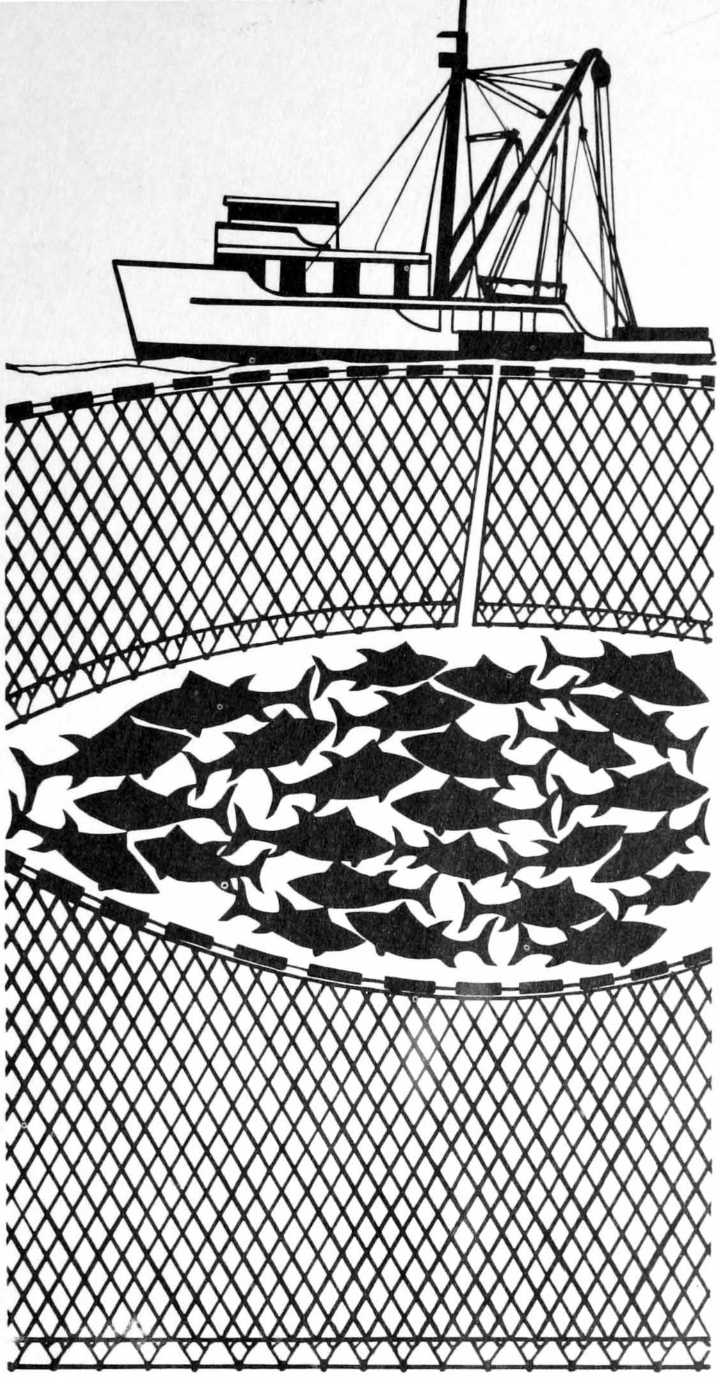

FISHERY INDUSTRIAL RESEARCH

VOLUME 2 NO. 4

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TECHNOLOGICAL INVESTIGATIONS OF POND-REARED FISH. 2--EXTENSION OF THE SHELF LIFE OF BUFFALOFISH PRODUCTS THROUGH USE OF ANTIOXIDANTS

by

R. A. Greig

ABSTRACT

The effectiveness of antioxidants in delaying the onset of rancidity in smoked buffalofish "ribs" and in a reconstituted buffalofish product was studied. Smoked buffalofish ribs were treated with the antioxidant propyl gallate and stored at 33° to 36° and -5° to -1° F. The reconstituted product was treated with either the antioxidant nordihydroguaiaretic acid or Tenox 2 (a commercial mixture of antioxidants) and stored at -5° to -1° F.

By use of a thiobarbituric acid test and of sensory evaluation, the two fish products and appropriate control samples were periodically examined for the development of rancidity. In general, the results indicated significant retardation of rancidity in the treated products and a corresponding increased refrigerated shelf life.

INTRODUCTION

Farmers of the lower Mississippi delta are making a strong effort to utilize the various species of food fish cultivated in the extensive water resources of that area (Johnson, 1959). The predominant species, and thus of greatest interest, is the bigmouth buffalofish (*Ictiobus cyprinellus* Valenciennes).

Various harvesting and marketing problems discourage using this fish for human food. Tiny, floating bones in the fish flesh, the high cost of harvesting and distributing the fish, and the limited marketing area resulting from the fish being sold primarily as a fresh product are examples (Sullivan and Seagran, 1963).

Previous studies indicated that acceptable products of high economic value could be produced from buffalofish and that certain processing techniques could remove the small bones. Smoked ribs and a reconstituted frozen product proved acceptable to consumers and made possible a greater marketing area than the fresh product (Sullivan and Seagran, 1963; McGoodwin, 1963). Effective marketing of the processed product could prove difficult, however, because of its relatively short shelf life. The tendency of the fat to oxidize and develop rancid off-flavors and off-odors was found to be the main factor causing the quality of products held at both frozen-storage (-5° to -1° F.) and refrigerator temperature (36° F.) to deteriorate.

The objective of the present study was to determine the effectiveness of antioxidants in delaying the onset of oxidative rancidity in (1) smoked buffalofish ribs held at frozen-storage and refrigerator temperatures and in (2) reconstituted buffalofish products held at frozen-storage temperatures.

SMOKED BUFFALOFISH RIBS

Preparation of Samples

Sides cut from bigmouth buffalofish (3 to 5 pounds in the round) were purchased from a commercial source in Arkansas.

The fish were fleeced, headed and eviscerated, and then split into whole sides with the backbone removed. The rough whole sides were then packed in crates, iced, and shipped to the laboratory. At the laboratory, the sides were immediately trimmed and cut into rib and dorsal loin sections for subsequent preparation of the smoked rib as described by Sullivan and Seagran (1963).

Before being smoked, the ribs were brined and treated with the antioxident propyl gallate. The ribs were immersed for 1 hour at 68° to 70° F. in 0.4-percent propyl

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gallate made up in a 10° salinometer salt solution (1/1, w/w)[1]. Control smoked ribs also were prepared without the antioxidant. The smoked ribs, both treated and control, then were stored in heat-sealed polyethylene bags at both refrigeration (33° to 36° F.) and frozen-storage (-5° to -1° F.) temperatures.

Methods of Evaluating Rancidity

Chemical.—In the objective estimation of the development of rancidity in the smoked rib products, samples were examined by a 2-thiobarbituric acid (TBA) test (Tarladgis, Watts, Younathan, and Dugan, 1960) to measure the amount of malonaldehyde. Three smoked ribs from each lot were skinned and boned, and the edible flesh was ground five times in a food grinder. Two 5-gram samples (± 0.02 g.) from each lot were distilled. Distillates were reacted with the TBA reagent, and the optical density (O.D.) of the colored malonaldehyde-TBA complex was read on a Bausch and Lomb "Spectronic 20" colorimeter at the wave length at maximum absorbency (525 millimicrons)[2]. TBA values were calculated from optical density measurements according to the procedure of Tarladgis, Watts, Younathan, and Dugan, (1960). The K value employed was 18.74[3].

Sensory.—The smoked ribs held at -5° to -1° F. were thawed in air. These and the smoked ribs held at 33° to 36° F. were then placed uncovered in an oven at 150° F. for 15 minutes.

Four laboratory staff members examined these products for flavor and odor and compared them with fresh samples.

Results and Discussion

Sensory.—Results of the organoleptic evaluations of the smoked ribs (fig. 1) held at 33° to 36° F. (sampled weekly) and those held at -5° to -1° F. (sampled triweekly) were as follows: Control smoked ribs held at 33° to 36° F. became rancid after approximately 3-1/2 weeks. In contrast, smoked ribs treated with propyl gallate and held at 33° to 36° F. had only trace rancidity at 10 weeks. After this time, mold growth was too great for further sensory evaluation.

Control smoked ribs held at -5° to -1° F. lasted 10 weeks, but those treated with propyl gallate had only slight or nonlimiting rancidity after 18 weeks.

TBA.—TBA values for the control smoked ribs stored at 33° to 36° F. increased rapidly and progressively (fig. 2). TBA values for the propyl gallate-treated smoked ribs (held at 33° to 36° F.) did not increase significantly during 13 weeks of storage and were always less than the TBA value obtained with the control after 1 week. TBA values of the control smoked ribs held at -5° to -1° F. showed a significant increase in fat oxidation after 7 weeks. TBA values of the ribs treated with propyl gallate increased in a similar fashion, although at a lesser rate, through 14 weeks, and subsequent examinations indicated that the protective action of the antioxidant was rapidly being lost.

Evaluation of the data indicated that oxidative rancidity in the product held at 33° to 36° F. could be significantly retarded with propyl gallate and that the shelf life could be extended from about 3 weeks to at least 9 weeks. Mold growth, however, limited the shelf life of this product to about 8 weeks of storage. The use of an efficient mold inhibitor, therefore, probably would improve its shelf life. The use of propyl gallate effected only a modest increase in shelf life of the frozen smoked rib product. Generally, TBA data supported sensory evaluations.

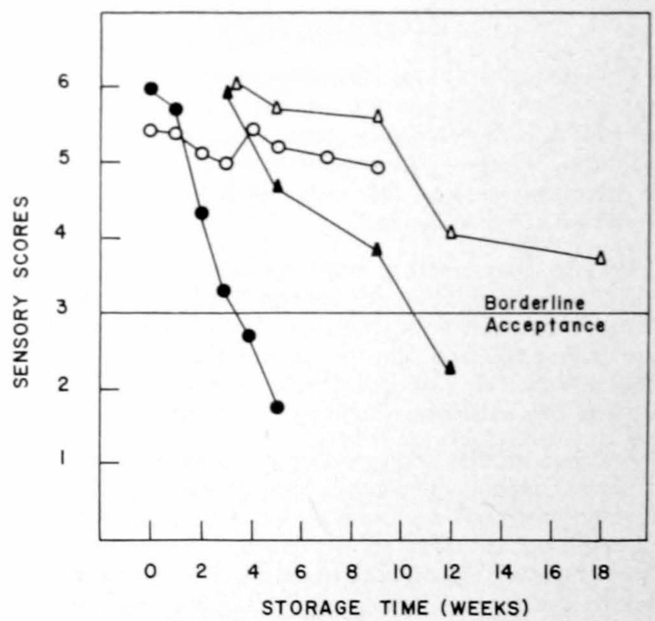

Figure 1.—Results of the sensory evaluation of smoked buffalofish ribs with and without added propyl gallate, stored at 33° to 36° F. and at -5° to -1° F. Sensory scores for degrees of rancidity development based on the following scale: 6 - none, 5 - trace, 4 - slight, 3 - moderate, 2 - strong, and 1 - inedible. Legend: ●——● control ribs stored at 33° to 36° F.; ▲——▲ control ribs stored at -5° to -1° F.; O——O propyl gallate-treated ribs stored at 33° to 36° F.; △——△ propyl gallate-treated ribs stored at -5° to -1° F.

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[1] The treated ribs absorbed from 0.014 percent to 0.019 percent propyl gallate, expressed as percent of the fat content of the ribs (16 percent). These data were obtained from treated samples submitted to Eastman Chemical Co., Kingsport, Tenn.

[2] The determined 525 mμ wave length of maximum absorption was less than reported by Tarladgis, Watts, Younathan, and Dugan, 1960. Spectral curves were therefore determined for the "Spectronic 20", following recalibration of the instrument, using standard, aqueous 1, 1, 3, 3 tetraethoxy propane (TEP) solutions. The resulting colored malonaldehyde-TBA complex also yielded a maximum absorbency at 525 mμ. Subsequently, however, spectral curves for both test and TEP samples were determined using a Beckman DB spectrophotometer (not available during the storage studies). Maximum absorption at 536 mμ was recorded in both cases, which agree well with the published values of 535 to 540 mμ (Tarladgis, Watts, Younathan, and Dugan, 1960).

[3] The value of K = 18.74 was determined from standard curves of known dilutions of TEP, ranging from 1×10^{-8} to 7×10^{-8} moles/5 ml., using the equation:

$$K = \frac{\text{moles TEP/5 ml.}}{\text{O. D.}} \times \text{M. W. malonaldehyde} \times \frac{10^7}{\text{S. W.}} \times \frac{100}{\text{\% recovery}}$$

where the value of the first term (derived from the standard curve) = 8.37×10^{-8}, sample weight (S.W.) = 5g., and recovery = 64.5 percent.

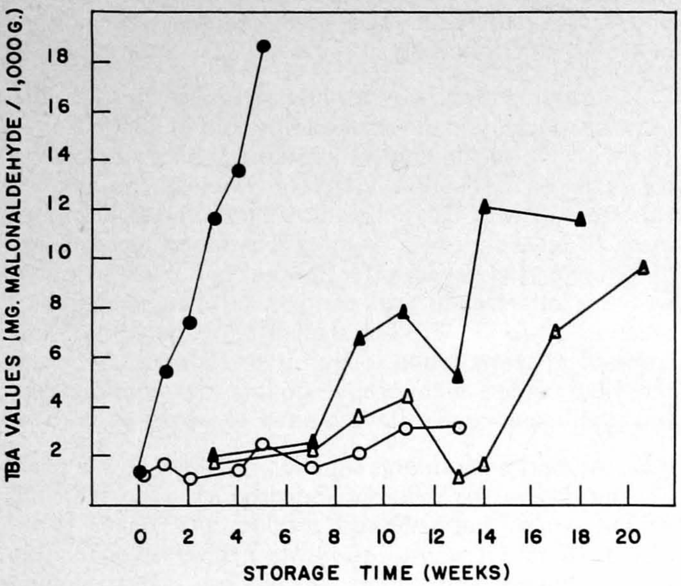

Figure 2.—Results of the TBA test on smoked buffalofish ribs with and without added propyl gallate, stored at 33° to 36° F. and at -5° to -1° F. Legend: ●——● control ribs stored at 33° to 36° F.; ▲——▲ control ribs stored at -5° to -1° F.; O——O propyl galate-treated ribs stored at 33° to 36° F.; △——△ propyl galate-treated ribs stored at -5° to -1° F.

RECONSTITUTED PRODUCTS

Preparation of Samples

The samples were prepared as before, with these exceptions:

After the loin tissue was ground and blended, and the flavoring and binding agents were added, the product was divided into three lots, and antioxidant was added in the following manner:

Lot 1.—Tenox 2[4] was blended into the product at a level of 0.05 percent of the fat content (16 percent) of the fish.

Lot 2.—Nordihydroguaiaretic acid (NDGA) was blended into the product at a level of 0.02 percent of the fat content of the fish. The NDGA was dispersed in 70-percent propylene glycol to facilitate addition.

Lot 3.—Propylene glycol was added to the third lot in the same proportion as to the antioxidant-treated samples. This lot served as a control.

The three lots then were frozen separately into 2-inch-thick commercial-type blocks on a plate freezer (plate temperature: -35° F.). The frozen blocks then were cut with a band saw into 1/2- by 2- by 3-inch portions. These portions were packaged singly in polyethylene bags and held at -5° to -1° F. for subsequent evaluation.

[4] A commercial mixture of butylated hydroxyanisole (20 percent), propyl gallate (6 percent), citric acid (4 percent), and propylene glycol (70 percent). Eastman Chemicals, Kingsport, Tenn.

Chemical.—The chemical tests were the same as those previously described, except that one portion of the reconstituted product for each lot was thawed and used without being ground further.

Sensory.—The sensory tests were the same as those previously described, except that individual portions of the frozen reconstituted product were placed in plastic bags and heated in boiling water for 20 minutes.

Results and Discussion

Sensory.—Control samples (fig. 3) became rancid after 7 weeks, and were rated unacceptable after 10 to 13 weeks of storage. Samples treated with NDGA had off-flavors by 10 weeks and were rated unacceptable after 23 weeks. Samples treated with Tenox 2 had only questionable traces of rancidity after 38 weeks.

TBA.—TBA values (fig. 4) indicated a marked and progressive increase in fat oxidation in the control samples from the outset of the test. TBA values of the samples treated with NDGA progressively increased throughout the test, although much more slowly than for the controls. TBA values of the samples treated with Tenox 2 did not increase significantly during 40 weeks.

TBA results showed that the antioxidants greatly decreased the rate of fat oxidation. Undoubtedly the intimate dispersion of antioxidant throughout the product during mixing is largely the cause of the more pronounced beneficial effects. The protective action of Tenox 2 was particularly effective, suggesting the desirability of using a mixture of antioxidants in systems showing high rates of oxidation. TBA data generally agreed well with sensory evaluations.

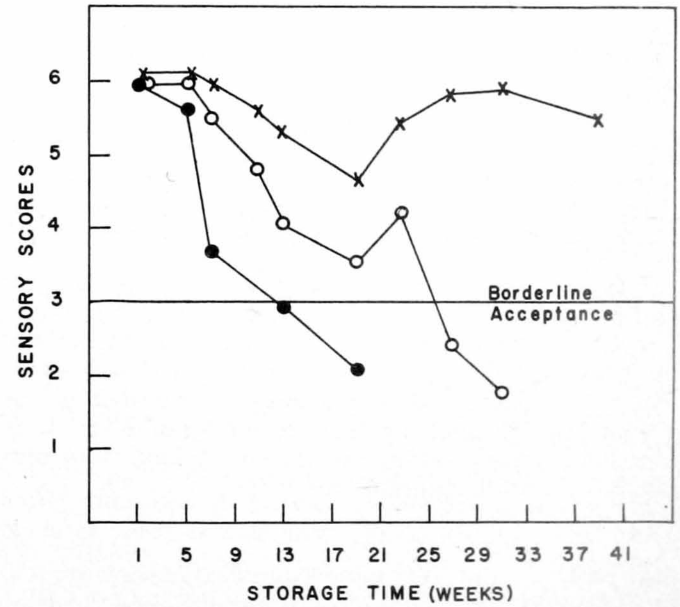

Figure 3.—Results of the sensory evaluation of the reconstituted buffalofish product, with and without added NDGA and Tenox 2, stored at -5° to -1° F. Sensory scores are based on the scale given in figure 1. Legend: ●——● control product; O——O antioxidant (NDGA)-treated product; X——X antioxidant (Tenox 2)-treated product.

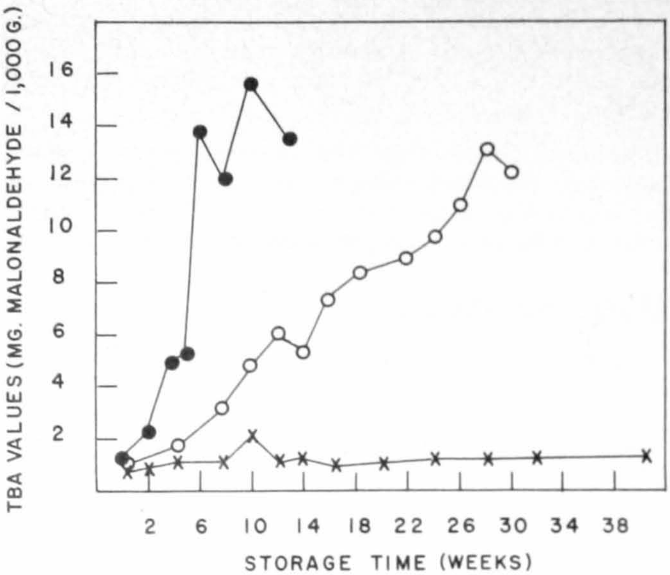

Figure 4.—Results of the TBA test on the reconstituted buffalofish product with and without added NDGA and Tenox 2, stored at -5° to -1° F. Legend: ●——● control product; O——O antioxidant (NDGA)-treated product; X——X antioxidant (Tenox 2)-treated product.

CONCLUSIONS

The studies reported here indicated some differences between antioxidants tested. Differences were also noted, based on how the antioxidant was applied to the product. Selection of a suitably approved antioxidant for the smoked ribs was especially difficult, because the ribs had to be immersed in water containing the antioxidant to allow it to be absorbed by the flesh. (Many antioxidants possess very limited solubility in water.) A more exhaustive examination of various approved antioxidants and methods of application may reveal more effective antioxidants and techniques than those reported in this study.

SUMMARY

Storage studies were conducted on buffalofish products treated with various antioxidants. Smoked ribs and a reconstituted product were the materials utilized.

Smoked buffalo ribs treated with the antioxidant propyl gallate were stored in polyethylene bags at 33° to 36° F. and at -5° to -1° F. Reconstituted buffalofish portions 1/2- by 2- by 3-inch) treated with either the antioxidant nordihydroguaiaretic acid (NDGA) or Tenox 2 were stored in polyethylene bags at -5° to -1° F. Control samples, untreated with antioxidant, were also stored under comparable conditions.

Samples of both products were periodically examined for rancidity by an organoleptic panel and by a thiobarbituric acid (TBA) test. The results of these examinations indicated the following:

1. Propyl gallate significantly retarded the development of rancidity in the smoked ribs held at 33° to 36° F. The shelf life of the control (untreated) smoked ribs was found to be about 3-1/2 weeks, whereas the smoked ribs treated with the antioxidant had a shelf life of at least 10 weeks (growth of mold was found to be a limiting factor, however, after 8 weeks). Propyl gallate was less effective in protecting the frozen smoked ribs held at -5° to -1° F. The shelf life for the control (untreated) ribs was found to be about 10 weeks, whereas the ribs treated with propyl gallate developed slight, but significant, rancid flavors after 18 weeks of storage.

2. Adding antioxidants significantly delayed the onset of rancidity in the reconstituted product. The shelf life of the control reconstituted product was found to be about 10 to 11 weeks, after which time objectionable rancid flavors and odors developed. The samples treated with NDGA did not become objectionably rancid until after 23 weeks of storage, and the samples treated with Tenox 2 showed only trace amounts of rancidity after 40 weeks.

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MS #1395

Note.—Trade names referred to in this publication do not imply endorsement of commercial products.

ECONOMIC ASPECTS OF THE U. S. ALBACORE FISHING INDUSTRY

by

E. A. Hale and D. B. Ferrel

ABSTRACT

This study furnished data and other information on operating costs and on earnings of fishermen producing albacore.

INTRODUCTION

The albacore fishing industry is largely centered in Southern California. Fishermen from Northern California, Oregon, and Washington, however, enter the fishery in Southern California and follow the northern migratory movement of the fish. Because the season for fishing albacore is relatively short, many fishermen supplement their incomes by fishing for other species of tuna and for salmon, mackerel, halibut, and shellfish. Yet, despite the short season, some 3,000 commercial fishermen in 1960 (Power, 1962) obtained a significant proportion of their income from the sale of albacore to the canneries.

One of the problems of the industry is that most of the vessels are old and obsolete. A representative sample taken in this survey shows that only a few vessels were under 5 years old. About 50 percent were 10 to 12 years old, and 20 percent were over 25 years old. Few vessels are being replaced in the fleet. The average vessel owner does not have the money to buy a new vessel because he has been forced to use his depreciation reserve to provide the cash for living expenses.

Many of the vessels are too small and lack the necessary fuel capacity to fish with an adequate margin of safety when the albacore appear 100 to 300 miles offshore. Some fishermen try to make up for this deficiency by loading fuel drums on the deck, but this practice impairs the stability of the vessel by raising the center of gravity. There is also danger that the full drums may break loose from their lashings in rough weather and injure the fishermen or damage the vessel.

The value of the albacore vessels, almost entirely owner-operated, averages about $20,000; however, replacement of these vessels would cost around $30,000 each, or more. If most vessel owners could have their dreams fulfilled, they would replace their present vessels with larger ones that are more efficient in design and performance.

The financial health of the fishery thus is critical. Information is needed to clearly determine the financial aspects of the fishery. This study was therefore designed (1) to furnish statistics on albacore and other tunas and (2) to furnish data on the financial aspects of the Pacific coast albacore fishery.

STATISTICS ON ALBACORE AND OTHER TUNAS

To provide a reference for determining the importance of albacore in relation to the other species of tuna and to the tuna industry as a whole, we give in this section selected statistics from governmental sources. Except for some tables for which data could not be up-dated, statistics cover the period 1945-62.

In the catch of tuna by species, in the Pacific Coast States, albacore contributed 15-20 percent of the total value of catch in most years (table 1).

Albacore constituted a greater percentage of the tuna taken off the States of the Pacific coast than did any other species (table 2).

Author's Note.—E. A. Hale, Ph.D., Department of Marketing, and D. B. Ferrel, M. B. A., C. P. A., Department of Accounting, Division of Business Administration, San Diego State College, San Diego, Calif.

Table 1.—Tuna catch by species, Pacific Coast States, 1945-61

Year	Albacore		Bluefin		Skipjack		Yellowfin		Total	
	Million pounds	*Million dollars*	*Million pounds*	*Million dollars*	*Million pounds*	*Million dollars*	*Million pounds*	*Million dollars*	*Million pounds*	*Million dollars*
1945	39.5	7.7	20.6	2.0	33.3	3.0	87.4	8.7	180.8	21.4
1946	24.1	4.8	22.0	2.2	41.1	4.3	127.2	14.6	214.4	25.9
1947	26.8	6.8	20.8	3.3	52.7	7.6	153.5	23.9	253.8	41.6
1948	49.5	14.7	6.5	1.1	60.6	9.5	199.4	33.4	316.0	58.7
1949	54.8	10.0	4.4	.7	80.5	11.9	190.5	31.0	330.2	53.6
1950	72.5	13.8	2.8	.4	126.8	18.1	187.9	28.8	390.0	61.1
1951	34.5	5.4	3.9	.6	116.6	16.7	161.5	25.0	316.5	47.7
1952	52.6	9.1	4.6	.7	84.8	10.9	178.8	28.3	320.8	49.0
1953	34.7	6.9	9.8	1.6	123.0	16.9	133.3	21.3	300.8	46.7
1954	27.0	5.4	21.0	3.6	153.8	23.3	119.4	20.6	321.2	52.9
1955	29.7	4.8	13.6	1.9	102.8	13.8	123.2	18.9	269.3	39.4
1956	41.3	7.1	12.6	1.6	123.7	14.2	150.9	20.4	328.5	43.3
1957	46.7	6.7	20.3	2.4	90.8	10.0	137.2	18.2	295.0	37.3
1958	38.4	7.9	30.7	4.0	123.4	14.2	123.7	16.7	316.2	42.8
1959	46.3	8.6	15.2	1.9	98.5	10.4	108.4	14.1	268.4	35.0
1960	40.2	5.9	12.0	1.5	46.3	4.8	189.3	23.6	287.8	35.8
1961	32.8	5.9	20.9	2.7	65.4	7.2	191.9	24.4	311.0	40.2

Source: U. S. Fish and Wildlife Service, Fishery Statistics of the United States, Washington, D. C.

Table 2.—Tuna catch by species and area of capture, Pacific Coast States, 1945-61

Year	Albacore		Bluefin		Skipjack		Yellowfin		Total	
	Off Pacific Coast States	Off Latin America	Off Pacific Coast States	Off Latin America	Off Pacific Coast States	Off Latin America	Off Pacific Coast States	Off Latin America	Off Pacific Coast States	Off Latin America
	Million pounds									
1945	27.2	12.3	14.1	6.7	.1	33.3	[1]	87.4	41.4	139.4
1946	15.2	9.0	15.5	6.5	1.8	39.3	[1]	127.2	32.5	182.0
1947	21.1	5.8	14.7	6.1	.9	51.8	[1]	153.5	36.7	217.2
1948	[2]23.6	25.9	1.7	4.9	.3	60.2	[1]	199.4	25.6	290.4
1949	31.2	23.6	2.3	2.1	[1]	80.5	[1]	190.5	33.5	296.7
1950	[2]48.9	23.6	[1]	2.7	2.3	124.5	6.5	181.4	57.7	332.2
1951	16.9	17.6	.8	3.0	.7	115.9	1.2	160.3	19.6	296.8
1952	25.9	26.7	.9	3.7	.1	84.7	.4	178.4	27.3	293.5
1953	14.2	20.5	3.9	5.9	.7	122.3	1.2	132.1	20.0	280.8
1954	15.2	11.8	5.6	15.4	[1]	153.7	--	119.4	20.8	300.3
1955	10.0	19.7	2.7	10.9	1.0	101.9	.9	122.3	14.6	254.8
1956	20.3	21.1	2.6	10.0	3.6	120.1	1.6	149.3	28.1	300.5
1957	25.7	20.9	10.5	9.8	.7	90.2	.4	136.9	37.3	257.8
1958	26.5	.7	15.3	15.4	2.4	120.4	.4	123.0	44.6	259.5
1959	32.7	--	13.0	2.2	1.4	97.1	.1	108.3	47.2	207.6
1960	32.1	3.0	4.4	7.6	[1]	46.3	[1]	189.3	36.5	246.2
1961	32.8	8.4	20.9	7.1	65.4	65.4	191.9	191.9	311.0	272.8

[1] Less than 100,000 pounds.
[2] Includes Alaska catch.
Source: U. S. Fish and Wildlife Service, Fishery Statistics of the United States, Washington, D. C.

The quantity of imported loins and discs is increasing rapidly (table 3). This increase may indicate a trend for less and less round-frozen albacore to be imported.

Imports of tuna during 1957 were greater for albacore (see table 3) than for other tuna species (tables 3 and 4). This fact emphasizes the importance of imports to the albacore fisherman.

Imports of albacore are double the domestic production; imports of other tuna are only one-third the domestic production (table 5).

Table 6 reports the U. S. supply of canned tuna during 1945-57.

Table 3.—U. S. imports of fresh and frozen albacore, 1945-62

Year	Received as whole fish, round weight	Loins and discs		Total round weight
		As received	Round weight[1]	
	Million pounds			
1945	--	--	--	--
1946	--	--	--	--
1947	--	--	--	--
1948	[2]2.4	--	--	2.4
1949	2.8	--	--	2.8
1950	[3]14.7	--	--	14.7
1951	32.1	[4]	.1	32.2
1952	39.7	.1	.3	40.0
1953	63.2	.4	1.0	64.2
1954	[5]56.1	.8	1.8	57.9
1955	[5]68.6	2.0	4.6	73.2
1956	[5]40.2	5.4	12.3	52.5
1957	[5]65.2	12.4	28.0	93.2
1958	51.6	N. A.	N. A.	N. A.
1959	52.0	N. A.	N. A.	N. A.
1960	69.8	1.8	4.1	73.9
1961	71.9	3.1	7.0	78.9
1962	83.9	1.7	3.8	87.7

[1] Loins and discs have been converted to round weight by mutiplying by 2.25.

[2] Represents total imports of tuna from Japan during these years.

[3] As reported in U. S. foreign dispatch number 700, Tokyo, dated January 11, 1957.

[4] Less than 1 million pounds.

[5] Reported imports of albacore from Japan and other countries.

N.A. = Data not available.

Source: U. S. Fish and Wildlife Service, Fishery Statistics of the United States, Washington, D. C.

In comparing the relative importance of imports, we must take into account the cases of canned product that can be derived from each product. According to the U. S. Tariff Commission, the yield from 1 ton of raw fish from each species of tuna varies from 39 to 49 cases (table 7).

Using skipjack as the basis (skipjack = 100), we obtain the following relative yields: albacore, 126; bluefin, 113; and yellowfin, 110.

Thus, in terms of canned-product equivalent, imports of albacore are greater by as much as 26 percent (assuming all imports to be skipjack tuna) or 14 percent (assuming all imports to be yellowfin tuna). Since (1) most albacore is canned as solid pack, (2) most skipjack and yellowfin are canned as chunk pack, and (3) canned albacore commands a premium price over the light-meat tunas, the importance of the albacore imports is even greater.

Table 4.—U. S. imports of fresh and frozen tuna, other than albacore, 1945-57

Year	Adjusted imports minus albacore round weight	Gilled and gutted		Total round weight
		As received	Round weight[1]	
	Million pounds			
1945	[2]1.8	--	--	1.8
1946	[2]1.4	--	--	1.4
1947	[2]2.6	--	--	2.6
1948	[2]3.0	--	--	3.0
1949	[2]7.1	--	--	7.1
1950	[2]28.9	--	--	28.9
1951	[2]26.9	--	--	26.9
1952	29.5	--	--	29.5
1953	31.9	--	--	31.9
1954	63.4	[3]4.2	4.7	68.1
1955	32.6	[3]44.0	49.3	81.9
1956	21.5	[3]58.5	65.5	87.0
1957	24.7	49.4	55.3	80.0

[1] Converted on the basis of gilled and gutted representing 1.12 percent of the round weight of the fish.

[2] During the years 1945-51 we estimate that only 10 percent of the receipts from Costa Rica and 40 percent of those from the Canal Zone represented actual imports. The remainder is considered to represent shipments taken by U. S. fishing craft.

[3] Estimated.

Source: U. S. Fish and Wildlife Service, Fishery Statistics of the United States, Washington, D. C.

Table 5.—U. S. supply of fresh and frozen tuna, 1945-57

Year	Albacore			Other tuna			Total
	Domestic catch [1]	Imports [2]	Total	Domestic catch [1]	Imports [2]	Total	
	Million pounds						
1945	39.5	--	39.5	143.1	1.8	144.9	184.4
1946	24.1	--	24.1	192.0	1.4	193.4	217.5
1947	26.8	--	26.8	228.9	2.6	231.5	258.3
1948	49.4	2.4	51.8	270.1	3.0	273.1	324.9
1949	54.8	2.8	57.6	278.9	7.1	286.0	343.6
1950	72.4	14.7	87.1	319.0	28.9	347.9	435.0
1951	34.5	32.2	66.7	284.4	26.9	311.3	378.0
1952	52.6	40.0	92.6	270.1	29.5	299.6	392.2
1953	34.7	64.2	98.9	268.1	31.9	300.0	398.9
1954	27.0	57.9	84.9	295.7	68.1	363.8	448.7
1955	29.8	73.2	103.0	240.6	81.9	322.5	425.5
1956	41.3	52.5	93.8	288.2	87.0	375.2	469.0
1957	46.7	93.2	139.9	250.1	80.0	330.1	470.0

[1] Data do not include the catch landed in Hawaii or Puerto Rico.

[2] Round weight basis. Does not include receipts into American Samoa.

Source: U. S. Fish and Wildlife Service, Fishery Statistics of the United States, Washington, D. C.

Table 6.—U. S. supply of canned tuna, 1945-57

Year	U. S. pack					Imported pack		Total
	From domestic catch		From imported fish [1]		Total			
	Million pounds	*Percent*	*Million pounds*	*Percent*	*Million pounds*	*Million pounds*	*Percent*	*Million pounds*
1945	86.5	93.5	0.7	0.8	87.2	[2]5.3	5.7	92.5
1946	89.6	94.4	0.6	0.6	90.2	[2]4.8	5.0	95.0
1947	107.4	93.7	1.1	0.9	108.5	[2]6.2	5.4	114.7
1948	129.6	92.2	2.6	1.9	132.2	[2]8.3	5.9	140.5
1949	134.0	93.6	4.6	3.2	138.6	4.6	3.2	143.2
1950	152.7	72.6	20.8	9.9	173.5	36.8	17.5	210.3
1951	125.8	74.7	29.5	17.6	155.3	13.0	7.7	168.3
1952	140.2	70.6	35.0	17.6	175.2	23.3	11.8	198.5
1953	135.9	61.8	49.6	22.5	185.5	34.6	15.7	220.1
1954	148.8	60.9	64.2	26.2	213.0	31.6	12.9	244.6
1955	113.4	48.9	83.0	35.8	196.4	35.6	15.3	232.0
1956	152.5	56.9	77.0	28.8	229.5	38.2	14.3	267.7
1957	139.7	50.5	92.8	33.5	232.5	44.2	16.0	276.7

[1] Includes pack canned in American Samoa.

[2] Includes bonito and yellowtail.

Source: U. S. Fish and Wildlife Service, Fishery Statistics of the United States, Washington, D. C.

Table 7.—Yield from 1 ton of raw fish, 1957

Species	Yield
	Cases[1]
Albacore	49
Bluefin	44
Yellowfin	43
Skipjack	39

[1] 48 cans, 7 ounces each.

Imports of canned tuna in oil and brine have been increasing in recent years (table 8). Tuna canned in brine is permitted to enter the United States at a substantially lower tariff than is tuna canned in oil.

According to data prepared by the U. S. Tariff Commission, albacore is the most important canned tuna import (table 9).

Table 8.—U. S. imports of canned tuna, 1945-61

Year	Quantity		Total
	Canned in oil	Canned in brine	
	Million pounds		
1945	[1]5.3	--	[1]5.3
1946	[1]4.7	--	4.7
1947	[1]6.1	--	6.1
1948	[1]8.3	(2)	8.3
1949	4.5	0.1	4.6
1950	36.4	0.4	36.8
1951	3.6	9.4	13.0
1952	4.3	19.0	23.3
1953	4.7	29.9	34.6
1954	1.1	30.5	31.6
1955	0.8	34.7	35.5
1956	0.6	37.6	38.2
1957	1.1	43.2	44.3
1958	.8	45.4	46.2
1959	.8	55.3	56.1
1960	.6	51.2	51.8
1961	.4	58.2	58.6

[1] Prior to 1948 imports of bonito and yellowtail were included with those of tuna. In 1948 part of the bonito and yellowtail was included with tuna.

Source: U. S. Fish and Wildlife Service, Fishery Statistics of the United States, Washington, D. C.

FINANCIAL ASPECTS OF THE PACIFIC COAST ALBACORE FISHERY

In this section, we first summarize the financial status of the industry and then give the detailed findings by which we arrived at our conclusions. In these more detailed parts of the section, we state the general problem and the limitations of the work and then discuss income and expense.

FINANCIAL SUMMARY

Classification of Data

Boats.—Boats primarily engaged in the Pacific coast albacore fishing were classified in three ways: (1) by method of fishing—whether they were jig boats or bait boats, (2) by boat lengths, and (3) by whether they were fishing for albacore only or for albacore and other fish. For all classifications, we made comparative analyses of average income and expenses and cost per pound to catch albacore.

Income.—Income consisted of receipts from sales of albacore and other fish. Boat owners made additional income by extending the length of the fishing season and entering other fisheries, such as those for salmon, tuna (other than albacore), and fresh-market fish.

Table 9.—Imports of canned tuna into the United States by 35 importers (1955, 1956, and January-September 1957 listed)

Item	Quantity			Foreign value			Unit value		
	1955	1956	Jan.-Sept. 1957	1955	1956	Jan.-Sept. 1957	1955	1956	Jan.-Sept. 1957
	Milion pounds			*Million dollars*			*Cents per pound*		
Tuna in brine:									
Albacore:									
Solid pack:									
7-oz. cans	5.8	8.8	7.2	2.6	3.9	3.1	45.0	44.7	43.4
13-oz. cans	2.0	2.6	2.3	.9	1.1	1.0	44.0	43.8	43.4
66½-oz. cans	5.4	5.8	4.7	2.2	2.4	1.9	41.9	41.1	40.1
All other	.3	.3	.2	.1	.1	.1	36.2	36.6	32.9
Flake	.2	.3	.2	.1	.1	.1	34.0	33.6	32.2
Other than albacore:									
Solid pack:									
7-oz. cans	3.8	4.9	4.2	1.5	1.8	1.6	38.4	37.3	37.3
13-oz. cans	.8	1.1	1.1	.3	.4	.4	37.5	37.2	37.3
66½-oz. cans	3.0	4.4	3.2	1.1	1.5	1.1	35.9	34.1	35.4
All other	.2	.2	.1	.1	.1	[1]	31.3	29.7	32.9
Flake	.1	.2	.1	.1	.1	[1]	24.5	29.5	32.0
Tuna in oil	.2	[2].1	.1	.1	[2].1	[1]	38.6	[2]112.7	31.9
Tuna total	21.6	28.6	23.3	8.9	11.6	9.3	41.0	40.6	40.0

[1] Less than $1,000.

[2] Includes 96,000 pounds, valued at $129,000, with a unit value of 134.4 cents per pound, reported by one importer.

Source: U. S. Tariff Commission, 1958. Tunafish report on investigation pursuant to a resolution by the Committee on Finance of the United States Senate dated August 20, 1957, 93 p. + 77 tables.

Table 10.—Average income and expense for boats in Pacific coast albacore fishery

Item	Jig boats			Bait boats			All boats		
	1956 (26 boats)	1957 (31 boats)	1958 (38 boats)	1956 (9 boats)	1957 (10 boats)	1958 (9 boats)	1956 (35 boats)	1957 (41 boats)	1958 (47 boats)
Catch receipts	$13,317	$11,552	$10,758	$15,865	$19,749	$22,059	$13,972	$13,551	$12,922
Expenses:									
Trip	3,638	3,167	2,643	7,512	7,878	9,131	4,634	4,316	3,886
Other boat	4,502	4,624	4,545	4,817	7,119	7,415	4,583	5,233	5,094
Total	8,140	7,791	7,188	12,329	14,997	16,546	9,217	9,549	8,980
Net income	5,177	3,761	3,570	3,536	4,752	5,513	4,755	4,002	3,942
Average price per ton	N. A.	N. A.	N. A.	N. A.	N. A.	N. A.	343	289	411

N. A. = Data not available.

Expenses.—Expenses are presented under two classifications: (1) trip and (2) other boat expenses. Trip expenses include: labor, fuel, food, provisions, bait, and ice[1]. Other boat expenses include: (1) repairs and maintenance of the hull, motor, and equipment; (2) insurance, depreciation, licenses, taxes, interest, moorage costs, fishing gear, supplies, truck, and auto expense; and (3) cooperative assessments.

The summary in table 10 presents a comparison of jig boats with bait boats by averages for all boats reporting. Table 11 presents comparable data gathered by the U. S. Tariff Commission.

Overall View of Financial Aspects

Average income for 1956-58.—The average income for all boats was $4,755 in 1956, $4,002 in 1957, and $3,942 in 1958. These amounts do not include any payment to the owner of the boat for his labor nor do they include any provision for a return on capital invested. In some instances, there were two owners

[1] Trip expenses include cost of foreign country permits in some instances.

Table 11.—Average income and expense, Pacific coast albacore jig boats[1]

Item	1956 (163 boats)	1957 (135 boats)
Catch receipts	$14,020	$14,018
Expenses:		
Fuel	983	1,138
Repairs	1,814	2,044
Bait and ice	328	308
Food	649	805
Depreciation	1,523	1,588
Taxes	155	178
Interest	125	204
Labor	2,279	2,700
Other vessel expense	914	995
Other business expense	230	293
Total	9,000	10,253
Net income	5,020	3,765

[1] Typical jig-boat operations, comparable to those of the boats included in the present study, are included. Segregation of bait-boat data was not possible and was omitted.

Source: U. S. Tariff Commission, Tuna Fish, August 20, 1957, and May 1958. (Adaptation.)

operating a boat; in other instances, a husband and wife; many boats were operated by a single owner.

Catch receipts.—The catch receipts and the net income of jig boats declined steadily from 1956 through 1958. During the same period, bait boats increased their catch receipts and their net income. Both trip and other boat expenses increased steadily for bait boats. The 39.0 percent increase of catch receipts from 1956 through 1958 as compared to the 34.2-percent increase of total expense from 1956 through 1958 reflects an increased effort that produced a higher net income.

Boats engaged in two or more fisheries.—Further analysis of financial data reveals that boats that engaged in two or more fisheries had a lower cost per pound for catching albacore than did the boats that fished for albacore only. Engaging in two fisheries prolonged the fishing season and thus produced a larger amount of income from catch receipts. A portion of the semifixed expenses—such as repairs and maintenance of hull, of motor, and of equipment, and depreciation, taxes, and other expenses—thus were absorbed by the second fishery and reduced the amount chargeable to albacore fishing.

Financial health of the industry.—The financial condition of the albacore fishery is critical. Table 12 illustrates that the average boat owner was required to use capital funds (depreciation) to obtain sufficient annual income.

Table 12.—Use of depreciation funds

Item	1956	1957	1958
Average net income for all boats reporting[1]	$4,755	$4,003	$3,942
Average annual depreciation claimed (recovery of capital invested)	1,336	1,397	1,268
Funds available	6,091	5,400	5,210
Estimated average annual earnings if employed on shore	6,000	6,000	6,000
Difference between actual earnings and potential earnings ashore	91	- 600	- 790

[1] Fishery earnings do not provide for a return on capital invested or a provision for boat replacement.

GENERAL STATEMENT OF PROBLEM AND LIMITATIONS

Boats

Classification.—Conferences with representatives of industry leaders, cooperative officers and managers, and individual boat owners reflected a need to differentiate between profitability and efficiency of jig and bait boats. The distinction stems from the method of fishing, rather than from physical characteristics of the boat. On a jig boat, the fishermen use several troll lines; on a bait boat, they attract the fish by throwing out live bait (chum) and then take the fish by pole and line. Bait boats require larger crews than jig boats.

Operations.—Boat operators do not confine their activity to specific areas but go wherever fish are found. The location changes daily and yearly.

Productive comparisons.—To relate productivity to size of boat, we classified boats by length, as follows:

- Under 40 feet.
- 40 feet through 44 feet.
- 45 feet through 49 feet.
- 50 feet through 60 feet.

The use of length rather than carrying capacity was chosen because (1) carrying capacity increases with boat length and (2) information on length was found to be more accurate than estimates of carrying capacity.

Computing Cost Per Pound

Analysis of the data showed the need to compute cost per pound to catch albacore, not only for jig and bait fishing, but also for boats fishing for albacore and other fish.

Selection of Time Period

To obtain information from the individual fisherman, we considered the 3-year period 1956-58 to be sufficient.[2]

Source of Financial Data

Voluntary nature.—The fisherman was the source of information on financial data. The research group depended on his cooperation for information needed for analysis and interpretation. Collection of financial information was complicated by some boat owners failing to supply adequate data.

This study does not include information about tuna clippers and purse seiners that fish primarily for skipjack, yellowfin, and bluefin but that may make one or possibly two trips a year for albacore.

Fishermen interviewed.—During the research, fishermen were interviewed. Information resulting from these interviews greatly aided us to understand the problems of the industry and to interpret the data in the returned questionnaires (tables 13-24).

Data on specific boats.—Although the States of California, Oregon, and Washington collect data for every pound of fish caught and sold for each boat, we were unable to obtain this information for specific boats. Various State laws do not permit the disclosure of such information unless the information is given by the boat owner himself.

[2] Information on part-time fishermen—that is, people on vacations or on boats not primarily engaged in albacore fishing—were not included in the tabulations.

Table 13.—Income and expenses for Pacific coast albacore boats (under 40′ in length), 1956

Item	Jig boats															Bait boats				
	A-38′	B-38′	C-34′	D-39′	E-39′	F-36′	G-34′	H-33′	I-35′	J-34′	K-37′	L-39′	M-36′	N-38′	Total (7)	O-38′	P-38′	Q-38′	R-38′	Total (4)
Catch receipts:																				
Albacore	$8,226	$11,506	$8,395	$6,700	$696	N. A.	N. A.	$899	N. A.	N. A.	N. A.	N. A.	N. A.	$10,670	$47,092	$7,175	$13,406	$17,417	$19,269	$57,267
Other fish	875	----	----	----	----	----	----	----	----	----	----	----	----	----	875	5,864	----	----	----	5,864
Total	9,101	11,506	8,395	6,700	696	----	----	899	----	----	----	----	----	10,670	47,967	13,039	13,406	17,417	19,269	63,131
Expenses:																				
Trip expenses — albacore:																				
Labor	----	50	----	----	443	----	----	----	----	----	----	----	----	1,588	2,081	2,164	3,168	3,751	6,968	16,051
Fuel and lubricants	676	1,197	475	460	343	----	----	115	----	----	----	----	----	695	3,961	330	481	1,210	937	2,958
Food and provisions	528	437	175	370	462	----	----	128	----	----	----	----	----	543	2,643	596	483	1,776	600	3,455
Foreign country permits	916	----	----	----	----	----	----	----	----	----	----	----	----	----	916	588	527	548	816	2,479
Bait and ice	244	----	125	428	----	----	----	----	----	----	----	----	----	----	797	69	266	417	189	941
Miscellaneous	----	----	----	116	----	----	----	----	----	----	----	----	----	----	116	----	----	----	----	----
Total	2,364	1,684	775	1,374	1,248	----	----	243	----	----	----	----	----	2,826	10,514	3,747	4,925	7,702	9,510	25,884
Trip expenses — other fish:																				
Labor	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	760	----	----	----	760
Fuel and lubricants	147	----	----	----	----	----	----	----	----	----	----	----	----	----	147	604	----	----	----	604
Food and provisions	115	----	----	----	----	----	----	----	----	----	----	----	----	----	115	592	----	----	----	592
Foreign country permits	95	----	----	----	----	----	----	----	----	----	----	----	----	----	95	701	----	----	----	701
Bait and ice	16	----	----	----	----	----	----	----	----	----	----	----	----	----	16	69	----	----	----	69
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	373	----	----	----	----	----	----	----	----	----	----	----	----	----	373	2,726	----	----	----	2,726
Other boat expenses:																				
Repair and maintenance	2,309	2,102	1,000	900	218	----	----	889	----	----	----	----	----	1,265	8,683	1,522	1,226	2,372	982	6,102
Insurance	----	----	375	----	636	----	----	----	----	----	----	----	----	950	1,961	----	1,014	894	1,528	3,436
Licenses and taxes on boat	----	269	49	75	106	----	----	80	----	----	----	----	----	125	704	196	220	268	231	915
Payroll and other taxes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	134	211	----	146	491
Interest	----	----	----	----	190	----	----	----	----	----	----	----	----	----	190	----	----	----	298	298
Depreciation	1,560	----	815	----	139	----	----	261	----	----	----	----	----	1,873	4,648	577	1,087	600	600	2,864
Moorage	----	----	----	----	----	----	----	85	----	----	----	----	----	----	85	81	101	----	----	182
Truck and auto	----	----	----	----	----	----	----	----	----	----	----	----	----	500	500	----	331	188	----	519
Fishing gear	417	----	----	125	----	----	----	----	----	----	----	----	----	----	542	490	452	350	316	1,608
Assessments - cooperatives	----	----	----	----	30	----	----	----	----	----	----	----	----	----	30	176	226	----	400	802
Supplies	----	----	----	----	122	----	----	----	----	----	----	----	----	----	122	----	----	----	----	----
Miscellaneous	606	410	1,090	----	----	----	----	176	----	----	----	----	----	365	2,647	----	----	950	----	950
Total	4,892	2,781	3,329	1,100	1,441	----	----	1,491	----	----	----	----	----	5,078	20,112	3,176	4,868	5,622	4,501	18,167
Total expenses	7,629	4,465	4,104	2,474	2,689	----	----	1,734	----	----	----	----	----	7,904	30,999	9,649	9,793	13,324	14,011	46,777
Net income or (loss)	[1] 1,472	7,041	4,291	4,226	(1,993)	----	----	(835)	----	----	----	----	----	2,766	16,968	3,390	3,613	4,093	[2] 5,258	16,354

[1] Two owners on boat.

[2] No owners on boat.

N. A. Data not available.

Table 14.—Income and expenses for Pacific coast albacore boats (under 40' in length), 1957

Total	Jig boats															Bait boats				
	A-38'	B-38'	C-34'	D-39'	E-39'	F-36'	G-34'	H-33'	I-35'	J-34'	K-37'	L-39'	M-36'	N-38'	Total (8)	O-38'	P-38'	Q-38'	R-38'	Total (4)
Catch receipts:																				
Albacore	$7,394	$9,387	$8,059	$5,400	$2,639	N. A.	$5,445	N. A.	N. A.	N. A.	N. A.	N. A.	$10,500	$10,922	$59,746	$5,921	$15,159	$22,390	$6,339	$49,809
Other fish	----	358	----	----	----	----	----	----	----	----	----	----	1,500	----	1,858	4,100	----	----	----	4,100
Total	7,394	9,745	8,059	5,400	2,639	----	5,445		----	----	----	----	12,000	10,922	61,604	10,021	15,159	22,390	6,339	53,909
Expenses:																				
Trip expenses — albacore:																				
Labor	----	40	----	----	571	----	----	----	----	----	----	----	----	945	1,556	1,625	4,441	3,713	2,282	12,061
Fuel and lubricants	570	1,146	590	460	484	----	749	----	----	----	----	----	600	900	5,499	306	575	1,027	1,017	2,925
Food and provisions	385	601	200	375	1,020	----	574	----	----	----	----	----	500	521	4,176	377	648	1,297	618	2,940
Foreign country permits	456	----	----	60	----	----	----	----	----	----	----	----	----	----	516	191	543	614	585	1,933
Bait and ice	82	----	125	428	----	----	----	----	----	----	----	----	----	----	635	69	217	156	81	523
Miscellaneous	----	----	----	126	----	----	----	----	----	----	----	----	----	----	126	----	----	----	----	----
Total	1,493	1,787	915	1,449	2,075	----	1,323	----	----	----	----	----	1,100	2,366	12,508	2,568	6,424	6,807	4,583	20,382
Trip expenses — other fish:																				
Labor	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	785	----	----	----	785
Fuel and lubricants	----	44	----	----	----	----	----	----	----	----	----	----	185	----	229	273	----	----	----	273
Food and provisions	----	23	----	----	----	----	----	----	----	----	----	----	250	----	273	418	----	----	----	418
Foreign country permits	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	551	----	----	----	551
Bait and ice	----	----	----	----	----	----	----	----	----	----	----	----	75	----	75	69	----	----	----	69
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	----	67	----	----	----	----	----	----	----	----	----	----	510	----	577	2,096	----	----	----	2,096
Other boat expenses:																				
Repair and maintenance	1,507	2,152	1,653	900	537	----	1,913	----	----	----	----	----	620	1,607	10,889	1,294	1,707	1,805	1,857	6,663
Insurance	----	----	307	----	----	----	----	----	----	----	----	----	843	950	2,100	----	815	1,149	1,159	3,123
Licenses and taxes on boat	----	251	49	75	34	----	20	----	----	----	----	----	115	126	670	183	220	165	135	703
Payroll and other taxes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	67	220	125	128	540
Interest	----	----	----	----	245	----	----	----	----	----	----	----	353	----	598	----	----	25	330	355
Depreciation	1,893	----	701	----	334	----	191	----	----	----	----	----	1,013	1,273	5,405	577	1,040	----	600	2,217
Moorage	----	----	----	----	----	----	----	----	----	----	----	----	35	----	35	75	95	----	----	170
Truck and Auto	----	----	----	----	----	----	346	----	----	----	----	----	----	500	846	----	369	279	----	648
Fishing gear	715	----	----	125	----	----	----	----	----	----	----	----	1,050	----	1,890	146	838	978	119	2,081
Assessments - cooperatives	----	----	----	----	----	----	106	----	----	----	----	----	----	----	106	169	309	----	151	629
Supplies	----	----	----	----	265	----	----	----	----	----	----	----	----	----	265	174	----	----	----	174
Miscellaneous	735	669	1,000	----	----	----	216	----	----	----	----	----	----	365	2,985	----	50	1,835	----	1,885
Total	4,850	3,072	3,710	1,100	1,415	----	2,792	----	----	----	----	----	4,029	4,821	25,789	2,685	5,663	6,361	4,479	19,188
Total expenses	6,343	4,926	4,625	2,549	3,490	----	4,115	----	----	----	----	----	5,639	7,187	38,874	7,349	12,087	13,168	9,062	41,666
Net income or (loss)	[1]1,051	4,819	3,434	2,851	(851)	----	1,330	----	----	----	----	----	6,361	3,735	22,730	2,672	[2]3,072	9,222	[3](2,723)	12,243

[1] Two owners on boat.

[2] Owner on boat for three of five trips.

[3] No owner on boat.

N.A. = Data not available.

Table 15.—Income and expenses for Pacific coast albacore boats (under 40′ in length), 1958

Item	Jig boats															Bait boats				
	A-38′	B-38′	C-34′	D-39′	E-39′	F-36′	G-34′	H-33′	I-35′	J-34′	K-37′	L-39′	M-36′	N-38′	Total (12)	O-38′	P-38′	Q-38′	R-38′	Total (4)
Catch receipts:																				
Albacore	$2,644	$7,449	$6,152	N. A.	N. A.	$2,182	$3,771	$694	$9,317	$3,847	$7,000	$6,885	$13,000	$6,744	$69,685	$4,566	$17,739	$23,399	$11,073	$56,777
Other fish	2,304	1,375	----	----	----	----	1,046	----	----	----	4,000	2,336	2,570	----	13,631	6,706	----	----	----	6,706
Total	4,948	8,824	6,152	----	----	2,182	4,817	694	9,317	3,847	11,000	9,221	15,570	6,744	83,316	11,272	17,739	23,399	11,073	63,483
Expenses:																				
Trip expenses — albacore:																				
Labor	----	58	----	----	----	150	----	----	----	634	1,750	1,000	----	625	4,217	919	6,706	5,957	4,587	18,169
Fuel and lubricants	394	734	320	----	----	440	710	64	447	723	750	318	700	597	6,197	111	692	1,054	496	2,353
Food and provisions	211	380	125	----	----	900	387	100	600	296	600	155	600	465	4,719	217	777	999	839	2,832
Foreign country permits	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	150	140	----	290
Bait and ice	31	----	125	----	----	----	7	----	276	----	315	----	----	----	754	46	261	293	105	705
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	636	1,172	570	----	----	1,490	1,104	164	1,323	1,653	3,415	1,473	1,200	1,687	15,887	1,293	8,586	8,443	6,027	24,349
Trip expenses — other fish:																				
Labor	----	----	----	----	----	----	----	----	----	----	1,000	733	----	----	1,733	1,695	----	----	----	1,695
Fuel and lubricants	411	136	----	----	----	----	75	----	----	----	300	354	140	----	1,416	661	----	----	----	661
Food and provisions	310	70	----	----	----	----	----	----	----	----	600	----	250	----	1,230	940	----	----	----	940
Foreign counry permits	449	----	----	----	----	----	----	----	----	----	----	----	----	----	449	943	----	----	----	943
Bait and ice	47	----	----	----	----	----	150	----	----	----	150	----	85	----	432	92	----	----	----	92
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	1,217	206	----	----	----	----	225	----	----	----	2,050	1,087	475	----	5,260	4,331	----	----	----	4,331
Other boat expenses:																				
Repair and maintenance	1,626	2,644	1,078	----	----	3,749	1,019	342	1,904	429	851	790	2,850	957	18,239	597	1,004	2,417	1,361	5,379
Insurance	----	----	308	----	----	421	----	----	845	----	----	----	1,000	950	3,524	----	937	803	1,125	2,865
Licenses and taxes on boat	----	288	49	----	----	116	25	29	45	81	83	18	115	253	1,102	184	220	151	133	688
Payroll and other taxes	----	----	----	----	----	----	----	----	----	----	----	106	----	----	106	42	232	128	350	752
Interest	----	----	----	----	----	----	----	----	----	----	----	----	587	----	587	----	----	25	194	219
Depreciation	1,290	----	426	----	----	----	168	585	----	----	974	1,574	1,214	1,073	7,304	577	1,153	----	600	2,330
Moorage	----	----	----	----	----	79	----	96	----	----	----	----	58	----	233	96	106	----	----	202
Truck and auto	----	----	----	----	----	----	346	----	----	----	----	----	----	500	846	----	350	317	----	667
Fishing gear	301	----	----	----	----	----	----	----	153	----	270	663	325	----	1,712	160	666	1,143	357	2,326
Assessments - cooperatives	----	----	----	----	----	----	60	----	----	----	----	----	137	----	197	69	229	----	221	519
Supplies	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Miscellaneous	444	840	704	----	----	35	160	627	----	226	----	----	----	365	3,401	----	50	1,291	----	1,341
Total	3,661	3,772	2,565	----	----	4,400	1,778	1,679	2,947	736	2,178	3,151	6,286	4,098	37,251	1,725	4,947	6,275	4,341	17,288
Total expense	5,514	5,150	3,135	----	----	5,890	3,107	1,843	4,270	2,389	7,643	5,711	7,961	5,785	58,398	7,349	13,533	14,718	10,368	45,968
Net income or (loss)	[1](566)	3,674	3,017	----	----	(3,708)	1,710	(1,149)	5,047	1,458	3,357	3,510	7,609	959	24,918	3,923	[2]4,206	8,681	[3]705	17,515

[1] Two owners on boat.

[2] Owner on boat for only one of six trips.

[3] No owner on boat.

N.A. = Data not available.

Table 16.—Income and expenses for Pacific coast albacore boats (40′ to 44′ in length), 1956

Item	Jig boats														Bait boats
	A-44′	B-41′	C-42′	D-42′	E-40′	F-41′	G-40′	H-43′	I-42′	J-40′	K-40′	L-42′	M-42′	Total (8)	One bait boat reporting N-42′
Catch receipts:															
Albacore	$16,462	N. A.	$13,200	$8,415	N. A.	$15,543	$9,483	$17,722	N. A.	$9,829	N. A.	$15,900	N. A.	$106,554	$26,642
Other fish	----	----	----	1,531	----	8,504	----	----	----	4,013	----	2,700	----	16,748	----
Total	16,462	----	13,200	9,946	----	24,047	9,483	17,722	----	13,842	----	18,600	----	123,302	26,642
Expenses:															
Trip expenses — albacore:															
Labor	2,580	----	1,575	84	----	4,569	----	1,891	----	482	----	3,975	----	15,156	7,586
Fuel and lubricants	2,175	----	892	686	----	1,400	779	894	----	604	----	1,300	----	8,730	989
Food and provisions	1,462	----	869	416	----	852	523	943	----	360	----	500	----	5,925	471
Foreign country permits	----	----	----	235	----	----	----	----	----	----	----	----	----	235	683
Bait and ice	----	----	343	55	----	773	----	213	----	600	----	200	----	2,184	281
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	6,217	----	3,679	1,476	----	7,594	1,302	3,941	----	2,046	----	5,975	----	32,230	10,010
Trip expenses — other fish:															
Labor	----	----	----	331	----	----	----	----	----	----	----	675	----	1,006	----
Fuel and lubricants	----	----	----	240	----	490	----	----	----	329	----	150	----	1,209	----
Food and provisions	----	----	----	250	----	370	----	----	----	270	----	150	----	1,040	----
Foreign country permits	----	----	----	226	----	----	----	----	----	----	----	----	----	226	----
Bait and ice	----	----	----	15	----	----	----	----	----	600	----	150	----	765	----
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	----	----	----	1,062	----	860	----	----	----	1,199	----	1,125	----	4,246	----
Other boat expenses:															
Repair and maintenance	178	----	1,716	985	----	3,781	1,649	2,310	----	926	----	725	----	12,270	1,096
Insurance	----	----	----	----	----	253	----	----	----	826	----	400	----	1,479	746
Licenses and taxes on boat	168	----	93	141	----	68	10	139	----	50	----	73	----	742	255
Payroll and other taxes	144	----	62	----	----	170	39	----	----	6	----	233	----	654	377
Interest	274	----	----	----	----	----	320	536	----	345	----	240	----	1,715	----
Depreciation	2,680	----	1,501	807	----	472	1,126	4,320	----	1,215	----	1,921	----	14,042	1,469
Moorage	75	----	192	75	----	59	----	----	----	60	----	----	----	461	----
Truck and auto	----	----	331	200	----	869	----	----	----	----	----	----	----	1,400	----
Fishing gear	----	----	286	25	----	----	272	482	----	197	----	230	----	1,492	----
Assessments-cooperatives	----	----	240	----	----	----	----	307	----	----	----	----	----	547	----
Supplies	----	----	102	----	----	----	----	----	----	----	----	----	----	102	----
Miscellaneous	85	----	90	15	----	699	914	----	----	----	----	867	----	2,670	903
Total	3,604	----	4,613	2,248	----	6,371	4,330	8,094	----	3,625	----	4,689	----	37,574	4,846
Total expenses	9,821	----	8,292	4,786	----	14,825	5,632	12,035	----	6,870	----	11,789	----	74,050	14,856
Net income or (loss)	6,641	----	4,908	5,160	----	9,222	3,851	5,687	----	6,972	----	6,811	----	49,252	[2]11,786

[1] Owner and wife on boat.

[2] Two owners on boat.

N.A. = Data not available.

Table 17.—Income and expenses for Pacific coast albacore boats (40′ to 44′ in length), 1957

Item	Jig boats														Bait boats
	A-44′	B-41′	C-42′	D-42′	E-40′	F-41′	G-40′	H-43′	I-42′	J-40′	K-40′	L-42′	M-42′	Total (11)	One bait boat reporting N-42′
Catch receipts:															
Albacore	$15,517	$4,732	$14,401	$7,451	N. A.	$17,256	$3,657	$10,904	$8,872	$3,520	$7,678	$15,044	N. A.	$109,032	$33,141
Other fish	----	----	----	1,789	----	6,784	----	----	----	4,699	7,056	1,600	----	21,928	----
Total	15,517	4,732	14,401	9,240	----	24,040	3,657	10,904	8,872	8,219	14,734	16,644	----	130,960	33,141
Expenses:															
Trip expenses — albacore:															
Labor	3,560	558	2,211	----	----	5,012	----	766	1,700	168	----	3,761	----	17,736	5,741
Fuel and lubricants	1,566	1,013	1,003	746	----	1,437	450	893	579	564	619	1,200	----	10,070	997
Food and provisions	1,083	866	965	386	----	892	311	644	517	365	313	625	----	6,967	448
Foreign country permits	----	----	----	227	----	----	----	----	----	----	----	----	----	227	782
Bait and ice	----	208	304	52	----	722	----	237	----	600	406	150	----	2,679	268
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	6,209	2,645	4,483	1,411	----	8,063	761	2,540	2,796	1,697	1,338	5,736	----	37,679	8,236
Trip expenses — other fish:															
Labor	----	----	----	386	----	----	----	----	----	----	----	400	----	786	----
Fuel and lubricants	----	----	----	128	----	510	----	----	----	243	569	160	----	1,610	----
Food and provisions	----	----	----	120	----	320	----	----	----	274	287	150	----	1,151	----
Foreign country permits	----	----	----	123	----	----	----	----	----	----	----	----	----	123	----
Bait and ice	----	----	----	7	----	----	----	----	----	600	273	125	----	1,005	----
Micsellaneous	----	----	----	----	----	----	----	----	----	----	460	----	----	460	----
Total	----	----	----	764	----	830	----	----	----	1,117	1,589	835	----	5,135	----
Other boat expenses:															
Repair and maintenance	1,709	985	1,428	1,265	----	4,734	2,461	2,093	1,544	447	694	1,150	----	18,510	1,536
Insurance	----	----	----	----	----	298	----	----	----	446	515	712	----	1,971	824
Licenses and taxes on boat	153	84	95	139	----	84	11	123	81	58	132	76	----	1,036	235
Payroll and other taxes	67	----	108	----	----	182	44	----	116	8	----	208	----	733	295
Interest	190	----	----	----	----	----	295	494	----	----	73	180	----	1,232	----
Depreciation	2,680	424	1,575	872	----	472	1,065	4,320	388	741	2,542	1,921	----	17,000	1,469
Moorage	75	113	105	91	----	56	----	----	96	49	----	----	----	585	----
Truck and auto	----	----	294	200	----	951	----	----	190	----	----	----	----	1,635	----
Fishing gear	----	----	305	30	----	----	122	302	266	1,401	796	230	----	3,452	----
Assessments-cooperatives	----	----	240	----	----	360	----	219	139	----	----	85	----	1,043	----
Supplies	----	8	136	----	----	----	----	----	----	----	----	----	----	144	----
Miscellaneous	85	----	81	----	----	683	606	----	----	----	----	692	----	2,147	786
Total	4,959	1,614	4,367	2,597	----	7,820	4,604	7,551	2,820	3,150	4,752	5,254	----	49,488	5,145
Total expense	11,168	4,259	8,850	4,772	----	16,713	5,365	10,091	5,616	5,964	7,679	11,825	----	92,302	13,381
Net income or (loss)	4,349	473	5,551	4,468	----	7,327	[1](1,708)	813	3,256	2,255	[2]7,055	4,819	----	38,658	[2]19,760

[1] Owner and wife on boat.

[2] Two owners on boat.

N.A. = Data not available.

Table 18.—Income and expenses for Pacific coast albacore boats (40′ to 44′ in length), 1958

Item	Jig boats														Bait boats
	A-44′	B-41′	C-42′	D-42′	E-40′	F-41′	G-40′	H-43′	I-42′	J-40′	K-40′	L-42	M-42′	Total (12)	One bait boat reporting N-42′
Catch receipts:															
Albacore	$11,298	$3,531	N. A.	$4,622	$4,478	$18,400	$10,466	$13,407	$8,752	$9,050	$8,187	$12,000	$12,756	$116,947	$32,384
Other fish	----	397	----	811	3,937	2,500	----	----	----	2,846	9,029	3,400	----	22,920	----
Total	11,298	3,928	----	5,433	8,415	20,900	10,466	13,407	8,752	11,896	17,216	15,400	12,756	139,867	32,384
Expenses:															
Trip expenses — albacore:															
Labor	2,870	494	----	8	----	2,602	1,391	656	939	2,014	----	3,000	2,521	16,495	7,186
Fuel and lubricants	1,152	879	----	499	175	1,500	885	906	462	408	542	800	777	8,985	1,100
Food and provisions	822	680	----	302	95	971	632	753	320	447	380	550	468	6,420	442
Foreign country permits	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Bait and ice	----	54	----	----	170	128	----	276	----	600	386	150	180	1,944	171
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	4,844	2,107	----	809	440	5,201	2,908	2,591	1,721	3,469	1,308	4,500	3,946	33,844	8,899
Trip expenses — other fish:															
Labor	----	----	----	----	----	----	----	----	----	----	----	850	----	850	----
Fuel and lubricants	----	30	----	120	153	430	----	----	----	402	598	300	----	2,033	----
Food and provisions	----	129	----	----	84	300	----	----	----	224	420	150	----	1,307	----
Foreign country permits	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Bait and ice	----	116	----	----	149	----	----	----	----	600	371	200	----	1,436	----
Miscellaneous	----	----	----	----	----	----	----	----	----	----	500	----	----	500	----
Total	----	275	----	120	386	730	----	----	----	1,226	1,889	1,500	----	6,126	----
Other boat expenses:															
Repair and maintenance	233	2,080	----	1,533	1,270	2,636	2,143	2,530	1,922	697	1,306	500	3,000	19,850	1,978
Insurance	----	----	----	----	----	297	----	----	----	739	----	672	----	1,708	346
Licenses and taxes on boat	168	101	----	142	146	83	11	185	86	44	139	92	216	1,413	239
Payroll and other taxes	196	----	----	----	----	85	398	----	100	100	----	193	328	1,400	379
Interest	----	31	----	----	----	----	271	292	----	220	32	150	----	996	----
Depreciation	1,399	358	----	673	----	2,282	1,170	4,360	440	760	1,992	1,923	1,150	16,507	1,242
Moorage	176	106	----	96	----	97	----	----	96	91	----	----	----	662	----
Truck and auto	----	----	----	200	----	1,132	----	----	458	----	----	----	----	1,790	----
Fishing gear	----	----	----	25	----	----	204	324	210	2,034	1,445	250	296	4,788	----
Assessments-cooperatives	----	----	----	----	----	----	----	180	40	----	----	150	----	370	----
Supplies	----	13	----	----	----	----	----	----	----	----	----	----	----	13	----
Miscellaneous	75	----	----	----	522	716	863	----	----	----	----	657	----	2,833	1,446
Total	2,247	2,689	----	2,669	1,938	7,328	5,060	7,871	3,352	4,685	4,914	4,587	4,990	52,330	5,630
Total expenses	7,091	5,071	----	3,598	2,764	13,259	7,968	10,462	5,073	9,380	8,111	10,587	8,936	92,300	14,529
Net income or (loss)	4,207	(1,143)	----	1,835	5,651	7,641	2,498	2,945	3,679	2,516	[1]9,105	4,813	3,820	47,567	[1]17,855

[1] Two owners on boat.
N.A. = Data not available.

Table 19.—Income and expenses for Pacific coast albacore boats (45' to 49' in length), 1956

Item	Jig boats								Bait boats		
	A-48'	B-46'	C-47'	D-48'	E-45'	F-49'	G-47'	Total (4)	H-46'	I-48'	Total (2)
Catch receipts:											
Albacore	$14,871	N. A.	$4,564	N. A.	$15,492	$17,629	N. A.	$52,556	$5,018	$4,523	$9,541
Other fish	----	----	----	----	3,639	5,206	----	8,845	----	----	----
Total	14,871	----	4,564	----	19,131	22,835	----	61,401	5,018	4,523	9,541
Expenses:											
Trip expenses — albacore:											
Labor	3,512	----	----	----	1,951	4,927	----	10,390	1,166	1,248	2,414
Fuel and lubricants	1,909	----	804	----	697	806	----	4,216	705	1,184	1,889
Food and provisions	506	----	225	----	602	499	----	1,832	551	559	1,110
Foreign country permits	----	----	----	----	----	----	----	----	----	816	816
Bait and ice	87	----	289	----	747	701	----	1,824	203	----	203
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----
Total	6,014	----	1,318	----	3,997	6,933	----	18,262	2,625	3,807	6,432
Trip expenses — other fish:											
Labor	----	----	----	----	853	1,382	----	2,235	----	----	----
Fuel and lubricants	----	----	----	----	341	364	----	705	----	----	----
Food and provisions	----	----	----	----	195	331	----	526	----	----	----
Foreign country permits	----	----	----	----	----	----	----	----	----	----	----
Bait and ice	----	----	----	----	117	234	----	351	----	----	----
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----
Total	----	----	----	----	1,506	2,311	----	3,817	----	----	----
Other boat expenses:											
Repair and maintenance	585	----	854	----	1,860	1,055	----	4,354	1,343	1,039	2,382
Insurance	1,162	----	----	----	105	750	----	2,017	----	1,650	1,650
Licenses and taxes on boat	303	----	71	----	60	----	----	434	----	292	292
Payroll and other taxes	159	----	----	----	82	258	----	499	----	62	62
Interest	372	----	----	----	----	----	----	372	----	----	----
Depreciation	1,285	----	945	----	2,295	1,662	----	6,187	280	1,505	1,785
Moorage	----	----	548	----	----	----	----	548	----	----	----
Truck and auto	----	----	----	----	619	----	----	619	----	----	----
Fishing gear	336	----	87	----	238	281	----	942	229	----	229
Assessments-cooperatives	167	----	83	----	143	314	----	707	----	----	----
Supplies	----	----	----	----	143	----	----	143	----	----	----
Miscellaneous	326	----	104	----	485	----	----	915	185	358	543
Total	4,695	----	2,692	----	6,030	4,320	----	17,737	2,037	4,906	6,943
Total expenses	10,709	----	4,010	----	11,533	13,564	----	39,816	4,662	8,713	13,375
Net income or (loss)	4,162	----	554	----	7,598	9,271	----	21,585	356	[1](4,190)	(3,834)

[1] No owner on boat.

N.A. = Data not available.

Table 20.—Income and expenses for Pacific coast albacore boats (45′ to 49′ in length), 1957

Item	Jig boats								Bait boats		
	A-48′	B-46′	C-47′	D-48′	E-45′	F-49′	G-47′	Total (5)	H-46′	I-48′	Total (2)
Catch receipts:											
Albacore	$11,999	N. A.	$3,107	2,108	$15,653	$18,760	N. A.	$51,627	$9,425	$8,677	$18,102
Other fish	----	----	----	----	1,961	4,900	----	6,861	----	----	----
Total	11,999	----	3,107	2,108	17,614	23,660	----	58,488	9,425	8,677	18,102
Expenses:											
Trip expenses — albacore:											
Labor	2,562	----	----	----	318	4,845	----	7,725	1,628	4,262	5,890
Fuel and lubricants	1,952	----	448	810	1,401	1,073	----	5,684	1,004	764	1,768
Food and provisions	492	----	250	340	831	471	----	2,384	869	312	1,181
Foreign country permits	----	----	----	----	----	----	----	----	----	898	898
Bait and ice	45	----	37	----	55	50	----	187	210	----	210
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----
Total	5,051	----	735	1,150	2,605	6,439	----	15,980	3,711	6,236	9,947
Trip expenses — other fish:											
Labor	----	----	----	----	----	1,220	----	1,220	----	----	----
Fuel and lubricants	----	----	----	----	139	450	----	589	----	----	----
Food and provisions	----	----	----	----	180	391	----	571	----	----	----
Foreign country permits	----	----	----	----	----	----	----	----	----	----	----
Bait and ice	----	----	----	----	139	150	----	289	----	----	----
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----
Total	----	----	----	----	458	2,211	----	2,669	----	----	----
Other boat expenses:											
Repair and maintenance	2,358	----	823	----	2,161	3,887	----	9,229	2,527	4,494	7,021
Insurance	1,300	----	426	200	279	625	----	2,830	----	1,833	1,833
Licenses and taxes on boat	329	----	72	19	60	176	----	656	----	----	----
Payroll and other taxes	87	----	----	----	18	----	----	105	----	211	211
Interest	644	----	----	----	39	----	----	683	----	----	----
Depreciation	2,570	----	1,167	629	2,295	2,216	----	8,877	320	1,506	1,826
Moorage	----	----	230	176	----	----	----	406	----	----	----
Truck and auto	----	----	----	----	566	----	----	566	----	----	----
Fishing gear	145	----	162	49	326	435	----	1,117	260	----	260
Assessments-cooperatives	248	----	85	----	280	424	----	1,037	----	----	----
Supplies	----	----	----	----	152	----	----	152	----	----	----
Miscellaneous	422	----	257	----	561	----	----	1,240	470	1,087	1,557
Total	8,103	----	3,222	1,073	6,737	7,763	----	26,898	3,577	9,131	12,708
Total expenses	13,154	----	3,957	2,223	9,800	16,413	----	45,547	7,288	15,367	22,655
Net income or (loss)	(1,155)	----	(850)	(115)	7,814	7,247	----	12,941	2,137	[1](6,690)	(4,553)

[1] No owner on boat.

N.A. = Data not available.

Table 21.—Income and expenses for Pacific coast albacore boats (45′ to 49′ in length), 1958

Item	Jig boats								Bait boats		
	A-48′	B-46′	C-47′	D-48′	E-45′	F-49′	G-47′	Total (7)	H-46′	I-48′	Total (2)
Catch receipts:											
Albacore	$8,548	$5,850	$2,925	$1,863	$16,361	$20,861	$15,006	$71,414	$10,179	$15,557	$25,736
Other fish	----	----	----	----	1,501	4,862	3,021	9,384	----	6,000	6,000
Total	8,548	5,850	2,925	1,863	17,862	25,723	18,027	80,798	10,179	21,557	31,736
Expenses:											
Trip expenses — albacore:											
Labor	1,903	----	----	----	594	----	----	2,497	2,965	7,469	10,434
Fuel and lubricants	1,321	547	536	492	943	1,068	720	5,627	1,111	1,411	2,522
Food and provisions	441	306	100	275	1,016	561	450	3,149	755	443	1,198
Foreign country permits	----	----	----	----	----	----	----	----	----	557	557
Bait and ice	165	----	90	----	48	50	140	493	168	193	361
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----
Total	3,830	853	726	767	2,601	1,679	1,310	11,766	4,999	10,073	15,072
Trip expenses — other fish:											
Labor	----	----	----	----	151	----	----	151	----	2,763	2,763
Fuel and lubricants	----	----	----	----	307	459	282	1,048	----	522	522
Food and provisions	----	----	----	----	243	383	288	914	----	164	164
Foreign country permits	----	----	----	----	----	----	----	----	----	----	----
Bait and ice	----	----	----	----	87	150	300	537	----	71	71
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----
Total	----	----	----	----	788	992	870	2,650	----	3,520	3,520
Other boat expenses:											
Repair and maintenance	1,316	1,640	855	491	2,337	2,946	2,050	11,635	2,291	3,296	5,587
Insurance	921	----	469	170	737	600	415	3,312	----	1,700	1,700
Licenses and taxes on boat	354	----	96	45	60	----	147	702	----	271	271
Payroll and other taxes	127	----	----	----	42	----	----	169	----	492	492
Interest	576	----	----	10	----	----	40	626	----	----	----
Depreciation	2,630	1,530	1,348	825	2,295	2,216	2,434	13,278	320	1,838	2,158
Moorage	----	189	397	304	----	----	80	970	96	----	96
Truck and auto	----	144	----	----	596	----	320	1,060	----	3,691	3,691
Fishing gear	300	----	----	8	565	59	----	932	297	----	297
Assessments-cooperatives	121	67	47	85	127	300	120	867	----	----	----
Supplies	----	----	----	----	143	----	----	143	----	----	----
Miscellaneous	280	106	142	----	176	----	438	1,142	276	187	463
Total	6,625	3,676	3,354	1,938	7,078	6,121	6,044	34,836	3,280	11,475	14,755
Total expenses	10,455	4,529	4,080	2,705	10,467	8,792	8,224	49,252	8,279	25,068	33,347
Net income or (loss)	(1,907)	[1]1,321	(1,155)	(842)	7,395	[2]16,931	[2]9,803	31,546	1,900	[3](3,511)	(1,611)

[1] Owner and wife on boat.
[2] Two owners on boat.
[3] No owners on boat.

Table 22.—Income and expenses for Pacific coast albacore boats (50′ to 60′ in length), 1956

Item	Bait boats									Jig boats			
	A-50′	B-56′	C-53′	D-54′	E-58′	F-50′	G-50′	H-50′	Total (7)	I-56′	J-60′	K-56′	Total (2)
Catch receipts:													
Albacore	$19,680	$17,485	$13,083	$12,500	$7,868	N. A.	$24,168	$9,105	$103,889	N. A.	$20,250	$8,615	$28,865
Other fish	2,000	----	----	----	----	----	4,000	3,695	9,695	----	14,604	----	14,604
Total	21,680	17,485	13,083	12,500	7,868	----	28,168	12,800	113,584	----	34,854	8,615	43,469
Expenses:													
Trip expenses — albacore:													
Labor	3,200	----	2,667	1,200	2,731	----	----	1,028	10,826	----	6,897	2,468	9,365
Fuel and lubricants	869	1,905	1,458	600	711	----	1,080	824	7,447	----	1,114	340	1,454
Food and provisions	794	705	912	600	560	----	548	355	4,474	----	970	582	1,552
Foreign country permits	----	----	----	----	----	----	----	----	----	----	951	619	1,570
Bait and ice	----	----	----	----	424	----	----	----	424	----	517	99	616
Miscellaneous	----	----	----	----	51	----	----	----	51	----	----	463	463
Total	4,863	2,610	5,037	2,400	4,477	----	1,628	2,207	23,222	----	10,449	4,571	15,020
Trip expenses — other fish:													
Labor	----	----	----	----	----	----	----	----	----	----	4,974	----	4,974
Fuel and lubricants	150	----	----	----	----	----	325	283	758	----	803	----	803
Food and provisions	115	----	----	----	----	----	225	202	542	----	700	----	700
Foreign country permits	----	----	----	----	----	----	----	----	----	----	685	----	685
Bait and ice	160	----	----	----	----	----	242	239	641	----	373	----	373
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	425	----	----	----	----	----	792	724	1,941	----	7,535	----	7,535
Other boat expenses:													
Repair and maintenance	3,531	5,011	2,883	1,300	1,373	----	2,490	2,906	19,494	----	4,482	1,274	5,756
Insurance	270	----	1,000	300	337	----	400	936	3,243	----	----	----	----
Licenses and taxes on boat	32	49	390	120	17	----	50	56	714	----	----	175	175
Payroll and other taxes	----	----	63	----	76	----	----	----	139	----	249	----	249
Interest	90	----	357	----	----	----	----	250	697	----	418	201	619
Depreciation	2,097	1,837	1,285	500	1,946	----	1,645	2,030	11,340	----	2,301	2,127	4,428
Moorage	198	----	----	----	83	----	----	----	281	----	222	80	302
Truck and auto	----	----	----	----	----	----	----	----	----	----	640	----	640
Fishing gear	425	----	----	600	----	----	439	----	1,464	----	----	325	325
Assessments-cooperatives	242	----	288	----	142	----	449	----	1,121	----	246	----	246
Supplies	----	----	----	----	----	----	----	----	----	----	----	----	----
Miscellaneous	----	1,715	627	----	500	----	----	283	3,125	----	305	353	658
Total	6,885	8,612	6,893	2,820	4,474	----	5,473	6,461	41,618	----	8,863	4,535	13,398
Total expenses	12,173	11,222	11,930	5,220	8,951	----	7,893	9,392	66,781	----	26,847	9,106	35,953
Net income or (loss)	9,507	6,263	1,153	7,280	(1,083)	----	[1]20,275	3,408	46,803	----	8,007	(491)	7,516

[1] Two owners on boat.
N.A. = Data not available.

Table 23.—Income and expenses for Pacific coast albacore boats (50′ to 60′ in length), 1957

Item	Jig boats									Bait boats			
	A-50′	B-56′	C-53′	D-54′	E-58′	F-50′	G-50′	H-50′	Total (7)	I-56′	J-60′	K-56′	Total (3)
Catch receipts:													
Albacore	$20,499	$17,086	$12,572	$12,500	$9,987	N. A.	$18,216	$8,652	$99,512	$28,814	$25,500	$10,980	$65,294
Other fish	1,005	----	----	----	----	----	2,700	3,860	7,565	11,679	15,363	----	27,042
Total	21,504	17,086	12,572	12,500	9,987	----	20,916	12,512	107,077	40,493	40,863	10,980	92,336
Expenses:													
Trip expenses — albacore:													
Labor	3,000	----	1,742	1,200	2,139	----	----	785	8,866	6,642	5,233	2,790	14,665
Fuel and lubricants	865	2,155	1,275	600	613	----	840	1,356	7,704	1,840	1,951	418	4,209
Food and provisions	663	1,050	823	600	891	----	685	509	5,194	1,480	1,326	582	3,388
Foreign country permits	----	----	----	----	----	----	----	----	----	840	1,587	401	2,823
Bait and ice	----	----	----	----	279	----	----	----	279	200	69	132	401
Miscellaneous	----	----	----	----	82	----	----	----	82	----	----	290	290
Total	4,501	3,205	3,840	2,400	4,004	----	1,525	2,650	22,125	11,002	10,166	4,613	25,781
Trip expenses — other fish:													
Labor	----	----	----	----	----	----	----	----	----	3,909	3,154	----	7,063
Fuel and lubricants	200	----	----	----	----	----	350	292	842	829	1,175	----	2,004
Food and provisions	135	----	----	----	----	----	200	178	513	533	799	----	1,332
Foreign country permits	----	----	----	----	----	----	----	----	----	777	957	----	1,734
Bait and ice	180	----	----	----	----	----	229	217	626	164	42	----	206
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	515	----	----	----	----	----	779	687	1,981	6,212	6,127	----	12,339
Other boat expenses:													
Repair and maintenance	2,738	1,967	3,463	1,800	2,135	----	4,601	1,581	18,285	5,258	7,983	1,690	14,931
Insurance	465	----	1,000	300	350	----	356	1,163	3,634	2,830	----	----	2,830
Licenses and taxes on boat	34	51	390	120	17	----	50	56	718	224	----	185	409
Payroll and other taxes	----	----	44	----	103	----	----	----	147	138	112	----	250
Interest	60	----	346	----	----	----	----	175	581	192	36	199	427
Depreciation	2,257	1,837	1,266	1,000	1,946	----	1,645	1,557	11,508	4,098	3,008	1,868	8,974
Moorage	198	----	----	----	130	----	----	----	328	75	368	165	608
Truck and auto	----	----	----	----	----	----	----	----	----	----	684	----	684
Fishing gear	578	----	----	600	----	----	400	----	1,578	2,167	437	500	3,104
Assessments-cooperatives	123	----	255	----	187	----	506	----	1,071	586	----	----	586
Supplies	----	----	----	----	----	----	----	----	----	426	----	----	426
Miscellaneous	----	1,950	687	----	483	----	----	198	3,318	109	311	498	918
Total	6,453	5,805	7,451	3,820	5,351	----	7,558	4,730	41,168	16,103	12,939	5,105	34,147
Total expenses	11,469	9,010	11,291	6,220	9,355	----	9,862	8,067	65,274	33,317	29,232	9,718	72,267
Net income or (loss)	10,035	8,076	1,281	6,280	632	----	[1]11,054	4,445	41,803	7,176	[1]11,631	1,262	20,069

[1] Two owners on boats.

N.A. = Data not available.

Table 24.—Income and expenses for Pacific coast albacore boats (50′ to 60′ in length), 1958

Item	Jig boats									Bait boats			
	A-50′	B-56′	C-53′	D-54′	E-58′	F-50′	G-50′	H-50′	Total (7)	I-56′	J-60′	K-56′	Total (2)
Catch receipts:													
Albacore	$16,960	$11,879	$12,978	N. A.	$12,926	$16,174	$18,587	$8,960	$98,464	N. A.	$32,725	$7,651	$40,376
Other fish	2,684	----	----	----	----	----	3,000	694	6,378	----	30,551	----	30,551
Total	19,644	11,879	12,978	----	12,926	16,174	21,587	9,654	104,842	----	63,276	7,651	70,927
Expenses:													
Trip expenses — albacore:													
Labor	660	----	1,883	----	2,616	3,060	----	1,836	10,055	----	6,248	1,848	8,096
Fuel and lubricants	826	2,140	1,506	----	963	919	717	1,271	8,362	----	2,226	578	2,804
Food and provisions	599	850	720	----	849	876	444	555	4,893	----	1,543	602	2,145
Foreign country permits	----	----	----	----	----	----	----	----	----	----	1,592	----	1,592
Bait and ice	----	----	----	----	157	56	----	----	213	----	70	99	169
Miscellaneous	----	----	----	----	70	----	----	70	401	----	----	289	289
Total	2,085	2,990	4,109	----	4,655	4,931	1,161	3,662	23,593	----	11,679	3,416	15,095
Trip expenses — other fish:													
Labor	----	----	----	----	----	----	----	----	----	----	5,838	----	5,838
Fuel and lubricants	160	----	----	----	----	----	300	98	558	----	2,079	----	2,079
Food and provisions	120	----	----	----	----	----	175	63	358	----	1,442	----	1,442
Foreign country permits	----	----	----	----	----	----	----	----	----	----	1,487	----	1,487
Bait and ice	200	----	----	----	----	----	131	70	401	----	66	----	66
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----	----
Total	480	----	----	----	----	----	606	231	1,317	----	10,912	----	10,912
Other boat expenses:													
Repair and maintenance	4,543	7,430	3,348	----	2,364	3,251	2,119	1,576	24,631	----	10,564	2,501	13,065
Insurance	309	----	1,000	----	362	----	569	1,453	3,693	----	2,431	142	2,573
Licenses and taxes on boat	39	52	390	----	18	73	68	56	696	----	360	96	456
Payroll and other taxes	----	----	46	----	128	140	----	----	314	----	----	----	----
Interest	30	----	277	----	----	----	----	200	507	----	256	337	593
Depreciation	2,257	1,837	1,202	----	1,033	1,968	1,645	1,586	11,528	----	4,415	820	5,235
Moorage	198	----	----	----	144	86	----	----	428	----	327	219	546
Truck and auto	----	----	----	----	----	345	----	----	345	----	600	----	600
Fishing gear	559	----	----	----	----	136	569	----	1,264	----	1,983	536	2,519
Assessments-cooperatives	279	----	183	----	143	228	310	----	1,143	----	464	----	464
Supplies	----	----	----	----	----	95	----	----	95	----	----	----	----
Miscellaneous	----	1,900	665	----	600	75	----	402	3,642	----	2,249	762	3,011
Total	8,214	11,219	7,111	----	4,792	6,397	5,280	5,273	48,286	----	23,649	5,413	29,062
Total expenses	10,779	14,209	11,220	----	9,447	11,328	7,047	9,166	73,196	----	46,240	8,829	55,069
Net income or (loss)	8,865	(2,330)	1,758	----	3,479	4,846	[1] 14,540	488	31,646	----	[1] 17,036	(1,178)	15,858

[1] Two owners on boat.
N.A. = Data not available.

INCOME

Comparative Income Statements of Jig and Bait Boats

Order of presentation.—Comparisons by boat length for both jig- and bait-boat operations for the years 1956-58 are included in the following order:

Boats	
Under 40 feet	Tables 13-15
40 feet to 44 feet	Tables 16-18
45 feet to 49 feet	Tables 19-21
50 feet to 60 feet	Tables 22-24

The net income (or loss) shown is before Federal or State income taxes. It does not include any payment for the labor of the owners nor any return on capital invested.

Trip expenses—other fish—includes trips made for fish and crustaceans, such as lobster and crab. Salmon is most frequently listed as the second fishery under "other fish."

Table 25 summarizes the information shown in tables 13-24. Table 25, however, permits few generalized statements, as wide variations in boat operation were found when individual boats were compared.

Net income.—Average net income, for jig boats under 40 feet in length, was $2,424, $2,841, and $2,077 for 1956, 1957, and 1958 respectively. These amounts were not sufficient to pay the owner for his labor. In some operations, two partners ran the boat. Jig boats 50-60 feet long show a steady decline both in catch receipts and in net income. The respondents had various reasons for the declines; no clearly defined common cause was evident. The operating results of bait boats varied widely.

It was not possible to study the costs of the fishery without separating trip expenses by fisheries. When a boat engaged in two or more fisheries, allocation of "other" boat expenses had to be made between the fisheries engaged in by the given boat before true albacore expenses could be arrived at.

Tables 26-32 compare the average income and expenses of boats that fish for albacore only and boats that fish for albacore and other species.

Trip expenses.—The fishermen were asked to report separate trip expenses for trips made to catch albacore and for trips made to catch other fish. During the albacore season the albacore fishermen fish for albacore; out of season, they take other fish. With minor exceptions, they catch the species of fish they set out to take.

About 40 percent of the fishermen included fishing gear as an item of expense. Upon investigation, it was found that the term "fishing gear" did not mean the same thing to all fishermen. Items listed as "fishing gear" under trip expense included lines, lures, outrigger poles, sea anchors, chain, rope, boats, aprons, poles, and many other types of boat gear and supplies.

Many of the items might have been capitalized. At any rate, the benefit from their use extended for more than one season before they had to be replaced. For these reasons, fishing gear is listed in this study under "other boat expense" for the purpose of uniformity. Reporting in this manner was consistent with the overall facts, even though on a particular trip there might be loss of such items as nets, lines, anchors, and other gear.

Other boat expenses.—Other boat expenses were not clearly identifiable with specific trips and had to be allocated between the fisheries engaged in by the various boats. Allocation of other boat expenses was made on the basis of the relation of catch receipts in each fishery to total catch receipts.

Table 33 summarizes the average net income classified according to length of boat. It shows that boats operating in two fisheries yield higher average net incomes than do boats fishing for albacore only. This statement was true for boats of all lengths for all years, with only one exception.

Information on net income is shown without regard to the number of owners on the boat (tables 34 - 39). No attempt was made to classify boats by number aboard, because such classification would detract from the usefulness of the figures presented.

Cost per pound.—Information on average cost per pound to catch albacore can be useful in analyzing the problems of the industry and in arriving at possible solutions. Tables 34-39 reflect allocation of other boat expenses on the basis of catch receipts of albacore and other fish. This allocation is necessary if cost per pound is to be determined for comparative purposes.

Tables 34-39 show average cost per pound to catch albacore and average net income per pound for all boats reporting. Income and expenses of trips made to take fish other than albacore have been eliminated from the tables in order to make the data comparable. Table 40 summarizes the information shown in tables 34-39 and includes the gross income per pound to the industry for the years under review.

Jig and bait boats.—Analysis of the data presented reflects higher total expenses and lower net income per pound for the bait boats when compared to the jig boats for all years under review. The average catch by bait boats exceeded the catch by jig boats, however, by about 5 tons per boat in 1956, by 22 tons per boat in 1957, and by 19 tons per boat in 1958. The average price per ton received for albacore was $343 in 1956, $289 in 1957, and $411 in 1958. In 1958, bait boats maintained a much greater average catch than jig boats.

Jig boats.—The following summarization, table 41, shows that with only one exception, jig boats that engaged in two fisheries operated at a lower cost per pound for total expenses in all length classifications for all years. Boats that operated in two or more fisheries had a lower cost in catching albacore because other boat expenses—such as repairs, depreciation, insurance, and taxes—were spread over a broader income base. The fishing season was prolonged, and greater income was realized from the same semifixed costs during the year.

Bait boats.—Similar comparisons of the operation of bait boats was not possible because the necessary information was not available. A review, however, of tables 46-51 indicates in general that boats engaging in two fisheries had an advantage over boats relying on income from albacore fishing only.

Review of operations of individual boats reported in prior tables shows in certain instances, wide variations for one boat from year to year and from one boat to another in the same year.

Review of the fishery.—In this subsection, we are concerned with (1) expenditures and (2) variations in income.

Expenditures.—Expenditures on vessels and gear are curtailed during and after the season if the price per ton for albacore is low, as for example in 1957 when the average price per ton was only $289. Lack of income results in postponement of repairs, and in many instances, the acquisition of needed equipment is delayed. Conversely, in years of higher income, equipment is acquired and repairs are made during and after the season and before the end of the taxable year. Better financing would avoid this taking time out between trips during season to repair or to install equipment.

Variations of income.—Weather often causes income to vary. A small boat must return to port and "lay in" during storms, thus reducing the number of possible fishing days during the season. Many competent fishermen indicate that the first trip is important to an overall successful season. In many instances, the small boat cannot reach the offshore fish because of rough weather encountered and limited fuel capacity. Boats 50 feet long appear to have adequate capacity, range, and seaworthiness.

Table 25a.—Income and expenses for Pacific coast albacore boats, 1956-58

Item	1956				1957				1958			
Jig boats	Under 40' (7 boats)	40'-44' (8 boats)	45'-49' (4 boats)	50'-60' (7 boats)	Under 40' (8 boats)	40'-44' (11 boats)	45'-49' (5 boats)	50'-60' (7 boats)	Under 40' (12 boats)	40'-44' (12 boats)	45'-49' (7 boats)	50'-60' (7 boats)
Catch receipts	$6,852	$15,413	$15,350	$16,226	$7,700	$11,905	$11,698	$15,297	$6,943	$11,656	$11,543	$14,977
Expenses:												
Trip	1,555	4,559	5,520	3,595	1,636	3,892	3,730	3,444	1,762	3,331	2,059	3,558
Other boat	2,873	4,697	4,434	5,945	3,223	4,499	5,380	5,881	3,104	4,361	4,977	6,898
Total	4,428	9,256	9,954	9,540	4,859	8,391	9,110	9,325	4,866	7,692	7,036	10,456
Net income or (loss)	2,424	6,157	5,396	6,686	2,841	3,514	2,588	5,972	2,077	3,964	4,507	4,521
Bait boats	Under 40' (4 boats)	40'-44' (1 boat)	45'-49' (2 boats)	50'-60' (2 boats)	Under 40' (4 boats)	40'-44' (1 boat)	45'-49' (2 boats)	50'-60' (3 boats)	Under 40' (4 boats)	40'-44' (1 boat)	45'-49' (2 boats)	50'-60' (2 boats)
Catch receipts	$15,783	$26,642	$4,771	$21,735	$13,477	$33,141	$9,051	$30,779	$15,871	$32,384	$15,868	$35,464
Expenses:												
Trip	7,152	10,010	3,216	11,278	5,619	8,236	4,974	12,707	7,170	8,899	9,296	13,004
Other boat	4,542	4,846	3,472	6,699	4,797	5,145	6,354	11,382	4,322	5,630	7,378	14,531
Total	11,694	14,856	6,688	17,977	10,416	13,381	11,328	24,089	11,492	14,529	16,674	27,535
Net income or (loss)	4,089	11,786	(1,917)	3,758	3,061	19,760	(2,277)	6,690	4,379	17,855	(806)	7,929

Table 25b.—Income and expenses by length classification for Pacific coast albacore bait boats, 1956[1]

Item	Under 40'			40'-44'			45'-49'			50'-60'		
	Fish for albacore only (3 boats)	Fish for albacore and other fish (1 boat)		Fish for albacore only (1 boat)	Fish for albacore and other fish (0 boat)		Fish for albacore only (2 boats)	Fish for albacore and other fish (0 boat)		Fish for albacore only (1 boat)	Fish for albacore and other fish (1 boat)	
	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish
Catch receipts	$16,697	$7,175	$5,864	$26,642	----	----	$4,771	----	----	$8,615	$20,250	$14,604
Expenses:												
Trip expenses — albacore:												
Labor	4,629	2,164	----	7,586	----	----	1,207	----	----	2,468	6,897	----
Fuel and lubrication	876	330	----	989	----	----	945	----	----	340	1,114	----
Food and provisions	953	596	----	471	----	----	555	----	----	582	970	----
Foreign country permits	630	588	----	683	----	----	408	----	----	619	951	----
Bait and ice	291	69	----	281	----	----	102	----	----	99	517	----
Miscellaneous	----	----	----	----	----	----	----	----	----	463	----	----
Total	7,379	3,747	----	10,010	----	----	3,217	----	----	4,571	10,449	----
Trip expenses — other fish:												
Labor	----	----	760	----	----	----	----	----	----	----	----	4,974
Fuel and lubricants	----	----	604	----	----	----	----	----	----	----	----	803
Food and provisions	----	----	592	----	----	----	----	----	----	----	----	700
Foreign country permits	----	----	701	----	----	----	----	----	----	----	----	685
Bait and ice	----	----	69	----	----	----	----	----	----	----	----	373
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----
Total	----	----	2,726	----	----	----	----	----	----	----	----	7,535
Other boat expenses:												
Repair and maintenance	1,527	[2]838	[2]684	1,096	----	----	1,191	----	----	1,274	[2]2,604	[2]1,878
Insuracne	1,145	----	----	746	----	----	825	----	----	----	----	----
Licenses and taxes on boat	240	108	88	255	----	----	143	----	----	175	----	----
Payroll and other taxes	119	74	60	377	----	----	31	----	----	----	145	104
Interest	99	----	----	----	----	----	----	----	----	201	243	175
Depreciation	762	318	259	1,469	----	----	893	----	----	2,127	1,337	964
Moorage	34	45	36	----	----	----	----	----	----	80	129	93
Truck and auto	173	----	----	----	----	----	----	----	----	----	372	268
Fishing gear	373	270	220	----	----	----	115	----	----	325	----	----
Assessments-cooperatives	209	97	79	----	----	----	----	----	----	----	143	103
Supplies	----	----	----	----	----	----	----	----	----	----	----	----
Miscellaneous	317	----	----	903	----	----	272	----	----	353	177	128
Total	4,998	1,750	1,426	4,846	----	----	3,470	----	----	4,535	5,150	3,713
Total expenses	12,377	5,497	4,152	14,856	----	----	6,687	----	----	9,106	15,599	11,248
Net income or (loss) — albacore	4,320	1,678	----	11,786	----	----	(1,916)	----	----	(491)	4,651	----
Net income or (loss) — other fish	----	----	1,712	----	----	----	----	----	----	----	----	3,356
Total net income or (loss)	4,320	3,390		11,786	----		(1,916)	----		(491)	8,007	

[1] The above figures are averages, using all boats. Certain expenses are not common to all boats, or expenses may be reported under different headings.
[2] Other boat expenses for boats fishing for both albacore and other fish have been allocated between albacore and other fish on the basis of catch receipts of each to the total catch receipts.

Table 26.—Average net income, 1959, Pacific coast albacore jig boats[1]

Total	Under 40' (10 boats)	40'-44' (11 boats)	45'-49' (6 boats)	50'-60' (9 boats)	Total (36 boats)
Catch receipts	$8,000	$13,180	$20,733	$16,680	$13,875
Expenses:					
Trip	2,269	3,944	6,981	4,145	4,035
Other boat	2,853	4,357	6,367	6,638	4,845
Total	5,122	8,301	13,348	10,783	8,880
Net income	2,878	4,879	7,385	5,897	4,995

[1] Information regarding 1959 jig-boat operations is presented here in summary form. Owing to the lateness of collection, time did not permit the inclusion of the data in the comparative analysis form used for 1956, 1957, and 1958. Information on bait-boat operations is not included because of the smaller number of boats reporting.

Income in General

Cash receipts.—Income of the albacore fishery is not limited to sales of albacore alone, for receipts were obtained from the sale of other species.

The percentage of income from other fish has been increasing (table 42), as has the number of boats in two or more fisheries (table 43).

Income from other fish is reported from trips made primarily to take other fish, although in a few instances, there was a small amount of income from sales of other fish caught during albacore trips.

Effect of season on income.—The albacore fishery season is relatively short. Most albacore are landed during July, August, and September when the albacore boats must be at full operating efficiency to produce maximum catches. Personal interviews and observation at landing ports indicated that the top producers (highliners) were the boats that did not have to lay up during the season.

Fishing for other fish, such as salmon, prior to the albacore season, accomplished two purposes: (1) Acts as a shakedown period after layup overhaul, replacement, and addition of equipment during off-season periods and (2) produces income during this period. Because this additional fishing absorbs a proportional share of certain fixed boat expenses—such as repairs, depreciation, and insurance—the cost per pound to catch albacore is lower for those boats that engage in two fisheries.

EXPENSE

Trip Expense

Labor.—In this section, we consider labor aboard bait boats, labor aboard jig boats, methods used to pay crewmen, and payment for additional labor.

Bait boats.—Bait boats require a larger crew than do jig boats and therefore have increased labor costs. Bait boats had crews of one to five men, not including owners. The size of crew did not change appreciably during our study. Smaller bait boats usually operate with one owner and two crew members. Absentee ownership requires an additional crewman.

Results of absentee ownership were generally unfavorable in terms of net income. The cost of labor increased, often leaving these boats with an operating loss. At present there seems little possibility for successful operation by absentee owners.

Jig boats.—Table 44 summarizes the details of owners and crew members. Most of the boats were operated by the owner and one crewman and by the owner alone.

The cost of labor on jig boats often included a small amount of money paid by the boat owner for help in unloading, especially when he operated alone. One person cannot remove several tons of fish rapidly from the hold. The purchaser of fish at dockside, using two or three men and equipment, cannot wait for one man to fill the buckets by which fish are removed. The dock must be cleared for other boats desiring to unload.

Methods used to pay crewmen.—Methods used to pay crewmen vary widely. The owner often pays his crewmen either a percentage of the gross receipts, of the net receipts after trip expense, or of the net receipts after boat and trip expenses. Items included as trip expenses vary. Some boat owners pay a flat amount per ton with no deduction for trip expenses.

Payment for labor.—Payment for labor, although often based on catch receipts, may actually be for work done before the season starts. Labor costs are incurred when the boat is being readied for use, when the boat is laid up between trips and the boat is scaled, painted, and repaired during haulout. Labor costs were not the same for all boats; it was impossible to make comparisons.

Fuel and lubricants.—Fuel and lubricant expense was common to all boats. The condensed summary (table 45) may be used for comparative purposes.

Table 45 shows that the amount spent on fuel for boats under 40 feet is considerably less than for larger boats. Two factors contribute to this difference: (1) A smaller motor and (2) a smaller fuel capacity. Small boats with smaller fuel capacity do not travel as far to sea as the larger boats and usually do not make long runs at night in search of new schools of fish. In general, boats are limited in their stay at sea more by fuel capacity than by carrying capacity of the hold.

Table 27.—1956 average income and expenses by length classification for Pacific coast albacore bait boats[1]

Item	Under 40'			40'-44'			45'-49'			50'-60'		
	Fish for albacore only (3 boats)	Fish for albacore and other fish (1 boat)		Fish for albacore only (1 boat)	Fish for albacore and other fish (0 boat)		Fish for albacore only (2 boats)	Fish for albacore and other fish (0 boat)		Fish for albacore only (1 boat)	Fish for albacore and other fish (1 boat)	
	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish
Catch receipts	$16,697	$7,175	$5,864	$26,642	----	----	$4,771	----	----	$8,615	$20,250	$14,604
Expenses:												
Trip expenses — albacore:												
Labor	4,629	2,164	----	7,586	----	----	1,207	----	----	2,468	6,897	----
Fuel and lubrication	876	330	----	989	----	----	945	----	----	340	1,114	----
Food and provisions	953	596	----	471	----	----	555	----	----	582	970	----
Foreign country permits	630	588	----	683	----	----	408	----	----	619	951	----
Bait and ice	291	69	----	281	----	----	102	----	----	99	517	----
Miscellaneous	----	----	----	----	----	----	----	----	----	463	----	----
Total	7,379	3,747	----	10,010	----	----	3,217	----	----	4,571	10,449	----
Trip expenses — other fish:												
Labor	----	----	760	----	----	----	----	----	----	----	----	4,974
Fuel and lubricants	----	----	604	----	----	----	----	----	----	----	----	803
Food and provisions	----	----	592	----	----	----	----	----	----	----	----	700
Foreign country permits	----	----	701	----	----	----	----	----	----	----	----	685
Bait and ice	----	----	69	----	----	----	----	----	----	----	----	373
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----
Total	----	----	2,726	----	----	----	----	----	----	----	----	7,535
Other boat expenses:												
Repair and maintenance	1,527	[2]838	[2]684	1,096	----	----	1,191	----	----	1,274	2,604[1]	1,878[1]
Insurance	1,145	----	----	746	----	----	825	----	----	----	----	----
Licenses and taxes on boat	240	108	88	255	----	----	143	----	----	175	----	----
Payroll and other taxes	119	74	60	377	----	----	31	----	----	----	145	104
Interest	99	----	----	----	----	----	----	----	----	201	243	175
Depreciation	762	318	259	1,469	----	----	893	----	----	2,127	1,337	964
Moorage	34	45	36	----	----	----	----	----	----	80	129	93
Truck and auto	173	----	----	----	----	----	----	----	----	----	372	268
Fishing gear	373	270	220	----	----	----	115	----	----	325	----	----
Assessments-cooperatives	209	97	79	----	----	----	----	----	----	----	143	103
Supplies	----	----	----	----	----	----	----	----	----	----	----	----
Miscellaneous	317	----	----	903	----	----	272	----	----	353	177	128
Total	4,998	1,750	1,426	4,846	----	----	3,470	----	----	4,535	5,150	3,713
Total expenses	12,377	5,497	4,152	14,856	----	----	6,687	----	----	9,106	15,599	11,248
Net income or (loss) — albacore	4,320	1,678	----	11,786	----	----	(1,916)	----	----	(491)	4,651	----
Net income or (loss) — other fish	----	----	1,712	----	----	----	----	----	----	----	----	3,356
Total net income or (loss)	4,320	3,390		11,786	----		(1,916)	----		(491)	8,007	

[1] The reader is cautioned to note that the above figures are averages, using all boats. Certain expenses are not common to all boats, or expenses may be reported under different headings.

[2] Other boat expenses for boats fishing for albacore and other fish have been allocated between albacore and other fish on the basis of catch receipts of each to the total catch receipts.

Table 28.—Income and expenses by length classification for Pacific coast albacore jig boats, 1956[1]

Item	Under 40'			40'-44'			45'-49'			50'-60'		
	Fish for albacore only (6 boats)	Fish for albacore and other fish (1 boat)		Fish for albacore only (4 boats)	Fish for albacore and other fish (4 boats)		Fish for albacore only (2 boats)	Fish for albacore and other fish (2 boats)		Fish for albacore only (4 boats)	Fish for albacore and other fish (3 boats)	
	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish
Catch receipts	$6,478	$8,226	$875	$14,217	$12,422	$4,187	$9,718	$16,561	$4,423	$12,734	$17,651	$3,232
Expenses:												
Trip expenses — albacore:												
Labor	347	----	----	1,512	2,278	----	1,756	3,439	----	1,650	1,409	----
Fuel and lubricants	548	676	----	1,185	998	----	1,357	752	----	1,169	924	----
Food and provisions	353	528	----	949	532	----	366	551	----	694	566	----
Foreign country permits	----	916	----	----	59	----	----	----	----	----	----	----
Bait and ice	92	244	----	139	407	----	188	724	----	106	----	----
Miscellaneous	19	----	----	----	----	----	----	----	----	13	----	----
Total	1,359	2,364	----	3,785	4,274	----	3,667	5,466	----	3,632	2,899	----
Trip expenses — other fish:												
Labor	----	----	----	----	----	252	----	----	1,118	----	----	----
Fuel and lubricants	----	----	147	----	----	302	----	----	353	----	----	253
Food and provisions	----	----	115	----	----	260	----	----	263	----	----	181
Foreign country permits	----	----	95	----	----	57	----	----	----	----	----	----
Bait and ice	----	----	16	----	----	191	----	----	176	----	----	214
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----
Total	----	----	373	----	----	1,062	----	----	1,910	----	----	648
Other boat expenses:												
Repair and maintenance	1,062	[2]2,087	[2]222	1,463	[2]1,139	[2]466	720	[2]1,160	[2]298	2,642	[2]2,469	[2]506
Insurance	327	----	----	----	273	97	581	332	96	409	418	117
Licenses and taxes on boat	117	----	----	103	65	18	187	25	6	144	37	9
Payroll and other taxes	----	----	----	61	78	24	80	133	38	35	----	----
Interest	32	----	----	283	113	34	186	----	----	89	87	27
Depreciation	515	1,410	150	2,407	873	231	1,115	1,571	408	1,392	1,586	338
Moorage	14	----	----	67	36	13	274	----	----	21	60	6
Truck and auto	83	377	40	83	183	85	----	251	59	----	----	----
Fishing gear	21	----	----	260	90	24	212	205	55	150	254	34
Assessments-cooperatives	5	----	----	137	----	----	125	179	50	108	202	29
Supplies	20	----	----	26	----	----	----	58	14	----	----	----
Miscellaneous	340	548	58	272	302	94	215	197	46	711	67	27
Total	2,536	4,422	470	5,162	3,152	1,086	3,695	4,111	1,070	5,701	5,180	1,093
Total expenses	3,895	6,786	843	8,947	7,426	2,148	7,362	9,577	2,980	9,333	8,079	1,741
Net income or (loss) — albacore	2,583	1,440	----	5,270	4,996	----	2,356	6,984	----	3,401	9,572	----
Net income or (loss) — other fish	----	----	32	----	----	2,039	----	----	1,443	----	----	1,491
Total net income or (loss)	2,583	1,472		5,270	7,035		2,356	8,427		3,401	11,963	

[1] The above figures are averages, using all boats. Certain expenses are not common to all boats, or expenses may be reported under different headings.

[2] Other boat expenses for boats fishing for both albacore and other fish, have been allocated between albacore and other fish on the basis of catch receipts of each to the total catch receipts.

Table 29.—Income and expenses by length classification for Pacific coast albacore bait boats, 1957[1]

Item	Under 40'			40'-44'			45'-49'			50'-60'		
	Fish for albacore only (3 boats)	Fish for albacore and other fish (1 boat)		Fish for albacore only (1 boat)	Fish for albacore and other fish (0 boat)		Fish for albacore only (2 boats)	Fish for albacore and other fish (0 boat)		Fish for albacore only (1 boat)	Fish for albacore and other fish (2 boats)	
	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish
Catch receipts	$14,629	$5,921	$4,100	$33,141	----	----	$9,051	----	----	$10,980	$27,157	$13,521
Expenses:												
Trip expenses — albacore:												
Labor	3,479	1,625	----	5,741	----	----	2,945	----	----	2,790	5,938	----
Fuel and lubricants	873	306	----	997	----	----	884	----	----	418	1,896	----
Food and provisions	854	377	----	448	----	----	591	----	----	582	1,403	----
Foreign country permits	581	191	----	782	----	----	449	----	----	401	1,214	----
Bait and ice	151	69	----	268	----	----	105	----	----	132	135	----
Miscellaneous	----	----	----	----	----	----	----	----	----	290	----	----
Total	5,938	2,568	----	8,236	----	----	4,974	----	----	4,613	10,586	----
Trip expenses — other fish:												
Labor	----	----	785	----	----	----	----	----	----	----	----	3,532
Fuel and lubricants	----	----	273	----	----	----	----	----	----	----	----	1,002
Food and provisions	----	----	418	----	----	----	----	----	----	----	----	666
Foreign country permits	----	----	551	----	----	----	----	----	----	----	----	867
Bait and ice	----	----	69	----	----	----	----	----	----	----	----	103
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----
Total	----	----	2,096	----	----	----	----	----	----	----	----	6,170
Other boat expenses:												
Repair and maintenance	1,790	[2]765	[2]529	1,536	----	----	3,511	----	----	1,690	[2]4,362	[2]2,259
Insurance	1,041	----	----	824	----	----	917	----	----	----	1,007	408
Licenses and taxes on boat	173	108	75	235	----	----	----	----	----	185	80	33
Payroll and other taxes	158	40	27	295	----	----	106	----	----	----	84	41
Interest	118	----	----	----	----	----	----	----	----	199	80	35
Depreciation	547	341	236	1,469	----	----	913	----	----	1,868	2,397	1,157
Moorage	32	44	31	----	----	----	----	----	----	165	142	80
Truck and auto	216	----	----	----	----	----	----	----	----	----	214	129
Fishing gear	645	86	60	----	----	----	130	----	----	500	908	395
Assessments-cooperatives	153	100	69	----	----	----	----	----	----	----	209	85
Supplies	----	103	71	----	----	----	----	----	----	----	152	62
Miscellaneous	628	----	----	786	----	----	779	----	----	498	136	74
Total	5,501	1,587	1,098	5,145	----	----	6,356	----	----	5,105	9,771	4,758
Total expenses	11,439	4,155	3,194	13,381	----	----	11,330	----	----	9,718	20,357	10,928
Net income or (loss) — albacore	3,190	1,766		19,760	----	----	(2,279)	----	----	1,262	6,800	----
Net income or (loss) — other fish	----	----	906	----	----	----	----	----	----	----	----	2,593
Total net income or (loss)	3,190	2,672		19,760	----		(2,279)	----		1,262	9,393	

[1] The above figures are averages, using all boats. Certain expenses are not common to all boats, or expenses may be reported under different headings.

[2] Other boat expenses for boats fishing for both albacore and other fish have been allocated between albacore and other fish on the basis of catch receipts of each to the total catch receipts.

Table 30.—Income and expenses by length classification for Pacific coast albacore jig boats, 1957[1]

Item	Under 40'			40'-44'			45'-49'			50'-60'		
	Fish for albacore only (6 boats)	Fish for albacore and other fish (2 boats)		Fish for albacore only (6 boats)	Fish for albacore and other fish (5 boats)		Fish for albacore only (3 boats)	Fish for albacore and other fish (2 boats)		Fish for albacore only (4 boats)	Fish for albacore and other fish (3 boats)	
	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish
Catch receipts	$6,643	$9,944	$929	$9,681	$10,190	$4,386	$5,738	$17,207	$3,431	$13,036	$15,789	$2,522
Expenses:												
Trip expenses — albacore:												
Labor	253	20	----	1,466	1,788	----	854	2,582	----	1,270	1,262	----
Fuel and lubricants	626	873	----	917	913	----	1,070	1,237	----	1,161	1,020	----
Food and provisions	513	551	----	731	516	----	361	651	----	841	610	----
Foreign country permits	86	----	----	----	45	----	----	----	----	----	----	----
Bait and ice	106	----	----	125	386	----	27	53	----	70	----	----
Miscellaneous	21	----	----	----	----	----	----	----	----	21	----	----
Total	1,605	1,444	----	3,239	3,648	----	2,312	4,523	----	3,363	2,892	----
Trip expenses — other fish:												
Labor	----	----	----	----	----	157	----	----	610	----	----	----
Fuel and lubricants	----	----	115	----	----	322	----	----	295	----	----	281
Food and provisions	----	----	137	----	----	230	----	----	285	----	----	171
Foreign country permits	----	----	----	----	----	25	----	----	----	----	----	----
Bait and ice	----	----	38	----	----	201	----	----	----	----	----	209
Miscellaneous	----	----	----	----	----	92	----	----	145	----	----	----
Total	----	----	290	----	----	1,027	----	----	1,335	----	----	661
Other boat expenses:												
Repair and maintenance	1,353	[2]1,308	[2]78	1,703	[2]1,202	[2]456	1,060	[2]2,501	[2]523	2,341	[2]2,570	[2]403
Insurance	210	369	53	----	263	131	642	372	80	413	519	142
Licenses and taxes on boat	51	172	12	91	67	31	140	97	22	145	38	8
Payroll and other taxes	----	----	----	56	64	15	29	8	1	37	----	----
Interest	41	155	22	163	40	10	215	18	2	87	59	19
Depreciation	732	443	64	1,742	884	426	1,455	1,899	357	1,512	1,554	266
Moorage	----	16	2	65	27	12	135	----	----	33	63	3
Truck and auto	141	----	----	81	169	61	----	252	32	----	----	----
Fishing gear	140	460	66	166	249	242	119	317	64	150	300	26
Assessments-cooperatives	18	----	----	100	67	22	111	293	60	111	186	24
Supplies	44	----	----	24	----	----	----	68	9	----	----	----
Miscellaneous	386	322	13	129	223	52	226	250	31	780	46	20
Total	3,116	3,245	310	4,320	3,255	1,458	4,132	6,075	1,181	5,609	5,335	911
Total expenses	4,721	4,689	600	7,559	6,903	2,485	6,444	10,598	2,516	8,972	8,227	1,572
Net income or (loss) — albacore	1,922	5,255	----	2,122	3,287	----	(706)	6,609	----	4,064	7,562	----
Net income or (loss) — other fish	----	----	329	----	----	1,901	----	----	915	----	----	950
Total net income or (loss)	1,922	5,584		2,122	5,188		(706)	7,524		4,064	8,512	

[1] The above figures are averages, using all boats. Certain expenses are not common to all boats, or expenses may be reported under different headings.

[2] Other boat expenses for boats fishing for both albacore and other fish have been allocated between albacore and other fish on the basis of catch receipts of each to the total catch receipts.

Table 31.—Income and expenses by length classification for Pacific coast albacore bait boats, 1958[1]

Item	Under 40'			40'-44'			45'-49'			50'-60'		
	Fish for albacore only (3 boats)	Fish for albacore and other fish (1 boat)		Fish for albacore only (1 boat)	Fish for albacore and other fish (0 boat)		Fish for albacore only (1 boat)	Fish for albacore and other fish (1 boat)		Fish for albacore only (1 boat)	Fish for albacore and other fish (1 boat)	
	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish
Catch receipts	$17,404	$4,566	$6,706	$32,384	----	----	$10,179	$15,557	$6,000	$7,651	$32,725	$30,551
Expenses:												
Trip expenses — albacore:												
Labor	5,750	919	----	7,186	----	----	2,965	7,469	----	1,848	6,248	----
Fuel and lubricants	747	111	----	1,100	----	----	1,111	1,411	----	578	2,226	----
Food and provisions	872	217	----	442	----	----	755	443	----	602	1,543	----
Foreign country permits	97	----	----	----	----	----	----	557	----	----	1,592	----
Bait and ice	220	46	----	171	----	----	168	193	----	99	70	----
Miscellaneous	----	----	----	----	----	----	----	----	----	289	----	----
Total	7,686	1,293	----	8,899	----	----	4,999	10,073	----	3,416	11,679	----
Trip expenses — other fish:												
Labor	----	----	1,695	----	----	----	----	----	2,763	----	----	5,838
Fuel and lubricants	----	----	661	----	----	----	----	----	522	----	----	2,079
Food and provisions	----	----	940	----	----	----	----	----	164	----	----	1,442
Foreign country permits	----	----	943	----	----	----	----	----	----	----	----	1,487
Bait and ice	----	----	92	----	----	----	----	----	71	----	----	66
Miscellaneous	----	----	----	----	----	----	----	----	----	----	----	----
Total	----	----	4,331	----	----	----	----	----	3,520	----	----	10,912
Other boat expenses:												
Repair and maintenance	1,594	[2]242	[2]355	1,978	----	----	2,291	[2]2,379	[2]917	2,501	[2]5,464	[2]5,100
Insurance	955	----	----	346	----	----	----	1,227	473	142	1,257	1,174
Licenses and taxes on boat	168	75	109	239	----	----	----	196	75	96	186	174
Payroll and other taxes	237	17	25	379	----	----	----	355	137	----	----	----
Interest	73	----	----	----	----	----	----	----	----	337	132	124
Depreciation	584	234	343	1,242	----	----	320	1,326	512	820	2,283	2,132
Moorage	35	39	57	----	----	----	96	----	----	219	169	158
Truck and auto	222	----	----	----	----	----	----	2,664	1,027	----	310	290
Fishing gear	722	65	95	----	----	----	297	----	----	536	1,026	957
Assessments-cooperatives	150	28	41	----	----	----	----	----	----	----	240	224
Supplies	----	----	----	----	----	----	----	----	----	----	----	----
Miscellaneous	447	----	----	1,446	----	----	276	135	52	762	1,163	1,086
Total	5,187	700	1,025	5,630	----	----	3,280	8,282	3,193	5,413	12,230	11,419
Total expenses	12,873	1,993	5,356	14,529	----	----	8,279	18,355	6,713	8,829	23,909	22,331
Net income or (loss) — albacore	4,531	2,573	----	17,855	----	----	1,900	(2,798)	----	(1,178)	8,816	----
Net income or (loss) — other fish	----	----	1,350	----	----	----	----	----	(713)	----	----	8,220
Total net income or (loss)	4,531	3,923		17,855	----		1,900	(3,511)		(1,178)	(17,036)	

[1] The above figures are averages, using all boats. Certain expenses are not common to all boats, or expenses may be reported under different headings.

[2] Other boat expenses for boats fishing for both albacore and other fish have been allocated between albacore and other fish on the basis of catch receipts of each to the total catch receipts.

Table 32.—Income and expenses by length classification for Pacific coast albacore jig boats, 1958[1]

Item	Under 40'			40'-44'			45'-49'			50'-60'		
	Fish for albacore only (6 boats)	Fish for albacore and other fish (6 boats)		Fish for albacore only (5 boats)	Fish for albacore and other fish (7 boats)		Fish for albacore only (4 boats)	Fish for albacore and other fish (3 boats)		Fish for albacore only (4 boats)	Fish for albacore and other fish (3 boats)	
	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish	Albacore	Albacore	Other fish
Catch receipts	$4,823	$6,792	$2,272	$11,336	$8,610	$3,274	$4,797	$17,409	$3,128	$13,489	$14,836	$2,126
Expenses:												
Trip expenses — albacore:												
Labor	235	468	----	1,675	1,160	----	476	198	----	1,890	832	----
Fuel and lubricants	432	601	----	836	686	----	724	910	----	1,387	938	----
Food and provisions	414	372	----	599	489	----	281	676	----	824	533	----
Foreign country permits	----	----	----	----	----	----	----	----	----	----	----	----
Bait and ice	67	59	----	91	213	----	64	79	----	53	----	----
Miscellaneous	----	----	----	----	----	----	----	----	----	18	----	----
Total	1,148	1,500	----	3,201	2,548	----	1,545	1,863	----	4,172	2,303	----
Trip expenses — other fish:												
Labor	----	----	289	----	----	121	----	----	50	----	----	----
Fuel and lubricants	----	----	236	----	----	290	----	----	349	----	----	186
Food and provisions	----	----	205	----	----	187	----	----	305	----	----	119
Foreign country permits	----	----	75	----	----	----	----	----	----	----	----	----
Bait and ice	----	----	72	----	----	205	----	----	179	----	----	134
Miscellaneous	----	----	----	----	----	71	----	----	----	----	----	----
Total	----	----	877	----	----	874	----	----	883	----	----	439
Other boat expenses:												
Repair and maintenance	1,410	[2]1,235	[2]395	1,966	[2]1,102	[2]330	1,076	[2]2,079	[2]366	4,098	[2]2,403	[2]343
Insurance	421	139	28	----	192	52	390	502	82	341	702	75
Licenses and taxes on boat	96	71	17	133	76	30	124	599	10	133	48	6
Payroll and other taxes	----	13	5	204	43	11	32	13	1	79	----	----
Interest	----	82	16	113	47	15	147	11	2	69	71	6
Depreciation	347	605	265	1,704	847	294	1,583	1,975	340	1,510	1,612	217
Moorage	29	8	2	54	47	8	223	22	4	58	57	9
Truck and auto	83	45	13	92	167	24	36	271	35	86	----	----
Fishing gear	26	183	77	207	350	186	77	189	19	34	324	52
Assessments-cooperatives	----	27	6	44	17	5	80	153	29	139	169	27
Supplies	----	----	----	----	2	----	----	44	4	24	----	----
Miscellaneous	326	179	62	188	203	68	132	175	29	810	124	10
Total	2,738	2,587	886	4,705	3,093	1,023	3,900	5,493	921	7,381	5,510	745
Total expenses	3,886	4.087	1,763	7,906	5,641	1,897	5,445	7,356	1,804	11,553	7,813	1,184
Net income or (loss) — albacore	937	2,705	----	3,430	2,969	----	(648)	10,053	----	1,936	7,023	----
Net income or (loss) — other fish	----	----	509	----	----	1,377	----	----	1,324	----	----	942
Total net income or (loss)	937	3,214		3,430	4,346		(648)	11,377		1,936	7,965	

[1] The above figures are averages, using all boats. Certain expenses are not common to all boats, or expenses may be reported under different headings.

[2] Other boat expenses for boats fishing for both albacore and other fish have been allocated between albacore and other fish on the basis of catch receipts of each to the total catch receipts.

Table 33.—Average net income or (loss) for Pacific coast albacore jig boats

Boat length	1956		1957		1958	
	Fish for albacore only	Fish for albacore and other fish	Fish for albacore only	Fish for albacore and other fish	Fish for albacore only	Fish for albacore and other fish
Feet	Dollars					
Under 40	(6) 2,583	(1) 1,472	(6) 1,922	(2) 5,584	(6) 937	(6) 3,214
40 - 44	(4) 5,270	(4) 7,035	(6) 2,122	(5) 5,188	(5) 3,430	(7) 4,346
45 - 49	(2) 2,356	(2) 8,427	(2) (706)	(2) 7,524	(4) (648)	(3) 11,377
50 - 60	(4) 3,401	(3) 11,063	(4) 4,064	(3) 8,512	(4) 1,936	(3) 7,965

Note: Figures in parentheses (left of each colum) indicates number of boats.

Table 34.—Average cost per pound to catch albacore and average net income or (loss) per pound for Pacific coast albacore bait boats, 1956

Item	Under 40'		40'-44'		45'-49'		50'-60'	
	Fish for albacore only (3 boats)	Fish for albacore and other fish (1 boat)	Fish for albacore only (1 boat)	Fish for albacore and other fish (0 boat)	Fish for albacore only (2 boats)	Fish for albacore and other fish (0 boat)	Fish for albacore only (1 boat)	Fish for albacore and other fish (1 boat)
	Cents per pound							
Trip expenses:								
Labor	4.75	5.17	4.88	----	4.34	----	4.91	5.83
Fuel and lubricants	.90	.79	.64	----	3.39	----	.67	.94
Food and provisions	.98	1.42	.30	----	1.99	----	1.16	.82
Foreign country permits	.64	1.40	.44	----	1.47	----	1.23	.81
Bait and ice	.30	.16	.18	----	.36	----	.20	.44
Miscellaneous	----	----	----	----	----	----	.92	----
Total	7.57	8.94	6.44	----	11.55	----	9 09	8.84
Other boat expenses:								
Repair and maintenance	1.57	2.00	.70	----	4.28	----	2.53	2.20
Insurance	1.18	----	.48	----	2.96	----	----	----
Licenses and taxes on boat	.25	.26	.16	----	.52	----	.35	----
Payroll and other taxes	.12	.18	.24	----	.11	----	----	.12
Interest	.10	----	----	----	----	----	.40	.21
Depreciation	.78	.76	.95	----	3.20	----	4.23	1.13
Moorage	.03	.11	----	----	----	----	.16	.11
Truck and auto	.18	----	----	----	----	----	----	.32
Fishing gear	.38	.64	----	----	.41	----	.65	----
Assessments-cooperatives	.21	.23	----	----	----	----	----	.12
Supplies	----	----	----	----	----	----	----	----
Miscellaneous	.33	----	.58	----	.98	----	.70	.15
Total	5.13	4.18	3.11	----	12.46	----	9.02	4.36
Total expenses	12.70	13.12	9.55	----	24.01	----	18.11	13.20
Net income or (loss) per pound	4.43	4.01	7.58	----	(6.88)	----	(.98)	3.93

Table 35.—Average cost per pound to catch albacore and average net income or (loss) per pound for Pacific coast albacore jig boats, 1956

Item	Under 40'		40'-44'		45'-44'		50'-60'	
	Fish for albacore only (6 boats)	Fish for albacore and other fish (1 boat)	Fish for albacore only (4 boats)	Fish for albacore and other fish (4 boats)	Fish for albacore only (2 boats)	Fish for albacore and other fish (2 boats)	Fish for albacore only (4 boats)	Fish for albacore and other fish (3 boats)
	Cents per pound							
Trip expenses:								
Labor	.92	----	1.82	3.14	3.10	3.55	2.22	1.36
Fuel and lubricants	1.45	1.40	1.43	1.38	2.39	.73	1.57	.90
Food and provisions	.93	1.10	1.14	.73	.64	.57	.93	.55
Foreign country permits	----	1.91	----	.08	----	----	----	----
Bait and ice	.24	.51	.17	.56	.33	.75	.14	----
Miscellaneous	.05	----	----	----	----	----	.02	----
Total	3.59	4.92	4.56	5.89	6.46	5.65	4.88	2.81
Other boat expenses:								
Repair and maintenance	2.81	4.34	1.77	1.57	1.27	1.20	3.55	2.39
Insurance	.87	----	----	.37	1.02	.34	.55	.40
Licenses and taxes on boat	.31	----	.12	.09	.33	.03	.19	.04
Payroll and other taxes	----	----	.07	.11	.14	.14	.05	----
Interest	.08	----	.34	.16	.33	----	.12	.08
Depreciation	1.36	2.94	2.90	1.20	1.97	1.62	1.87	1.54
Moorage	.04	----	.08	.05	.48	----	.03	.06
Truck and auto	.22	.79	.10	.25	----	.26	----	----
Fishing gear	.06	----	.31	.12	.37	.21	.20	.25
Assessments-cooperatives	.01	----	.17	----	.22	.19	.15	.20
Supplies	.05	----	.03	----	----	.06	----	----
Miscellaneous	.90	1.14	.33	.42	.38	.20	.96	.07
Total	6.71	9.21	6.22	4.34	6.51	4.25	7.67	5.03
Total expenses	10.30	14.13	10.78	10.23	12.97	9.90	12.55	7.84
Net income or (loss) per pound	6.83	3.00	6.35	6.89	4.16	7.23	4.58	9.29

Table 36.—Average cost per pound to catch albacore and average net income or (loss) per pound for Pacific coast albacore bait boats, 1957

Item	Under 40'		40'-44'		45'-49'		50'-60'	
	Fish for albacore only (3 boats)	Fish for albacore and other fish (1 boat)	Fish for albacore only (1 boat)	Fish for albacore and other fish (0 boat)	Fish for albacore only (2 boats)	Fish for albacore and other fish (0 boat)	Fish for albacore only (1 boat)	Fish for albacore and other fish (2 boats)
	Cents per pound							
Trip expenses:								
Labor	3.43	3.96	2.50	----	4.69	----	3.67	3.15
Fuel and lubricants	.86	.74	.43	----	1.41	----	.55	1.01
Foods and provisions	.84	.92	.20	----	.94	----	.76	.75
Foreign country permits	.57	.47	.34	----	.72	----	.53	.64
Bait and ice	.15	.17	.12	----	.17	----	.17	.07
Miscellaneous	----	----	----	----	----	----	.38	----
Total	5.85	6.26	3.59	----	7.93	----	6.06	5.62
Other boat expenses:								
Repair and maintenance	1.76	1.87	.67	----	5.59	----	2.22	2.32
Insurance	1.03	----	.36	----	1.46	----	----	.54
Licenses and taxes on boat	.17	.26	.10	----	----	----	.24	.04
Payroll and other taxes	.16	.10	.13	----	.17	----	----	.05
Interest	.12	----	----	----	----	----	.26	.04
Depreciation	.54	.83	.64	----	1.46	----	2.46	1.27
Moorage	.03	.11	----	----	----	----	.22	.08
Truck and auto	.21	----	----	----	----	----	.11	.11
Fishing gear	.64	.21	----	----	.21	----	.66	.48
Assessments-cooperatives	.15	.24	----	----	----	----	.11	.11
Supplies	----	.25	----	----	----	----	.11	.08
Miscellaneous	.62	----	.34	----	1.24	----	.65	.07
Total	5.43	3.87	2.24	----	10.13	----	6.71	5.19
Total expenses	11.28	10.13	5.83	----	18.06	----	12.77	10.81
Net income or (loss) per pound	3.15	4.30	8.60	----	(3.63)	----	1.66	3.62

Table 37.—Average cost per pound to catch albacore and average net income or (loss) per pound for Pacific coast albacore jig boats, 1957

Item	Under 40'		40'-44'		45'-49'		50'-60'	
	Fish for albacore only (6 boats)	Fish for albacore and other fish (2 boats)	Fish for albacore only (6 boats)	Fish for albacore and other fish (5 boats)	Fish for albacore only (3 boats)	Fish for albacore and other fish (2 boats)	Fish for albacore only (4 boats)	Fish for albacore and other fish (3 boats)
	Cents per pound							
Trip expenses:								
Labor	.55	.03	2.18	2.53	2.15	2.16	1.41	1.15
Fuel and lubricants	1.36	1.26	1.37	1.29	2.69	1.04	1.28	.93
Food and provisions	1.11	.80	1.09	.73	.91	.55	.93	.56
Foreign country permits	.19	----	----	.07	----	----	----	----
Bait and ice	.23	----	.19	.55	.07	.04	.08	----
Miscellaneous	.04	----	----	----	----	----	.02	----
Total	3.48	2.09	4.83	5.17	5.82	3.79	3.72	2.64
Other boat expenses:								
Repair and maintenance	2.94	1.90	2.54	1.70	2.67	2.10	2.59	2.35
Insurance	.45	.54	----	.37	1.61	.31	.46	.48
Licenses and taxes on boat	.11	.25	.14	.10	.35	.08	.16	.04
Payroll and other taxes	----	----	.08	.09	.07	.01	.04	----
Interest	.09	.22	.24	.06	.54	.01	.10	.05
Depreciation	1.59	.64	2.59	1.25	3.66	1.59	1.67	1.42
Moorage	----	.02	.10	.04	.34	----	.04	.06
Truck and auto	.31	----	.12	.24	----	.21	----	----
Fishing gear	.30	.67	.25	.35	.30	.26	.17	.27
Assessments-cooperatives	.04	----	.15	.09	.28	.25	.12	.17
Supplies	.10	----	.04	----	----	.06	----	----
Miscellaneous	.84	.47	.19	.32	.57	.21	.86	.04
Total	6.77	4.71	6.44	4.61	10.39	5.09	6.21	4.88
Total expenses	10.25	6.80	11.27	9.78	16.21	8.88	9.93	7.52
Net income or (loss) per pound	4.18	7.63	3.16	4.65	(1.78)	5.55	4.50	6.91

Table 38.—Average cost per pound to catch albacore and average net income or (loss) per pound for Pacific coast albacore bait boats, 1958

Item	Under 40'		40'-44'		45'-49'		50'-60'	
	Fish for albacore only (3 boats)	Fish for albacore and other fish (1 boat)	Fish for albacore only (1 boat)	Fish for albacore and other fish (0 boat)	Fish for albacore only (1 boat)	Fish for albacore and other fish (1 boat)	Fish for albacore only (1 boat)	Fish for albacore and other fish (1 boat)
	Cents per pound							
Trip expenses:								
Labor	6.79	4.13	4.56	----	5.98	9.86	4.96	3.92
Fuel and lubricants	.88	.50	.70	----	2.24	1.86	1.55	1.40
Food and provisions	1.03	.98	.28	----	1.53	.59	1.61	.97
Foreign country permits	.11	----	----	----	----	.74	----	1.00
Bait and ice	.26	.21	.11	----	.34	.25	.27	.04
Miscellaneous	----	----	----	----	----	----	.78	----
Total	9.07	5.82	5.65	----	10.09	13.30	9.17	7.33
Other boat expenses:								
Repair and maintenance	1.88	1.09	1.25	----	4.62	3.14	6.71	3.43
Insurance	1.12	----	.22	----	----	1.62	.38	.79
Licenses and taxes on boat	.20	.34	.15	----	----	.26	.26	.12
Payroll and other taxes	.28	.08	.24	----	----	.47	----	----
Interest	.09	----	----	----	----	----	.90	.08
Depreciation	.69	1.05	.79	----	.65	1.75	2.20	1.43
Moorage	.04	.17	----	----	.19	----	.59	.11
Truck and auto	.26	----	----	----	----	3.51	----	.19
Fishing gear	.85	.29	----	----	.60	----	1.44	.65
Assessments-cooperatives	.18	.13	----	----	----	----	----	.15
Supplies	----	----	----	----	----	----	----	----
Miscellaneous	.53	----	.92	----	.56	.18	2.05	.73
Total	6.12	3.15	3.57	----	6.62	10.93	14.53	7.68
Total expenses	15.19	8.97	9.22	----	16.71	24.23	23.70	15.01
Net income or (loss) per pound	5.35	11.57	11.32	----	3.83	(3.69)	(3.16)	5.53

Table 39.—Average cost per pound to catch albacore and average net income or (loss) per pound for Pacific coast albacore jig boats, 1958

Item	Under 40'		40'-44'		45'-49'		50'-60'	
	Fish for albacore only (6 boats)	Fish for albacore and other fish (6 boats)	Fish for albacore only (5 boats)	Fish for albacore and other fish (7 boats)	Fish for albacore only (4 boats)	Fish for albacore and other fish (3 boats)	Fish for albacore only (4 boats)	Fish for albacore and other fish (3 boats)
	Cents per pound							
Trip expenses:								
Labor	1.00	1.42	3.03	2.76	2.04	.23	2.88	1.15
Fuel and lubricants	1.84	1.81	1.52	1.64	3.10	1.08	2.11	1.30
Food and provisions	1.77	1.13	1.09	1.17	1.20	.80	1.25	.74
Foreign country permits	----	----	----	----	----	----	----	----
Bait and ice	.28	.18	.17	.51	.27	.09	.08	----
Miscellaneous	----	----	----	----	----	----	.03	----
Total	4.89	4.54	5.81	6.08	6.61	2.20	6.35	3.19
Other boat expenses:								
Repair and maintenance	6.01	3.74	3.56	2.63	4.61	2.45	6.24	3.33
Insurance	1.79	.42	----	.46	1.67	.59	.52	.97
Licenses and taxes on boat	.41	.21	.24	.18	.53	.07	.20	.07
Payroll and other taxes	----	.04	.37	.10	.13	.02	.12	----
Interest	----	.25	.20	.11	.63	.01	.11	.10
Depreciation	1.48	1.83	3.09	2.02	6.78	2.33	2.30	2.23
Moorage	.12	.02	.10	.11	.95	.03	.09	.08
Truck and auto	.35	.14	.17	.40	.15	.32	.13	----
Fishing gear	.11	.55	.37	.84	.33	.22	.05	.45
Assessments-cooperatives	----	.08	.08	.04	.34	.18	.21	.23
Supplies	----	----	----	----	----	.05	.04	----
Miscellaneous	1.39	.54	.34	.48	.57	.21	1.23	.17
Total	11.66	7.82	8.52	7.37	16.69	6.48	11.24	7.63
Total expenses	16.55	12.36	14.33	13.45	23.30	8.68	17.59	10.82
Net income or (loss) per pound	3.99	8.18	6.21	7.09	(2.76)	11.86	2.95	9.72

Table 40.—Average cost per pound to catch albacore, average net income or (loss) per pound, and average weight of catch, Pacific coast albacore jig boats

Item	Income and expense								
	Jig boats			Bait boats			All boats		
	1956 (26 boats)	1957 (31 boats)	1958 (38 boats)	1956 (9 boats)	1957 (10 boats)	1958 (9 boats)	1956 (35 boats)	1957 (41 boats)	1958 (47 boats)
	Cents per pound								
Gross income per pound: Industry average[1]	17.13	14.43	20.54	17.13	14.43	20.54	17.13	14.43	20.54
Expenses: Trip	4.65	3.98	4.98	8.03	5.58	8.59	5.61	4.53	5.96
Other boat	5.90	5.88	8.95	5.35	5.26	6.76	5.74	5.67	8.28
Total	10.55	9.86	13.85	13.38	10.84	15.35	11.35	10.20	14.24
Net income per pound	6.58	4.57	6.69	3.75	3.59	5.19	5.78	4.23	6.30
	Weight of catch								
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Average per boat	69,624	71,517	45,676	79,338	115,278	83,995	72,122	82,190	53,014

[1] Fishery Statistics of the United States, Fish and Wildlife, 1956, 1957, and 1958.

Table 41.—Average cost per pound to catch albacore and average net income or (loss) per pound Pacific coast albacore jig boats

Item	Cost and income					
	1956		1957		1958	
	Fish for albacore only	Fish for albacore and other fish	Fish for albacore only	Fish for albacore and other fish	Fish for albacore only	Fish for albacore and other fish
	Cents per pound					
Cost per pound on boats:						
Under 40'	(6) 10.30	(1) 14.13	(6) 10.25	(2) 6.80	(6) 16.55	(6) 12.36
40'-44'	(4) 10.78	(4) 10.23	(6) 11.27	(5) 9.78	(5) 14.33	(7) 13.45
45'-49'	(2) 12.97	(2) 9.90	(3) 16.21	(2) 8.88	(4) 23.30	(3) 8.68
50'-60'	(4) 12.55	(3) 7.84	(4) 9.93	(3) 7.52	(4) 17.59	(3) 10.82
Net income per pound on boats:						
Under 40'	(6) 6.83	(1) 3.00	(6) 4.18	(2) 7.63	(6) 3.99	(6) 8.18
40'-44'	(4) 6.35	(4) 6.89	(6) 3.16	(5) 4.65	(5) 6.21	(7) 7.09
45'-49'	(2) 4.16	(2) 7.23	(3) (1.78)	(2) 5.55	(4) (2.76)	(3) 11.86
50'-60'	(4) 4.58	(3) 9.29	(4) 4.50	(3) 6.91	(4) 2.95	(3) 9.72

Note: Figures in parentheses (left of each column) indicates number of boats.

The difference in amount of fuel consumed by jig boats and bait boats did not appear to be significant in overall comparisons. Bait boats do, however, make more trips to and from fishing areas. Jig boats are continually on the move, but make fewer trips to port. The two factors apparently offset one another, because fuel expenses were not very different. It must be remembered that bait boats show a much larger catch receipt for the same expenditure for fuel. Of the total catch receipts reported by jig and bait boats for the years under review, 7.7 percent was expended for fuel.

The smaller jig boats have lower annual provision costs than other boats (table 46). This difference is largely because the owner was often the only person on board. Bait boats, with crewmen aboard, showed somewhat larger average expenses. Of the total catch receipts reported by both jig and bait boats for the years under review, 5.3 percent was expended for food and provisions.

Table 42.—Relative amount of income from albacore and from other fish, 1956-58

Item	Amount relative to total income in:		
	1956	1957	1958
	Percent	*Percent*	*Percent*
Albacore	88.4	87.5	84.3
Other fish	11.6	12.5	15.7

Little effort has been made to reduce costs.

Foreign country permits.—The amount spent for entering territorial waters of foreign countries was negligible during the period under review. This expense may become important in the overall cost in future years if

Table 43.—Boats fishing only for albacore and boats fishing for albacore and other species

Fishery	Boats					
	1956		1957		1958	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*
Albacore	23	65.7	26	63.4	25	53.2
Albacore and other fish	12	34.3	15	36.6	22	46.8
Total	35	100.0	41	100.0	47	100.0

Table 44.—Number of crew members and owners aboard jig boats

Crew	Boats		
	1956	1957	1958
	No.	*No.*	*No.*
Owner fishes alone	7	9	9
Owner and one crewman	11	13	19
Owner and two crewmen	4	3	1
Two owners and no crewman	3	4	5
Husband and wife and no crewman	1	1	1
Total boats reporting	26	30	35

Table 45.—Average annual cost of fuel and lubricants on jig boats and bait boats

Year	Annual cost of fuel and lubricants							
	Jig boats				Bait boats			
	Under 40'	40'-44'	45'-49'	50'-60'	Under 40'	40'-44'	45'-49'	50'-60'
1956	$566	$1,091	$1,054	$1,064	$740	$989	$945	$727
1957	687	915	1,137	1,101	731	997	884	1,403
1958	516	749	804	1,195	588	1,100	1,261	1,402

Table 46.—Average annual cost of provisions for jig boats and bait boats

Year	Jig boats				Bait boats			
	Under 40'	40'-44'	45'-49'	50'-60'	Under 40'	40'-44'	45'-49'	50'-60'
1956	$377	$741	$458	$639	$864	$471	$555	$776
1957	522	633	477	742	735	448	591	1,129
1958	393	535	450	699	708	442	599	1,073

the fish encounter changing oceanic conditions in their migrations. When albacore first appear off the coast of Mexico, it is expedient to take out a permit to enter the territorial waters of that country to obtain bait, protection from storms, or repairs for the boats.

Bait and ice.—Bait and ice as expenses were not common to all boats. Bait boats use live bait to chum the fish. Jig boats usually carry a few 5-gallon cans of dead bait, which is used occasionally to chum fish so that they will follow in the wake of the boat as it circles or tacks back and forth through the school of fish. Some jig boats also use live bait carried in a small bait tank on the deck.

Other Boat Expense

Repairs and maintenance.—Repair and maintenance of hull, motors, and equipment is the largest expense for jig boats and is exceeded only by the labor expense of bait boats (table 47).

The expense of repair and maintenance for jig boats has increased both in total and as a percentage of the total income (table 47). Bait boats had increased expenses, but their percentage increase did not reflect as sharp an increase as did the jig boats. This difference was accounted for by increased catch receipts by bait boats.

Dollar amounts shown do not include the owner's labor. Various boat owners reported that the time they worked during layup was substantial. If the boat owner did not spend part of his off-season time repairing the boat, few boats would show profit. The high labor costs for electrical, refrigeration, and motor services would absorb the income.

Table 47.—Average cost of repairs and maintenance for jig boats and bait boats

Year	Cost for jig boats		Cost for bait boats	
	Average expense	Amount relative to catch receipts	Average expense	Amount relative to catch receipts
	Dollars	*Percent*	*Dollars*	*Percent*
1956	1,723	12.9	1,704	10.7
1957	1,836	15.9	3,015	15.3
1958	1,956	18.2	2,890	13.1

Table 48.—Average repair and maintenance expenses

Year	Jig boats				Bait boats			
	Under 40'	40-44'	45-49'	50-60'	Under 40'	40-44'	45-49'	50-60'
1956	$1,240	$1,534	$1,089	$2,785	$1,526	$1,096	$1,191	$2,878
1957	1,361	1,683	1,846	2,612	1,666	1,536	3,511	4,977
1958	1,520	1,754	1,662	3,519	1,345	1,978	2,794	6,533

Repairs and maintenance may, in some instances, include expenditures that should properly be capitalized. In this instance, cost would be written off as depreciation over a longer time. Investigation of this area did not reflect unreasonable methods of depreciation in use generally. Because boat and equipment must be constantly repaired to maintain around-the-clock schedules while at sea, the methods now used by the majority of boat owners appear to be sound.

Table 48 shows average repair and maintenance expense classified according to length of boat involved. This information indicates that, as would be expected from the fact that the tonnage of a vessel increases faster than does its length, boats of the 50- to 60-foot class have expense greater than their proportionate lengths would indicate. This increased expense may be the result not only of the proportionately greater tonnage but of the age of these boats, coupled with the higher cost of repair parts. There was a time after World War II when surplus motors and parts were obtainable at low costs.

Few generalized statements may be made about insurance. The average cost for jig boats appeared to be about 50 percent less than average cost for bait boats (table 49); however, the types of coverage were not revealed by the questionnaires. Interviews with fishermen indicated that a large percentage of the bait boats that have southern cities as their home ports are insured individually through private insurance companies.

A large percentage of jig boats were registered in northern ports, where owners belong to cooperative associations and have collective insurance rates.

About 57 percent of the boats carried insurance of some form. Many boats were uninsurable.

Many fishermen stated that insurance premiums were too high. Few businessmen in other industries, however, would consider operating without insuring their investment.

Licenses and taxes on boat.—Annual boat licenses are required by California, Oregon, and Washington. A fisherman may carry one, two, or all of these State licenses.

Taxes on boats vary from State to State. In California, the county assessor appraises boats and levies a county tax. Boats registered in Washington were subject only to a State tax of minor consequence.

Payroll and other taxes.—Payroll taxes include social security and unemployment taxes levied against the boat owner. The owner of the boat sometimes pays the employee's share of social security taxes. The amount of taxes paid varies with the number of crew. Comparison of bait-boat operations to jig-boat operations shows that this category of expense is much larger for the bait boats, because of the larger crews on the bait boats. Jig boats carry only one or two crew members, and often none.

Interest.—One expense of boat operation is interest (table 50).

Boat owners often state that credit was unavailable through banks. Many said that they had investigated the Federal Government Fisheries Loan Program. Some had applied; only one stated that he had secured a loan in this manner. In general, fishermen felt that this program was of little use and was generally unavailable to them, owing to regulations that would have to be complied with in securing and repaying loans.

Interviews indicated that, for the first trip of the season, cooperatives furnished fuel, gear, and other supplies to many of the boat owners, who repaid them after catch receipts were obtained. Other methods of financing trip expense, equipment, and other necessary expenditures were arranged by borrowing from relatives, borrowing on car or truck, and borrowing from the cannery.

Table 49.—Average cost of insurance for jig and bait boats

Year	Total boats in sample		Boats reporting insurance expense		Average cost of insurance	
	Jig	Bait	Jig	Bait	Jig	Bait
	Number	*Number*	*Number*	*Number*	*Dollars*	*Dollars*
1956	26	9	15	5	580	1,166
1957	31	10	18	6	585	1,435
1958	38	9	19	7	644	1,069

Table 50.—Average interest expense for jig and bait boats

Year	Total boats in sample	Total boats reporting	Average interest paid by boats reporting payment
	Number	*Number*	*Dollars*
1956	35	12	293
1957	41	17	228
1958	47	17	208

The amount of interest expense is low. Many fishermen stated that they could not earn a living if they had to make both interest and principal payments on a boat.

Depreciation.—A review of the boat-depreciation schedule, table 51, shows four main property classifications used in computing depreciations.

Hull.—Prior to 1950, 48 boats were built; after 1950, only 3 boats were built (table 52).

The estimated life used most frequently in determining the cost allocated for depreciation varied from 10 to 20 years (table 53).

Many boat owners did not depreciate the hull, motor, and equipment separately. Use of a composite life does not appear to be consistent with sound depreciation theory, as the life of a motor or other equipment is substantially less than that of the hull. Consideration should be given by these boat owners to separate assets with different lives.

The straight-line method of computing estimated hull depreciation was used by every boat owner.

"Main engine".—Data on engine depreciation revealed that the engine was often included with the hull for depreciation purposes.

The estimated life used most frequently in estimating engine depreciation was 5-10 years (table 54). Except for the ease of computation, no explanation was found for use of either 5 years or the jump to 10 years. Boat owners should take a more realistic approach to the problem of main-engine life. Accelerated depreciation would be consistent with the strain on the boat motors during day-and-night operation in the fishing season. Analysis of the repairs and maintenance reported by boat owners indicated that some method of accelerated depreciation in the first few years after acquisition should be considered.

Refrigeration.—With the exception of 3 boats, the 15 boats reported on used mechanical refrigeration. Some of the owners apparently consider their refrigeration installation costs as expenses rather than as capital investments.

There was approximately an even division in the use of 5 and 10 years as the estimated life for determining the depreciation cost (table 55). Ease of computation appeared to be the reason for the use of the two periods. When installing new or additional refrigeration, boat owners should investigate the various accelerated depreciation methods available to them.

Electronic and other equipment.—Assets listed under electronic and other equipment included radio, telephone, direction finder, loran, fathometer, automatic pilot, radar, auxiliary motors, and various other boat equipment, including trucks and autos used for business purposes. Purchase of boat equipment was capitalized by some boat owners and expensed by others. Electronic equipment is subject to hard usage and usually needs continual repair. Justification of short-life estimates in this classification appears to be in accord with sound accounting principles, if confined to electronic and similar equipment.

Moorage.—For 1958, average expenditures for moorage amounted to $149 for 21 boats reporting. Moorage in San Diego was not a problem, although certain boat owners stated that in other localities, docking facilities were crowded and in some cases taken by sports fishing craft.

Usually the boat owner pays a yearly moorage rental on the basis of length of boat. Additional facilities, such as showers and other accomodations necessary for owners living on boats permanently are available at additional cost in certain areas. The inclusion of such costs might account for the unusually large amounts appearing under individual boat operations in tables 13-24.

Truck and automobile.—Expenses of truck and personal automobiles used for hauling supplies, gear, and equipment, and for other business trips appear in about 25 percent of the questionnaires. Personal interviews indicated that family members often brought repair parts from the home-port city to the location where the boat was to be laid up for repairs.

Depreciation of truck and auto was usually included as expense under this heading, rather than in the depreciation schedule. It also appears, however, in the depreciation-expense schedule under other equipment for some boats. For the boats reporting truck and auto expense separately, the average expenditure for the 3 years was $550.

Fishing gear.—This category of expense was not clearly defined in the minds of the fishermen. Certain respondents did not list any expense for fishing gear. Accordingly, only limited comparisons can be made. The average expense was higher for bait boats than for jig boats. Larger crews on bait boats required larger expentitures for such items as poles, lines, hooks, and nets.

Both jig and bait boats had increasing costs from 1956 through 1958. Increased cost of individual items would account for this fact, because interviews with fishermen did not indicate that they had made any changes in the type of fishing gear used.

Fishing gear for albacore and other fish is included in the expenses listed in table 56. Review of individual boat operations did not suggest that the larger boats necessarily had larger expenditures. Expenses vary widely from year to year, depending upon such factors as loss by storm, natural wear, and money available.

Table 51.—Depreciation data on hull, engine, refrigeration, and electronic and other equipment for jig and bait boats, 1958

Type and designation	Boat		Hull				Main engine				Refrigeration				Electronic and other equipment				Total depreciation
	Length	Date built	Date acquired	Cost	Life	Depreciation	Date acquired	Cost	Life	Depreciation	Date acquired	Cost	Life	Depreciation	Date acquired	Cost	Life	Depreciation	
Under 40'	*Feet*	*Year*	*Year*	*Dollars*	*Years*	*Dollars*	*Year*	*Dollars*	*Years*	*Dollars*	*Year*	*Dollars*	*Years*	*Dollars*	*Year*	*Dollars*	*Years*	*Dollars*	*Dollars*
Jig:																			
A	38	1946	1946	15,000	15	850	1956	1,875	6	313	1957	1,475	5	(1)	1949	2,905	5-10	127	1,290
B	38	1947	N.A.	----	----	(1)	N.A.	----	--	(1)	N.A.	----	--	(1)	N.A.	----	----	(1)	(1)
C	34	1946	1946	5,000	20	250	1946	2,750	10	(1)	1948	1,200	N.A.	(1)	52-57	2,515	10-20	176	426
D	39	1944	1946	[2]6,400	N.A.	----	N.A.	----	--	---	ICE	----	--	---	1954	1,000	----	(1)	----
E	39	1941	1956	[3]6,250	15	----	N.A.	----	--	---	N.A.	----	--	---	N.A.	----	----	---	----
F	36	1949	1958	[3]5,000	N.A.	----	N.A.	----	--	---	ICE	----	--	---	N.A.	----	----	---	----
G	34	1942	1946	[3]5,615	N.A.	----	N.A.	----	--	---	1948	400	N.A.	---	N.A.	----	----	168	168
H	33	1920	1956	[3]2,093	5	418	N.A.	----	--	---	1957	750	5	167	N.A.	----	----	---	585
I	35	1946	1958	[3]8,800	----	----	N.A.	----	--	---	N.A.	----	--	---	N.A.	----	----	---	----
J	34	1949	1957	3,500	N.A.	----	1958	1,245	--	---	1957	426	N.A.	---	1958	1,629	N.A.	---	----
K	37	1939	1939	8,000	N.A.	----	N.A.	----	--	---	N.A.	----	--	---	N.A.	----	----	974	974
L	39	1945	1958	[3]13,000	15	438	N.A.	----	--	---	N.A.	----	--	---	N.A.	2,940	2-3	1,136	1,574
M	36	1949	1957	[2]13,500	10	1,148	N.A.	----	--	---	1957	1,035	10	66	N.A.	----	----	---	1,214
N	38	N.A.	1949	4,500	10	450	N.A.	----	--	(1)	N.A.	----	--	(1)	55-57	3,538	5-6	623	1,073
Total						3,554				313				233				3,204	7,304
Bait:																			
O	38	1946	1946	10,175	15	577	1946	4,000	--	(1)	1946	800	N.A.	(1)	46-52	2,510	----	(1)	577
P	38	1944	1944	8,100	15	540	1946	4,630	10	(1)	1951	1,500	--	(1)	55-58	3,400	4-5	613	1,153
Q	38	1946	1946	[3]12,500	10	(1)	N.A.	----	--	(1)	1946	2,000	--	(1)	N.A.	----	----	---	(1)
R	38	1945	1948	[2]14,000	N.A.	----	N.A.	----	--	---	N.A.	1,000	--	---	N.A.	----	----	600	600
Total						1,117												1,213	2,330
40'-44'																			
Jig:																			
A	44	1946	1953	[3]26,800	10	1,399	N.A.	----	--	---	N.A.	----	--	---	N.A.	----	--	---	1,399
B	41	1949	1949	2,617	25	105	1958	507	2	253	N.A.	----	--	---	N.A.	----	--	---	358
C	42	1947	1950	N.A.	--	----	N.A.	----	--	---	N.A.	----	--	---	N.A.	----	--	---	-----
D	42	1947	1947	[2]10,000	20	500	N.A.	----	--	---	N.A.	1,500	--	(1)	56-57	733	3-5	173	673
E	40	1945	1945	[3]13,000	--	(1)	N.A.	----	--	(1)	1957	800	--	(1)	N.A.	----	--	(1)	(1)
F	41	1946	1946	8,727	20	437	1958	2,850	5	570	1958	5,000	5	1,000	51-58	1,553	5-10	275	2,282
G	40	1946	1950	10,000	10	1,000	1950	5,000	5	(1)	N.A.	----	--	(1)	52-58	1,876	5-10	170	1,170
H	43	1946	1954	16,050	6	2,675	1954	4,000	5	800	1954	1,550	5	310	57-58	2,300	4	575	4,360
I	42	1945	1956	1,879	15	125	1956	1,000	5	200	1957	100	2	50	1957	622	5-8	65	440
J	40	1935	1956	10,000	20	425	1956	3,500	10	300	ICE	----	--	---	1956	225	5	35	760
K	40	1945	1945	22,500	15	1,533	1953	1,454	10	145	1953	2,047	10	205	53-56	783	10	109	1,992
L	42	1953	1954	12,000	15	814	1956	1,500	5	300	1954	3,005	5	640	1956	845	5	169	1,923
M	42	1934	1938	[3]15,000	N.A.	1,150	N.A.	----	--	---	N.A.	----	--	---	N.A.	----	--	---	1,150
Total						10,163				2,568				2,205				1,571	16,507
Bait:																			
N	42	1948	1948	12,704	12½	1,015	1953	[4]1,084	10	108	1949	1,000	N.A.	(1)	1953	1,185	10	119	1,242

1 Fully depreciated.
2 Hull and motor.
3 Boat and equipment.
4 Overhaul cost.
N.A. = Data not available.

Table 51.—Continued

Type and designation	Boat: Length	Boat: Date built	Hull: Date acquired	Hull: Cost	Hull: Life	Hull: Depreciation	Main engine: Date acquired	Main engine: Cost	Main engine: Life	Main engine: Depreciation	Refrigeration: Date acquired	Refrigeration: Cost	Refrigeration: Life	Refrigeration: Depreciation	Electronic and other equipment: Date acquired	Electronic and other equipment: Cost	Electronic and other equipment: Life	Electronic and other equipment: Depreciation	Total depreciation
	Feet	*Year*	*Year*	*Dollars*	*Years*	*Dollars*	*Year*	*Dollars*	*Years*	*Dollars*	*Year*	*Dollars*	*Years*	*Dollars*	*Year*	*Dollars*	*Years*	*Dollars*	*Dollars*
45'-49' Jig:																			
A	48	1948	1956	[3]26,296	10	2,630	N.A.	----	--	---	N.A.	----	--	---	N.A.	----	--	---	2,630
B	46	1923	1954	3,900	5	780	1958	4,000	10	400	1958	3,500	10	350	N.A.	----	--	---	1,530
C	47	1947	1950	9,700	20	485	1956	2,300	5	460	1957	1,539	10	154	1957	1,812	5,10	249	1,348
D	48	1957	1957	[3]12,961	10	825	N.A.	----	--	---	N.A.	----	--	---	1958	179	5	---	825
E	45	1949	1949	10,500	20	525	1949	11,200	10	1,120	1956	3,000	5	600	1952	1,000	20	50	2,295
F	49	1950	1950	15,600	20	780	1950	8,000	10	800	1957	2,770	5	554	1951	1,631	20	82	2,216
G	47	1947	1947	18,385	33	557	1947	7,000	15	467	1955	3,220	3	1,073	1957	1,350	4	337	2,434
Total						6,582				3,247				2,731				718	13,278
Bait:																			
H	46	1943	1947	[2]3,500	N.A.	320	N.A.	----	--	---	1955	1,500	--	---	N.A.	----	--	---	320
I	48	1946	1946	15,000	15	1,000	1946	7,083	14	506	1947	1,800	N.A.	---	55-58	2,150	5-10	332	1,838
Total						1,320				506								332	2,158
50'-60' Jig:																			
A	50	1938	1941	10,925	20	754	1953	3,628	10	363	1955	3,583	7	512	54-57	3,150	5	628	2,257
B	56	1945	1946	26,500	20	1,325	1946	10,000	10	([1])	1954	4,000	10	512	N.A.	----	--	---	1,837
C	53	1928	1939	[2]3,119	10	312	1942	8,800	N.A.	([1])	1953	5,636	10	626	N.A.	----	--	264	1,202
D	54	1918	1956	5,000	N.A.	----	N.A.	----	--	---	N.A.	----	--	---	N.A.	----	--	---	----
E	58	1947	1947	20,000	20	1,000	1947	10,000	10	([1])	N.A.	----	--	---	1947	500	15	33	1,033
F	50	1946	1958	20,000	15	1,000	1958	1,655	10	124	1958	2,500	10	188	N.A.	----	--	656	1,968
G	50	1945	1945	22,000	20	1,100	1946	7,500	N.A.	([1])	1953	4,200	10	420	1946	1,250	10	125	1,645
H	50	1935	1949	[3]29,900	--	[3]1,586	N.A.	----	--	---	1952	6,475	N.A.	---	N.A.	----	--	---	1,586
Total						7,077				487				2,258				1,706	11,528
Bait:																			
I	56	1949	1949	26,600	12	----	N.A.	----	--	---	1949	N.A.	--	---	N.A.	----	--	---	----
J	60	1954	1957	36,000	15	2,400	N.A.	----	--	---	N.A.	----	--	---	1957	6,046	3	2,015	4,415
K	56	1918	1949	8,870	5-8	374	1952	1,229	5	60	1950	1,200	6	([1])	54-58	2,128	3,5	386	820
Total						2,774				60								2,401	5,235

[1] Fully depreciated.
[2] Hull and motor.
[3] Boat and equipment.
N.A. = Data not available.

Table 52.—Number of boats built prior to 1940 and during various periods thereafter to 1958

Year built	Boats
	Number
1940 and prior	10
1941 through 1945	12
1946 through 1950	26
1950 through 1958	3

Table 53.—Estimated life used in hull depreciation

Estimated life of hull	Vessel owners using indicated estimate
Years	*Number*
20	11
15	11
10	8

Table 54.—Estimated life of main engine used in depreciation

Estimated life	Vessel owners using designated estimate
Years	*Number*
10	12
5	7

Table 55.—Estimated life of refrigeration equipment

Estimated life	Vessel owners using estimate
Years	*Number*
10	8
5	7

Table 56.—Average expenses for fishing gear on jig and bait boats

Boat operation	1956	1957	1958
Jig	$296	$423	$435
Bait	360	681	735

SUMMARY AND CONCLUSIONS

This study indicates that many albacore fishermen are in a serious financial situation. The data show that the combined wage payment and investment return is small. If $6,000 per 12-month year is assumed to be a reasonable wage, many of the vessels had no return on invested capital.

Part of the albacore fishermen's difficulties can be solved by better operation of his present equipment and vessel. For example, he can attempt to reduce his time in port to a minimum, possibly use a larger number of lines when trolling, and consider using live-bait fishing at least part of the time.

The effect of method of fishing was evaluated. For 2 of the 3 years investigated (1956-58), live-bait boats produced greater net income than did trollers.

Vessels investigated varied in length between 30 and 60 feet. The larger vessels produced larger catches and were more profitable.

The survey indicated that better understanding of accounting methods and depreciation requirements would be advantageous to albacore fishermen.

An important economic factor for the albacore fishermen is the problem of foreign competition. Imports have been greater than United States production in recent years, and have an important bearing on the gross income the fisherman obtains from his catch of albacore.

ACKNOWLEDGMENT

Although specific mention can be made of only those people who contributed directly to the study, we appreciate the aid of the many others who contributed indirectly.

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MS #1264

FROZEN KING CRAB *(Paralithodes camtschatica)* MEAT: EFFECT OF PROCESSING CONDITIONS ON FLUIDS FREED UPON THAWING

by

Jeff Collins and Russel L. Brown

ABSTRACT

A study was made of a number of stages in the production of frozen cooked king crab meat. The amount of fluids freed upon thawing (FFT) was definitely related to the types of meat packed and the amount of water in the pack as affected by cooling in water and addition of flood water. Other production variables studied had little or no effect on FFT.

INTRODUCTION

An understanding of the factors that affect drained weight is economically important to processors of frozen cooked king crab meat, not only because crab meat frees fluids upon thawing (FFT) but also because there is a large variation in the amount of such fluids from sample to sample. FFT should be reduced to a minimum to avoid adverse consumer reaction to "buying water" even though the packages are sold on a drained-weight basis. It is also desirable to reduce variation in the amount of FFT, since nonuniformity of drained weights of individual packages requires expensive overfill to ensure that minimum weight requirements are met.

FFT is often referred to as "drip"; however, the distinction between FFT in frozen king crab and the more usual meaning of "drip" should be carefully noted.

Drip is usually defined as the cloudy liquid that exudes from frozen meat upon thawing and is derived from the natural fluids of raw muscle. The amount of drip depends upon the method employed to measure it. For instance, relatively small amounts of drip are obtained when muscle is thawed on a wire screen as compared to that obtained by centrifuge or press methods, which apply considerable force. The term "drip" is often modified to indicate the method of its determination or process stage in which it occurs; thus we often see the terms "cook drip", "centrifuge drip", or "free drip". "Weep" has been used to describe the exudate of unfrozen, raw muscle. None of these terms adequately apply to the FFT of the manufactured frozen cooked king crab product, since such an exudate is composed of unknown relative amounts of fluids freed from the original raw muscle, fluids exchanged during aqueous cooking, various amounts of processing water (for example, cooling, fluming), and glaze.

When initially considering the problem, we assumed that if a particular step in production had a definite effect on FFT, the step could then be placed under quality control and the variation could be minimized. Accordingly, the purpose of the experiments reported here was to compare the amount and variation in FFT in frozen cooked king crab meat when prepared by using semicommercial production techniques with the following variations:

1. Meat type.
2. Floodwater.
3. Cooking time.
4. Cooking medium and processing water.
5. Shredded meat.
6. Ascorbic acid flood.
7. Moisture content.

Author note.—Jeff Collins, *Chemist*, Bureau of Commercial Fisheries Technological Laboratory, U. S. Fish and Wildlife Service, Ketchikan, Alaska; and Russel L. Brown, *Chemist*, Alaska Department of Fish and Game, Ketchikan, Alaska. The Fishery Technological Laboratory was jointly operated by the Bureau and the State of Alaska during the period of this study.

This paper is composed of several sections. In the Procedure section the common features that apply to procedures used in all experiments are discussed. The Analysis section is a discussion of the experiments for each processing variable studied. Methods and special conditions peculiar to individual experiments are included in this section. Finally, the data are summarized and conclusions are drawn.

PROCEDURE

Semicommercial Production of Cooked Frozen King Crab

Live king crab were butchered, and the carapace, viscera, and abdomen discarded. The leg sections were cooked in boiling sea water for 24 minutes, then cooled in a tank of overflowing sea water. The legs and claw arms were separated, and the meat removed both by hand and by squeezing between rubber rollers. Extracted meat was flumed onto belts for washing and inspection, segregated by meat type (fig. 1), then placed into rectangular containers measuring about 15 x 11 x 3 inches (table 1).

Table 1.—Order and amounts of different types of meat packed in each 15-pound block of crab meat

Order	Type of meat	Amount	
		Pounds	*Ounces*
1	Merus	6	1.0
2	Body and shoulder	5	10.0
3	Claw	1	1.5
4	Carpus-propus-dactylus	2	13.5
Total meat		15	10.0

After packing, 16 ounces of water were added to the meat (flood water) to provide an internal glaze (fig. 2). The resulting block of meat was frozen in a blast tunnel overnight (-20° to -40° F.), removed from the freezer carton, and given an external glaze. The glazed block was then returned to the original carton, packed along with several others into master cartons, and held at 0° F. until shipped.

The large blocks were shipped to a packaging plant at Bellingham, Wash., where they were sawed into consumer-sized portions. Each large block was first cut into thirds, then each third cut into 13 smaller portions as would be the practice for the 6-ounce consumer-sized portions or into 10 portions for the 8-ounce size. After being sawed, the 39 or 30 individual portions were repacked into the original freezer carton in the same order as sawed, overwrapped with a polyethylene bag, and sealed. The samples were then shipped, using suitable refrigeration, by either air freight or water to the Bureau of Commercial Fisheries Technological Laboratory at Ketchikan, Alaska.

The individual portions were numbered for identification (fig. 3). The geometry of this division causes differences in FFT between certain groups of the consumer-sized portions. Corner and end portions were more ragged than the inside portions and contained large voids that had filled with flood water. These portions, in nearly all cases, gave high FFT values. Excluding these portions when comparing the effect of processing conditions on FFT reduces variation between portions and improves the sensitivity of the experiment. Since our purpose was to compare the effect of treatment of blocks rather than describe the amount of FFT, the added precision in the mean justifies the exclusion of the data from the end and corner portions.

Determination of FFT

Since this study was production oriented, a method similar to that employed by the U. S. Department of the Interior in inspecting frozen king crab was used to determine FFT. For our purposes, the technique[1] was standardized as follows: The sample is placed in a 6- by 12-inch laminated poly-cello bag that has 12-1/4-inch holes punched along the bottom edge and several additional holes punched in each bottom corner. The sample and bag are weighed and placed into a larger polyethylene bag, which serves to collect the FFT. This outer bag also contains a 3-ounce cylindrical weight used to keep the bags from floating when immersed in a water bath to thaw. The bags are tacked to a board and suspended in a constant-temperature water bath (fig. 4). The 5-inch-long portion of meat is submerged 3-3/4 inches to 8-3/4 inches beneath the surface and held at 60° F. for 25 or 40 minutes for the 6- or 8-ounce portions, respectively. The sample is then removed from the water bath and held at an angle for 30 seconds on each side to assist in drainage of the exudate. After drainage, the inner bag containing the thawed meats is removed and weighed. The results are expressed as percentage FFT, calculated as loss in weight divided by original weight times 100.

Moisture Analyses

The thawed meats were recombined with the FFT and thoroughly blended in a sealed jar using an electric blender. Moisture was determined by drying about 5 grams of blended meats at 105° C. for 24 to 28 hours.

[1] The method was developed by David Miyauchi, Bureau of Commercial Fisheries Technological Laboratory, Seattle, Wash. [Unpublished manuscript—Seattle Manuscript Report No. 43, "Studies on thawing frozen king crab meat", (April 1959)].

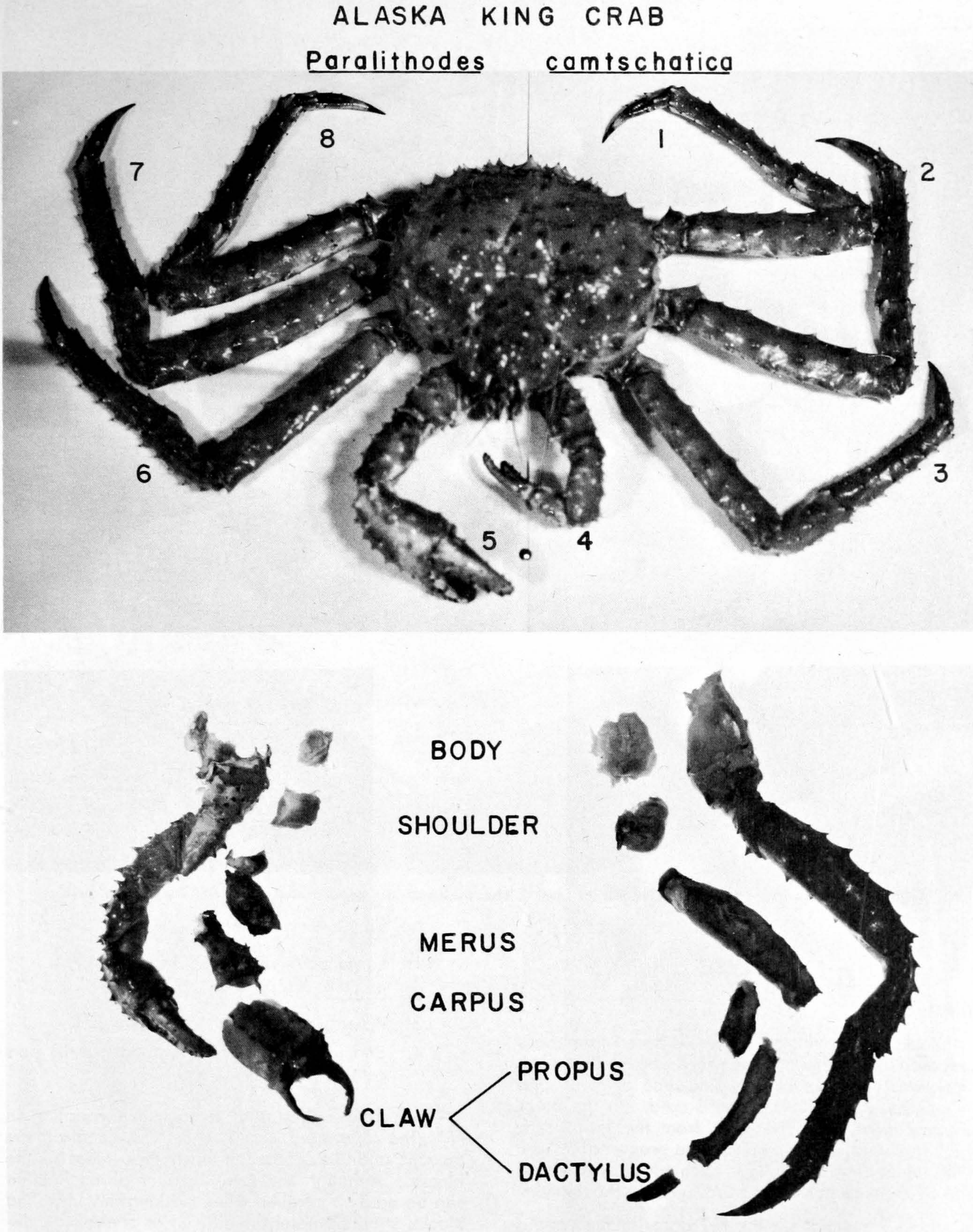

Figure 1.—Photo showing a king crab, the numbering system used to designate legs, the various parts of a leg and claw section, and the meat types removed therefrom.

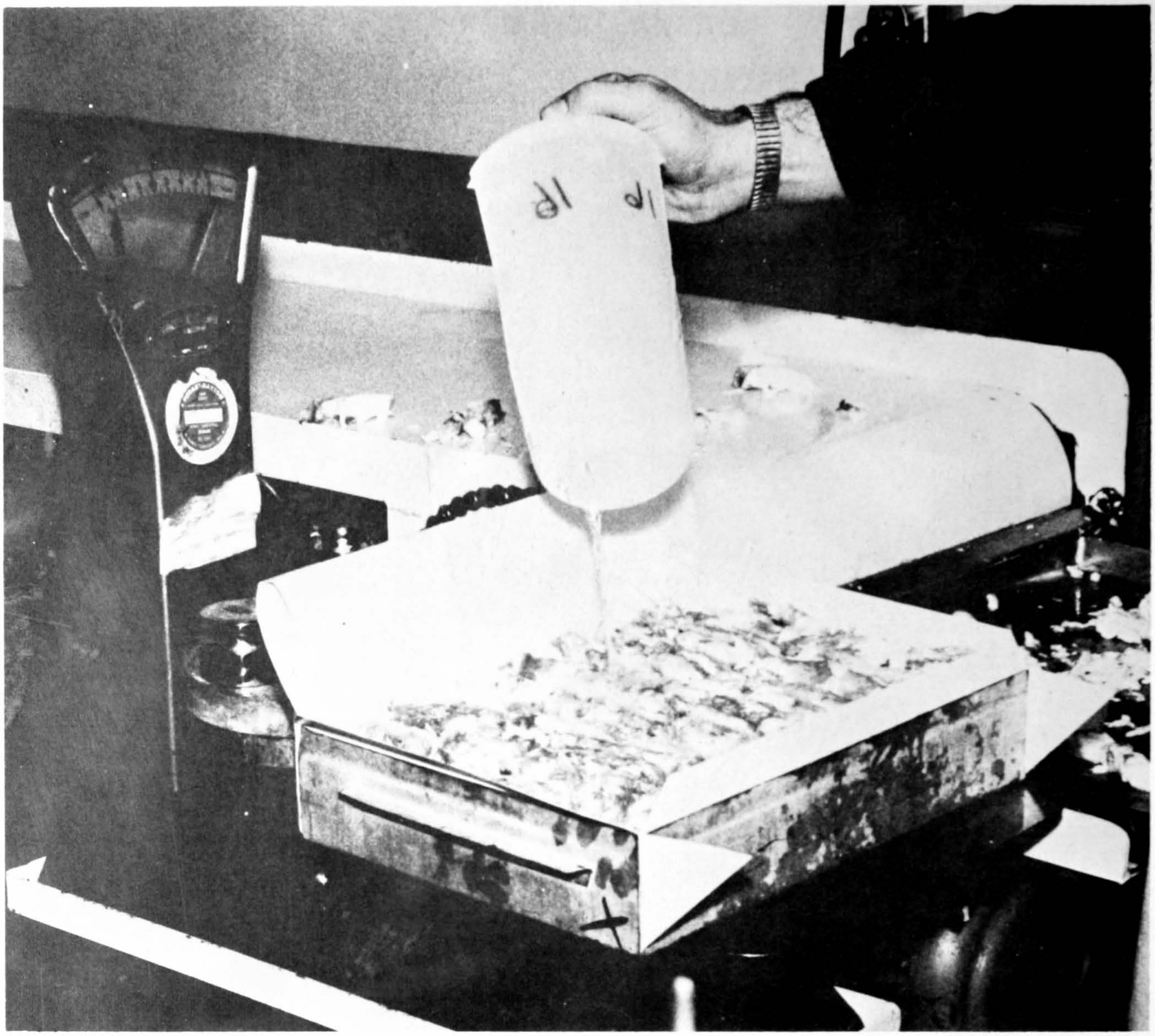

Figure 2.—Showing the packed block of meat, the addition of flood water, and the inspection belt.

ANALYSIS

Meat Type

Blocks used in this experiment differed from those prepared using the normal procedure in that each block was made up of only one type of meat, and 24 ounces of flood water were used. In the block of claw meat, only the meat from the large claw itself was used. The samples were prepared in April 1961 at Seldovia, Alaska. Each block was sawed into 39 6-ounce consumer-sized portions for analysis.

Table 2 summarizes the FFT data for the various types of meat. Analysis of variance and a comparison of individual means show that there are four statistically different groups with respect to FFT—namely:

1. Large claw, with about 14 percent FFT.
2. Body, with about 20 percent FFT.
3. Propus, with about 16 percent FFT.
4. Shoulder-merus-carpus, with about 18 percent FFT.

The data suggest that to minimize variation in FFT, the operator should accurately control the amount and distribution of each type meat in the blocks. Although the total amount of each meat can be easily controlled when packing the 15-pound blocks, it unfortunately is difficult to control the distribution so that each subdivided 6- or 8-ounce portion contains the same proportion of each type meat. For example, meat from about eight large claws will be layered in the 15-pound block, but because this

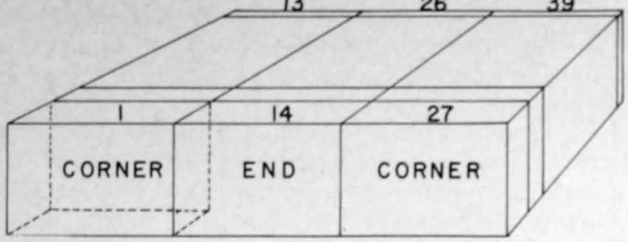

Figure 3.—Schematic diagram showing division of the 15-pound production block into consumer-sized portions.

amount is insufficient to cover the entire surface, individual 6- or 8-ounce consumer-sized packages may or may not contain claw meat. Since the meat from the merus has large variance, the amount and distribution of this type of meat should be carefully controlled.

Table 2.—Average FFT values for the six types of frozen king crab meat computed from 39 6-ounce portions of each type [1]

Type of meat	Amount of FFT	
	Average	Standard deviation
	Percent	*Percent*
Large claw	14.3 (13.8)	2.56 (2.02)
Propus	16.7 (15.9)	3.18 (2.33)
Carpus	18.7 (18.9)	2.24 (1.79)
Merus	20.4 (17.6)	7.07 (4.17)
Shoulder	18.2 (17.4)	3.17 (2.58)
Body	20.6 (20.1)	3.06 (2.62)

[1] The parenthetical figures exclude the six end and corner portions sawed from the 15-pound blocks of crab meat.

Addition of Flood Water

Each block of meat was packed in the usual way except that the amount of flood water added was varied (0, 8, 16, and 24 ounces). These blocks and all subsequent blocks reported in this paper were

Figure 4.—Equipment used in FFT determinations of consumer-sized portions of frozen king crab.

prepared at Port Wakefield, Alaska, in late October 1962. Each block was sawed into 30 8-ounce consumer-sized portions for analysis.

Table 3 summarizes the fluids freed upon thawing (FFT) data for the different amounts of flood water.

Table 3.—Percentage FFT and moisture content of consumer-sized portions of frozen king crab meat sawed from blocks prepared alike except for varying the amount of flood water[1]

Flood water added	Amount of FFT		Moisture content
	Average	Standard deviation	
Ounces	*Percent*	*Percent*	*Percent*
0	12.2 (11.1)	2.68 (1.47)	(79.6)
8	13.1 (12.5)	2.22 (1.51)	(80.0)
16	14.2 (12.8)	3.75 (2.29)	(80.4)
24	17.9 (17.0)	3.43 (2.09)	(81.3)

[1] The parenthetical figures exclude the six end and corner portions sawed from the 15-pound block of crab meat. Each 15-pound block was sawed into 30 8-ounce consumer-sized portions.

Analysis of variance and comparison of individual means show a significant difference in drip values between the samples flooded with 24 ounces of water and the other samples. The sample flooded with 16 ounces of water was also significantly different from the 8- and 0-ounce flood samples. The amount of FFT, the standard deviation, and the moisture content increased with the addition of flood water.

Water added as a flood probably behaves similarly to that picked up during processing—aqueous cooling, fluming, etc. That is, water found in the final 8-ounce portion is water regardless of where it was picked up during the process. On this assumption, all of the flood-water samples (96 8-ounce portions) were grouped to compare moisture content with FFT. The resulting curve of moisture vs. FFT (fig. 5) indicates an average increase of 3.7-percent FFT for each percent increase in moisture.

Cooking Time

For these blocks, the normal procedure was used except that each batch of crab was cooked in sea water for 16, 20, 24, or 28 minutes at a ratio of crab to water of 1:15. The water was changed after each cook. The average weight of the crab for the first three cooks was 7.5 pounds and in the 28-minute cook, 9.1 pounds (table 4). The butchering yields were nearly identical—about 73 percent. Although the yield of meat tended to decrease with longer cooks, it was fairly constant in the range from 20 to 24 minutes.

Table 5 summarizes the FFT data for crab meat cooked for various periods of time in boiling sea water. Analysis of variance and comparison of individual means indicates that the samples cooked for 24 minutes are significantly different in FFT from samples cooked for 16, 20, and 28 minutes. The direct relation between moisture and FFT found in the previous experiment was also evident in this series. The samples cooked for 24 minutes had the lowest FFT and the lowest moisture content.

Cooking Medium and Processing Water

One of the major variations from plant to plant in processing king crab is the type of water used in cooking and subsequent processing. Factory ships generally use sea water throughout the process, and shore plants use either fresh water or sea water, depending on the availability and purity. Some plants using fresh water add salt to the cook water to simulate sea water. Additional salt is sometimes added after each or several batches of crab to compensate for salt absorbed by the meat.

Table 4.—Yield of king crab meat from crabs cooked in boiling sea water for different periods of time

Cooking time	Crabs	Live weight	Yield of meat
Minutes	*Number*	*Pounds*	*Percent*
16	15	113	31.3
20	15	114	28.5
24	15	114	28.1
28	10	91	26.0

Table 5.—Percentage FFT and moisture content of consumer-sized portions of frozen king crab meat sawed from blocks prepared alike except for varying the time of cooking[1]

Time of cooking	Amount of FFT		Moisture content
	Average	Standard deviation	
Minutes	*Percent*	*Percent*	*Percent*
16	15.6 (14.4)	3.31 (2.26)	(80.5)
20	15.5 (14.5)	2.59 (1.96)	(80.7)
24	14.2 (12.8)	3.75 (2.29)	(80.4)
28	15.3 (14.6)	2.27 (1.68)	(80.9)

[1] The parenthetical figures exclude the six end and corner portions sawed from the 15-pound block of crab meat. Each 15-pound block was sawed into 30 8-ounce consumer-sized portions.

Four blocks of frozen crab meat were prepared to determine if FFT is affected by the type of process water. Table 6 summarizes the data for meats cooked and processed in several media. Analysis of variance and comparison of individual means indicates a significant difference between the sample cooked in 6-percent brine and the sample cooked and processed in sea water. No other differences were noted.

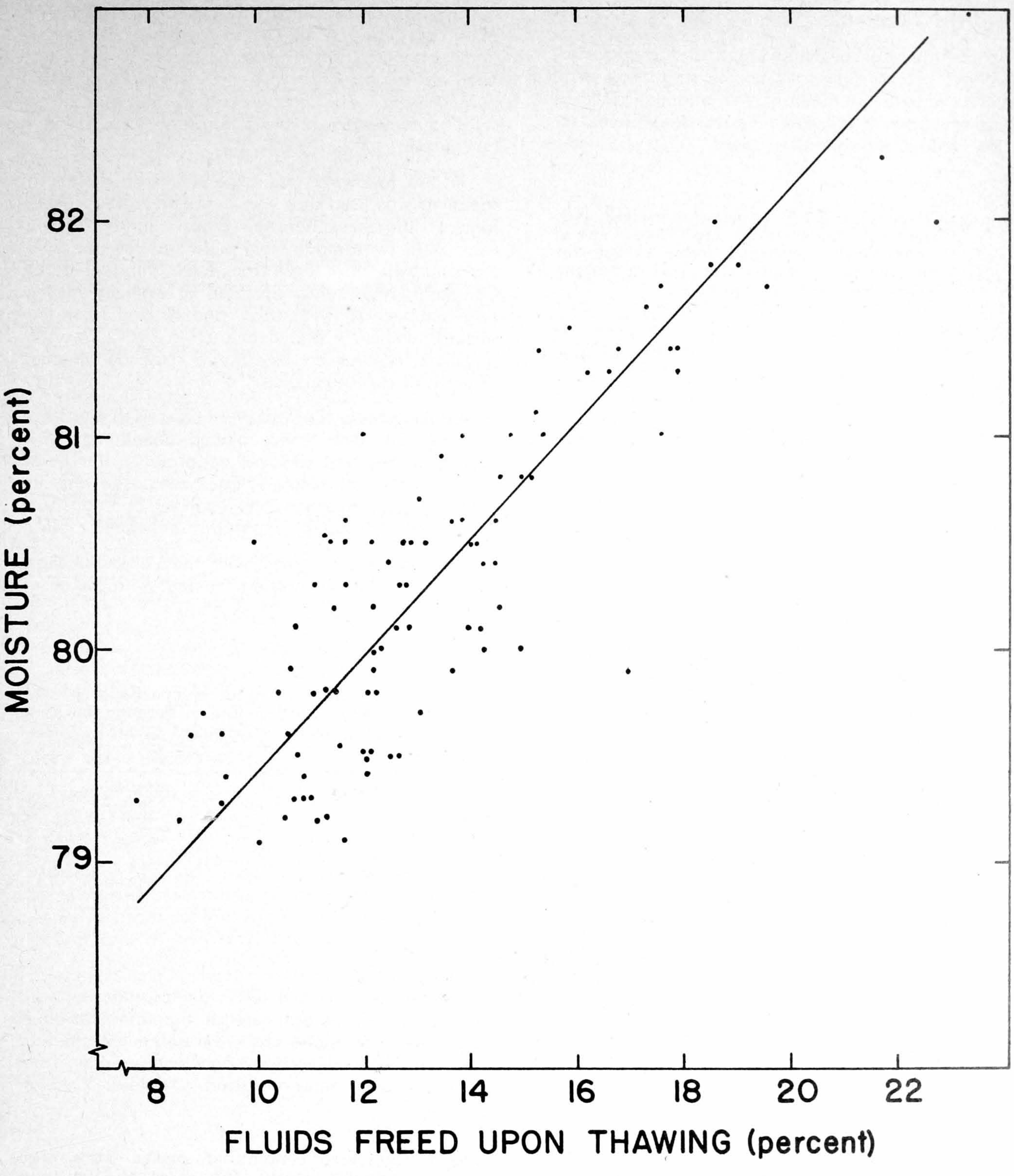

Figure 5.—Relation between moisture content and FFT for samples of frozen king crab prepared alike except for varying the amount of flood water.

Shredded Meats

Some processors of frozen king crab have attempted to get a more uniform pack by shredding large pieces of meat. Presumably, the smaller pieces of meat would result in smaller water-filled voids resulting in less variable FFT values.

Table 6.—Percentage FFT of consumer-sized portions of frozen king crab meat sawed from blocks prepared alike except for varying the type of water used in cooking and subsequent processing[1]

Sample preparation	Amount of FFT	
	Average	Standard deviation
	Percent	*Percent*
Fresh-water cook and fresh-water process	(14.3)	(1.90)
Fresh-water cook and sea-water process	(13.6)	(2.27)
Sea-water cook and sea-water process	(12.8)	(2.29)
6-percent brine cook and sea-water process	(14.5)	(1.90)

[1] The parenthetical figures exclude the six end and corner portions sawed from the 15-pound block of crab meat. Each 15-pound block was sawed into 30 8-ounce consumer-sized portions.

To determine if the size of the pieces would affect FFT, we prepared samples by the normal method except that the pieces of meat were broken into smaller pieces by hand while we were packing the 15-pound block. The average FFT and standard deviation for these samples were 13.7 percent and 1.73 percent respectively, as compared to 12.8 percent and 2.29 percent for the control samples. The difference is not significant. We concluded that shredding had little effect on drip.

Ascorbic Acid Flood

Ascorbic acid has been used to help prevent blueing in frozen crab meat. A sample was prepared normally except that 16 ounces of 0.1 percent aqueous ascorbic acid was used as flood water instead of water. The average FFT and the standard deviation for these samples were 13.2 percent and 1.66 percent, respectively, as compared to 12.8 percent and 2.29 percent for the control. The difference is not significant.

Moisture Content

The data from the cooking time experiment show that the moisture content and the FFT varied only slightly with the time of cooking. Differences may have been masked, however, by the absorption of water during the 20-minute period of cooling in the tank of overflowing water. Since total moisture content and FFT are related, it was of interest to determine the moisture content of crab that have been cooked for various times without a subsequent water cooling step and to determine the rate of absorption of water during cooling. The samples in this experiment were prepared from live crab that had been air freighted from a commercial plant in Petersburg, Alaska. The crab were held in a tank of circulating sea water at the laboratory prior to being butchered.

In the following two experiments, a system of sampling was used that was designed to reduce biological differences between crabs. In this system, composites were made from eight sections (six walking and two claw legs) from eight different crabs. Composite No. 1 thus consisted of walking leg-section numbers 1, 2, 3, 6, 7, and 8, and claw leg-section numbers 4 and 5 of crab A, B, C, F, G, H, and D, E, respectively (see figure 1 for identification of leg and claw numbers).

Cooking time.—Each of eight composite crabs was tied together with string, placed simultaneously in boiling water, and removed separately after being cooked for 16-30 minutes. Each composite was suspended in air to drain and cool for one-half hour before being shucked. The data are given in table 7.

The relation is erratic but may show a slight downward trend in moisture content with increased cooking time.

Table 7.—Moisture content of composite king crab samples cooked for different times in boiling water and cooled in air

Cooking time	Moisture content
Minutes	*Percent*
16	80.1
18	80.2
20	79.9
22	80.5
24	79.9
26	79.7
28	80.1
30	79.8

Cooling time.—Each of eight composites were cooked for 24 minutes, cooled in tap water for intervals up to 2 hours, and drained for 30 minutes before being shucked. The moisture contents resulting from different cooling times are given in table 8.

Table 8.—Moisture content of cooked king crab samples cooled for different times in tap water

Cooling time	Moisture content
Minutes	*Percent*
0	82.7
5	83.4
10	83.8
15	83.5
20	83.8
30	84.0
60	83.9
120	84.2

These data show a rapid uptake of moisture for the first 5 minutes of cooling followed by a very much reduced further rate of increase. The overall range from 82.7 to 84.2 percent moisture could result in an increase in FFT of 5.5 percent if calculated by the previously mentioned direct ratio of 1.0 percent moisture : 3.7 percent FFT (fig. 5). The nearly 3 percent higher moisture content noted in this experiment (compare data of tables 7 and 8) is probably caused by the brackish-water conditions in the sea-water live tank. The laboratory live tank is located in a small-boat harbor into which Ketchikan Creek empties. Adverse weather and tides cause brackish conditions. In the first part of this experiment, the crab were held in the live tank about 2 hours, whereas in the second part, they were held overnight. Had this biological uptake of water not occurred, it is possible that the moisture content might have increased even more than it did with time of cooling in water.

SUMMARY AND CONCLUSIONS

This study was undertaken to determine the effect of certain variations in production methods on the total amount and within-block variation in fluids freed upon thawing (FFT) of consumer-sized portions cut from blocks of frozen king crab meat. It was assumed that if a particular step in the production line had a definite effect on FFT it could then be placed under quality control and the variation in FFT could be minimized. The production variables considered and results obtained are as follows:

Type of meat. Significantly different levels of FFT were found for meat from: (1) claw, (2) body, (3) propus, and (4) shoulder-merus-carpus.

Addition of flood water. In general, the addition of flood water results in higher FFT, higher moisture content, and greater within-block variation. FFT and moisture content were found to be directly related.

Cooking time. The within-block variation was unaffected by the time of cooking, but the amount of FFT was affected. As with the flood-water series, high FFT values were found with high-moisture content. Cooking for longer periods resulted in lower yields of meat.

Cooking medium and process water. The amount and within-block variation in FFT was not significantly affected by the water system except where 6-percent salt water was used as cooking medium.

Shredded meats. Shredding the meats into smaller pieces when packing the production block had no significant effect on FFT.

Ascorbic acid flood. Substituting a 0.1-percent solution of ascorbic acid for the regular flood water also had no significant effect on FFT.

Moisture content. The total moisture content of meats that had been cooked for increasing periods of time but without subsequent water cooling may have decreased slightly. The total moisture content of cooked meats cooled in a tank of overflowing water increased rapidly in the first 5 minutes of cooling and increased irregularly thereafter to 120 minutes but at a reduced rate.

This study suggests that a processor of frozen king crab could significantly reduce the variation and amount of FFT, assuming he follows good freezing and cold-storage practices, by:

1. Distributing each type of meat so that each consumer-sized portion contains equal amounts of each type.

2. Diverting the corner end portions of the blocks to a different pack or trimming the periphery.

3. Standardizing all steps where water may be absorbed or lost and discontinue the practice of the addition of water.

Other production variables considered in this study had little or no effect on FFT.

ACKNOWLEDGMENT

Lowell Wakefield, President, Wakefield Fisheries, Port Wakefield, Alaska, and his staff helpfully cooperated by allowing us to use their facilities to prepare the samples analyzed for this report.

MS #1399

THIAMINASE ACTIVITY IN FISH: AN IMPROVED ASSAY METHOD

by

R. H. Gnaedinger

ABSTRACT

An improved thiochrome procedure for determining the thiaminase activity of whole fish is described. Results are presented showing the applicability of the method to various species of fish and to a mink diet. The method is quite sensitive.

INTRODUCTION

The physiological activity of thiamine is destroyed by the enzyme thiaminase, which is present in many species of fish. There is a potential large use of these species in the diets of such animals as mink. Although thiaminase is destroyed by cooking, mink prefer raw fish to cooked fish. The occurrence of thiaminase in these fish is therefore of nutritional and economic importance.

The activity of the enzyme has been studied by estimating its destructive action on thiamine. Of the various chemical methods that have been employed for the estimation of thiamine, the earlier colorimetric procedures (Melnick and Field, 1939) have largely been replaced by the more sensitive fluorometric method for the determination of thiochrome. The original thiochrome procedure of Jansen (1936) has been modified by Hennessy and Cerecedo (1939) to permit the determination of small, absolute amounts of thiamine in various biological materials. These modifications included the use of (a) base exchange to remove possible interfering substances and of (b) enzymatic hydrolysis of the raw material to release protein-bound thiamine. Numerous workers have used this approach to measure the thiaminase activity of fishery products, but the resultant procedures were time consuming and not readily adaptable to routine use.

The purpose of the present paper is to describe an improved thiochrome procedure for the rapid quantitative assay of the thiaminase activity in whole fish. In the proposed method, relatively large amounts of standard thiamine are added to the assay mixture. Consequently, the need for the time-consuming enzyme hydrolysis and base-exchange techniques has been eliminated. The proposed procedure, which combines some of the desirable features of the published methods for determining thiaminase activity also includes some new techniques.

PROPOSED ASSAY METHOD

Preparation of Thiaminase Extract

Whole, partially thawed fish[1] were ground three times through a 1/16-inch plate and stored at -20° C. until analyzed. Exactly 20 grams of the frozen sample was homogenized with 180 milliliters of cold 5-percent KCl for 1 minute at high speed in an electric blender. The homogenate then was centrifuged at about 1150 x gravity for 5 minutes at 1° C. The supernatant was filtered through gauze, and the residue was discarded.

Reaction of Extract with Thiamine

Ninety-five milliliters of thiaminase extract and 5 milliliters of a standard thiamine solution[2] were brought to incubation temperature by submerging them separately in a 37° C. water bath for 10 minutes before mixing. At the start of the assay (0 time),

[1] Alewife *(Alosa pseudoharengus)*. Six different samples were trawl-caught at various locations in Lake Michigan between October 1962 and August 1963 by the Bureau of Commercial Fisheries M/V *Kaho*.

[2] Stock solution: 100 milligrams of dry thiamine hydrochloride diluted to 1 liter with 0.01 N HCl. Twenty milliliters of stock thiamine solution was diluted to 100 milliliters with distilled water.

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the extract was added to the thiamine, and the reaction was allowed to proceed for 30 minutes at 37° C. At regular intervals, a 10-milliliter aliquot of the assay mixture was transferred to a 25-milliliter volumetric flask containing 12 milliliters of hot 0.1 N HCl, which had been preheated in a boiling water bath. The flask was heated for an additional 10 minutes in the boiling water bath to coagulate the protein, cooled rapidly to room temperature under tap water, and diluted to 25 milliliters with 2.5 M sodium acetate. The mixture was then filtered (Whatman 41H) and analyzed for thiamine content.

Oxidation of Thiamine to Thiochrome

Five milliliters of each filtrate was transferred to separate Hennessy base-exchange centrifuge tubes, and 3 milliliters of 3-percent cyanogen bromide was added to each tube except the blank, to which distilled water was added. An aliquot of each filtrate was run concurrently with each sample to serve as a blank. Each tube was swirled lightly to ensure that the oxidizing agent mixed completely with the thiamine. Two milliliters of 30-percent NaOH was then added to each tube, which was again swirled lightly. Fifteen milliliters of isobutyl alcohol was added, and each tube was shaken vigorously for 2 minutes and then was centrifuged at low speed to separate the liquid phases. The aqueous layer was discarded, and the butanol layer was shaken with 1.5 grams of anhydrous sodium sulfate until clear.

Measurement of Fluorescence of Thiochrome

The clear solution in each tube was decanted into a cuvette, and the fluorescence was read with a photofluorometer[3] in accordance with the manufacturer's directions for determining thiamine. The fluorescence due to the thiochrome was obtained by subtracting the fluorescence of the blank from the fluorescence of the oxidized sample.

Evaluation of Thiaminase Activity

The destruction of thiamine by the thiaminase extracts was depicted graphically by plotting the fluorescence of the thiochrome against the time of reaction. Thiaminase activity was determined by the slope of the thiamine-destruction curve from which the amount of thiamine converted per unit of time was computed. Extracts that destroyed no thiamine under the conditions of the assay method, and thus yielded curves of zero slope, were considered thiaminase free.

[3] Coleman Model 12C. (Trade names referred to in this publication do not imply endorsement of commercial products.)

EXPERIMENTAL AND DISCUSSION

Preparation of Extract

The maximum rate of enzyme activity was obtained by homogenizing the fish with 5-percent KCl. Concentrations of 3-percent and 10-percent KCl gave similar results, but the rates were slightly lower than the maximum. Extraction with 1.5-percent KCl was no better than with water, which yielded relatively low levels of activity. These results are in agreement with those of Woolley (1941) and Sealock, Livermore, and Evans (1943), who stated that the thiamine-destroying principle is relatively insoluble in water. These workers, as well as Krampitz and Woolley (1944), used a 10-percent NaCl solution to extract the principle from fresh tissue and from acetone-desiccated powders of fish viscera.

Several workers have stated that thiaminase loses its activity slowly, even when preparations of the enzyme are stored at low temperatures. Sealock, Livermore, and Evans (1943) stated that aqueous extracts of fresh tissue lost up to 36 percent of their thiaminase activity in 10 days at 5° C. Similarly, the thiaminase preparation of Mazrimas, Song, Ingraham, and Draper (1963) had a half-life of only 6 days at 4° C. Experiments were therefore made to determine the stability of thiaminase in the extracts used in the present study. The thiaminase extracts lost no enzymatic activity during 4 hours of storage at 1° C. After 24 hours at this temperature, however, a loss in activity of about 10 percent had occurred. Further tests were made to determine the rate of thiaminase inactivation at the incubation temperature used in the assay procedure. Extracts held at 37° C. for 4 hours lost approximately 58 percent of their activity. The high rate of inactivation of thiaminase, especially at the temperature of maximum activity, indicates the need for a rapid method of assay for the enzyme.

Incubation of Thiaminase Extract with Thiamine

The incubation times used with the various thiaminase assay procedures appearing in the literature vary considerably. With whole fish, relatively long incubation times were generally used—for example, up to 24 hours. Short incubation times were more applicable for analyzing partially purified thiaminase preparations. In the present study, an attempt was made to use a short incubation time for the analysis of whole fish. It was found that by reducing the substrate concentration to a level where it became a variable in the rate of reaction, the sensitivity of the assay could be increased. The levels used, however, were still greatly in excess of the resident thiamine of the samples. As a result, the thiaminase activity of very small amounts of whole fish could be detected easily within a 30-minute incubation period (fig. 1).

A short incubation time is desirable from the standpoint of studying the quantitative aspects of thiaminase in whole fish. Precision in assays is thus improved, and an estimate of the activity originally present in the fish is facilitated. Also, since the total time required to run an assay is shortened, the proposed method lends itself to routine laboratory use.

Inactivation of Thiaminase and Removal of Protein

The purpose of transferring the aliquot of assay mixture to the hot HCl was (a) to inactivate the thiaminase instantly and (b) to prevent the breakdown of thiamine during heating by maintaining a low pH. Heating the acid mixture for 10 minutes appeared adequate to ensure complete coagulation of the protein for its subsequent removal. Heating the assay mixture in the presence of hydrochloric acid was found to be superior to the conventional use of trichloroacetic acid (TCA) to remove protein, since the TCA interferes with the fluorescence of thiochrome.

The addition of sodium acetate to the acid digest increased the pH of the resulting mixture to 5.0, which was found to be optimum for the oxidation of thiamine by cyanogen bromide (Fujiwara and Matsui, 1953). It also facilitated the flocculation of the coagulated protein of the otherwise turbid mixture. Thus, treatment with both heat and sodium acetate yielded, after filtration, a clear solution for thiamine analysis.

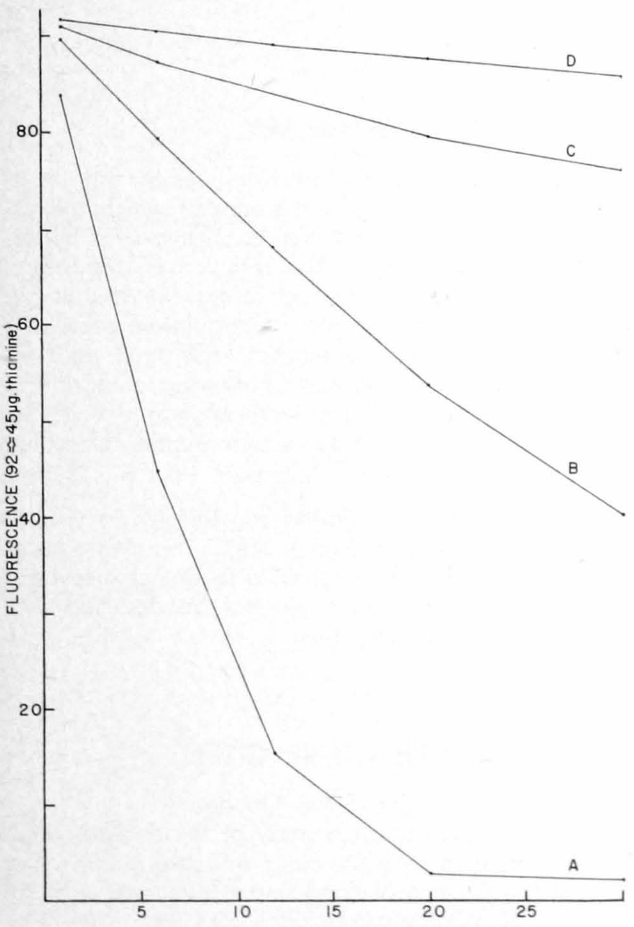

Figure 1.—Effect of enzyme concentration on rate of thiamine destruction. Grams of whole alewife per milliliter of homogenate: A, 0.1; B, 0.05; C, 0.025; D, 0.0125.

Oxidation of Thiamine to Thiochrome

Cyanogen bromide was used as the oxidizing agent instead of the more commonly used potassium ferricyanide. Fujiwara and Matsui (1953) state that this oxidizing agent is safe and reliable for determining thiamine in both pure solutions and biological materials. The applicability of this agent to thiaminase assays in fish, however, had not previously been established. Bottomley and Nobile (1962) state further that with cyanogen bromide, the oxidation of thiamine in flour is immediate and quantitative but that with potassium ferricyanide, it is not. Thus, if cyanogen bromide is used, the timing of this step would not have to be rigidly standardized. In confirmation of this hypothesis, consistent and reproducible results were obtained in this study when various oxidation times were used. Further tests showed that thiochrome remained stable up to 16 hours at room temperature in the dark. Immediate reading of the fluorescence of the oxidized samples, therefore, was not imperative. These results indicate that cyanogen bromide can be used successfully as the oxidizing agent for analyzing fish samples.

The fluorescence arising from substances other than thiochrome was evaluated with a blank, which was prepared by adding water instead of cyanogen bromide to the aliquot of filtrate. This procedure appeared to be valid, as the fluorescence of the cyanogen bromide-treated thiamine-free samples was nearly identical to that of the blank.

Suitability of Method

Tests were made to determine the amount of added thiamine hydrochloride lost during the course of the assay procedure. Results showed that no measurable loss occurred, as the amount of thiamine recovered from a thiaminase-free extract was equal to that obtained from a 5-percent KCl solution alone. Further tests showed that thiamine was not measurably destroyed in either distilled water or 5-percent KCl, or in the thiaminase-free homogenate up to 1 hour of incubation at 37° C.

The precision of the method was evaluated by running replicate assays of a fish sample with high thiaminase activity. The thiamine-destruction curves thus obtained showed that the amount of thiamine destroyed after 10 minutes was approximately 65 $\pm$ 8 percent.

The proposed assay method was tested for sensitivity by using it to evaluate a fresh-water chub test, diet (for mink) that was suspected of containing a low level of thiaminase activity. The test diet contained (before water was added) 30 percent fish, which consisted of 88.34 percent chub *(Coregonus hoyi)*, 10.42 percent alewife *(Alosa pseudoharengus)*, 0.68 percent American smelt *(Osmerus mordax)*, and 0.56 percent stone rollers *(Campostoma anomalum)*. The suspected thiaminase-containing species had been inadvertently mixed with the chub at the time of capture. The diet contained approximately 0.3 milligrams of thiamine per pound of feed (before addition of water). Thus, the thiamine content of the diet appeared to be adequate for normal growth (Leoschke and Elvehjem, 1959).

This diet was fed at the Cornell Fur Animal Experiment Station to 22 female mink throughout their gestation and lactation periods, and the results were compared with those for a group of 14 females maintained on a chub-free diet. During this time, weight losses of the mothers were comparable for both diets. Fewer kits, however, were born to the animals on the chub diet. Also, these kits had significantly higher mortalities and significantly lower growth rates than did the kits from the control animals.[4]

These symptoms, which are characteristic of a marginal nutritional deficiency, were suspected as being caused by a thiamine deficiency, since the diet contained thiaminase-active fish. Accordingly, the diet was subsequently analyzed for thiaminase activity by the method described here and was found to be definitely thiaminase-active (fig. 2, curve C). Thus, the method was sensitive enough to detect a level of thiaminase activity that could not be confirmed conclusively by a feeding test. These results present a correlation between a chemical and a biological test for thiaminase activity, a relation that has not been reported before in the literature.

Tests were also made to determine the applicability of the proposed method for analyzing whole fish other than alewife. Figure 2 shows the relative thiaminase activities of several species, as well as of a mixture of these species. The results show that alewife, smelt, and stone rollers were thiaminase-active; whereas, chub was not. Furthermore, the activity of the thiaminase-active fish was easily detectable even when they were mixed with a large amount of chub, or with a complete mink diet. Cooked-fish samples have also been analyzed successfully. Thus, the results show that the proposed assay method can be used successfully to analyze various species of fish for thiaminase activity.

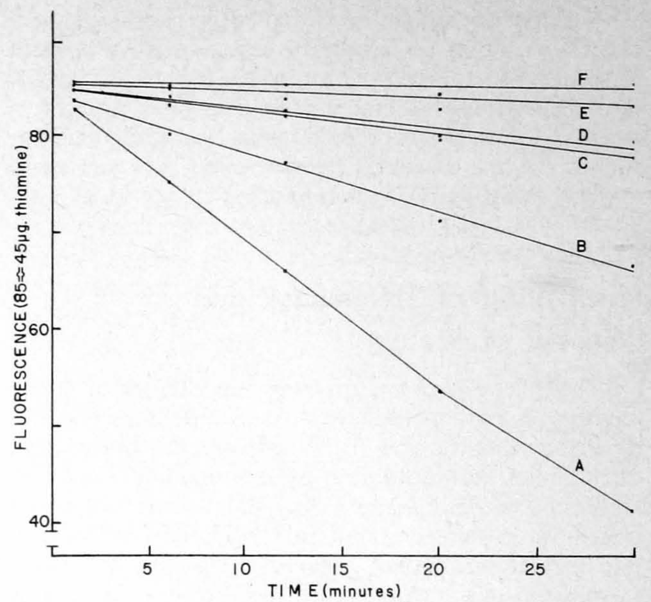

Figure 2.—Thiaminase activity of various species of fish and a mink diet. A, alewife; B, smelt; C, mink diet; D, mixed fish; E, stone rollers; F, chub.

SUMMARY

Thiaminase is extracted from whole fish at its natural pH with KCl, and the rate at which the extract destroys a given amount of thiamine hydrochloride is determined. The reaction is stopped at prescribed intervals by inactivating the thiaminase with heat and at low pH. Coagulated protein is removed by filtering the extract, leaving a clear solution for thiamine analysis. Following oxidation of the thiamine to thiochrome with cyanogen bromide, the content of thiochrome is determined fluorometrically.

The method was applied successfully to various species of fish and to a mink diet. The method was found to be sufficiently sensitive to detect a level of thiaminase activity that could not be detected with certainty by a feeding test.

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MS #1411

ADDENDUM

Since the manuscript was first submitted for publication, the proposed assay method has been modified to include the use of an enzyme activator. The sensitivity of the assay was increased markedly by the addition of cysteine (1×10^{-2}M) to the 5-percent KCl, which was also buffered to pH 6.5 with solid sodium borate. This modification allowed reducing the effective sample size from 20 to 5 grams and the reaction time from 30 to 20 minutes.

DRIP FORMATION IN FISH
3--COMPOSITION OF DRIP FROM DEFROSTED PACIFIC COD FILLETS[1]

by

David Miyauchi, John Spinelli,

and John A. Dassow

ABSTRACT

This paper, the third in a series on the formation of drip in fish, reports on (1) a comparison of the composition of free drip and centrifuge drip taken from paired lots of frozen Pacific cod fillets and (2) changes in the composition of drip taken from cod fillets after varying periods of storage at 0° and 20° F.

INTRODUCTION

Loss of "drip" (tissue fluid) when frozen fishery products are defrosted is a continuing problem for fish processors, buyers, and users. The loss of tissue fluid may adversely affect such attributes of quality as juiciness, tenderness, flavor, and appearance. This loss also contributes to disagreements in the assessment of the net weight of fishery products. Accordingly, studies have been undertaken at the Bureau of Commercial Fisheries Technological Laboratory at Seattle to obtain a better understanding of the factors that affect the formation of drip in fish.

At the start of this work, the literature on the formation of drip in fish was reviewed (Miyauchi, 1963). Various laboratory methods of measuring the water-binding capacity of fish protein then were tested, and a centrifugal method of measuring the volume of drip during the thawing and the heating of frozen cod fillets (Miyauchi, 1962) was developed.

To minimize the formation of drip in commercially frozen fillets, some processors brine-dip steaks and fillets of those species of fish that are not readily susceptible to the development of rancidity. Tarr (1942) concluded that this prevention of drip by sodium chloride brine dipping depends upon the interaction of sodium chloride with certain of the proteins to increase their liquid-binding power. More recently, polyphosphate solutions have been used commercially as a dip for frozen fish fillets (Mahon, 1962). Wierbicki, Kunkle, Cahill, and Deatherage (1954 and 1956) and Wierbicki, Cahill, Kunkle, Klosterman, and Deatherage (1955) have reported on the post-mortem shifts in the ion-protein ratio and changes in the water-holding capacity of beef, but no such study appears to have been made with fish. The determination of the composition of drip, therefore, appeared desirable to provide background information that might suggest further studies on the ion-protein interaction and changes in the water-holding capacity of fish protein.

Composition data may reveal changes caused by storage temperatures and storage time. If, however, the concentration of the constituents of drip remain relatively constant, the composition data may suggest possible objective means of differentiating between the juices native to the fish flesh and the water that is picked up or that is added to the product during processing prior to freezing.

[1] This paper was presented at Pacific Division of Institute of Food Technologists, combined meeting of Pacific Division of AAAS and AIBS, Oregon State University, Corvallis, Oreg., August 29, 1962.

Author note.—David Miyauchi, *Chemist;* John Spinelli, *Chemist;* and John A. Dassow, *Supervisory Chemist;* Bureau of Commercial Fisheries Technological Laboratory, Seattle, Wash.

Variations in the amounts of drip obtained from defrosted fish flesh, depend upon factors such as thawing temperature, thawing time, and the application of external force or pressure. In many studies, sufficient quantities of drip for analysis can be obtained only by extracting centrifuge drip or expressed drip. It also appeared desirable, therefore, to determine the composition of drip collected under conditions of minimum drip formation (free drip) and of drip collected under conditions of maximum drip formation (centrifuge drip).

A number of workers have investigated the changes in the composition of drip taken from fish after various periods of frozen storage. Sanford[2] found no significant change in the concentration of total solids, ash, total nitrogen, protein nitrogen, heat-coagulable nitrogen, or free amino nitrogen in centrifuge drip from rockfish (*Sebastodes* sp.) fillets that were frozen for about 12 hours, but he found a significant decrease in the concentration of these constituents in the drip from fillets that were stored 1 year at 0° F. Good (1954) found that the amino nitrogen content of drip was not affected appreciably by freezing and then storing at 0° F. but that the protein nitrogen content of drip decreased very gradually, both with time of iced storage prior to freezing and with time of frozen storage.

The specific purposes of the study presented here accordingly are:

1. To compare the composition (total solids, total nitrogen, protein nitrogen, ash, sodium, potassium, phosphorus, calcium, and magnesium) of free drip and centrifuge drip from frozen Pacific cod fillets.

2. To determine any changes in composition of free drip and centrifuge drip from fillets that were stored for varying periods of time at 0° F. and 20° F.

COMPARISON OF COMPOSITION OF FREE DRIP AND CENTRIFUGE DRIP

Procedure

Samples.—Cod that were well iced for 1 to 2 days were obtained directly from a fishing vessel and were sorted at random into 19 lots consisting of six cod each. (Six fish per lot were used in order to obtain sufficient quantities of free drip for analysis and also to minimize the variables arising from the raw material.)

Paired fillets were cut from each fish. One of each pair of fillets was designated as sample A and the other as sample B. Thus each lot of six fish was subdivided into two samples, with each sample consisting of six fillets.

The six fillets per sample were wrapped in aluminum foil and were frozen in circulating air at -20° F. and were then treated as follows:

1. The samples from lot 1 through lot 4 were used for the initial sampling, which was made on the third day after freezing.

2. Samples from lot 5 through lot 14 were stored at 0° F. and were sampled after 3, 6, and 12 months of storage.

3. Samples from lot 15 through lot 19 were stored at 20° F. and were sampled after 1, 2-1/2, and 6 months of storage.

Collection of drip.—As already indicated, both free and centrifuge drip were collected.

Free drip.—The sample was removed from frozen storage, and the aluminum foil was stripped from the six fillets. The fillets were weighed, placed in plastic bags that were perforated with 1/4-inch-diameter holes, and then were suspended inside a larger plastic bag. These bags were hung on racks overnight for 16 hours in a forced-air refrigerated room at 40° F., so that as the drip formed from the defrosted fillet, it passed through the perforations of the inner bag and collected in the bottom of the outer bag. This free drip was saved for chemical analyses.

Centrifuge drip.—The frozen cod fillets were chopped into small pieces and were ground in an electric meat grinder, using a plate with 3/8-inch holes. The ground flesh was thoroughly mixed, and 20-gram samples were weighed into special glass centrifuge tubes as described earlier (Miyauchi, 1962). The samples in the tubes were left in the 40° F. room overnight for thawing. The next morning, the samples were centrifuged 10 minutes at 170 x gravity. The centrifuge drip was recovered for chemical analyses.

Analysis of drip.—The drip was analyzed for total solids, ash, electrolytes, and nitrogen components.

Total solids.—Twenty to thirty grams of drip was dried in Vitreosil crucibles (50 milliliter size) at 103° C. in a convection oven to a constant weight.

Ash.—The samples that were dried for the determination of total solids were slowly charred over a Meker burner, were transferred to a muffle furnace, where the temperature was gradually raised to 500° C., and then were ashed until all of the carbon had been removed.

Electrolytes.—In the preparation of the electrolyte solutions, the ash was moistened with 5 milliliters of 0.1 N HCl and heated to boiling. This solution was quantitatively transferred to 50-milliliter volumetric flasks, using hot distilled water to complete the transfer. The following electrolytes were determined: potassium, sodium, phosphorus, and calcium and magnesium.

[2] F. Bruce Sanford. 1952. Unpublished data from progress reports of the Bureau of Commercial Fisheries Technological Laboratory, Seattle, Wash.

Potassium.—Potassium was determined by the gravimetric cobaltinitrite method (Association of Official Agricultural Chemists, 1955). Two milliliters of 1.0 N HNO_3 was added to 5 milliliters of the electrolyte solution, and the volume was adjusted to 20 milliliters. To this solution, 10 milliliters of a 20-percent solution of sodium cobaltinitrite was added, and the determination of potassium as the insoluble dipotassium sodium cobaltinitrite was completed.

Sodium.—Sodium in 10 milliliters of the electrolyte solution was determined by the uranyl acetate method (AOAC, 1955), except that zinc uranyl acetate reagent (Chemical Rubber Publishing Company, 1956) was used in place of the magnesium uranyl acetate solution.

Phosphorus.—Phosphorus was determined volumetrically (AOAC, 1955). The phosphorus in 5 milliliters of the electrolyte solution was precipitated as ammonium phosphomolybdate. The precipitate was dissolved in an excess of standardized alkali, which was then back-titrated with a standard acid solution.

Calcium and Magnesium.—Calcium and magnesium were determined by titration with ethylenediaminetetraacetate (EDTA) (Lott and Cheng, 1957) by the following modified procedure: Ten milliliters of the electrolyte solution was passed through a column of Dowex 2 anion exchange resin in the hydroxyl form. The column (3/8 by 4 inches) was eluted with distilled water until 100 milliliters was collected.

1. Calcium.—To a 50-milliliter aliquot, 50-percent sodium hydroxide was added until a pH of 13 was obtained. Three drops of 10-percent potassium cyanide, 2 drops of 1-percent gelatin solution, and 3 drops of Calcon indicator (Baker's Eriochrome Blue Black R-C1202) were added. Titration was made with 0.01 M EDTA to a blue end point. Calculations were made as follows:

mg. of Ca = ml. of 0.01 M EDTA x 0.40

2. Magnesium.—To the other 50 milliliters of the resin-treated solution, 2 milliliters of ammonium buffer solution, 3 drops of 10-percent potassium cyanide, 2 drops of 1-percent gelatin, and 2 drops of Eriochrome Black T indicator were added. The solution was heated to boiling and was titrated with 0.01 M EDTA to a blue end point. Magnesium was calculated as follows:

mg. of Mg = [(ml. of EDTA used in Mg titration) minus (ml. of EDTA in Ca titration)] x 0.243

Nitrogen components.—Total nitrogen and protein were determined.

Total nitrogen.—Total nitrogen was determined by the standard macro Kjeldahl method (AOAC, 1955).

Protein.—Protein was determined by biuret analysis (Snow, 1950).

Results and Discussion

The composition data of free drip taken from sample A and of centrifuge drip taken from sample B from each of the 19 lots of paired fillets are presented in table 1. The quantitative differences in the composition of free drip and centrifuge drip may be studied by examining the data in table 1 for each individual lot.

In the drip taken from lot 1 through lot 4 on the third day after freezing, slightly larger amounts of total solids, total nitrogen, ash, and potassium were usually found in the free drip than in the centrifuge drip; but in the drip taken from the lots that were held in frozen storage for varying lengths of time (lots 5-19), equal or slightly smaller amounts of these constituents were found in the free drip. These differences, however, were neither large enough nor consistent enough to be significant. The quantitative differences of other constituents between free drip and centrifuge drip showed no trend but varied randomly within a range that can be attributed to sampling and to the analytical methods used.

The differences between free drip and centrifuge drip for the various constituents for the lots in each storage interval and for the 19 lots taken as a whole were subjected to statistical analysis by Student's t-test. No significant differences in the amounts of the constituents were found between free drip and centrifuge drip. It thus appears that drip of relatively constant composition is obtained when defrosted cod fillets are centrifuged and that the composition of free drip and centrifuge drip is comparable. Similarly, Baker (1943) found that when fish shrink during cooking, liquor of constant composition appears to be released.

In future composition studies where relatively large quantities of drip are required for analysis, it appears justifiable to use centrifuge drip in lieu of free drip, thus permitting the use of smaller fish samples.

COMPOSITION OF DRIP TAKEN FROM COD FILLETS AFTER VARYING PERIODS OF STORAGE AT 0° AND 20° F.

The amounts and composition of free drip and centrifuge drip taken from the lots of six cod fillets after varying periods of storage at 0° and 20° F. also are presented in table 1.

At 0° F., the amounts of free drip from the fillets increased during the first 3 months, then decreased significantly but erratically during subsequent storage. At 20° F., the substantial increase in free drip during the early storage periods was consistent with the 0° samples; however, the greater drop in free drip of the lot held for 6 months at 20°, in comparison with that at 0° for 6 months, must be attributable to the greater effect of the higher temperature on

Table 1.—Chemical composition[1] of free drip (A) and centrifuge drip (B) taken from 19 lots of paired cod fillets after varying periods of storage at 0° and 20° F.

Storage temp.	Storage time	Lot	Drip content[2] A	Drip content[2] B	Total solids A	Total solids B	Total N A	Total N B	Protein N A	Protein N B	Ash A	Ash B
° F.	Mos.	No.	Percent		Percent		Percent		Percent		Percent	
0	0	1	3.3	16.8	8.0	8.2	1.13	1.14	0.50	0.56	1.19	1.14
		2	4.3	--	8.0	7.7	1.14	1.09	0.56	0.57	1.15	1.13
		3	2.3	19.2	7.9	7.5	1.15	1.12	0.50	0.31	1.18	1.16
		4	2.6	20.3	8.1	7.5	1.12	1.06	0.57	0.44	1.16	1.14
		Mean	3.1	18.8	8.0	7.7	1.14	1.10	0.53	0.47	1.17	1.14
	3	5	11 7	38.2	6.8	7.5	0.92	1.02	0.62	0.63	1.16	1.25
		6	7.9	38.6	6.5	7.5	0.88	1.05	0.44	0.55	1.11	1.12
		7	6.0	40.2	6.5	7.8	0.91	1.04	0.55	0.63	1.20	1.14
		8	7.3	39.4	7.3	7.3	0.97	0.99	0.49	0.44	1.21	1.23
		Mean	8.2	39.1	6.8	7.5	0.92	1.02	0.52	0.56	1.17	1.18
	6	9	4.6	39.3	6.9	6.9	0.99	0.93	0.55	0.31	1.13	1.22
		10	5.6	39.9	6.9	7.0	0.92	0.92	0.48	0.45	1.09	1.07
		11	3.7	39.6	6.8	7.0	0.93	1.02	0.31	0.40	1.09	1.13
		Mean	4.6	39.6	6.9	7.0	0.95	0.96	0.45	0.39	1.10	1.14
	12	12	7.0	38.2	6.8	7.0	0.96	1.03	0.44	0.50	1.24	1.29
		13	3.3	40.7	6.8	6.7	0.94	0.94	0.42	0.53	1.14	1.17
		14	3.8	40.5	6.5	6.6	0.85	0.91	0.43	0.44	1.12	1.14
		Mean	4.7	39.8	6.7	6.8	0.92	0.96	0.43	0.49	1.17	1.20
20	1	15	6.3	37.1	6.4	7.0	0.88	0.94	0.44	0.45	1.14	1.16
		16	7.3	37.7	6.1	6.9	0.83	0.94	0.43	0.44	1.14	1.22
		Mean	6.8	37.4	6.2	7.0	0.86	0.94	0.44	0.44	1.14	1.19
	2.5	17	6.2	42.3	5.7	6.4	0.79	0.88	0.50	0.56	1.11	1.17
		18	7.2	40.3	6.2	7.0	0.86	0.97	0.56	0.55	1.17	1.16
		Mean	6.7	41.3	6.0	6.7	0.82	0.92	0.53	0.56	1.14	1.16
	6	19	2.0	42.2	5.6	5.8	0.77	0.79	0.44	0.44	1.12	1.12

Storage temp.	Storage time	Lot	Sodium A	Sodium B	Potassium A	Potassium B	Calcium A	Calcium B	Phosphorus A	Phosphorus B	Magnesium A	Magnesium B
° F.	Mos.	No.	Mg./100 g.		Mg./100 g.		Mg./100 g.		Mg./100 g.		Mg./100 g.	
0	0	1	40	27	290	284	6	6	76	103	9	15
		2	33	39	334	250	7	6	98	86	12	13
		3	40	41	326	296	7	6	100	123	11	11
		4	42	42	310	308	5	6	106	109	--	--
		Mean	39	37	315	284	6	6	95	105	11	13
	3	5	51	45	377	452	10	10	188	198	7	7
		6	52	47	420	415	12	10	174	174	6	6
		7	63	55	386	440	11	12	183	183	6	7
		8	52	54	425	380	15	16	118	132	10	8
		Mean	54	50	402	422	12	12	166	172	7	7
	6	9	52	29	346	365	19	22	131	198	14	15
		10	38	28	381	411	19	22	181	147	14	16
		11	--	--	--	--	--	--	--	--	--	--
		Mean	45	28	364	388	19	22	156	172	14	16
	12	12	54	52	348	386	10	10	191	136	8	8
		13	46	52	364	346	17	13	130	119	7	7
		14	--	--	--	--	--	--	--	--	--	--
		Mean	50	52	356	366	14	12	160	128	8	8
20	1	15	48	45	364	386	15	12	187	178	--	--
		16	--	--	366	352	11	14	189	189	--	--
		Mean			365	369	13	13	188	184	--	--
	2.5	17	66	60	382	425	11	11	121	142	7	8
		18	56	54	377	428	12	12	158	138	8	8
		Mean	61	57	380	426	12	12	140	140	8	8
	6	19	52	44	428	420	7	8	120	116	12	11

[1] Based on percent weight of drip.
[2] Based on percent weight of fillet.

water-binding characteristics of the tissue. This would seem to be supported by the percentage of protein nitrogen, which is similar or lower in the drip taken at a sharply reduced volume. The amounts of centrifuge drip increased sharply during the early storage, but in contrast to the free-drip observations, small increases rather than decreases were observed during subsequent storage. Evidently the force of the centrifugal method is sufficient to overcome the water-binding characteristic that appeared to limit free drip in older samples. Again, the reasonably constant level of protein nitrogen in the centrifuge drip in later storage periods suggests a physical change related to water-binding characteristics.

The amounts of total solids in both free drip and centrifuge drip decreased significantly during storage at 0° and 20° F.; however, this trend during storage was not consistent.

The ash content showed no significant change. Although sodium, potassium, phosphorus, and calcium contents appeared to increase initially with time of frozen storage at 0° and 20° F., the changes thereafter were irregular and showed no definite trend.

The amount of total nitrogen in the drip decreased significantly during the early period of storage of the frozen fillets. Decreases in total nitrogen occurred at a greater rate at 20° than at 0° F. Protein nitrogen fluctuated between 0.4 and 0.6 percent with time of storage at both temperatures, and no trend is evident.

The results of this study suggest that total solids and total nitrogen contents of free and centrifuge drip may be useful criteria in determining whether cod fillets have been frozen and stored. Low values may indicate excessively long storage, high storage temperatures, or combined time-temperature effects. Additional work is anticipated to determine if the trends that were observed with composite drip samples from six fillets can also be observed with drip from individual fillets after varying periods of frozen storage.

SUMMARY AND CONCLUSIONS

Comparisons were made between (1) the composition of free drip and centrifuge drip from frozen cod fillets and (2) the composition of free and centrifuge drip from fillets stored at 0° and 20° F. In short, in the first experiments, the variables were free drip and centrifuge drip, and in the second, temperature and time of storage.

The composition of free drip and of centrifuge drip taken from paired lots of frozen Pacific cod fillets was closely comparable and indicated that drip of relatively constant composition is obtained when frozen cod fillets are defrosted.

The effect of time and temperature of storage of the fillets on the composition of the drip was variable. The amounts of total solids and nitrogen in centrifuge drip decreased significantly during frozen storage, the largest change occurring within the early storage periods. Changes in the amount of total solids and nitrogen in centrifuge drip were influenced by storage temperature. Decreases in these two constituents occurred at a greater rate at 20° F. than 0° F.

Ash content showed no significant change, and protein nitrogen fluctuated between 0.4 and 0.6 percent with time of storage at both temperatures. The amounts of mineral constituents in the drip varied, and no definite trend was observed.

The results of this study suggests that total solids and total nitrogen contents of free and centrifuge drip may be useful in determining whether cod fillets have been frozen and stored.

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Note.—Trade names referred to in this publication do not imply endorsement of commercial products.

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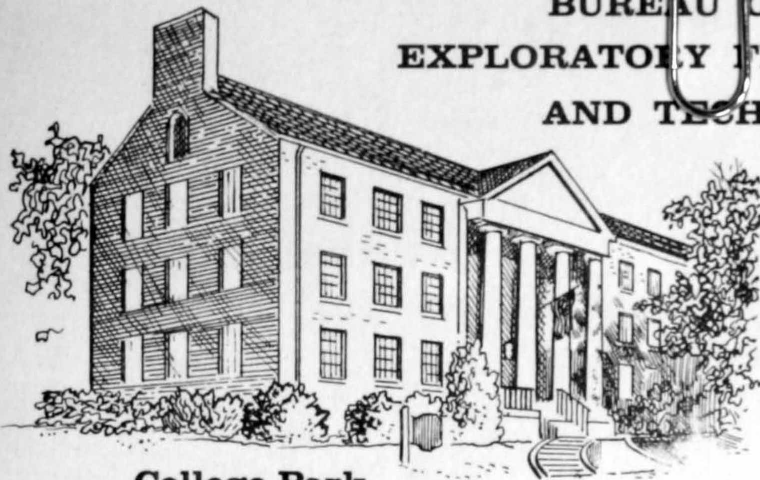

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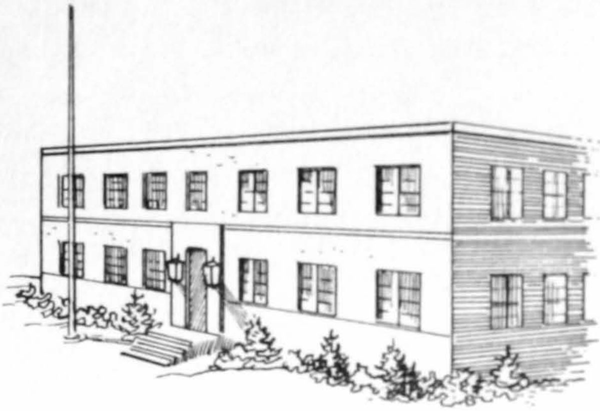

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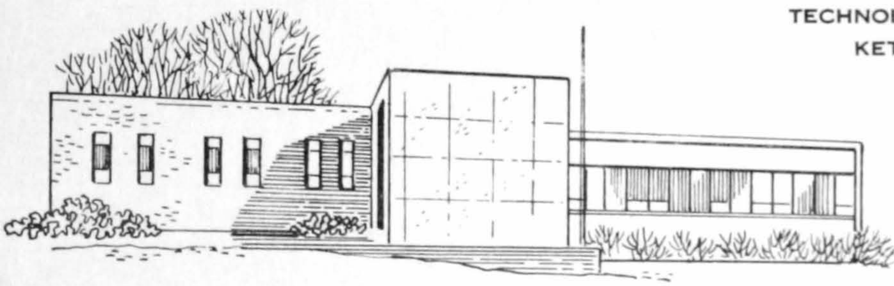

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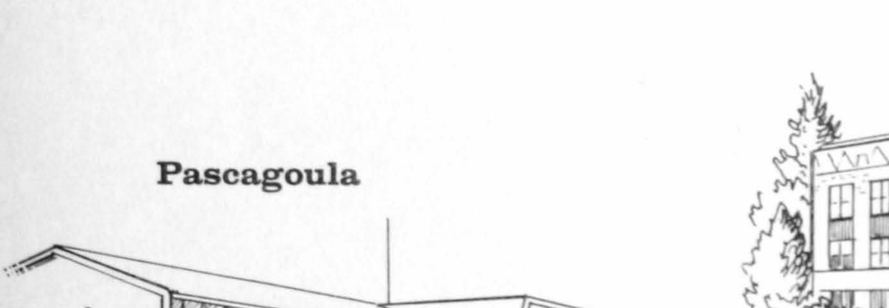

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