-370.

SUPPLEMENT

Papers not listed previously

Eklund, M. E., F. T. Poysky, and D. I. Wieler.
1966. The significance of *Clostridium botulinum* type E in the application of radiation-pasteurization process to Pacific crab meat and flounder. U.S. At. Energy Comm., Div. Tech. Inform., 6th Annu. AEC Food Irradiat. Contract. Meet., Sum. Accomplishments, CONF-661017, pp. 123-127.

Miyauchi, David, John Spinelli, and Gretchen Pelroy.
1966. Application of radiation-pasteurization process to Pacific Coast fishery products. U.S. At. Energy Comm., Div. Tech. Inform., 6th Annu. AEC Food Irradiat. Contract. Meet., Sum. Accomplishments, CONF-661017, pp. 3-8.

1966. Application of radiation-pasteurization processes to Pacific crab and flounder. Final summary for the period November 1965 through October 1966. U.S. At. Energy Comm., Div. Isotop. Develop., Annu. Rep., TID-23835, 110 pp.

ADDRESSES[1]

Branch of Technology
Washington, D.C.

Allen, Harold B.

Fish protein concentrate - A new concept.
Instructional Symposium on Fish Protein Concentrate an Inter-American Bank Training Course for the Development of Industrial Projects, Lima, Peru, May 29.

International Symposium on Protein Foods and Concentrates, Bombay, India, June 24.

Fish protein concentrate - An international development.
Second Interamerican Conference on Naval Research, Rio de Janeiro, Brazil, November 14.

Brooker, James R.

The Bureau of Commercial Fisheries - Food and Drug Administration cooperative inspection activities.
FDA/BCF/Industry Workshops on Sanitation in the Breaded Shrimp Industry, Brownsville, Texas, May 4.

FDA/BCF/Industry on Sanitation in the Breaded Shrimp Industry, Los Angeles, California, May 6.

FDA/BCF/Industry Workshops on Sanitation in the Breaded Shrimp Industry, Tampa, Florida, June 24.

Procuring better quality seafoods through USDI inspection.
Meeting of Officials of State of Maryland Institutions, Mount Wilson, Maryland, November 29.

Technological Laboratory
Ann Arbor, Michigan

Billy, Thomas J.

Catfish.
Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 17-20.

Emerson, John A.

The bottom fisheries.
Michigan State University, Food Science Department, East Lansing, Michigan, April 9.

Shelf life extension of fishery products through use of controlled atmospheres.
Atlantic Fisheries Technological Confer-

[1] If you wish more information on any of the addresses, the directory is on page 230. Please give complete citation as shown in each address.

Emerson—Con.
ence, Kennebunkport, Maine, September 17-20.

Gnaedinger, Richard H.
Mink research.
Michigan Fur Breeders Association, Grand Rapids, Michigan, April 6.

The effect of dressing, filleting, and cooking on the reduction of pesticide levels in chub and perch.
Central States AFDOUS (Association of Food and Drug Officials of the United States) Meeting, Springfield, Illinois, November 2.

Graikoski, John T.
Ecology of *Cl. botulinum* in the Great Lakes.
Seminar, University of Michigan, Department of Microbiology, Ann Arbor, Michigan, October 25.

Seagran, Harry L.
Potentials for utilization of freshwater fish.
Michigan State University, East Lansing, Michigan, January 13.

Technological Laboratory
College Park, Maryland

Ambrose, Mary E.
Determination of IPA in FPC.
Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 17-20.

Brown, Norman L.
The FPC program.
Luncheon meeting of the Small Business Development Center, Atlantic City, New Jersey, March 17.

Businessmen's Group, Wildwood, New Jersey, March 18.

Current status of FPC program at the Bureau of Commercial Fisheries.
Engineering Foundation Research Conference on "Engineering of Unconventional Protein Production," Santa Barbara, California, August 7-11.

Dubrow, David L.
Effect of heating raw fish prior to solvent extraction.
Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 17-20.

Food technology aspects.
Meeting of the Institute of Food Technologists, Washington, D.C., November 8.

Ernst, Robert, Jr.
Engineering aspects.
Meeting of the Institute of Food Technologists, Washington, D.C., November 8.

Hammerle, Olivia A.
FPC in foods and nutrition.
Seminar on FPC, Columbia University, New York City, New York, January 18.

Fish protein concentrate as an industry.
Conference on Oceanography as an Investment, Lake Hopatcong, New Jersey, November 30-December 2.

Kifer, R[obert] R.
Diversification.
Workshop Meeting, National Fish Meal and Oil Association, College Park, Maryland, March 28.

Fermentation.
Workshop Meeting, National Fish Meal and Oil Association, College Park, Maryland, March 28.

Swine reproduction.
Workshop Meeting, National Fish Meal and Oil Association, College Park, Maryland, March 28.

Turtle grass.
Workshop Meeting, National Fish Meal and Oil Association, College Park, Maryland, March 28.

Fatty acid composition of swine (*Sus domesticus*) tissue. I. Effect of dietary incorporation of menhaden fish oil.
Annual Meeting of the American Society of Animal Sciences, Reno, Nevada, July 30-August 3.

Fatty acid composition of swine (*Sus domesticus*) tissue. 2. Relation of marine polyunsaturated fatty acids fed and deposited to off "fishy" flavor.
Annual Meeting of the American Society

of Animal Sciences, Reno, Nevada, July 30-August 3.

Miller, David.
Oil feeding.
Workshop Meeting, National Fish Meal and Oil Association, College Park, Maryland, March 28.

Payne, Willie.
Protein quality.
Workshop Meeting, National Fish Meal and Oil Association, College Park, Maryland, March 28.

Pariser, E. R.
BCF research program on FPC.
Seminar on FPC, Columbia University, New York City, New York, January 18.

Fish protein concentrate.
Meeting of Chartered Engineers of Iceland, Reykjavik, Iceland, May 9.

Powell, J. J.
Past, present, and future status of the blue crab mechanization program.
Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 17-20.

Sidwell, Virginia D.
The use of FPC in foods.
Meeting of the Chesapeake Section of the American Association of Cereal Chemists, Laurel, Maryland, February 23.

University of Maryland, Modern Theories of Health Class, College Park, Maryland, March 17.

Changes in physical and sensory characteristics of bread containing varying amounts of fish protein concentrate (FPC) and lysine.
52nd Annual Meeting of the American Association of Cereal Chemists, Los Angeles, California, April 2-6.

The use of fish protein concentrate in food products.
Seminar, Cornell University, Ithaca, New York, May 16.

Foods and nutrition on the nutritive value and uses of fish protein concentrate.
University of Maryland, Home Economics students, at Bureau of Commercial Fisheries Technological Laboratory, College Park, Maryland, November 16.

Snyder, Donald G.
Fish protein concentrate—1967.
Seminar on FPC, Columbia University, New York City, New York, January 18.

Fish protein concentrate.
Workshop Meeting, National Fish Meal and Oil Association, College Park, Maryland, March 28.

Research progress on fish protein concentrate.
Conference on Fish Protein Concentrate, Ottawa, Canada, October 24 and 25.

Fish protein concentrate—A history of its development.
Conference on Oceanography as an Investment, Lake Hopatcong, New Jersey, November 30-December 2.

Summary of data on wholesomeness of BCF product.
Joint Meeting of Committee on Marine Protein Resource Development and Toxicology Subcommittee of Food Protection Committee, National Academy of Sciences, Washington, D.C., December 7-8.

Fish protein concentrate—A history of its commercial developments.
Marine Science Symposium of the American Association for the Advancement of Science at their Annual Meeting, New York City, New York, December 27-28.

Stillings, B[ruce] R.
Nutritive value of fish protein concentrate.
Meeting of the Chesapeake Section of the American Association of Cereal Chemists, Laurel, Maryland, February 23.

Nutrition in the world picture.
University of Maryland, Modern Theories of Health Class, College Park, Maryland, March 17.

Nutritional quality of wheat flour supplemented with fish protein concentrate or lysine.
52nd Annual Meeting of the American

Stillings—Con.

Association of Cereal Chemists, Los Angeles, California, April 2-6.

FPC feasibility studies—Report of survey trips to Latin America and Asia.

University of Maryland Interdepartmental Nutrition Seminar, College Park, Maryland, December 14.

Stillings, B. R., and Norman L. Brown.

The development and nutritive value of fish protein concentrate.

Nutrition Seminar, University of Maryland, College Park, Maryland, March 9.

Technological Laboratory

Gloucester, Massachusetts

Bezanson, Allan F.

Seminar on seafood containerization.

Annual Meeting of National Fisheries Institute, Denver, Colorado, April 12.

Carlson, Clarence J.

The effect of superchilled storage on the quality of frozen haddock.

12th International Congress of Refrigeration and FAO Technical Conference on Freezing and Irradiation of Fish, Madrid, Spain, August 30-September 8. (Presented by John A. Holston.)

Superchilling fish - A review.

12th International Congress of Refrigeration and FAO Technical Conference on Freezing and Irradiation of Fish, Madrid, Spain, August 30-September 8. (Presented by John A. Holston.)

Carver, Joseph H.

Radiopasteurization of fish at sea.

Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 19.

Connors, Thomas J.

New methods of handling fish at sea.

New England Fisheries Institute Meeting, Gloucester, Massachusetts October 16.

Seafood Producers Association Meeting, New Bedford, Massachusetts, October 30.

Gloucester Fisheries Commission Meeting, Gloucester, Massachusetts, October 31.

Kiwannis Club, Gloucester, Massachusetts, November 15.

Gould, Edith.

An enzymatic method for distinguishing between unfrozen fish and fish that have been frozen and thawed.

Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 17-20.

Green, John H.

Determination of carbohydrate pathway for *Clostridium botulinum*.

Annual Meeting of American Society for Microbiology, New York, New York, April 29-May 4.

The potential and problems of food harvest from the oceans.

54th Annual Meeting of International Association of Milk, Food and Environmental Sanitarians, Inc., Miami Beach, Florida, August 14-17.

EDTA in ice as a preservative for eviscerated fish.

Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 17-20.

Kaylor, John D.

Industry interest in food irradiation.

Southern Interstate Nuclear Board, Oak Ridge, Tennessee, February 3.

A brief review of irradiation of fresh seafoods.

Massachusetts Shellfish Association Officials, Boston, Massachusetts, March 16.

The Gloucester irradiator.

Fisheries Council, Gloucester, Massachusetts, June 7.

Progress in irradiation of fresh seafoods.

Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 19.

Operations and progress of the marine products development irradiator.

Seventh Annual Atomic Energy Commission Contractors Meeting, Washington, D.C., September 28.

King, Frederick J.

Research on the chemistry of radiopasteurized seafoods.

Seventh Annual Atomic Energy Commission Contractors Meeting, Washington, D.C., September 28.

Lane, J. Perry.

BCF quality control standards for fishery products.

U.S. Public Health Service Workshop on "Current Concepts in Food Protection," Harrisburg, Pennsylvania, February 27-March 3.

Seafood purchasing.

Food Purchasing Institute for Nursing, Convalescent, and Rest Homes, University of Rhode Island, Kingston, Rhode Island, June 22.

Workshop on vocational teachers, Westfield State College.

Westfield State College, Westfield, Massachusetts, June 29.

BCF quality control program and irradiation research.

U.S. Public Health Service Workshop on "Current Concepts in Food Protection," Plainview, Long Island, New York, November 28.

Peters, John A.

Quality problems in the fishing industry.

University College Galway, Alumni Association, Galway, Ireland, June 17.

Summary of sessions on freezing seafood.

Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 17-20.

12th International Congress of Refrigeration and FAO Technical Conference on Freezing and Irradiation of Fish, Madrid, Spain, August 30-September 8.

Ronsivalli, Louis J.

Study of irradiated-pasteurized fishery products.

Seventh Annual Atomic Energy Commission Contractors Meeting, Washington, D.C., September 27.

Summary report of the Marine and Fish Technology Subcommittee.

Seventh Annual Atomic Energy Commission Contractors Meeting, Washington, D.C., September 28.

A method for predicting quality scores in irradiated-pasteurized fish.

IFT Meeting, Minneapolis, Minnesota, October 4.

Use of radiation for preserving fish.

Kiwannis Club, Gloucester, Massachusetts, October 5.

Radiation and its use to preserve fish.

WHDH-TV - N.E. Farmer's Program, Boston, Massachusetts, October 13.

Food preservation with emphasis on radiation.

WHDH-TV - American Chemical Society Educational Program for High School Chemists, Boston, Massachusetts, December 4.

Ryan, John J.

Workshop on vocational teachers, Westfield State College.

Westfield State College, Westfield, Massachusetts, June 29.

Tinker, Burton L.

Workshop on smoked fish.

U.S. Food and Drug Workshop, Boston, Massachusetts, August 15.

Technological Laboratory

Pascagoula, Mississippi

Garrett, E. Spencer.

A microbiologist reviews practical approaches toward improving product quality.

FDA/BCF Workshop, Brownsville, Texas, May 4.

FDA/BCF Workshop, Los Angeles, California, May 6.

FDA/BCF Workshop, St. Petersburg, Florida, June 23.

Salmonella in fish meal.

Mississippi Menhaden Co., Pascagoula, Mississippi, June 5.

Garrett—Con.
Salmonella in fish meal—Con.
Fish Meal Co., Moss Point, Mississippi, June 5.

Standard Products, Inc., Moss Point, Mississippi, June 5.

American Protein Co., Milwaukee, Wisconsin, June 7.

Lake Industries, Milwaukee, Wisconsin, June 7.

Shillings Fish Co., Pewaukee, Wisconsin, June 7.

American Protein Co., Inc., Menominee, Michigan, June 8.

Empire Menhaden Products, Inc., Empire, Louisiana, August 7.

Wallace Quinn Fisheries, Empire, Louisiana, August 7.

Ocean Protein Products, Inc., Dulac, Louisiana, August 8.

Quinn Menhaden Fisheries, Dulac, Louisiana, August 8.

Louisiana Menhaden Co., Houma, Louisiana, August 8.

Fish Meal Co., Morgan City, Louisiana, August 9.

Seacoast Products, Inc., Abbeville, Louisiana, August 10.

Louisiana Menhaden Co., Cameron, Louisiana, August 11.

Gulf Menhaden Co., Cameron, Louisiana, August 11.

Ocean Protein Products, Cameron, Louisiana, August 11.

Louisiana Menhaden Co., Lake Charles, Louisiana, August 11.

Texas Menhaden Co., Sabine Pass, Texas, August 11. (Two talks made here — same talk, different audiences.)

Ocean Protein Products, Inc., Port Arthur, Texas, August 11.

Regional Office, Bureau of Commercial Fisheries, St. Petersburg, Florida, August 14.

Protein Products Corp., Fort Meyers, Florida, August 15. (Two talks made here — same talk, different audiences.)

Wallace Quinn Fisheries, Fernandina Beach, Florida, August 17.

Nassau Fertilizer & Oil Co., Inc., Fernandina Beach, Florida, August 17.

Lewis Crab Factory, Brunswick, Georgia, August 18.

Standard Products of North Carolina, Inc., Southport, North Carolina, August 21.

Standard Products of North Carolina, Inc., Beaufort, North Carolina, August 22.

Beaufort Fisheries, Inc., Beaufort, North Carolina, August 22.

Standard Products of North Carolina, Inc., Moorehead City, North Carolina, August 23.

Reedville Oil & Guano Co., Inc., Cape Charles, Virginia, August 25.

Tidewater Crab Co., Newport News, Virginia, August 25.

Reedville Oil & Guano Co., Inc., Reedville, Virginia, August 26.

Standard Products, Inc., Reedville, Virginia, August 26.

Standard Products Co., Inc., Kilmarnock, Virginia, August 28.

Standard Products, Inc., White Stone, Virginia, August 28.

Standard Products, Inc., Rocksbury, Virginia, August 28.

Seacoast Products, Inc., Lewes, Delaware, August 29.

Reedville Oil & Guano Co., Inc., Wildwood, New Jersey, August 30.

J. Howard Smith, Inc., Port Monmouth, New Jersey, August 31.

Point Judith By-Products, Inc., Narragansett, Rhode Island, September 5.

Lipman Marine Products, Inc., Gloucester, Massachusetts, September 5.

Pine States By-Products, Inc., South Portland, Maine, September 7.

Seapro, Inc., Rockland, Maine, September 8.

Central Office, Division of Industrial Research, Bureau of Commercial Fisheries, Washington, D.C., September 20.

National Fish Meal & Oil Association Technical Meeting, Washington, D.C., September 21.

Love, Travis D.
Engineering technology in the Gulf seafood industry.
Quarterly Meeting of the Southern Section of the Association of Professional Engineers, Biloxi, Mississippi, November 25.

Thompson, Mary H.
Quality means profits.
American Shrimp Canners Association, New Orleans, Louisiana, March 9.

New aspects of handling Southern fish and shellfish.
Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 15.

Thompson, Mary H., and R. N. Farragut.
Fatty acids of the Chesapeake Bay blue crab.
Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 15.

Thompson, Mary H., and H. A. Thompson.
Shrimp connective tissue in relation to texture.
Atlantic Fisheries Technological Conference, Kennebunkport, Maine, September 15.

Technological Laboratory
Seattle, Washington

Barnett, Harold J.
Recommended procedure for packing live Dungeness crab for air shipment.
BCF/Industry Workshop, Seattle, Washington, November 30.

Dassow, John A.
Current techniques and trends.
Refrigeration Workshop for Large-Boat Operators, Fisheries Research Board of Canada, Canadian Department of Fisheries, Vancouver, British Columbia, December 14.

Dyer, John A.
The Bureau's process for FPC.
Annual Meeting of Pacific Fisheries Technologists, Ocean Shores, Washington, March 19-22.

Considerations for reduction of Salmonella in fish reduction plant operations.
BCF Salmonella Workshop for Fish Meal Industry, Seattle, Washington, May 11.

Eklund, Melvin W.
Review of analytical methods in food microbiology: *Clostridium botulinum.*
Round Table, Annual Meeting of American Society for Microbiology, New York, New York, May 3.

Salmonella in fish reduction plants.
BCF Salmonella Workshop for Fish Meal Industry, Seattle, Washington, May 11.

Growth and toxin production of *Clostridium botulinum* type E and nonproteolytic types B and F in nonirradiated and irradiated fisheries products with temperature ranges of 36° to 72° F.
Seventh Annual Atomic Energy Commission Food Irradiator Contractors Meeting, Washington, D.C., September 27.

Summary of accomplishments: Growth and toxin production of *Clostridium botulinum* type E and nonproteolytic types B and F in nonirradiated and irradiated fisheries products with temperature ranges of 36° to 72° F.
Report to American Institute of Biological Sciences at Seventh Annual Atomic Energy Commission Food Irradiator Contractors Meeting, Washington, D.C., September 28.

Gauglitz, Erich J.
Review of pesticide research at the Seattle Technological Laboratory.
Washington State Interagency Committee

Gauglitz—Con.
on Health Hazards of Pesticides, Olympia, Washington, December 19.

Groninger, Herman S.
Degradation of fishery products: Muscle nucleotidase activity and inhibition during processing and storage.
Annual Meeting of Pacific Fisheries Technologists, Ocean Shores, Washington, March 19-22,

Hall, Alice S.
Career opportunities for women in Federal Government.
Rainier Beach High School Assembly, Seattle, Washington, February 2.

Roosevelt High School, Seattle, Washington, February 13.

Nathan Hale High School, Seattle, Washington, February 13.

Garfield High School, Seattle, Washington, February 15.

West Seattle High School, Seattle, Washington, February 20.

Sealth High School, Seattle, Washington, February 25.

Miyauchi, David.
Summary of accomplishments: Application of radiation-pasteurization processes to Pacific Coast fishery products.
Seventh Annual Atomic Energy Commission Food Irradiator Contractors Meeting, Washington, D.C., September 28.

Nelson, Richard W.
Chilling conditions in handling fresh fishery products—How the chilling conditions are attained.
Ballard High School, Class in Marine Refrigeration, Seattle, Washington, March 7.

Freezing procedures in handling fishery products.
Ballard High School, Class in Marine Refrigeration, Seattle, Washington, March 8.

Air shipping live Dungeness crab.
Annual Meeting of Pacific Fisheries Technologists, Ocean Shores, Washington, March 22.

Plant operations: Quality and sanitation.
FDA/BCF Shellfish Sanitation Workshop for Industry, Eureka, California, November 4.

FDA/BCF Shellfish Sanitation Workshop for Industry, Newport, Oregon, November 7.

Outlook for further research.
BCF/Industry Workshop, Seattle, Washington, November 30.

Patashnik, Max.
Quality effects of freezing and frozen storage of fish.
Ballard High School, Class in Marine Refrigeration, Seattle, Washington, March 8.

Pelroy, Gretchen A.
Radiation pasteurization of fish.
Public Health Service, Basic Radiological Training Course, Seattle, Washington, August 16.

Spinelli, John.
Quality indices used to assess irradiated seafoods.
12th International Congress of Refrigeration and FAO Technical Conference on Freezing and Irradiation of Fish, Madrid, Spain, September 10.

Improving yield and quality of fresh fillets with polyphosphates.
BCF/Industry Workshop, Seattle, Washington, November 30.

Steinberg, Maynard A.
Radiation preservation of foods.
Annual Meeting of Pacific Fisheries Technologists, Ocean Shores, Washington, March 19-22.

Standards and inspection of fishery products.
Annual Meeting of Pacific Fisheries Technologists, Ocean Shores, Washington, March 19-22.

Fish oil program.
Meeting of National Fish Meal and Oil Association, College Park, Maryland, March 28.

FPC—A progress report.
BCF Dinner-Meeting with Industry,

Norselander Restaurant, Seattle, Washington, May 3.

Greenland halibut.
BCF Dinner-Meeting with Industry, Norselander Restaurant, Seattle, Washington, May 3.

Health aspects of fish processing.
BCF/Industry Salmonella Workshop for Fish Meal Industry, Seattle, Washington, June 7.

Fish protein concentrate.
Meeting of Izaak Walton League, Tacoma, Washington, December 22.

Teeny, Fuad M.
Radiation at sea.
Public Health Service, Basic Radiological Training Course, Seattle, Washington, August 16.

Tretsven, Wayne I.
Chilling conditions in handling fresh fishery products—Factors involved in quality changes.
Ballard High School, Class in Marine Refrigeration, Seattle, Washington, March 7.

Progress report—Extending keeping quality of chilled salmon with controlled atmospheres.
BCF/Industry Workshop, Seattle, Washington, November 30.

Technological Laboratory
Terminal Island, California

Crawford, L.
The evaluation of canned tuna.
Tunaboat Refrigeration Conference, Long Beach, California, April 25-26.

Finch, Roland.
Direct contact Freon freezing.
Tunaboat Refrigeration Conference, Long Beach, California, April 25-26.

Physical and operational factors affecting the freezing of tuna.
Tunaboat Refrigeration Conference, Long Beach, California, April 25-26.

Preservation of tuna for canning.
Tunaboat Refrigeration Conference, Long Beach, California, April 25-26.

Symposium on the living resources of the California Current system—The food technologists point of view, food.
California Cooperative Oceanic Fisheries Investigations 30th Annual Conference, Lake Arrowhead, California, December 12.

Food Science Pioneer Research Laboratory
Seattle, Washington

Gruger, E. H.
Aquatic animal lipids and their components.
American Oil Chemists' Society Meeting, New Orleans, Louisiana, May 10.

Natural antioxidants-lipid hydroperoxide interactions.
Seminar, University of California, Davis, California, November 14.

Karrick, N. L.
Pioneer Research Laboratory, BCF program on oxidation in fish and fisheries products.
Annual Meeting of Pacific Fisheries Technologists, Ocean Shores, Washington, March 20.

Malins, D. C.
Biosynthesis of the ether linkage in nature.
University of Aberdeen, Chemistry Department, Aberdeen, Scotland, March 1.

Biosynthesis of plasmalogens from glycerol ethers.
Biochemical Society Meeting, Dublin, Ireland, March 20.

Studies with carbon-14 on the biosynthesis of ether-containing glycerolipids.
Seminar, University of Washington, Seattle, Washington, October 25.

Stansby, Maurice E.
Program of Food Science Pioneer Research Laboratory.
Meeting of National Fish Meal and Oil Association, College Park, Maryland, March 28.

Branch of Reports
Seattle, Washington

Sanford, F. Bruce.
Organizing the technical article.
Seventh Annual Short Course on Technical Writing sponsored jointly by University of Washington and Society of Technical Writers and Publishers, Seattle, Washington, September 20-22.

Heading-introduction technique.
Seventh Annual Short Course on Technical Writing sponsored jointly by University of Washington and Society of Technical Writers and Publishers, Seattle, Washington, September 20-22.

LISTS OF PUBLICATIONS FOR PREVIOUS YEARS

1955-61 Fishery Industrial Research 2(2): 43-48.

1962 Fishery Leaflet 560. (Copies available from the Bureau of Commercial Fisheries Publications, U.S. Fish and Wildlife Service, 1801 North Moore Street, Arlington, Virginia 22209.)

1963 Fishery Leaflet 572. (Copies available from the Bureau of Commercial Fisheries Publications, U.S. Fish and Wildlife Service, 1801 North Moore Street, Arlington, Virginia 22209.)

1964 Fishery Industrial Research 3(1): 9-21.

1965 Fishery Industrial Research 3(4): 47-58.

1966 Fishery Industrial Research 4:151-164.

DIRECTORY

Bureau of Commercial Fisheries
Technological Laboratory
P.O. Box 640
Ann Arbor, Michigan 48107

Bureau of Commercial Fisheries
Technological Laboratory
P.O. Box 128
College Park, Maryland 20740

Bureau of Commercial Fisheries
Technological Laboratory
Emerson Avenue
Gloucester, Massachusetts 01931

Bureau of Commercial Fisheries
Technological Laboratory
622 Mission Street
Ketchikan, Alaska 99901

Bureau of Commercial Fisheries
Technological Laboratory
239 Frederick Street (P.O. Drawer 1207)
Pascagoula, Mississippi 39567

Bureau of Commercial Fisheries
Technological Laboratory
2725 Montlake Boulevard East
Seattle, Washington 98102

Bureau of Commercial Fisheries
Food Science Pioneer Research Laboratory
2725 Montlake Boulevard East
Seattle, Washington 98102

Bureau of Commercial Fisheries
Division of Publications
Building 67, U.S. Naval Air Station
Seattle, Washington 98115

Bureau of Commercial Fisheries
Division of Food Science
U.S. Department of the Interior
Washington, D.C. 20240

MS #1888

CONTENTS

GPO 996-706