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AN ECONOMIC ANALYSIS OF FREEZING FISH AT SEA[1/]

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CONCLUSIONS

This analysis indicates that conversion of the large trawlers now operating out of Boston to freezing-at-sea would benefit all segments of the industry. It is clear that, if new trawlers are built for operation out of Boston, they should be equipped for freezing-at-sea.

The questions which remain are:

1. Is conversion to freezing-at-sea so decidedly an improvement over existing methods that its adoption is clearly called for?

2. How likely is it that this and other needed changes will in fact take place?

We have seen that the growth of imports and the development of new products, such as fish sticks, have stimulated an expansion of the domestic market. The manufacturing segment of the fish industry has indeed grown to meet this need, but the expansion has taken place without any fundamental alteration in trawler methods, and in the face of a decline in the level of activity of the trawling industry. Thus it is clearly conceivable that future growth of the market and the manufacturing industry--some of it away from coastal areas--can take place without including the trawling industry.

As foreign fisheries increase their level of activity and their rate of modernization, while the local fisheries fail to grow, imports should increase their price and quality advantage over domestic groundfish; thus the ability to operate at full capacity will be afforded to the local industry, to an increasing degree, only in periods of peak production and demand. At the same time there may well be an acceleration of the present tendency toward geographic dispersion of manufacturing facilities, a development which further separates the production centers from the sources of supply, and increases the competitive disadvantage of domestically-caught fish. Thus the entire groundfish trawling industry may lag more and more behind the rest of the fish industry, and eventually decline seriously.

From time to time--as in parts of 1956--more optimistic prospects appear to emerge for the local fishing industry than the foregoing analysis suggests. It is difficult to avoid the conclusion, however, that these are temporary, while the long-run factors at work can be expected to affect adversely the industry as a whole. On the other hand, it is true that greater integration of trawling and processing, intelligent marketing efforts, and adequate levels of investment do permit some of the larger firms to survive and prosper.

1/ This is a summary of a more detailed report, The Economics of Freezing Fish at Sea, by William H. Miernyk and Sumner M. Rosen, prepared for the U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries under a contract completed in June 1956, and financed with funds provided by the Saltonstall-Kennedy Act of 1954. Detailed statistics and citations of sources are omitted from this summary in the interest of brevity and readability. Unless otherwise indicated, all statistical data are from the U. S. Fish and Wildlife Service.

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Long-run growth requires in our judgment a level of investment in new trawling equipment which probably will not be provided by the industry. Those changes which have taken place in the industry, and have induced investment, have been on the market and processing side, not to any great extent on the raw materials side. Thus we do not expect, under present circumstances, that most of the industry as presently constituted, with its present attitudes and prospects, is willing in the immediate future to meet the challenge and take the risks which are involved in conversion to freezing-at-sea. Yet many of the changes which conversion to freezing fish at sea would impose on the industry are beginning to emerge already, and others may well emerge in the future.

Fig. 1 - Display pointing out the advantages of freezing fish at sea.

Among these is the tendency of some firms to tie more closely together their trawling and processing operations. Even those firms which specialize in one or the other branch of operations frequently maintain close financial ties with the oth so as to secure the economic advantages of intergrated operations.

The initiative, as well as the ability to survive, seems to be turning more and more with the large companies, those most likely to adopt freezing-at-sea if it is to come into commercial operation.

Many changes remain to be made, however, before freezing-at-sea will recomme itself to interests able to act. New handling processes, especially in unloading fi

from trawlers, and new kinds of labor are needed. Yet we know that resistance to the elimination of existing costly, inefficient methods is stubborn and deep-rooted. Fishermen will resist the imposition of longer trips, despite the financial incentives

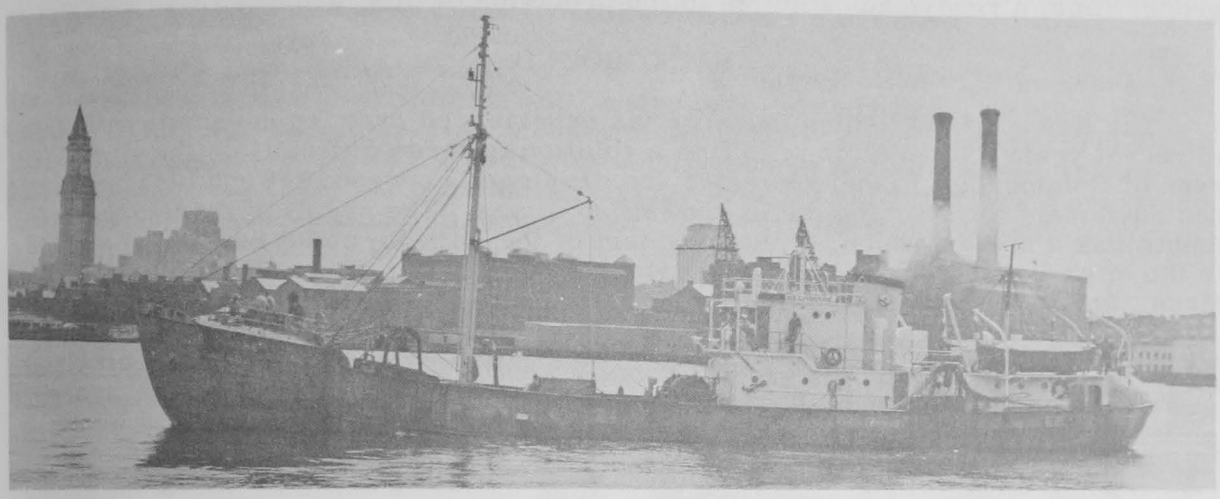

Fig. 2 - The U. S. Fish and Wildlife Service research vessel Delaware, equipped with an original experimental freezer, demonstrated the feasibility of freezing fish in brine on a fishing vessel at sea in studies conducted several years ago.

offered, if past experience is any guide. And a troubled history of labor-management relations will increase the difficulty of securing agreement on this and related crucial matters.

New methods, requiring new investments, will increase the risk of loss if accidents or bad weather (perennial risks in fishing) strike. These risks have always operated to limit, and to make unique, the men involved in fishing; for this reason the fishing industry is more dominated by tradition and history than most others. Such an industry offers more than the normal resistance to new ideas and methods. Only the most persuasive arguments, coupled with extreme economic pressure, are likely to prove effective.

Fig. 3 - A 2,000-pound load of haddock about to be frozen round aboard the Bureau of Commercial Fisheries research trawler Delaware.

We conclude that the returns from freezing-at-sea are neither so great, so sure, nor so devoid of risk as to attract the firms presently dominant in the industry. It is important to note that some of the large national corporations involved in fish marketing and processing have watched with care the development of the freezing-at-sea technique. Such firms are, in our judgment, most likely to lead the way when and if the returns justify such a step.

Although we are not optimistic as to the likelihood of adoption in the near future, the long-run prospect is more favorable. The sea should furnish an increasing share of protein foods as populations continue to grow. At the same time, certain crucial advantages of foreign over domestic fisheries should diminish

as time passes; already some foreign costs have risen sufficiently to reduce the attractiveness of United States investment abroad. It may turn out that freezing-at-sea has been developed ahead of its time in the United States, but will prove, at the proper time, a readymade solution to the problems of this industry.

BACKGROUND

The New England fishing industry has experienced growing economic difficulties in recent years. In an attempt to find a solution to these difficulties, the U. S. Bureau of Commercial Fisheries tested and developed between 1948 and 1955 techniques and equipment for freezing whole groundfish at sea. The result of these experiments was a method which, in the judgment of the Bureau, could readily be applied to the offshore fleet of large otter trawlers operating out of the Fish Pier in Boston, Mass., and to the processing firms which process and freeze most of the catch of haddock, scrod, and other groundfish. Once the technical problems were solved, the question arose whether this new method would prove economically sound. This investigation was designed to answer that question.

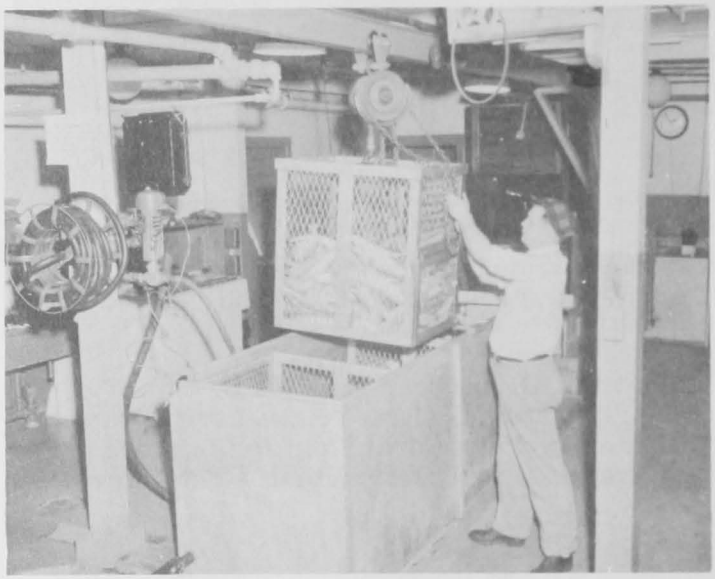

Fig. 4 - Hoisting thawed round fish from the experimental thawing tank in the Bureau's Boston Fishery Technological Laboratory when several years ago it studied the problems encountered in freezing fish at sea.

The analysis included an examination of:

1. The effect of freezing-at-sea on domestic landings and prices, on the quality of the end product, on costs, and on earnings of the fishing fleet.

2. The size of investment which would be needed to convert the present fleet, and present packaging plants, to the new method, and the probable sources of such investment.

3. The effect which conversion might have on the ability of the domestic industry to compete with foreign sources of supply.

4. The attitude of key segments of the industry to the new method.

The conclusions of the study briefly were:

1. Adoption of freezing-at-sea would serve to smooth out the seasonal variation of catches and prices. It would thus make possible more efficient utilization of trawlers and packaging equipment, at lower cost and at higher rates of return than prevail under present conditions.

2. The investment needed to convert large trawlers presently operating out of Boston, on the basis of 1956 estimates, would be a minimum of $60,000 and a maximum of $87,500 if compression-type refrigerating equipment were used; a minimum of $58,750 and a maximum of $62,500 if ammonia-absorption equipment were adopted. On the other hand, the average age of the present fleet makes unlikely any investments of this size because they represent a range of 29.4 percent to 49.1 percent of the depreciated value of trawlers now in use.

3. Incorporation of freezing-at-sea equipment in new trawlers, if such are added to the fishing fleet in the future, would not materially increase the cost of such trawlers. In this case the total costs are so great that such new investment is unlikely without some assistance from the Federal Government.

4. Imports have grown steadily through 1956, an indication that the share of the market for domestic production will, under present conditions, continue to decrease. While precise comparisons of the costs of fishing and filleting abroad with those which could prevail in the domestic industry using freezing-at-sea are not possible, it is clear that the substantial savings in costs which the new method could make possible would improve the competitive ability of the domestic industry.

5. Facing a discouraging record of poor profits, unstable earnings for labor, and high costs of new capital equipment, few segments of the industry foresee adoption of the freezing-at-sea method in the foreseeable future, without substantial outside assistance. Fewer still were found who themselves would seriously consider adopting this new method.

ANALYSIS OF THE INDUSTRY

GENERAL DESCRIPTION: In recent years fishing activity in Boston has been dominated by the large otter trawlers. These ocean-going vessels, capable of staying at sea for up to 12-14 days at a time, sail as far as the waters off northern Nova Scotia. These vessels have the capacity to hold up to 320,000 pounds of iced drawn (gutted) fish, or an estimated average of 220,000 pounds. The port's fleet of large otter trawlers has decreased steadily, from 59 in 1947 to 30 in 1956. Landings at Boston by the large otter-trawler fleet declined from 142.0 million pounds in 1950 (83 percent of the total landed at the Boston Fish Pier) to 92.0 million pounds in 1956 (63 percent of the total landed). Thus the fleet of large trawlers continues to supply the bulk of the fish landed at Boston, though to a diminished degree.

Fish in Boston is processed by 42 firms. The bulk of their output, which has fallen in recent years, is in the form of frozen fillets, though there is a considerable local demand for fresh fish which varies seasonally.

In both trawling and processing, it is unlikely that greater efficiency and lower costs could be achieved with present methods. In processing, for example, increasing mechanization has apparently failed to increase the annual output per worker, because of large seasonal fluctuations in the volume of production. The same is true of trawling, which is also burdened by aging equipment, lack of new entrants into the labor force, and the necessity to travel farther in search of dwindling supplies of groundfish.

After a period of decline and demoralization, the industry in 1955-56 began to show evidence of new vigor. Average catches for Boston large trawlers improved in 1956; a Federal loan fund for repair and maintenance of vessels and gear was provided; a new processing and marketing cooperative came into existence; plans for redevelopment of the Boston Fish Pier and related facilities were worked out. Nevertheless, in 1956 as in previous years, the long-range outlook remained unfavorable.

RECENT TRENDS IN LANDINGS AND PRICES: Total United States production of groundfish (including ocean perch) fillets rose from 1947 to 1951, but has declined since then. Production in 1954 was 122.4 million pounds, compared with 148.8 million pounds in 1951. The decline affected all species of groundfish. The decline in landings at the Boston Fish Pier by large offshore otter trawlers, the focus of this study, is thus a part of the general decline in domestic landings of groundfish. But the decline in the activity of this sector of the industry has been larger since 1951 than the over-all decrease in domestic groundfish landings.

Prices received by fishermen and vessel owners for catches of large and scrod haddock on the Boston Fish Pier were fairly stable, on an annual basis, during the period 1947-1954, except for a decline in 1955. Since 1954, average annual at-vessel prices received by the large offshore otter trawlers have been slightly (about 2 percent) below the general at-vessel price level on the Boston Fish Pier, while in 1953 they were over nine percent above the general level.

Although annual average at-vessel prices have been fairly stable, seasonal fluctuations are great in both landings and prices. In 1956, for example, landings in January were only 39 percent of landings in April, the peak month. In other years there is a similar range from the lowest to the highest month: in 1955, the minimum was 52 percent of the maximum; in 1954, the minimum was 37 percent of the maximum; in 1953, the minimum was 58 percent of the maximum; in 1952 the minimum was 49 percent of the maximum. Analysis confirms that these fluctuations are truly seasonal, within a stable secular pattern.

In 1956, at-vessel prices varied greatly as well. The highest average ex-vessel price, $10.98 per hundredweight, occurred in January, as compared with a low of $5.26 in April. Thus the minimum average price in Boston was 48 percent of the maximum in 1956, as compared with 56 percent in 1955 and 58 percent in 1954.

On a month-to-month basis, prices fluctuate somewhat less than do landings, so total sales revenue of the fishing fleet follows changes in landings more than prices. This suggests that measures which can stabilize the level of fishing activity over the year would contribute more to stable incomes and economic operation of trawlers than would measures intended principally to stabilize prices.

Retail haddock frozen fillet prices have tended to follow wholesale prices rather than other retail prices or the general wholesale price index. While retail prices and the general wholesale price index both were fairly stable in the period 1952-1955, wholesale and retail haddock prices declined sharply and fairly steadily over this entire period, except for some strength exhibited in 1953. By September 1955, the index (1952 = 100) of retail prices of haddock had dropped to 90.6, while the Bureau of Labor Statistics Cost of Living Index, converted to the same base, was 101.2, and the general wholesale price index was 100.1.

All large trawlers landing large and scrod haddock in Boston received average monthly revenues of $821,700 in 1952; this declined in 1953 to $718,500, in 1954 to $670,500, and in 1955 to $556,300. In 1956 there was a slight rise, to $649,600, a level still below that of 1954 and previous years. The total decline from 1952 to 1955 was 32.8 percent, and from 1952 to 1956 it was 20.9 percent.

To the instability of prices, landings, and revenues still another destabilizing feature of present operations must be added, namely, the "sellover," a feature of ex-vessel sales peculiar to New England. Under the regulations of the New England Fish Exchange, there may be a resale of fish, after the original sale has been made, if fish being unloaded from the vessel do not qualify as first quality. This vague provision, which is at times invoked by buyers, tends to provoke controversy and to worsen relations between the fishermen and vessel owners on one hand, and the fish dealers on the other.

PROFIT AND EARNINGS: In offshore trawling there have been declines in both employment and the number of trawlers in operation; yet, even in a declining industry there are often wide variations in the performance of individual firms. Our analysis suggests that the profit position of some New England fishing establishments is quite favorable; these would be the likely sources of new investment if freezing-at-sea is deemed feasible.

It is clear that the profitability of individual trawlers depends to a considerable degree on their ability to spend a large number of days at sea. Analysis of detailed data available for the period 1950-1953 covering eight large otter trawlers reveals how greatly profit depends on economizing on overhead costs through intensive use of the trawler at sea:

1. There is a clear correlation between average annual profits before Federal income taxes and days spent at sea, and a similar relationship, less close, between net annual profits and total days at sea for each of the three fishing seasons.

2. Three of the eight trawlers earned profits averaging $15,210 per year before taxes, or 10.3-11.5 percent of present depreciated trawler values.

3. Average earnings for all eight trawlers were well below this figure; thus any average is likely to conceal wide variations in individual performance.

4. It is likely that similar earning ability, depending on the same basic factors, holds for the entire large otter trawler fleet as well as for this small sample.

Fig. 5 - Experimental freezing tank used for pilot-scale experiments to determine time required to freeze round fish in refrigerated brine prior to sea experiments aboard the research vessel Delaware.

It is significant to note that average annual earnings of the trawlers did not depend primarily on the total or average catch of the trawler, but on the total time spent at sea, as indicated by total trips. This was true whether the data were summarized for the entire three-year period or analyzed separately for each year.

The estimates of "present value" used to compute rates of return were computed using public statements showing original costs, annual rates of depreciation, and present estimated values of trawlers in use in 1956. It was possible to derive reasonable averages for all of these values, dividing the trawlers into two groups--(1) those built before and (2) since World War II--and using two rates of depreciation, reflecting the accounting practice of those firms which use "high" and "average" estimates. Thus rates of return could be calculated, using available income data, on several alternative bases.

For the prewar group, for which a "standard" year of construction, 1937, was adopted, the rates of return were as follows:

	Average Earnings, Before Federal Income Tax	Average Net Operating Profit
	(Percent)	
All trawlers	3.811	5.312
Three best trawlers	10.864	12.566

For the postwar group, with a "standard" year of construction, 1946, rates of return were as follows:

	Average Earnings, Before Federal Income Tax		Average Net Operating Profit	
	High Rate of Depreciation	Average Rate of Depreciation	High Rate of Depreciation	Average Rate of Depreciation
	(Percent)			
All trawlers	4.227	3.894	5.893	5.428
Three best trawlers	12.052	11.101	13.929	12.831

These data are admittedly limited, and the conclusions are thus far from iron-clad. It is difficult to escape the conclusion, however, that profits of a satisfactory level can be and are being earned in trawling by some firms.

FINANCIAL RESOURCES: If freezing-at-sea is feasible, to what extent can investment be expected from the fishing industry? To throw light on this question, we analyzed the available sources of information concerning the recent history of investment in the industry, the willingness of banks to make investment capital available, and existing pools of liquid wealth directly concerned with the fishing industry.

We estimated that, between 1946 and 1955, four companies have invested a total of $2.5 million in eight large trawlers intended for operation out of Boston. Individual companies invested from $200,000 to more than $1,000,000 each. Of the 8 vessels, 7 are known to have had bank financing, which, under prevailing lending practices, represented 40 percent to 50 percent of the total. Of the 8 trawlers, 2 proved unable to pay their way and were sold. For the remainder, the probable expected rate of repayment of the loan would have been about $2,000 per month per vessel, over a 48-month period, and $1,200 over a 60-month period, exclusive of interest. At the normal proportion of bank money to owners' equity, this implies a total earnings rate of about $3,000 per month for the shorter period, and $2,200 per month for the longer one.

Today, in comparison, construction costs have risen greatly. At the same time, the porportion of total costs which the banks in this area would be likely to furnish has probably fallen. If we assume that a total investment of $1,600,000 would build three large new trawlers equipped for freezing-at-sea, and with a hold capacity substantially higher than that of present vessels, it would appear likely that bank participation would not exceed 30-35 percent. This suggests a minimum figure of investment capital of about $1.0 million.

Public data on file with the Commonwealth of Massachusetts, for four large firms with headquarters in Boston, showed liquid assets in 1954 equal to $3.5 million, and current liabilities of $1.73 million. Thus $1 million for new investment could be raised, though it would strain available resources. It should be noted that for these companies as a whole net liquidity--the difference between current assets and current liabilities--grew steadily between 1949 and 1954. These companies are all closely held, and controlled by families long active in the local fishing industry and, presumably, deeply interested in its survival. They are integrated concerns, able to take advantage of the combined economies which freezing-at-sea would make possible in both trawling and processing.

LABOR IN FISHING: Total employment in trawling out of Boston has declined steadily since 1947; during the same period, as fewer men entered the industry each year, the average age of the fishermen has risen. In 1955 we estimated that more than one-third of the membership of the Atlantic Fishermen's Union were over 50 years of age, and two-thirds were more than 40 years old. Estimated employment in 1947 was 3,764, as compared with only 2,657 in 1953.

About 40 percent of union members were born in the United States. Among foreign-born union members 22 percent came from Newfoundland, 13 percent from Iceland, and 9 percent from Nova Scotia. Thus the proportion of foreign-born in this industry probably exceeds by a sizable margin that in other occupational groups in New England.

Earnings of fishermen have varied considerably more than those of manufacturing workers, and there has been a pronounced narrowing of the historical differential between them. Thus the inducement to younger men to enter fishing has been greatly weakened.

IMPORTS AND THE NEW ENGLAND FISHERIES: The steady increase in imports of groundfish fillets since 1945 has caused increasing concern within the local industry, culminating in three full-scale inquiries by the U. S. Tariff Commission in response to "escape clause" requests for tariff and quota relief by the industry. None of these actions has resulted in tariff or quota changes.

Canada, Iceland, Denmark, Norway, and West Germany have become the principal suppliers of fillet imports. Since 1954, fillet imports have exceeded the total of domestic production. In 1956 fillet imports set a record of 138.6 million pounds. Thus, in the period 1951-1955, while domestic fillet production was falling, the total available supply (domestic production plus imports) rose steadily, with imports representing in recent years the more significant share of the total.

Canada and Iceland together supplied about 90 percent of all fillet imports in 1954, 89 percent in 1955, and 92 percent in 1956. Canada's share rose sharply from about 59 percent in 1954 to 73 percent in 1955, and remained at that figure in 1956. Iceland's fillet exports to the United States rose in 1956, after a decline in 1955.

Groundfish fillet imports show fairly systematic seasonal variation; July and October have generally been peak months, and September and November low points. The fact that import quotas are imposed on a quarterly basis induces a falling off of imports in the last month of each quarter, and a rise in the first month of the subsequent quarter. March is the exception to this rule, apparently because of the great Lenten demand for fish.

The U. S. Tariff Commission indicated in 1952 that costs in both Canada and Iceland are below domestic costs in the production of both raw fish and manufactured fillets. Canadian government expenditures to assist their fisheries have largely gone for general development, education, research, and similar purposes. Direct financial assistance to the fishing industry, as in the Fishermen's Indemnity Fund, has not been great, and has been confined for the most part to smaller vessels valued up to $7,500.

It should be noted that the dissenting opinion in the Tariff Commission's Report for 1952, and the majority opinion in its report for 1954, do not consider that direct subsidies constitute a major element in the competitive superiority of foreign over domestic groundfish activities. This advantage arises rather from better access to the fishing grounds, newer equipment, and more modern methods of fishing and processing.

It is clear that imports have played and are likely to play an ever-increasing part in the domestic market. Such dominance naturally tends to inhibit domestic investment in fishing. This is particularly true with the large trawler, where domestic investment has been small, because the large trawler is expensive and its return notoriously uncertain.

FISH PROCESSING INDUSTRY IN BOSTON: In 1951 there were 47 processing plants operating in Boston; this number had decreased to 42 in 1955. Total production of fresh and frozen fillets in 1951 totaled 65.2 million pounds worth $16 million; in 1955, despite the introduction of fish sticks, total production was only 51 million pounds, worth $13.8 million. This was a decline in volume of 21.8 percent, and in value of 13.7 percent. At the same time, average monthly employment in fish processing fell from about 996 to 1951 to about 783 in 1955, a decline of slightly more than 20 percent.

There has been a 40-hour week guaranteed the workers under union contract since 1946, and the need for an even and regular flow of raw materials to the processing lines has been a primary problem. Yet the processing plants, which depend on the trawling fleet for their raw material supplies, alternate between periods of great pressure and overtime work on the one hand, and periods of drastic underutilization of capacity on the other, depending on the time of year and the volume of fresh fish landed at Boston.

In these circumstances, steps so far taken to increase the mechanization of fish processing have failed to overcome the handicap of sporadic and uncertain supplies of raw material. Annual output per worker in fish processing in 1951 was approximately 65,420 pounds; by 1955; despite mechanization in filleting and related operations, output per worker had dropped to 65,100 pounds.

While the average size of processing firms in Boston is small, some firms are quite large. In 1955 the three largest firms produced 31 percent of all fillets, and accounted for 41 percent of all fillet sales. And the 20 largest firms accounted for 84 percent of all fillets produced in the Boston area. Thus more than half the firms in the industry together produced less than one-fifth of all fillets produced in 1955.

We estimated processing costs for a firm with a weekly capacity of 75,000 pounds of fillets, or 3.8 million pounds per year, assuming full use of capacity. Such a firm would represent the significantly large, though not the very largest, units in the industry. Direct or variable costs predominate; fixed costs in 1955 would have been 2.8-4.6 percent, material costs over 75 percent, and labor costs 10-14 percent of total costs at full capacity. If the plants in question actually operated at 60 percent of capacity, a more realistic assumption, raw material costs would have been only 67-69 percent of the total, and labor costs a maximum of 20 percent.

The two most important results of this cost structure are: (1) the incessant pressure for lower fresh fish prices in order to lower raw material costs, and (2) the need for full use of the labor force, at least on a weekly basis. As mechanization grows, this will add to the pressure for full use of capacity not only on a weekly, but on an annual basis.

Nevertheless, the economies of mechanized filleting under present operating conditions are still so slight that it remains possible for small firms to enter the industry, with relatively small amounts of capital, and to survive.

The formation in 1956 of the Boston Fisheries Cooperative, Inc., symbolized growing awareness of the need for new attitudes, greater efficiency, and a larger measure of cooperation than had hitherto prevailed if the industry is to prosper. Experiments with new products, new processes, better packaging, more effective advertising, and credit pooling arrangements reflect the attempts of the local industry to solve some of its most pressing problems. Yet the fundamental sources of the difficulty remain in the two related operations of trawling and processing; unless these can be invigorated and revived, other changes will, in the long run, mean little.

ANALYSIS OF FREEZING-AT-SEA

With our analysis of the present state and recent past of the Boston fishing industry in mind, let us examine the impact on various elements of the problem of the new method of freezing-at-sea, in an effort to determine whether, on balance, represents an effective solution to the problem of survival and growth.

INDUSTRY ATTITUDES: We interviewed a representative sample of industry leaders, most of whom had some familiarity with the experiments conducted by t

U. S. Fish and Wildlife Service. Leaders of the larger companies had considerable detailed knowledge of the work and its results. Relatively few of those interviewed doubted that the process is technically feasible; many of them, however, had serious reservations about its economic advisability, and only one large processor-trawler owner was willing to predict that his own vessels would some day be converted to the new method. Most doubts arose because of the present age and relatively small capacity of even the largest vessels now in use. Thus, for most industry spokesmen, adoption is tied in with the problem of building new and larger trawlers. And few members of the industry foresee that this will take place in the absence of substantial Government assistance. Some of them referred also to the expected unwillingness of the labor force to spend greater time per voyage at sea than is now the case; to the system of payment which, in their view, makes trawler operation inherently uneconomical for the owners; to the backwardness of the industry generally; to high and unreasonable maritime insurance costs; and to other well-known issues in support of their pessimistic views. Nevertheless, an informed minority persisted in the view that adoption will come, and must come if the industry is to be preserved.

LABOR ATTITUDES: The fishermen are a cohesive, aging group who have lived for many years in an atmosphere of mutual distrust and suspicion in labor-management relations. They have in many cases become accustomed to certain operating methods, and might well resist changes in fishing, handling, and storage techniques. At the same time, most fishermen are stalwart union men who would probably go along with changes supported by the union leadership. And some elements at least among the union leadership were, in 1955, enthusiastic about the prospects under the new method. Still, transitional problems would certainly arise, particularly the issue of the maximum time to be spent at sea. Our estimate as to the probable average increase in trip duration is relatively small, however, so that this issue should not represent an insuperable obstacle. Were the industry able to attract a greater proportion of young new entrants, however, the problems of adaptation to the new method would of course diminish considerably.

Adoption of freezing-at-sea would require the elimination of the "lumpers," those workers who unload the trawlers. These men, although few in number, are well paid and can be expected to offer strong resistance to the elimination or radical alteration of their jobs. Since they are members of the Atlantic Fishermen's Union, the union leadership would have to recognize and deal with this problem.

As for the Seafood Workers' Union, representing the processing workers, they would support an innovation if it promises to increase and stabilize employment. Freezing at sea would not involve the use of factoryships, to which the union has long been opposed.

EFFECT OF FREEZING-AT-SEA ON LANDINGS AND PRICES: The elimination of the "sellover," the first result to be expected from adoption of freezing at sea, would be an unmixed blessing to the industry. Beyond that, pressure to sell because of the perishability of the product, now a major cause of price instability, would be removed if sellers could store their product for later resale. It is true that costs of storage would have to be borne by the fishermen or the vessel owners, and these in 1956 were estimated at 1.2 cents per pound for one month, and 1.5 cents per pound for two months' storage. But regular large-scale use of storage facilities for round-frozen fish should make possible substantially lower unit costs, and the inducement of price stability throughout the year would, in all likelihood, more than compensate for the costs of storage. Thus freezing at sea should act to reduce substantially the aggressive price competition which now takes place at the vessel level, channeling competitive energies into more constructive efforts: quality improvement, more efficient processing methods, better trawling methods, greater consumer acceptance, etc.

It is difficult to say whether price stability would increase total annual sales of round fish. Between 1947 and 1955 fluctuations in total sales closely paralleled fluctuations in total landings; with prices changing relatively less than landings. Revenues to the trawlers go up sharply when landings increase. Thus the question turns in part on another: What will be the effect of freezing-at-sea on total landings? If landings can be expeced to increase, then revenues should both become more stable and increase. We may conclude that revenues certainly should not fall; the expected greater stability of revenues would in itself be a useful and important advantage, and this should in fact happen under freezing at sea.

EFFECT ON QUALITY: It was possible to test the effect of freezing-at-sea on quality in two ways. We examined the results of scientific analysis which has been carried on since 1952. In addition, a survey of consumer reaction enabled us to estimate whether consumers found fillets produced from commercially-processed round-frozen fish better or worse than fillets produced from iced-drawn fish.

Conventional iced-drawn fish resist deterioration for a limited time only while in the hold of fishing vessels. Deterioration takes place because of bacterial and enzymatic action and because of the pressure of weight on fish first caught on a voyage and stored in the bottom of the holds. Freezing-at-sea eliminates both these causes of deterioration. The lower layers of fish are solid and thus resist the pressure of layers added later. More important, freezing inhibits bacterial action, and thus makes possible longer trips without running the risk of spoilage in the hold.

In exhaustive tests, technologists of the U. S. Fish and Wildlife Service found fillets from round-frozen fish more acceptable, fresher in appearance, and more appealing in taste than fillets from iced-drawn fish. This superiority was judged to hold for frozen fish stored up to six months.

In a test of consumer reaction conducted in 1955-1956, round-frozen haddock were stored, later at various intervals processed into fillets, packaged, refrozen, and the packaged fillets distributed through commercial channels. These fillets were then packed together with fillets from iced-drawn fish under identical working conditions. Consumers were asked to mark their reactions on a postcard enclosed in the package, comparing the two fillets which were not identified as being from different original stocks.

A total of 964 postcards were returned, of which the vast majority were complete. Thirty-five percent of the responses indicated a preference for fillets from round-frozen fish, 10 percent showed no preference, and 55 percent preferred fillets from conventional iced-drawn fish. Thus, although there was no preference for fillets from frozen fish, neither was there any overwhelming rejection of these fillets in favor of the conventional type.

When the returns were analyzed by date of postmark and by state of origin, substantial variations within this over-all pattern emerge. Thus, the degree of preference for iced-drawn fish increased between December and January, but then after the proportion of those favoring the round-frozen fish rose steadily. As for the separate areas from which answers came, the degree of preference for conventional fillets varied considerably. In some states there was a preference for fillets from fish frozen at sea, and in others there was no preference at all.

It is interesting to recall that objective tests rate fillets from round-frozen fish superior in quality to the average run of fillets from iced-drawn fish. But the typical consumer does not base his tastes and preferences on quality alone. It may also be true that in this experiment, which was conducted by a firm with a reputation for quality, presented consumers with a better quality of conventional fillets than would in fact be the case were we to compare fillets from round-frozen fish

with the average iced-drawn fillets produced by the local processing industry. It should be emphasized that freezing-at-sea would promote a higher uniform standard of quality than is now the case, and thus make possible a greater degree of general consumer acceptance of fish products on which the market could grow. Such a higher uniform standard, which would be available to the entire industry, was one of the deliberate goals of the research carried out on freezing at sea. The available evidence suggests that this new technique does make the achievement of such a standard possible.

EFFECT ON COSTS AND EARNINGS: We earlier indicated that under existing methods, profitability is most closely associated with ability to keep trawlers actively at sea. Freezing-at-sea clearly will increase this ability, and thus should affect earnings prospects favorably. Moreover, the correlation between earnings and trawler size is an argument in favor of freezing-at-sea, since this method is clearly most adaptable to the larger trawlers, the group most likely to survive and most able to take advantage of new developments in trawler technique.

The decided tendency for direct costs to fall as capacity utilization increases is another factor favoring the adoption of freezing-at-sea. One of the chief advantages of this method is that it permits the trawler to stay at sea on a given trip until it hold capacity is fully or largely utilized. Lower unit costs are inevitable under these operating conditions.

We have estimated that, on a trawler of the M/V Delaware (U. S. Fish and Wildlife Service research vessel) class, about 65 percent of original capacity would remain after conversion to freezing-at-sea, allowing both for the loss of hold space to the freezing equipment and for the smaller capacity per cubic foot of round-frozen as against the more closely packed iced-gutted fish.

It is extremely difficult to predict how adoption of freezing-at-sea would affect the composition and level of direct costs, so that we might make a direct comparison of costs under conventional and freezing techniques. We did calculate, for one trawler hypothetically converted to freezing-at-sea, that total annual direct costs for this trawler after conversion would be, on a conservative estimate, about 8.5 percent below those for the same trawler as she actually operated in 1955. However, this trawler would have landed less fish than in fact were landed by her, so that direct unit or per-hundredweight costs under conversion would have been about 10.1 percent higher. But this hypothetical comparison was for a trawler which had in 1955 a high actual degree of capacity utilization. And we showed earlier that, typically, large trawlers operate well below capacity, with consequent high unit costs.

As for overhead costs, we would expect greater use of capacity substantially to reduce the burden of present overhead costs, which must be borne by relatively small annual catches. Conversion to freezing would of course add new overhead costs. We estimated, on the basis of costs for installation in 1955, that this addition would bring total overhead costs to $54,000 per year on the average, a figure some $7,000-$10,000 above those prevailing in 1950-1953. Applying this figure to the expected value of annual catches for vessels of various lengths, we estimated that total overhead costs after conversion to freezing-at-sea would be 21.6 percent of annual catch values for vessels 100 feet long, declining to 18.2 percent for vessels 140 feet long. The actual range of overhead costs for eight trawlers examined over the 1950-1953 period was from 13.3 percent to 24.4 percent, and the aggregate total was 17.1 percent.

EFFECT ON PRICES AND REVENUES: We confined our analysis of price expectations to the assumption, well founded in our judgment, that freezing-at-sea would produce an upward stabilization of prices equivalent, in its effect on average prices, to eliminating the two lowest-price months of each year. This, for the period 1950-1954, would suggest an annual average price of $7.74 per hundredweight.

On this assumption, and using estimated annual catches of converted large trawlers, we found that annual revenues would not be substantially above those now received by large trawlers. On the other hand, new and larger trawlers specially designed to use this method would bring in substantially larger annual catches than are now possible, with consequent higher sales revenues. And both old and new trawlers would benefit from the substantial reductions in direct per-unit cost of production which would result from adoption of freezing-at-sea.

EFFECT ON THE PROCESSING INDUSTRY: Additional investment in processing plants to handle round-frozen fish would be quite small--less than $3,000 for thawing tanks able to handle 8,000 pounds of round fish a day. Handling would require more care than at present, which might raise labor costs by a modest amount. The firm which actually processed round-frozen fish for the consumer survey described earlier reported no appreciable increase in the costs of water, fuel, or electricity. Despite additional handling required, we have no evidence that this affected output per man-day. The principal effect of handling fish frozen at sea on the processing industry would be its assurance that regular operations almost fully utilizing equipment and labor could be carried on year-round. At the same time, freezing-at-sea promises a more uniformly high-quality raw material for processing than is now the case.

Although most processors do not have a direct interest in trawlers--in fact their short-run interests, as buyers of raw fish, often directly oppose those of the trawler owners and fishermen who sell the raw fish--it was encouraging for us to note more and more recognition by processors that their own future well-being is bound up with a stronger and more competitive trawler industry. They would welcome the steady flow of raw material from the storage plants to their processing operations, and thus many elements in the processing industry support, in principle, the adoption of freezing-at-sea.

COMMERCIAL USES FOR SHARKS

There is presently no commercial shark fishery in Florida. The shark fishery of the United States has always been a relatively minor one, and the only time it was of any importance was between the years 1939 to 1950. The livers were used for their vitamins A and D content, and the carcass was discarded. The synthesization of vitamins halted this industry. Shark skins have always had some value, for the finished leather made from certain species is extremely tough, resistant to abrasion yet very pliable. Most shark flesh, if properly handled can be made into wholesome food. Shark oil that contains little or no vitamin A is used in the tanning industry, this oil is occasionally utilized for low grade soaps and in tempering steel. The fins find a ready market in the Oriental trade where they are used in making soup. Other minor products from the shark is meal from the carcass, and their teeth which can be sold as curios. The market for all shark products is limited, and this is the reason the fishery is not pursued.

--Sea Secrets, The Marine Laboratory, Univeristy of Miami, Coral Gables, Fla.