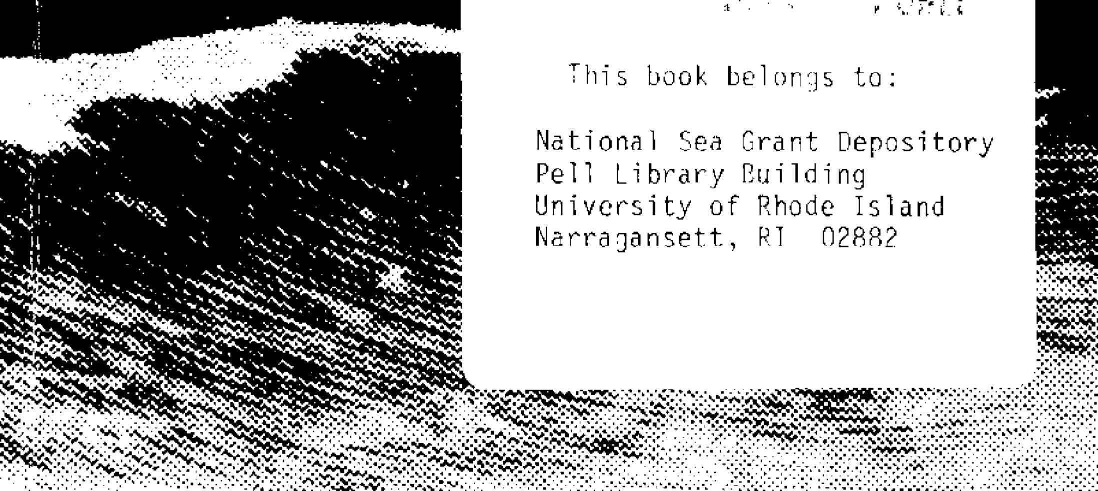
SEAFOOD HANDLING, PRESERVATION, MARKETING

PROCEEDINGS OF A TECHNICAL CONFERENCE
MARCH 15, 1978
SEATTLE



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COSPONSORS OF THE WORKSHOP

Washington Sea Grant Marine Advisory Program
Northwest Research Laboratory, National Food Processors Association
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Proceedings Editor: *John B. Peters*

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FOREWORD

This technical conference was organized by the Washington Sea Grant Marine Advisory Program. It was presented in conjunction with the 1978 Seafood Processors Workshop sponsored by the Northwest Research Laboratory of the National Food Processors Association. The purpose was to provide up-to-date information on seafood handling, refrigeration, and marketing to the owners and operators of seafood processing plants and fishing vessels in the Pacific Northwest.

The conference opened with a look at present day seafood marketing concepts and then a glimpse at what we might expect in the future. Talks on product quality, seafood handling systems, and details of fishing vessel refrigeration techniques followed. The final speaker examined some of the opportunities created for the United States fishing industry by enactment of the 200-mile fishery zone.

This conference brought together some of the leading industrial and scientific talents of the Pacific Northwest who shared relatively new and unpublished information. These proceedings summarize the thoughts of the speakers as well as questions from participants.

It is our hope that the sponsorship of this conference and the publication of its proceedings will help the fishing industry to adopt systems and methods which will result in improved quality of landed seafoods. Attainment of that goal would mean greater consumer acceptance of seafoods as well as increased profits to the fishermen, processors and the seafood brokers.

John B. Peters
September 1978

Seafood Markets—Today and Tomorrow

Gene Ruthford
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The subject I have been asked to discuss is "Today and Tomorrow in Sales." However, rather than confine myself to today and tomorrow, I believe I should go back one step and include yesterday. To me, seafood sales mean complete communication among the fisherman, the processor and the customer, with the sales department as the catalyst or the intermediary who effects a sale from the producer and delivers the product to the customer.

I would like to share with you an experience that I had while attending a seminar in Honolulu a couple of years ago. The main speaker was Dr. Eugene Jennings, who is head of the marketing service of Michigan State University. His seminar had to do with communication. For three days he had a capacity audience--standing room only. If you have ever attended a convention in Honolulu, you know that the beaches generally attract more people than do the meetings. But not this time. One reason is that Dr. Jennings is a great speaker and also a great man, but he also speaks with the authority of experience. He said you must remember three things in communicating:

- Know your audience
- Know your subject
- Speak to the issues at hand

If we go back to the 1950's, just after the war, we find that seafood was just starting to find its niche in the marketplace. During the war, it was difficult to get meat because of rationing, so fish became an item that people sought. Fish required no points and and had no price ceilings. The popularity of seafood soared. Most food chains, fish markets, and meat markets found that they could handle fish every day and make a profit. This was the first resurgence of active seafood marketing.

In those markets of yesteryear, every aspect tended to keep the price of seafood low. Seafood had to be cheaper than meat, it had to be cheaper than poultry, and it had to be available in sufficient quantity to allow chain stores to run specials. There was no brand identification of any consequence, and packing methods were not sophisticated. Whole fish were put in a box and shipped out by car or truck. Very little seafood was packed into retail packages, and what was did not move too well because few stores had cold storage facilities or freezer cases. There was little seafood promotion of any kind. As we progressed through the fifties, someone came up with the brilliant idea of breaded fish sticks. This product caught the public's fancy, and immediately there was a big surge in sales and then in the production of all kinds of seafoods.

Halibut and salmon were plentiful and cheap. Fish sticks went into school lunch programs and then into retail packaging. Portions then became an item for institutional feeding. These events marked the start of real merchandising of seafood.

Today, we still have not overcome the idea that seafood prices must be low, yet we are finding that we can sell seafood at higher prices than meat and certainly much higher than poultry. Over the past 10 years, some seafood prices have increased 250%, whereas some competitive foods have only increased about 50%. Even so, the per capita consumption of fish eaten in this country has increased nearly 20%.

A few years ago, it was difficult to sell fish in foreign markets. Japan was the largest and the most aggressive fishing nation in the world. Her ships sailed all the seas of the world, and they produced and exported to the United States. European countries did the same thing. But, in the past few years, over-production has caught up with these people. Japan has been careless about conservation; so have the European nations. In Europe, increases in population and in seafood consumption have finally caught up with production. Most of the North Sea has been closed temporarily to fishing. With the advent of the 200-mile limit, Japan has become an importing nation rather than an exporting nation. To her sorrow, Japan has found that without conservation she has no on-shore fisheries of any consequence.

I don't know whether Japan can rehabilitiate her fisheries, but I think she will do her best to do so. In the meantime, the United States has an opportunity to become the world's dominant fish-producing and marketing country. With the advent of the 200-mile limit, I think that, over time, we will be able to produce all the allowable catch available in this fishing conservation zone and subsequently will be able to pay our fishermen good prices and then sell their products at a profit. We also will be able to promote these products and guarantee their continuity in the marketplace.

If I have learned one thing in my years of marketing seafood, it is that you do not sell a customer one order at a time. You sell him a program. You sell him on the fact that you have a series of different products available that can be alternated. Then you ask him how much salmon, halibut or pollock he wants. How many fillets, how much crab in the shell or crab meat does he need? What does he need for the next 12 months? You would be surprised at his response. He may say: "I need a million pounds of this or half a million pounds of that or a hundred thousand pounds of this." At the initial contact, you do not even have to name prices, you just have to say that you will be at a competitive price level equal to the quality that you supply. The following year, it is easy to say to this customer, "I hope you have been satisfied, and I hope that you like what we have done for you."

Where the seafood industry is concerned, the two words most important in the English language are communication and conservation. We are blessed with a natural fishery resource which, if taken care of, will replenish itself for thousands of years. If we can prevent or control the dams and pollution, we are unlikely to lack natural fisheries resources. The present energy crisis is the result of limited quantities of fossil fuels. Once these resources are mined or pumped, there is no way to replenish them. The only resource comparable to our fisheries is our forests. We in fisheries should emulate those in the forest industry. In the past 10-15 years, that industry has, with conservation and communication, developed a forestry program of perpetual replenishment. We, too, have a natural resource that will replenish itself if we are careful and farm it correctly. Scientists have demonstrated that fisheries flourish with intelligent farming, intelligent harvesting, and adequate escapement of spawners without overescapement. Today, there are many other factors in our favor. Recently, you have heard on radio, seen on television , and read in newspapers and magazines about how healthful seafood is. Concurrently, many doctors and dieticians are warning against excess consumption of meat, sugar, salt, dairy products and saturated fats. Moreover, they are recommending eating many seafoods because their fats are a cholesterol depressant. Not all doctors agree with this cholesterol theory, but a lot do.

However, I take my hat off to those companies who are successfully marketing products that the medical profession and the media are opposing. What competitive advertising has done for the dairy industry is remarkable! I think these advertising campaigns are an example for the seafood industry to follow.

There are no secrets in the seafood business--no one company has an advantage over another. We pay approximately the same price to the fishermen. There is no formula that says, "do it one way and you will be successful or do it another and you will fail." It is just a matter of communication between your fisherman, your employees and your customers. Treat the fishermen right--pay them the prices to which they are entitled; be fair with them; help them with their gear, new ideas and new techniques; and help them secure loans needed for modern equipment. Get production moving!

Fortunately, I work for a company that is small enough to be able to react instantly. Right now, we are part of the developing Alaskan bottomfish industry. For over a year, we have been working hard to develop markets, and finally we are about to succeed. We have filleting equipment in operation, and we are putting up a product that is moving into the marketplace where it is being well received. We are packing pollock fillets, treated properly with antioxidant to prevent deterioration during shipment and in the marketplace. Furthermore, these fillets are processed so that they won't drip on a steam table after being batter fried or breaded or prepared in a variety of ways. They simply don't go limp, and they are just as tasty served in a restaurant as when cooked at home.

A certain well-known restaurant chain has more than 300 locations and is locating three new ones in Seattle. As a result of that single restaurant chain, consumption of seafood will run something like 10 million pounds in 1978. Last year, this chain featured a special--an "all-you-can-eat" special. Sure, they ran into some problems. They ordered crab, figuring on a 20-ounce serving, which they thought would be average. But the "average" serving turned out to be 32 ounces. They raised the price, but still people kept buying. It was a great traffic builder for them. As you know, snow crab production has increased this year to 150 million pounds. The annual sales could be a billion pounds if we had the processing equipment and the boats to handle this poundage. The customers are here and the fish is here. We simply must learn to communicate with one another in order to get the job done.

Now I would like to talk about tomorrow and where we go from here. There are 218 million people in this country, and the population is increasing by about 4% per year. Within the next 10 years, the U.S. population will have increased by 50%, which means that in 1988 there will be 109 million more people in this country. Today the annual per capita consumption of seafood is 13 pounds. If we multiply the projected population of 109 million by 13, that means approximately 1 1/2 billion pounds more seafood is going to be needed in 10 years than is needed today. Additionally, we have a duty to the developing nations of the world. Statisticians tell us that by the year 2000 the present world population is going to double. Where is the protein needed to feed this population going to come from?

We could take a lesson from the Japanese. Their annual per capita consumption is close to 100 pounds. They eat and enjoy seafoods that we do not even consider. For instance, we do not accept herring as a food fish, even though it is one of the finest food fishes in all the world. Instead we export our herring catch to Japan and Europe. There is a limit to what we can do. But we must develop the under-utilized species that are available to us.

Another example is hake. As you know, the government built two hake processing plants. But one little detail was overlooked--a ready supply of these fish. No one had talked to the fishermen before the plants were built. The only talking was done in Congress where hours were spent discussing the protein to be made from the hake. But the fishermen--one of the most important links of the marketing chain--were forgotten.

Fortunately my company has a president who is smart enough to realize the value of communication with fishermen. We have ordered more equipment, we have contracted with more boats, and we are working closely with the fishermen. Moreover, we are training people to run processing vessels. One vessel on the drawing board today will be able to do everything. This $4 million vessel will have filleting machines for both hake and pollock. It will have freezers and a complete fish oil and meal plant. It will be big enough to stay at sea for extended periods and mobile enough to go anywhere. It is being built not so much to replace our shore plant but to augment it, because that plant cannot accommodate the growth the seafood industry is going to experience within the next 10 years.

Although I expect to be here in the next 10 years, I don't expect to be around much longer. I do wish, however, that I had another 20 or 30 years because I know the young people who are coming up in this industry and what a challenge the industry is for them. What a future they have!

I cannot talk about marketing without talking about production. Hopefully, our vessel will be in the fishery in time for the next pollock season in May or June. A 100-foot vessel with enough power so that it can trawl mid-water like Russian and Japanese vessels, yet small and mobile enough so that it can run to our shore plant. This vessel could go out every day, and if we can get the help and the machinery, we could process all the pollock we know are available.

We have only scratched the surface. We have one order for 4 million pounds of fillets that we cannot fill because we do not have enough boats to fish. You may have seen ads in the newspapers requesting boats to go to Alaska. This is part of a move that is coming. I hope that this industry will stand on its hind legs and say, "Yes, we can handle it--if our government will give us the opportunity and time!"

We do not need foreign help. We need people on our fishery management councils who have had the experience in meeting a payroll, who have met tax deadlines, who have action management experience in the resource and not theoretical knowledge only. We need people who have been through the mill--people who know what our problems are. Who will not succumb to those who are trying to take this industry away from the people to whom it belongs--the fishermen and the processors.

Our's is a small company, but we have our whole stake put into capital equipment. You know what bank thinks about capital improvements! You talk brick and mortar to a banker, and he wants to look out the window. But if you talk about buying fish and turning your capital over three or four times a year, you can have all the money you want. We do not have any trouble getting money to buy fish because we can sell it; we can turn it back into cash at a profit. But when it comes to borrowing for capital improvements, it is a slow process.

This year we are stepping out with two other companies to experiment in the processing and holding of frozen salmon. We plan to put up an experimental pack of about 5 million pounds of salmon in a vacuum-sealed, cryovac bag. We are 10 years behind the poultry industry. Have you seen a turkey lately that has not been in cryovac? Meat is also packed in cryovac. Why? Because the product keeps better. With the old water-glazing method that started in 1900, there is always a chance of an incorrect glaze allowance. Without adequate protection in the freezer, fish dehydrate, turn rancid and discolor. After 9 months of storage, your customers may complain that your salmon is not the same quality of salmon they previously had received. Our method of packing salmon in a pouch and vacuumizing means that in 3 years the quality will be as good as the day the product is packaged. Absolutely no dehydration, discoloration, or oxidation. We plan to sell this packaged product all over the world and see how customers like it. It is an expensive process, but in the long run it should build demand for a quality product.

Prices of seafood have shut us out of certain markets. Many chain stores do not handle halibut or salmon anymore. But now a soup company comes along with five rows of frozen soups for the frozen sales case and they say, "We are going to spend $2 million in promoting this product." What does the manager of the supermarket do? He says, "Take your salmon steaks and get them out of here. They are not moving fast enough, and they are spoiling on us."

The most severe test of a frozen fish and package system is the retail case. Everyday the temperature is like a yo-yo--zero to 32, 32 to zero. No seafood can stand those temperature fluctuations, and the result is that nobody buys the product. The product is not selling because nobody takes care of it. We lost salmon sales to chain stores 10 years ago because of this problem.

This year we lost halibut sales because the price was too high. Why? It takes about 10 years for a halibut to grow into a marketable size and come into the fishery. Ten years ago we caught 75 million pounds of halibut. This year we are limited to 20 million pounds because we did not think of one word--conservation. We tried to connect this with our North Pacific Halibut Commission, but their hands were tied. There were thousands of foreign vessels up and down our coast taking the brood stock of our halibut. The people left in the halibut business are not the chain stores; they are the institutional food people who recognize that in any diet there must be variety of seafoods. They recognize that both halibut and salmon need to remain available, and they also recognize that king crab, snow crab, dungeness crab all have a place in our marketing.

In Washington, D.C., over the National Archives Building, is inscribed, "The past belongs to prologue." Someone asked Will Rogers what that inscription meant. He replied, "I think it means that you ain't seen nothing yet." I think he was right.

Q. *You mentioned that the hake plants failed because of a lack of communication with fishermen. Would you please comment on that*

A. I do not know about the technical end. All I know is that there were two hake plants--one in Neah Bay and one in Aberdeen. They both failed; the reasons why I do not know. But I know that now we recognize the fact that hake is an edible species if handled correctly.

One of the features of the new vessel that I spoke about is that there will be aboard a machine that can fillet, quick freeze and package fish immediately after they are caught.

Fishermen realize that if they want to take over the fisheries within the 200-mile zone they must modernize. Action by Congress to make available low-interest money--4% to 5% repayable over 20 years--for building new boats is not too far away. Boats are on the drawing board and will be in the water next year.

In the meantime, although our shore plants are going gung-ho, we still need product, we need boats, we need people, and, yes, we need more machinery. We did not anticipate that we would need so much. We must double the number of fillet machines we have. This will take time, and we will not have them installed until August.

More machinery requires more help. In a small city of 2,500 people like Petersburg, how do you find 50 more people to work an extra shift? We are building new living quarters because we must bring in people from the lower 48 states.

Q. *Do you think halibut will ever be marketed in this bag system you talked about?*

A. Yes, it will. As a matter of fact, we have some cryovac bags and a packaging machine in Petersburg and are preparing a test shipment of halibut going to Europe. Because the halibut is so large, it will have to be cut up, and we will have to be careful about the bones, the fins and so on. Halibut does not present any problems in marketing right now but may in the future if there is a big increase in the quota.

Q. *The current snow crab yield is 150 million pounds, but you mentioned that we have a potential yield of 1 billion pounds. Wouldn't that tend to deplete the resource?*

A. A report of research, carried out by the University of Alaska, on the catching and marketing of snow crab shows that there are two species of snow crab, the opilio and the bardi. That resource could support a billion-pound market today if we wanted to harvest and market the smaller opilio crab.

Satisfying the Customer

John Gerontis
Johnny's Seafoods
Tacoma, WA 98402

About 2 years ago, we incorporated and built a new plant. We spent a lot of money to emphasize the retail market itself, as well as the wholesale department. Now, we are not processors per se. We are what most people in the industry would consider purveyers. We take your product and distribute it to restaurants, institutions, supermarkets and, of course, to the housewife who drops in to pick up good, fresh seafood for dinner that night.

Recently, John Peters cornered me in our office one day and convinced me to come up here and talk about the problems we have at our end of the industry distribution chain. He asked me to speak on pleasing customers. I didn't believe that I could stand here for half an hour and talk about pleasing a customer because it really is quite simple. If you offer a wide selection of good quality seafoods to your customers, provide good service, charge a fair price that enables a fair profit, you shouldn't have many problems.

Now the rub is the word quality, and I mean consistently good quality. I am speaking specifically of fresh, locally marketed seafoods. If good quality is not available to me at all times, I cannot provide it to our customers at all times. I think in most instances of frozen products, such as snow crab, king crab, dungeness crab, shrimp meat, and gulf shrimp, there has been a dramatic improvement in quality over the last 10 or 12 years. On the other hand, there needs to be immediate and considerable improvement in quality control of fresh seafoods. I am speaking from my point of view as the end handler of the product that you people provide.

In the meat industry, beef is bought and sold according to the quality grade of each particular animal: canner, utility, good, choice and prime. Unfortunately, it seems nearly all seafood products are bought, processed and sold as #1 regardless of their true quality.

I can give you a few examples that I have experienced firsthand. Last summer, during the Oregon/Washington coastal shrimp season, we bought several thousand pounds from several different packers. All was top quality, and we had no problems whatsoever throughout the season. As the end of the season approached, we purchased large quantities of shrimp and put it in cold storage in order to have the product available throughout the closed season. As winter came, we started drawing from our inventory. Then, one day, one of the retail saleswomen came back and said, "John, there is something wrong with that shrimp meat." Earlier we had purchased a hundred cases from one packer, and this was the first case that we had withdrawn to use. I went out to the retail counter and looked at the shrimp. It was terrible! It was a very poor quality pack, from a packer that we had previously had no trouble with whatsoever. As we got further a ong with our investigation of this particular pack, we noticed that in each case there would be cans of perfectly good quality, but other cans would be bad. We then discovered that on the bottoms of the bad cans there was a little tiny blue mark, obviously made by a felt-tip pen. Thaw those cans out, and the shrimp in them was not good. In the cans without the mark, the product was fine. To me, that indicated an obvious and purposeful situation where this packer knew he was putting out a #2-quality product. He had mixed it with #1 and passed it on to us and others, with the hope that he would get by. This is what I am talking about. Poor quality is one thing that affects us. We don't need that type of product, and we shouldn't allow it to happen. Needless to say, this product was returned. But had we passed that on to our customers, we would not have done the industry a bit of good.

Another example: This time of year we find fresh fillets are a little tough to come by because of bad weather. This past year it seems we have had more than our share of storms and wind. One Friday afternoon, we got a call from a processor, offering us some true cod and rock fish fillets that we needed. My partner, who took the phone call, specifically asked if the quality was good. He was assured that it was, so late Friday we sent a truck and a driver from Tacoma to Seattle to pick up the fillets, bring them back, unload them, ice them properly, and run them into our cooler. Saturday morning, one of the saleswomen from the retail market grabbed a 25-pound sack, ran it out to the counter, came back and said, "John, there is something wrong with those fillets; they don't look good." I went out and found they were terrible! We put better fish than that in our garbage can! As a consequence, on Monday another truck with another driver carried those fillets back to Seattle. The processor gave us credit and apologized. But the incident didn't do us any good, and it didn't do the industry any good.

Another example: Have you ever been in the supermarket and looked at the oyster display in which the butcher lays jars down rather than standing them upright on the counter? There's water in the top of the jar over the oysters. I have seen oysters packed so loosely they could do the breast stroke from one end of that 10-ounce jar to the other and never touch each other. It is that bad! Now, most packers put out a very good oyster product, but still some are getting to the market that should not be there.

Chalky or milky halibut. Are you familiar with that, any of you? You must all be familiar with chalky and milky halibut. Let's go back in the past--10 or 12 years. That was the day of the 15¢-20¢-per-pound halibut. Those days are long gone and so are the supermarket ads of 19¢

red snapper, 29¢ silver salmon, and so forth. Thank goodness! In those days, the skipper and crew had a tough time making ends meet. I believe they had a market price of 12¢ or 14¢ per pound. However, during the last few years, any skipper who knows his business and is willing to get out and fish would make a very comfortable living at today's prices. Fifteen years ago in the era of the 50,000-pound trips at 20¢-30¢ per pound, there used to be a little asterisk on the pink sheet--"Note: 4,000-5,000 pounds of #2 halibut at 4¢ a pound less." On today's market of $1.30-$1.40-per-pound halibut (and probably a lot more this year, how in the world can we justify the little asterisk with just 4¢ a pound less for #2s? And where do the #2s generally end up, ladies and gentlemen? Integrated and sold with the #1, as #1. Have you ever tried to fillet or portion a graded, milky halibut? They are almost impossible to do anything with--you can't cut them, you can't fillet them, and you shouldn't market them.

I hope that I haven't given you the impression that I condemn the entire industry as one that produces nothing but an inferior product, for that is not my intention. We buy and sell a good many tons of product, and there are actually very few problems. We have spent many thousands of dollars with the packers of Oregon shrimp meat and a good many dollars with the packer that I had the one problem with. My point is that the one problem should have been prevented.

Now I realize that the tremendous world demand for limited resources such as our fisheries makes for a very competitive scramble on the part of processors and people in the industry. With the present sellers' market, it becomes difficult for buyers to be as selective as they should. However, if the industry expects to maintain control of its business without undue or excessive governmental regulation and if the industry wants to increase domestic consumption of its product, we must upgrade the quality of that product. In order to do that, we must start with the original handler of the product--the fisherman. It is a matter of educating and making him aware of the problems that he may be a part of, yet knows nothing about.

There are people here who are much more knowledgeable than I am about chilling, freezing, maintaining quality at sea and the technical aspects of quality control. But I believe it is necessary to educate the crews to make them more aware of their responsibility to handle their product in such a manner as to assure the very best quality seafood possible. That education could mean shorter trips, better crew training, better knowledge of dressing, handling and icing aboard the vessel. As Gene Ruthford pointed out, there are new fishing methods, new boats, new methods for maintaining quality at sea. Crews need to know about these technologies so that when the product hits the dock it will be of good quality.

The minute the vessel docks and unloads, the responsibility of maintaining quality transfers to the buyer. If he accepts any product as #2, he is doing the industry a disservice. No matter how you process a #2 product--you can can it, you can kipper it, you can smoke it, you can fry it, or you can bake it--it will still come out #2. If the industry will not buy it, the fisherman soon will not offer it for sale. Ladies and gentlemen, when I refer to a #2 product, I am not talking about a fresh calico or semi-bright chum, or any salmon that is turning color because it is nearing fresh water. If you catch a semi-bright chum salmon, handle it properly, process it properly you will have a good product. I am talking about any species that is deteriorating due to neglectful handling after it is caught.

I don't place all the blame on the fisherman, but he must be the starting point of any effort to upgrade quality. After all, it is the action of catching the fish, bringing it out of the ocean, and laying it on the deck of the ship that is the starting point of deterioration. His handling and caring of the product affects the final quality of the end product. He must always strive to do a better job, and if and when he does then it is up to the processor. Next, the processor should buy only the best quality and reject inferior products. Then he should process in such a manner that will assure's Johnny's Seafoods of receiving only the best possible quality product. If all this happens, it would be a real pleasure to sell. Ladies and gentlemen, fishermen and processors, deliver to us--your customers--a product that is consistently high in quality and will assure satisfied customers. Deliver to us a product not of high quality and you put the monkey on our backs. Although we are the end of the line, we are the people who distribute your products to the restaurants, to the institutions. We are responsible for getting that product to the housewife in good condition. And we can fulfill that responsibility only if we have your cooperation and good product to work with.

I think we must all work to solve our problems in the industry, rather than allow an outside authority to step in and attempt to do it for us.

Q. *Going back to the difficulty in what is a good fillet and the subjective use of "good." Could you describe the specifications that you would like to see if the seller says "good"?*

A. Let me answer this way: Johnny's Seafoods has never told any seller of seafoods that we are looking for a #2 product. We are looking for a #1 product! I have yet to see or have a processor or producer of fillets say, "John, I have a thousand pounds of #1 rock and a couple hundred pounds of #2 rock." As far as we are concerned, there shouldn't be any offerings of #2--they should all be #1. A good, bright fillet cut from a fish that has not started to deteriorate. A rock fish--a good, firm-quality product. Now when you fillet, anyone in the seafood business can look at it and judge by eye appeal alone. We don't have to run tests. Just eye appeal will tell you whether a fillet is a good, prime piece of fish. I don't even have to use my sense of smell to determine whether a fillet is top quality or intermediate quality or poor quality. It is just a matter of knowing what you are looking at. A meat manager can do the same, and most customers can walk into a meat market, look at the dark steaks, and tell whether they should have been pulled one or two days before. The same is true if you force us to buy fillets that have the bloom off them. We distribute to a meat market where they have two or three days in which to package the product and sell it to the housewife who possibly won't cook it until the next day. She expects and deserves a good product, but under these circumstances she cannot.

Q. *There is a lot of experience in your remarks. There's the quality of grading and subjective opinions. How much quality do we have left by the time you get the product?*

A. If we have a good,top-quality fillet on a Monday, and if we handle it properly, we can distribute that fillet to the retail market on Tuesday. The butcher can package it on Tuesday, and it would be good through Friday if the housewife also took proper care of it.

If a butcher likes to handle seafoods, when that delivery comes in his back door he won't let it go directly in the cooler. Immediately he'll set it on the block and pack, wrap and display. The butcher who leaves it in the back cooler because he doesn't like to handle fish is, first of all, not going to sell much fish. Second, he is going to put it in the corner and get to it last.

If we get good-quality fish on Monday and deliver it on Tuesday, the butcher can wrap it on Tuesday. Even if we deliver on Wednesday, the butcher can wrap the fish the same day. If he puts it on the counter and takes good care of it, the housewife will have a good piece of fish for dinner on Friday.

Q. *How many complaints do you have, either as a receiver of fish or from your customers, on parasites?*

A. Very few today as compared to 10 years ago. A lot of that is due to more care on the part of the processor at the fillet plant. A lot is also the result of education of the public. Ten or fifteen years ago, we delivered to 35 city schools every Thursday. And we would have 35 calls about the parasites. The efforts of local health departments and their presentations to institutional cooks have helped a lot.

Q. *Do you do any candling of your fillets?*

A. We used to candle when we delivered to the schools. They have since switched to buying more breaded fish items than fresh, and we no longer candle.

Q. *Do you feel the retail customer knows quality and can differentiate quality?*

A. I think that a retail customer who is not knowledgeable about quality will learn automatically the minute he or she takes a bad piece of fish home and throws it in the frying pan.

Q. *Do you provide your customers with recipes for seafood?*

A. We do provide recipes. We have probably 30 or 40 recipes--all proved and tried, all good recipes. We find that customers are tickled to death to go through them and pick them up. We also provide them to some of our markets where they can distribute them and make them available to their customers.

Vessel Fish Hold Inspection

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The last time I was in Seattle, I went down to a commercial wharf to see some of the fishing boats and, as might be expected, I found them very similar to boats in the Canadian fleet. Generally they are clean, well-kept and capable of landing good-quality fish. Boat fish-hold maintenance is the particular aspect of the fishing industry in which I am involved.

The standards for fish-hold inspection are relatively simple and straightforward. They call for fish-holding areas on board commercial boats to be maintained in a manner which will give greater confidence in the quality of the fish delivered for commercial sale.

Fish-hold inspection is one of the prerequisites for obtaining or renewing a license to fish commercially on the West Coast of Canada. If a boat is newly entering the fishing fleet, the commercial fishing vessel license is withheld until the fish-holding facilities are approved. If a boat with an existing license becomes due for reinspection, the owner must obtain inspection approval for his boat in order to ensure that the license remains in good standing.

In the year in which an inspection is required, a notice is sent to the owners of boats due for inspection. The notices are usually mailed early in the spring. The remainder of the calendar year is then allowed to obtain inspection approval. Boats which are not approved before the following year are not permitted license renewal until passed for inspection.

Included with the notice of reinspection is a schedule showing times and locations for inspection stations during the heavy season for inspection. When requests for inspection are received, they are coordinated with this schedule to give the best coverage within a reasonable time.

Boats which are inspected and failed or those found in poor condition while fishing are given notice requiring reinspection in that year. Fewer than 1% of the boats presented for inspection fail to pass. This is a good indication of the appreciation which Canadian fishermen have gained about the requirements for inspection of the fish holds on their boats.

In the last few years less than 10% of the boat owners notified of the required inspection have failed to present their boats for approval during the year in which they became due.

The principal concern of the fish-hold inspection is to assure that all areas and surfaces with which fish come into contact, aboard commercial fishing and transporting vessels, are constructed and maintained in good condition so that the catch is protected from damage and contamination and that these areas contribute to the preservation of fish quality. Such areas and surfaces include fish holds, checkers, side lockers, fish boxes and decks where fish are sorted and stored.

Following are the fish-hold inspection standards currently applied to commercial fishing vessels.

Fish Hold Standards--General

Fish-holds and contact surfaces are inspected to determine compliance with the requirements of Schedule C of the Fish Inspection Regulations. Where these provisions are met in a minimal way, a vessel may be given a 1-year approval. However, where good construction and durable materials are used, a vessel may be given either a 2- or 4-year approval in accordance with the following conditions:

One-year approvals.

These are granted to boats which are borderline with respect to fish-hold standards. If compliance with at least one section of the standards is questionable, the Inspection Officer may still issue a pass for the boat on the understanding that it be in better condition at the next inspection.

Two-year approvals.

These are given to boats with fish-holding facilities which meet but do not exceed the standards. Boats with holds constructed of painted wood, coated ferrocement or cement with an approved coating fall into this category. Often these boats are in good condition at the time of inspection, but normal wear and tear throughout the fishing season will cause a marked deterioration.

Boats which have wooden, fish-contact surfaces must be smooth and coated with a high-quality epoxy or enamel coating and overall appear to require little mid-season maintenance other than thorough washing after each delivery of fish.

Four-year approvals.

These are granted for vessels which exceed the minimal standards for hold inspection. All fish contact surfaces including holds, drum areas,

Figure 1. A typical combination fishing vessel in British Columbia.

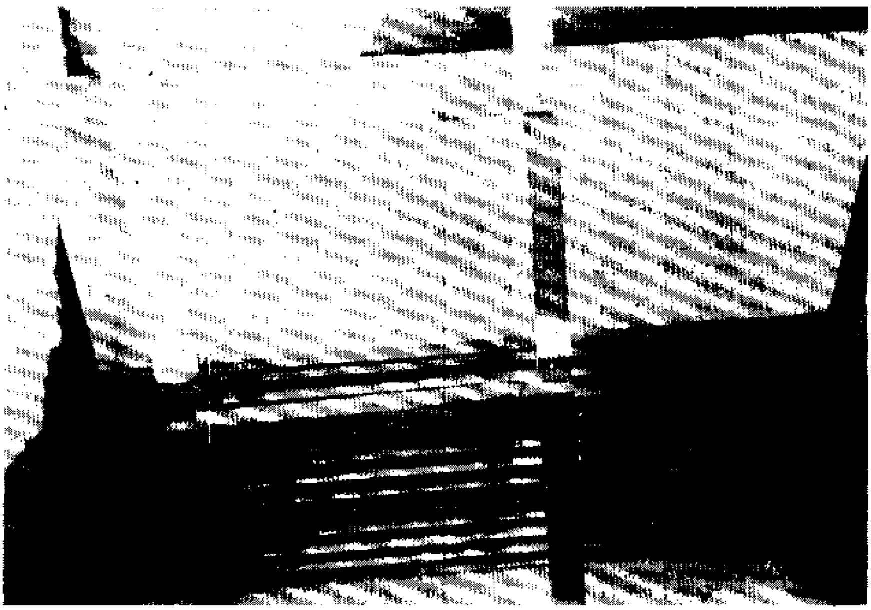

Figure 2. A good example of a properly designed and maintained fish hold. Note aluminum pen boards, stanchions and fiberglass lining.

checkers, etc. must be in excellent condition and capable of being easily maintained. Boats which receive this type of pass may have fiberglass holds and aluminum pen boards and stanchions in good condition. Examples of other acceptable materials are epoxy and polyurethane resins and salt-water resistant aluminum.

The first four regulations of Schedule C in the Fish Inspection Regulations must be me- to gain inspection approval. These are worded as follows:

- Boats shall have facilities for protecting fish from the sun and weather and from bilge and other contamination.

- Fish holds, pen boards and shelf boards shall be smooth and nonporous, constructed to facilitate proper cleaning, maintained in a condition satisfactory to the Minister and, if wood, coated with a material approved by the Minister.

- Where fish is stored against bulkheads separating fish holds from the engine room or other quarters, such bulkheads shall be watertight and well-insulated.

- Fish pens shall be shelved where necessary to prevent crushing of fish.

These regulations as written are general in nature and do not define the specific requirements applicable to individual types of boats. The following will list the standards of construction and operation necessary to satisfy fish-hold inspection requirements.

Materials and Corstruction

All materials used in fish-holding areas must be acceptable and maintained in a manner which will ensure that the quality of the fish is preserved. Examples of materials which are not acceptable in fish storage areas are unpainted wood, clear resins, oils or varnishes applied over bare wood, galvanized metals, etc. All new vessels entering the fishing or packing fleet for the first time must exceed the minimal requirements, e.g., painted wood is not acceptable. Fiberglass, plastics, salt-water resistant aluminum or other easily cleanable and durable materials only are acceptable.

Painted wood surfaces.

Many existing fishing vessels in the fishing fleet have painted wood fish holds. These will continue to be acceptable to meet fish-hold inspection standards provided that extra maintenance including smoothing, sealing and coating of all wood, fish-contact surfaces is carried out at least once a year. Cracks and seams must be filled and caulked as completely as possible. Rough surfaces in fish holds are often found in older, large wooden vessels, making annual repairs for these boats more important. Good preparation of the hold, including drying with a heater or air blower, is essential. Boats with wooden fish holds which are well maintained qualify for a 2-year inspection approval.

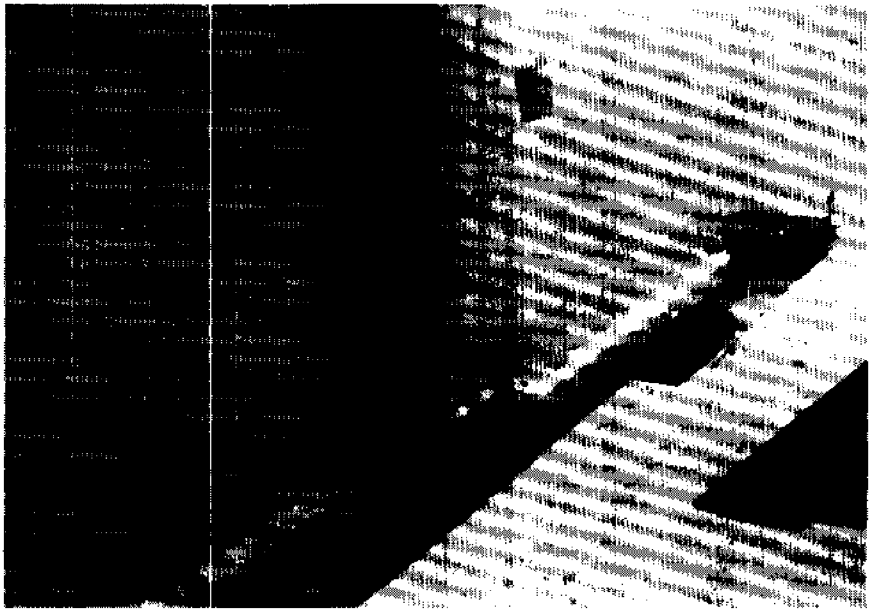

Figure 3. Detail of fish hold illustrating pump sump and screening. Note the easily maintained and durable hold lining.

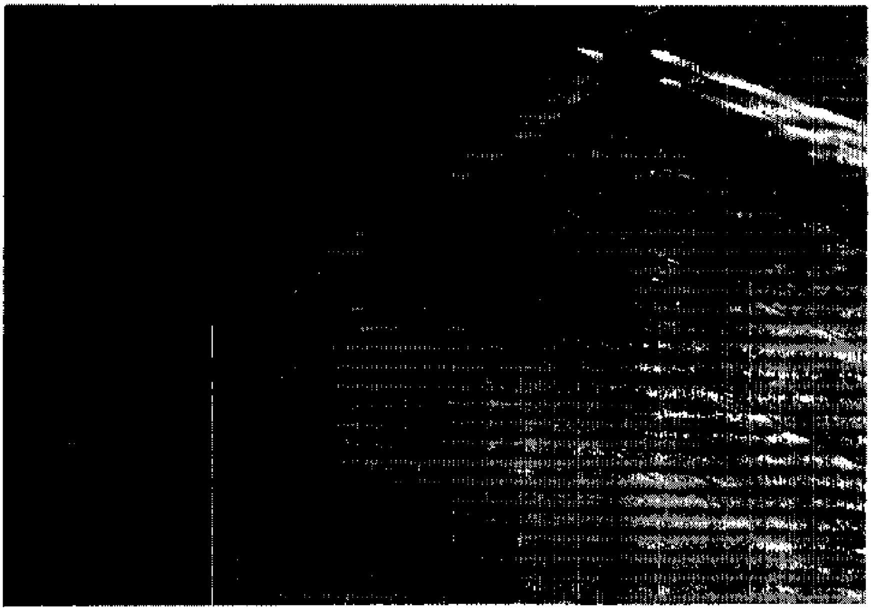

Figure 4. Wood surfaces are acceptable if properly constructed and maintained.

Cement floors.

Cement floors in fish holds do not require coating but should be sealed and made as smooth and watertight as possible. Cracks or crevices in the cement should be filled to prevent contamination.

False flooring.

Often in fish holds, sidelockers, containers or on deck areas on which fish are sorted or graded, a false floor or grating is desirable. These are usually constructed of wood coated with a durable material and are used to protect surfaces underneath from damage from fish-handling tools such as pughs or gaff hooks or to keep fish out of undesirable drainage or fish slime. As an example, in some gillnetters the cockpit or working area behind the drum is occasionally drained through scuppers located in the side locker. Installing a false floor in the side locker permits drainage and keeps fish from being contaminated by the drain water. If gratings are subject to heavy wear and tear from handling tools, they should be replaced at least annually.

Ferrocement.

Ferrocement used in any part of a fish hold must be sealed and coated with an approved material. This will help prevent rusting of the mesh reinforcing in the lining.

Wooden pen boards and stanchions.

Pen boards and stanchions must meet the same standards as hold linings. Any wooden boards which are cracked, split or broken must be replaced. Similarly, stanchions should not be too badly worn, and pen-board guides should be replaced as necessary.

Checkers and deck areas.

Deck areas which are fish-contact surfaces on boats must be clean and well-coated with a durable, light-colored material. Coatings other than paint are encouraged in these heavy wear areas. Recommended coatings are fiberglass, a durable deck surface coating or grating to cover the deck made from non-skid rubber or similar materials.

Due to the nature of operation of crab and prawn boats, a clear, free, well-maintained deck area is necessary. A minimum size of about 100 square feet is recommended. This will allow room to move and work the gear, store traps and provide access to the fish-storage areas, either containers on deck, or fish holds. The deck surfacing must be light colored and sufficiently durable to withstand the continuous heavy wear from traps and other gear.

Deck checkers on longline, seine or trawl vessels are expected to meet fish inspection requirements. Pen boards, gratings or other deck covers must be coated with suitable materials as stated above. Unpainted wood or dark surfaces are not acceptable.

Aluminum.

Salt-water resistant aluminum is a material recommended for use in fish holds, either as a hold lining or for other construction in the hold such

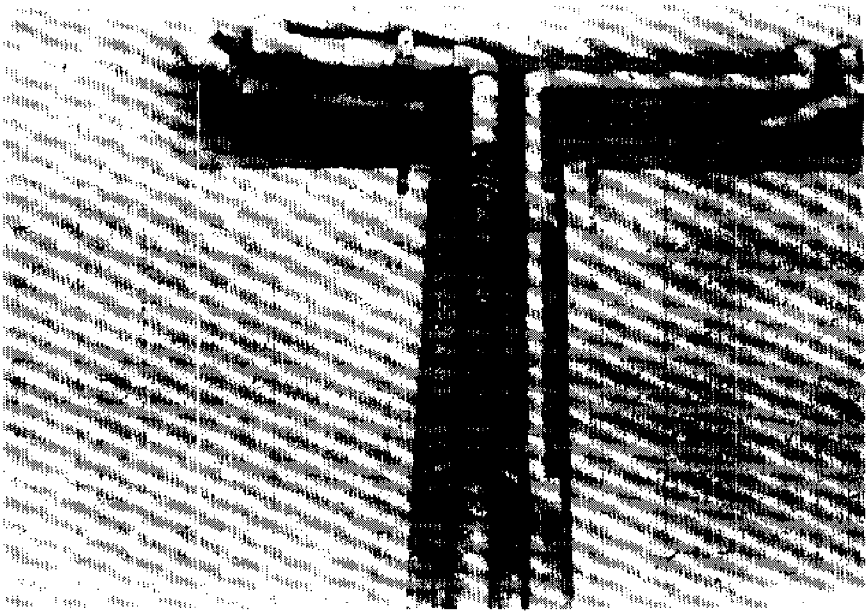

Figure 5. An illustration of a sealed and finished ferrocement hold with covers removed from enclosed piping.

Figure 6. Bulkheads must be insulated and sealed to reduce heat transfer and prevent contaminants from reaching the fish.

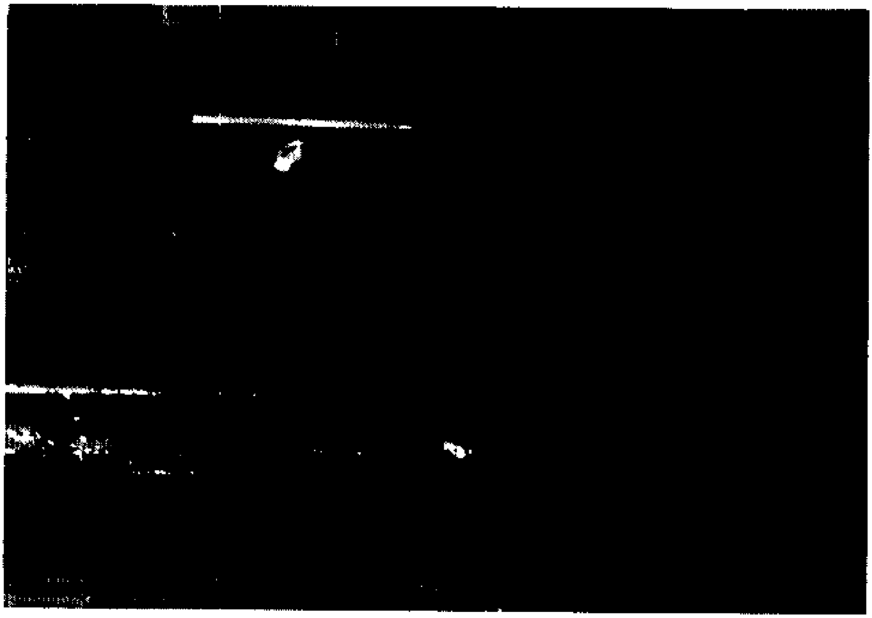

Figure 7. All fish contact surfaces, including deckheads, must be coated or sealed so that they may be readily cleaned and sanitized.

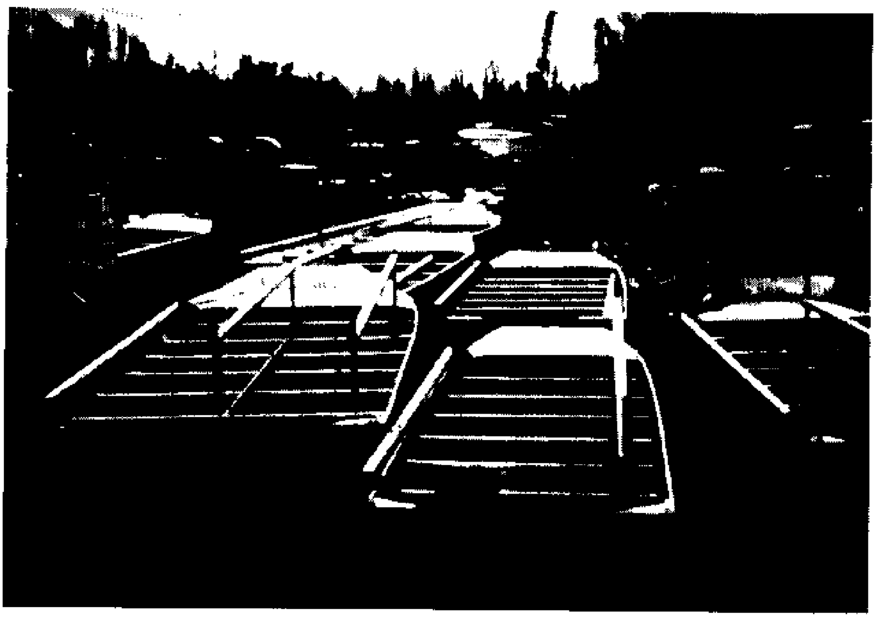

Figure 8. Aluminum herring skiffs.

as pen boards, stanchions, or gratings. If used as a hold lining, the aluminum should not be installed in thin sheets over wooden hold linings since leaking and punctures are often a problem. The linings should be reasonably heavy metal and fully sealed and fastened in accordance with recommended practices.

Insulation and watertight bulkheads.

Any bulkheads separating fish holds from engine rooms or other quarters are required by Section 3 of the Boat Inspection regulations to be watertight and well insulated. To meet this requirement, bulkheads must be sufficiently watertight to prevent bilge or oily water from leaking into the fish hold, either through the bulkhead or over the sides of the shaft log. For most boats not using refrigeration, insulation should be applied to fish-hold bulkheads at a thickness between 3-4 inches.

For refrigerated vessels, the thickness of the insulation will vary according to the desired holding temperatures, as shown in the table below:

	Holding Temperatures (°F)	Thickness of Insulation (inches)
Fish held on ice	44 to 32	3.0
	31 to 25	3.5
RSW or freezer boats	24 to 14	4.0
	13 to 3	4.5
	2 to -8	5.0
	-9 to -24	6.0

These thicknesses are based on a "k" factor of 0.5 for styrofoam and are given for the walls of the hold lining. An additional 1-inch thickness of insulation for all figures in the table should be added for the bulkhead between the fish hold and engine room. Fish boxes or containers should be insulated also.

Deckheads.

There has been some concern expressed by fishermen that coating the deckhead inside fish holds is not desirable, considering that the deck is then sealed on both sides and subject to dry rot. There are coatings available which will seal the wood but still allow the passage of water vapor. When the fish hold is filled to capacity, the deckhead becomes a fish-contact surface and must be coated itself or sheeted with coated plywood or similar material. This will allow a breathing space between the deckhead and the false ceiling.

Herring skiffs.

The herring skiff is a simple gillnet vessel primarily designed for herring fishing with limited scope for use in other fisheries. Holds of these boats are required to have protection from gas storage, separate facilities fore and aft for fishermen (so that they do not stand in the fish), a stiff brush for scrubbing, and some means for bailing it out. Either a self-bailer or mechanical equipment for this purpose must be installed. These vessels are almost exclusively of aluminum construction. A few skiffs have been constructed of fiberglass over plywood,

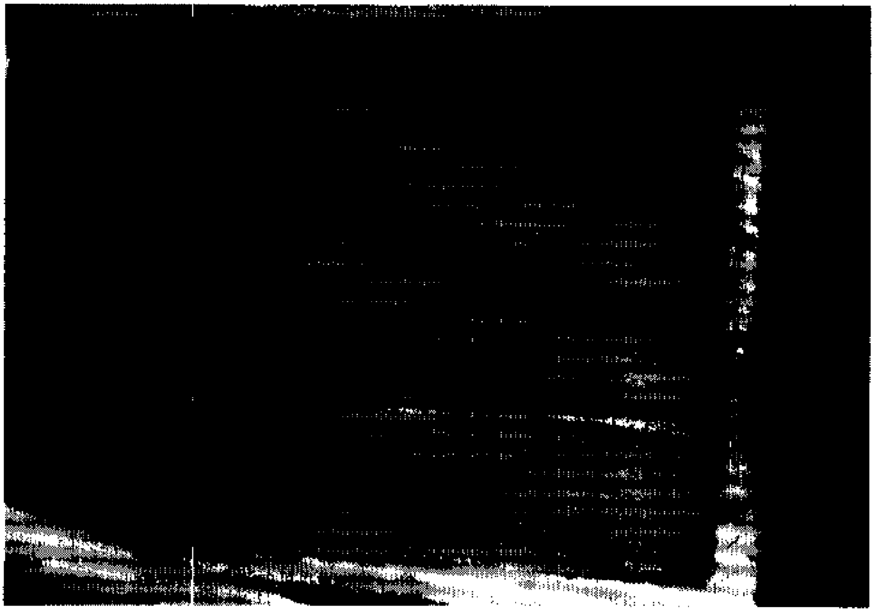

Figure 9. A well-designed fishing box. Note drainage and smooth, impervious surfaces.

Figure 10. Note clean, light-colored deck area under gillnet drum.

but their flat design and size has resulted in structural problems for this type of construction. Consequently, fiberglass skiffs are not encouraged and are limited to a 2-year approval. Aluminum skiffs are eligible for the extended 4-year pass.

Fish boxes and containers.

These are often used by smaller vessels engaged in fisheries such as cod, crab or prawn fishing. Usually they are installed in boats not designed to have fish holds. Acceptability of such containers depends on their location on the deck of the boat, their size, and their construction.

New containers must be constructed of durable materials such as fiberglass, non-toxic plastics or salt-water resistant aluminum. The lining of the box must be light colored and have no open cracks or seams. The total fish-holding capacity of a commercial fishing boat should be at least 60-80 cubic feet, and each container should be no less than 20 cubic feet.

Crab fishing vessels have been approved to hold the catch in large plastic buckets of the same type as waste disposal containers provided that they are brand new at the time of inspection and are made of virgin or new (not recycled) plastic. Although these containers are light, portable and generally acceptable for fish-hold inspection standards, the plastic of which they are composed is fairly soft and easily scratched. These containers are not encouraged unless replaced regularly.

Containers must have rigid, tight-fitting lids and be equipped with drainage or false flooring. If they are to be portable, there should be a frame or brace installed on the boat to hold them in position while fishing and to clearly identify that portion of the boat as a fish storage area.

Except for crab and prawn vessels which are open-decked and for which portable containers are usually desirable, fish boxes on boats are not encouraged. Fixed or permanently mounted fish holds or containers are usually found on boats which are clearly commercial craft. Use of pleasure craft for commercial fishing is often impractical and, in some cases, may detrimentally affect fish handled in commercial quantities. Their use is not encouraged.

Equipment

Covers.

All fish storage areas aboard boats must be equipped with rigid, tight-fitting covers to provide fish with protection from sun, weather or contamination. This applies to all areas where fish are stored including fish holds, boxes, side lockers, checkers and others.

Temporary storage in clean, well-painted or fiberglassed areas under the drum aboard gillnetters or seiners has been acceptable provided that the fish are moved into covered storage areas as soon as possible.

Checker areas aboard trollers must be covered as much as possible. It is recognized that in normal operation trollers other than day trollers will hold fish in the checkers for only brief periods. However, covers should be provided to assure that the fish will not be affected by sun

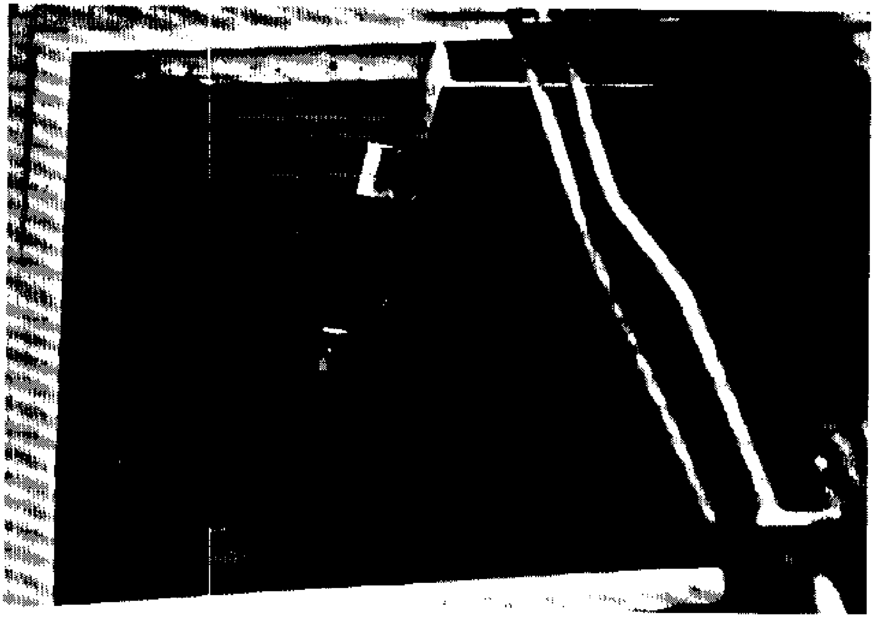

Figure 11. Chair guard installed in fish storage area.

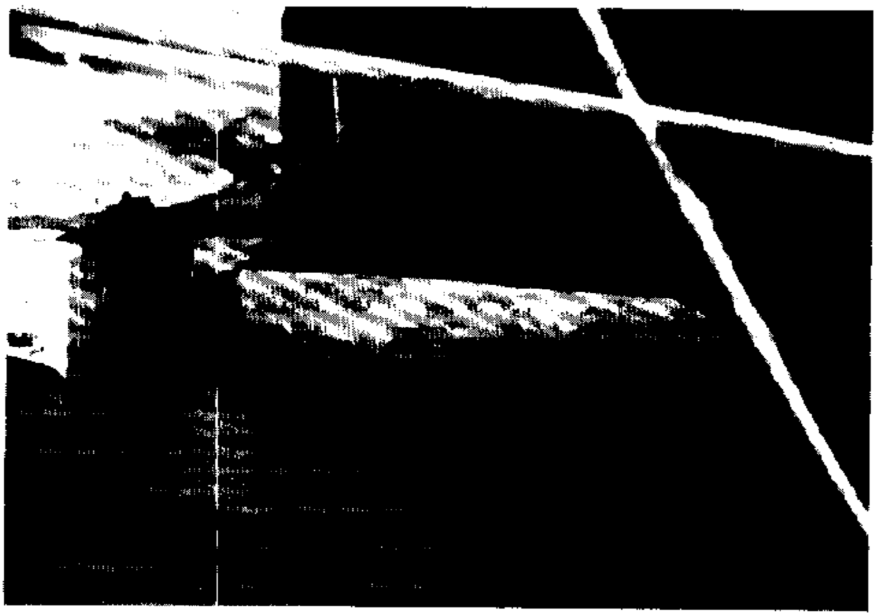

Figure 12. Drip pan installed under drum drive prevents oil seepage into fish side locker.

or weather if left uncovered during heavy fishing when fish may be left in checkers for longer periods.

Checker areas on other types of vessels such as long-liners or trawlers normally are not expected to be covered.

Grease and oil contamination.

Fish must be protected from physical damage or grease and oil contamination caused by exposed chains and drives located in or near fish-storage areas. Enclosing the chains or drives will protect fish from damage and prevent oil or grease from leaking into the fish holds. The covers usually are fastened in such a way that they can be removed for maintenance or repairs.

Grease or oil fittings on steering shafts or other equipment located in the fish holds should also be covered or enclosed if these fittings are in such a condition that the fish in the holds may be contaminated.

On gillnetters, pans must be installed under all drum drives or similar equipment located over side lockers or other fish-storage areas. Such pans should be firmly mounted in place, extend the full length of the drum drive, and be capable of draining away water, oil, or grease as soon as these spill into the pan.

Gurdy trays mounted over checker areas on board trollers should be designed so that accumulated oil, grease or dirt cannot spill onto fish. This may be accomplished by installing lips on both sides of the trays which will direct any spilled oil or grease on the trays away from the checkers. Another alternative is not to use the area under the gurdy trays for fish storage and to seal it off from the fish checkers.

Fuel or gas filler pipes.

New or unusual hull designs in some fishing vessels, including gillnetters and trollers, have put fuel or gas filler caps for main or auxiliary tanks in the middle of the side locker or checker areas. In such cases, the filler pipe should be extended so that the filler cap is directed away from and located outside the fish storage area. A lip around the filler cap may be necessary in some cases to prevent fuel or gas from spilling back into the fish hold.

Fish-handling tools.

Pughs, gaff hooks, shovels and other tools used for handling fish can be very damaging to good-quality fish if poorly used. Alternative fish-handling methods, which are gentler and do not depend upon striking or puncturing the fish, are encouraged.

<u>Operation</u>

Clean-up and maintenance.

Following each delivery of fish, holds should be thoroughly washed and scrubbed using a brush, detergent, sanitizer, and plenty of clean water. Blood, slime, or other waste left in fish-holding areas can contaminate the next load. Proteins in fish waste and blood which dry onto fish-

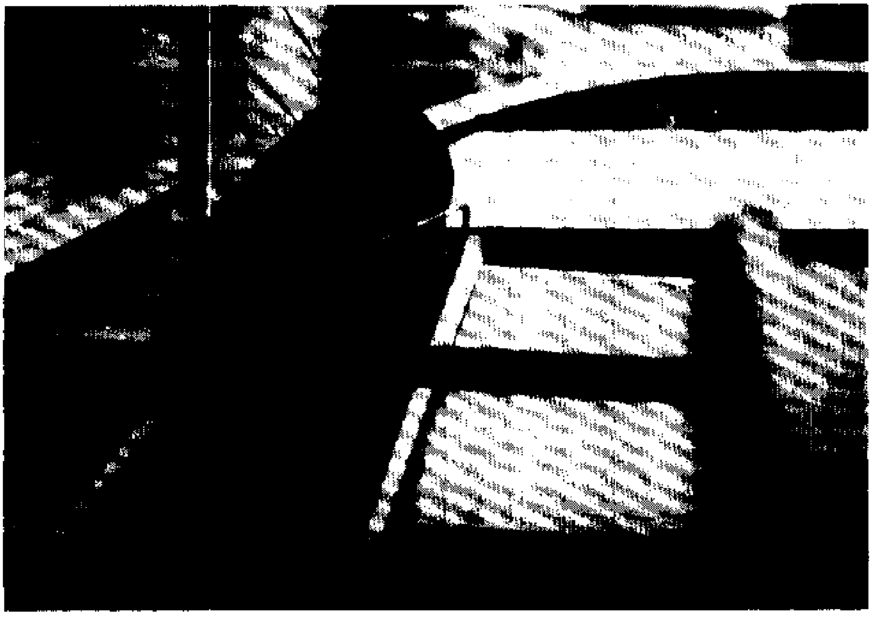

Figure 13. Acceptable gurdy installation. Note lips along both sides of gurdy tray.

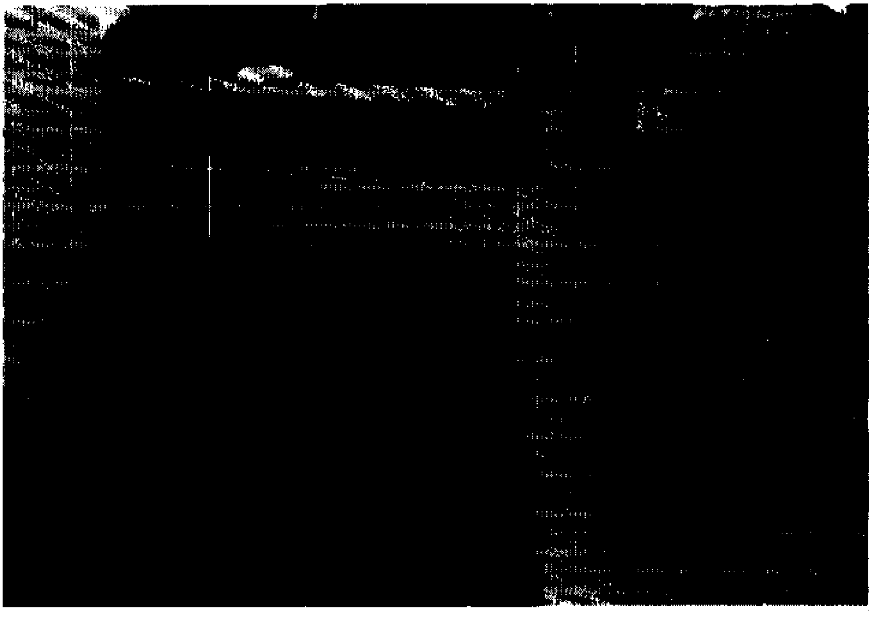

Figure 14. Fuel filler pipe extended through fish storage area.

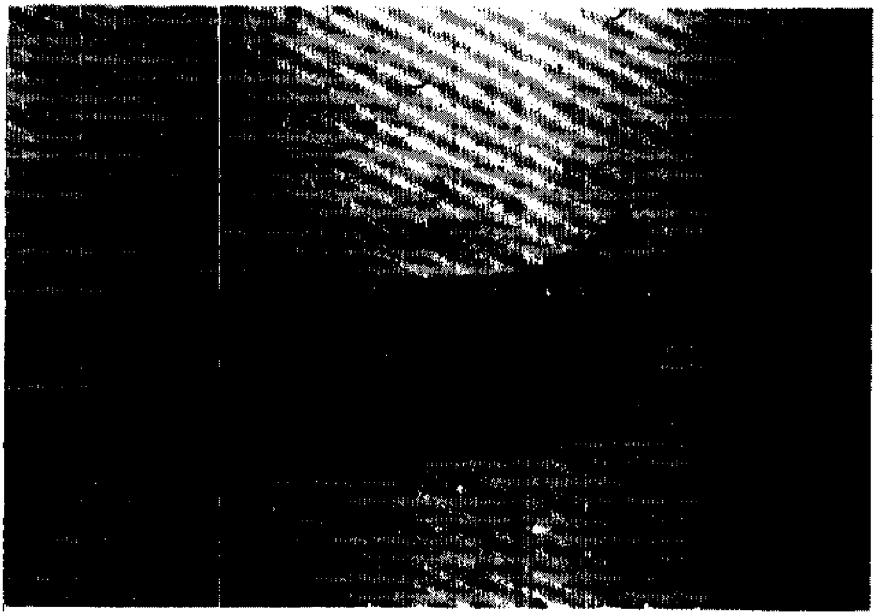

Figure 15. The gaff hook. Unskilled use can be damaging to good quality fish. Better alternatives for fish handling are encouraged.

hold surfaces make those areas very difficult to clean. For this reason the hold should be washed out as soon as possible after the fish are removed.

Bilge level.

Where a boat is designed with the propellor shaft running through the fish hold, the shaft usually has a shaft log built to enclose it. The bilge is permitted into the shaft log, but a bilge pump must keep the water level below the lowest point in the fish hold. If there is any possibility of the bilge rising or splashing into lower areas of the hold, these lower points may be built up using cement ballast or false flooring. Fish must be protected at all times from bilge contamination.

Deckloads.

During heavy fishing, a packer or collector may, on rare occasion, be unable to put all its fish into holds and must store remaining fish on deck. In this situation, the fish must be well-iced and covered so that they are not left exposed to sun, wind, rain or other forms of contamination. Deck areas may be approved for sorting or storing fish for brief periods less than 1 hour but extended storage is strongly discouraged.

Shelving.

When fish are stored more than 3 feet deep, fish on the bottom layers may be crushed. For this reason, shelving should be provided at 3-foot intervals to prevent crushing the fish stored below.

Refrigeration.

Fish-hold inspection requirements state that all fish from the time of catch must be chilled using ice or other acceptable means of refrigeration, including refrigerated sea water or freezing. It is well known that temperature is the most important single factor which affects the keeping time and quality of fish. It is most important to chill the fish as soon after catch as possible and to keep it chilled until processed.

There are principally three methods used for refrigerating fish on this coast: icing, freezing, or refrigerated sea water. Icing is the most common method. Inspection requirements call for the use of only finely divided or flake ice made from clean water. Used ice is contaminated and, if kept for a second trip, may spoil the catch. Good-quality ice is also important. "Green" or freshly made ice which is not yet fully chilled usually means that more ice must be used or a shorter trip made to ensure that the quality of the fish is preserved. Normally ice is used at one part ice evenly spread through three parts fish.

Refrigerated sea water systems (RSW) can keep good-quality fish if they are properly constructed and operated. These systems do not extend fishing time as much as they preserve quality on a short trip. The advantages of their use are that fish can be rapidly chilled after catch and that very little handling by the boat crew is necessary. In most cases, unloading from RSW fish holds is relatively easy. Poor operation of RSW can spoil full loads of fish, cause significant scale loss, and cause leeching of color and tainting of fish. RSW tanks and refrigeration lines must be thoroughly cleaned and disinfected after each trip. A cleaning "loop" built into the piping can facilitate washing and disinfection. Information about construction, operation and maintenance of RSW systems is available.

Freezing fish on the fishing grounds has been a significant advantage to salmon troll fishermen in the past few years. Its use in other fisheries is limited at this time. The main advantage of freezing is that, properly handled, the quality of the fish is preserved at the time of catch. This usually means a higher dockside price for fish. Another benefit is extended fishing times for fishermen with freezer-equipped boats. Again, construction and operation of these systems is important to gain the above advantages. If the fish are improperly prepared before freezing or are frozen too slowly, either because of poor system design or poor operation, the quality and advantages of freezing may be lost.

Fish Inspection Regulations call for fish to be frozen and stored in accordance with the following conditions:

> Where round or dressed fish is not contact frozen, freezing facilities shall be available to freeze fish by means of air at a temperature of -20°F (-29°C) or colder, moving at a velocity of not less than 400 feet per minute until the temperature at the centre of thickest section of the fish is -5°F (-21°C). (Schedule A, Section 46)

Fish should be frozen to this temperature within 12-24 hours.

> Rooms (holding areas) in which frozen fish is stored shall be maintained at a temperature of -15°F (-26°C) or colder. (Schedule D, Section I)

All boats equipped with freezer holds should be capable of freezing and holding frozen fish at these freezing rates and temperatures. Fluctuations in holding temperatures above -15°F (-26°C) will rapidly spoil good-quality fish.

As stated earlier, chilling the fish soon after catch is the most important operating practice on any boat. Fishermen whose boats do not have any refrigeration at present are encouraged to carry ice, regardless of how long the fish are kept on board--a few hours or a full day.

Q. *How many boats have qualified for a 4-year pass?*

A. Roughly 15% of the 8,000 boats in the Pacific fleet in Canada. Generally, most of the boats in the fleet are kept in very good condition and readily meet fish-hold inspection requirements.

The program started with a failure rate of 47%, but many of the boats which did not meet the standards usually could be brought into compliance by making a few minor repairs.

Most boats now pass on first inspection. The objective of the program has been to ensure that all boats meet a base standard of maintenance of the fish-hold areas, giving some confidence that the landed quality of the fish will be kept higher.

Q. *Have you been able to measure any difference in quality of landed fish?*

A. As pointed out earlier today, the yardstick for determinining quality is difficult to measure. One significant change has been determined by our Canned Fish Inspection Laboratory. Prior to the implementation of the fish-hold inspection program, approximately 3% of the canned fish which failed to pass inspection analysis was turned down because of bilge oil contamination. The amount failed now for this reason is negligible.

Q. *What was the original reason that the legislation came about? Who were the proponents and opponents of it?*

A. In 1970, a salmon license limitation program was set in place to control the excessive increase in fishing vessels entering the fleet. Good runs in many areas, coupled with rapidly escalating prices for salmon, were making fishing an attractive business. The resulting competition caused a generally low income for all participants.

Fish-hold inspection was introduced as part of the license limitation program, on the one hand to discourage the poorer boats from continuing to fish, thereby reducing competitive pressure on the better boats in the fleet, and on the other hand to give some assurance that the landed quality of the fish was kept high.

Q. *Did fishermen fight it at first?*

A. No, in fact there was very little opposition to the program. Several companies with fleets fishing for them asked for additional time to comply with the standards because of the initial expense involved. One must remember that most boats in the fishing business are looked upon as being an investment. As a capital investment and for personal pride, an individual or company will agree with most requests made if it can be shown that an improvement to the boat or the quality of the fish will result. Some fishermen have said that the program should have been brought in years before it was introduced.

Q. *When you initiated the program, did you begin with purse seiners, trawlers, halibut fishermen, or?*

A. All commercially licensed vessels were expected to meet the standards. Some thought was given to applying the requirements only to salmon vessels since these were the boats affected by the license limitation program, but this was later changed to apply to the whole fleet.

The initial concentration has been strictly on construction and maintenance of fish-storage areas. Without a smooth, clean, light-colored surface or area in which to store fish, careful handling will gain nothing. The expected improvement in handling has come hand-in-hand with the upgrading of the fish holds, partly because of the reduced possibility of contamination from the fish storage area itself, but also because of increased conscientiousness by the fisherman in the care of his fish.

We now feel ready to concentrate a little more heavily on the handling of fish on board. This will include more emphasis on chilling or refrigerating fish as soon as possible after landing. Over the past few years, several million dollars have been spent by the Department of Fisheries to subsidize the construction of new ice-making and storage facilities in Canada. This year we have asked all owners of vessels used for packing and transporting salmon to ensure that all fish held on board are kept iced or chilled by some means.

We are optimistically looking toward the day when all commercially caught fish will be chilled within a few hours after catch.

Maintaining Quality at Sea

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It is a remarkable thing that seafood processing plants of even modest size have a quality-control program, and most of them have technically trained people in charge of this program who are consistently present; however, I know of no fishing vessel that has a quality-control program or a quality-control supervisor on board. Yet, as we have heard repeatedly today, the fishing vessel occupies a critical position in the chain of production and distribution of seafoods. Whatever happens to the fish on board the vessel determines its condition in later stages of processing. If the fish is allowed to spoil on board, then you start off preparing fish sticks from spoiled fish. If the fish is held under good conditions, then you have a better chance of producing a product which will meet the requirements that one of the earlier speakers asked for.

Another thing that is important is that fishing vessels are not really designed to transport fish: they are designed to catch fish and bring them back in some way. But vessels are not specifically designed to provide optimum conditions or even good conditions for storage between the time of catching and the time of landing.

This situation is remarkable when one considers how long we have had a fishing industry. I just returned from a trip to Egypt where I saw wall paintings showing fish being caught in much the same way we catch them now. The only difference was that ancient Egyptians stomped on their catches with bare feet instead of heavy sea boots. They had the same kind of storage facilities on board open papyrus boats, as on board many of the vessels you saw illustrated in the slide show just preceding. Now this history doesn't help resolve any problem, but perhaps it points up the nature of the problem. We have an industry that has been going for thousands of years, yet it has not developed the kind of physical infrastructure (that's a popular word nowadays) that one might expect on vessels.

So, what, if anything, can be done? Let's look at the problem. As we also heard earlier this morning, a comparison is often made between the quality of meat products and the quality of fish and fish products at the retail market. Let us look at the difference in the way these products reach the market. The meat producer brings his cattle to market at the peak of condition. There they are handled in a very careful manner, so that they are held in tranquil condition. They are killed immediately in the abattoir, and then dismemberment and the subsequent handling process is supervised by a host of veterinarians and technical experts of various kinds.

Compare this with what happens at sea. We go out and kill at random--well not quite at random; we look at the little specks on the fish finder. We throw a net over the stern, drag it along the bottom for varying periods of time and then haul up a mixed collection of dead and dying fish. No pretreatment or preselection, no rapid killing. Some of the fish die slowly; some die quickly; some of them are still kicking when they are thrown down the hold. The intrinsic control of the raw material is at a much lower level than the equivalent control for the meat. That, I think, should be said and said repeatedly because we are faced with a different set of problems; therefore, we must solve them in a different way. I can perceive nowhere in the immediate future that there will be a band of veterinarians going to sea to painlessly and quickly kill and bleed all the fish caught in the ocean. It might be possible with the odd swordfish, but the FDA wouldn't allow us to land it anyway; so we are stopped. But I couldn't see this being done for herring. So we must look at this problem and its solution in a different light. What is it that we are trying to do?

One other factor that I want to draw out by way of introduction is the variation in our raw materials. Normally, where there is a variance in species there may be variance in the condition of the species. Not all raw materials are at the same stage. So we must deal with those situations. In mixed trawl fishing, which is where I see a lot of people heading with the opening of the fishing grounds to U.S. fishermen, we must deal with mixed fish with different properties.

In handling fish on board the vessel, it seems to me that there are two primary objectives which relate to the nature of the changes that take place in fish after death. First of all, we must retard the beginning of spoilage. In the initial phases after death, any animal goes through a set of chemical changes which can be seen obviously in the process we call rigor mortis, the stiffening of death. These chemical changes really should not be considered spoilage processes--there is no deterioration in the quality of the product. In meat, the quality of the product actually improves during this phase, and I think that this is true in some fish also. As long as this phase is going on, spoilage is prevented for various reasons that we needn't go into. One of the objectives of the prudent fisherman should be to prolong this phase as long as possible. I put up some of the things that one can do to prolong the phase. The reverse actions will inevitably cause the fish to move to the second stage of incipient spoilage quite quickly. Usually or frequently fish are caught far from the point of processing, and we are rarely in a position to hold in this first stage for the entire voyage. We must face the fact that at some point, some few days after catching, the fish will begin to go into the incipient phases of what is, ultimately, spoilage.

Now I am not going to go through my standard lecture. Many of you have heard it many times before, and most of you have heard this in general. Suffice it to say that the big bulk of spoilage is due to bacterial growth. These bacteria are present anywhere on the fish, and there is not a lot one can do about that. However, one can minimize the effects by reducing their rate of growth, removing some of them by washing--possibly by gutting--and, of course, most prominently by chilling and lowering the temperature which greatly reduces the rate of growth of bacteria. There was an earlier question about the requirements for refrigeration that was intriguing to me. It is true, of course, in a one-day fishery such as in some of the salmon areas, that chilling is perhaps of less importance and contamination from accidental sources is of more importance, particularly fecal contamination and so on. However, with any fishery in which a vessel is at sea for several days, the dominant controlling factor must be chilling and lowering the temperature because in the absence of this fish will spoil rapidly. Not only because of bacterial action, but because of enzyme action. Some of the species, particularly hake, that are now getting into our local fishery, seem to have some very active enzymes which can cause the flesh texture to change horribly within a very short period of time. These kinds of activities are particularly sensitive to high temperatures.

Let us just look quickly at the sequence of events. We all know what happens on board the vessel, but perhaps it is useful to categorize these events to see how each of them affects what is going on. First of all, catching. There is not a heck of a lot that a fisherman can do about the effects of catching other than to reduce the length of tow in the case of a trawl. There is no question--and many experiments have shown this--that the longer the tow, the poorer the condition of the fish on landing on deck. Obviously, a fisherman has to make compromise between what is economical and what is excellent practice from the point of view of quality. That raises one other issue we will perhaps have time briefly to talk about later. That is, what incentive do fishermen have to produce high-quality product, if they receive the same price for average quality as they do for high quality. Why should they go to the trouble of producing a high quality if they are not reimbursed for it? I am sure this could be discussed for a long time.

The other factors on catching: If the fish are large, it is a good idea to kill them and bleed them as soon as caught. This procedure reduces the rate of change a great deal. Once the fish are on deck, they must be sorted and washed and possibly eviscerated or gutted and bled. On this coast, it is not very common to gut fish because of the kinds of fish that we have been in the habit of catching. I would point out, however, that we are moving to different species, and some of these species require gutting if one is going to expect any shelf life from them, either on the vessel or on the shore. I will show you some evidence of this shortly. On deck, the important thing is to move quickly, yet avoid physical damage. Another well-established fact, both in practical terms and in laboratories, is that fish that are tromped upon spoil more rapidly than those that are handled with care. You can run this experiment on your own vessels anytime you wish. Just set aside those fish that you are standing on, which is a common practice on vessels, and see how quickly they go bad.

Fish should be gotten down below deck as quickly as possible. In more modern trawlers that one sees in Europe and some other parts of the world, much of this operation is done in a covered deck area, where the fish are protected and so are the men from adverse weather and bad conditions. Once below deck, the objective is to cool fish as quickly as possible. Traditionally, this has meant packing them in ice, and it is remarkable how poorly some of the icing on board vessels is done. In northern waters, cooling fish takes a lot less ice than you might think.

But preventing fish from warming up again takes a great deal more ice than one would suspect. Yet one can go into holds and find very little ice up against bulkheads, quite a lot of ice in between fish, which is of course the reverse of the proper situation. Proper storage, the same kind of thing. Again, of course, properly designed vessels would be a lot easier to pack than the kinds of vessels we generally have. Usually they are excellent seaworthy craft, good fishing vessels, but lousy carriers of fish.

Separation of species is desirable; for if you mix species with different spoilage rates, the ones with the fastest spoilage rate will tend to cause the others to spoil more rapidly. I am sure that many fishermen know this instinctively. Moreover, processors do like the species delivered separately. I believe separation of catches is more in the nature of what we might see in the future than what we see now. Assuming that there is any quality demand in the market (and we heard from John earlier that there is), it would seem desirable that the fresher the fish, the higher would be the price. To achieve this would require separation of catches so that 5-day-old fish are not mixed with 9-day-old fish.

Off-loading is hardly the job of the fisherman, though it often becomes his job. Here minimum handling and minimum damage are obviously important. Now, these are all nice theoretical points. Is there any way that one can approach these ideal conditions realistically? Before we discuss that, however, I'll show you what I mean about the need to gut fish in certain cases.

In some recent Danish work on cod (which is the nearest I can get to hake), some fish are gutted and iced and other fish are ungutted and iced. The quality grade of the ungutted fish, even in the very early stages of storage, is quite low and these fish reach grade-2 and reject levels much earlier than the gutted fish. I suspect that this is going to be the case with soft species such as hake and pollock, which we are catching now. If the fish are feeding, we are going to have a much-reduced shelf life. In the Danish work, researchers found that this factor influenced the quality of the frozen product tremendously. After a few days' storage in ice, the ungutted fish were quite unsuitable for the production of a frozen product. They were tainted and soft.

I thought we might look at some of the things that might be done on board present vessels. We heard from the first speaker that there are plans afoot for mechanizing on-deck handling of fish at sea. The Danes have developed a little system for sorting out mixed catches at sea and for packing them into the ice room in an expeditious manner. Fish go through a sorting device into a well. The first sorting device separates out the largest fish. The rest go into a roller and number three separates small fish which are then automatically mixed with ice and sent below. Big, edible fish go out the same. If we make use of those stocks which the Russians and the Japanese have been catching for us until recently, I suspect we will be faced with mixed-fish catches increasingly. This system is adaptable to a small Danish trawler which is certainly equivalent to the vessels we have around here. So it doesn't take a great vessel to handle this type of mechanization.

Containerization is a bee that I've had in my bonnet for a number of years. It has always seemed silly to me that we bulk pack fish in trawlers and then dig them out again with shovels for sorting and unloading. This excessive handling results in a product of decreased quality. Two types of containerization are available. One is simply a modification of a rather old-fashioned system--boxing. These are nested, plastic boxes with drain holes in the bottom. In use, they are filled with a given level of ice prior to shipping on board the vessel. Then they are taken on board on double pallets. Subsequently, the pallets are split, and the fish are placed directly in the boxes. The boxes fit together so that it is unnecessary to put on top icing--the box on top acts as icing. This system is designed for Denmark where fish are shipped directly from vessels to retail markets, and I don't know how applicable it will be here.

There is another more feasible operation that better relates to some of the things we are doing already. We in the Pacific Northwest in many ways pioneered the use of refrigerated seawater, and it is being rediscovered in many other parts of the world with modifications. This is a system that the British developed for herring, but it is being used for other purposes. It is a portable, insulated, chilled seawater system in which refrigeration is supplied not by an external compressor and pump, but by ice. The technique is to prefill boxes with ice to a specified level and put them into a vessel prior to departure. At sea, the catch is loaded directly into the container, the containers are filled with seawater and an air-bubbling system is set going. This gives very rapid cooling, because the slush-ice system has the initial advantage of not requiring external refrigeration. It also is easy to unload because the whole chamber can be unloaded and shipped to its destination.

The Danes have also developed another technique and tested it in Chile with hake. The technique consists of two systems: a portable, chilled-seawater tank in one part and boxed systems in the other with a deck support system analagous to the one that I discussed earlier. This system enables the handling of large amounts of hake with the same size crews that we typically have on the West Coast and with the same type vessel typical of the vessels in South America.

To conclude, the facts regarding quality on board vessels haven't changed over the last 20 years or so. Incidentally, is Gene Ruthford still here? As I came in, he was talking about the use of cryovac for salmon sections. I recall talking with him 20 years ago about the use of cryovac for salmon sections. Although we have come a long way in the development of plastics and packing since then, the situation hasn't changed. Fish still spoil as a result of bad handling, inappropriate packaging on board the vessel and plain carelessness. Solutions have become more numerous, I think. We have facilities for prepacking, we have techniques for providing containerization on board the vessel, and in the long run we do see a move within the fishboat-building industry to build boats which are designed not only for the fishing task but also for the task of transporting fish and maintaining them in good condition.

As an educator, the thing I would like very much to see is some system whereby fishermen are taught how to handle fish. At the risk of being run out of town, I will say that in my travels over the world I have met many, many good fishermen, but I have met very few fishermen who know what do do with the fish once it is on deck. They can find them and catch them, but keeping them in good condition is apparently not very well understood.

Q. *Using slush ice or refrigerated seawater or something like that, how many pounds per cubic foot is optimum?*

A. Twenty-five pounds per cubic foot in the chilling phase. In the British system it is a bit like a tuna operation. They pack and chill tuna and fill the tanks up from other tanks once the temperature is down. I hope the quality is better than the tuna situation.

Q. *From the standpoint of cost and possible increased revenues to the fisherman, do you feel there is an incentive to make improvements on fishing boats or do you know any advantages to changing to containerization, chilled seawater, etc., on existing craft?*

A. The standard methods used on this coast to chill seawater are well established on vessels and, depending upon the system, can be profitable or marginal. One of the problems with large, chilled seawater tanks is that the whole catch goes into one tank, and if there is an error or malfunction the whole catch goes down the drain. One of the advantages of containerization is that catches are separated.

The other question is a very large one, and I think someone is going to be addressing this in a later talk today. The crux of the issue (incentive to fishermen to improve) was addressed a bit in the discussion of consumer demand. I don't think there is any question that the attitude of the public is such that you are going to see an increased demand for consistent quality in fish products. It is not just that we have a number of bad fish products, but that the consistency of the quality of raw fish products is absolutely atrocious. To some extent, our Canadian colleagues did accept a regulatory answer as a first stage. Though I notice that the last speaker was very careful about where they went and avoided going into too much intensive regulation. The industry that I always think of is the milk industry, which of course is regulated to beat the band but also is--at least used to be--a very profitable industry. Everybody made money off it!

Q. *You suggested gutting the fish on trawl-caught fish. Will trawl-caught fish that have been gutted fillet properly?*

A. That is a gooc question. It depends on the machine, and it depends on the fish. First of all, most filleting machines are designed to cut whole fish. There are some which incorporate a gutting step in them. I've seen them in Europe, but I don't know whether there are any functioning here. Some fish are probably inappropriate for gutting. Local rock fish are really very difficult to handle unless we can get a simple gutting machine. The problem is that fish such as hake and other smallish, soft-fleshed fish are very, very sensitive to the effect of gut enzymes released around them. This happens when the fish get squeezed. Some system needs to be devised to deal with this. But you are right, there really is a problem with most filleting machines. There are some that will handle them, though.

Q. *The quality of the English product is good. They are gutting and gilling and delivering a good-quality product.*

A. That is quite right. Some of their trawlers are typically running 16- and 18-day trips up to the North Atlantic area. There is no way to keep a fish for 14, 15 days without gutting it.

Q. *Because it is partially processed, the troll-caught salmon is a better-quality product. By the same token, why couldn't dogfish be recognized?*

A. There are some practical problems, but I agree with you in principle that they should be gutted. I have heard some schemes to catch hake and fillet them at sea and bring them in, in chilled storage. I hope that whoever will be considering that recognizes that fillets spoil a lot faster than whole fish. Sometime these little fine points are overlooked.

Chilling Seafood at Sea

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Today I will present a review of recent developments in the British Columbia fisheries dealing almost exclusively with fish-handling and chilling procedures and equipment that have been developed by the engineering group at our laboratory in Vancouver. These techniques have been adopted by our industry on a significant industrial scale.

My subject is a broad one which encompasses all of our major fisheries, and I can therefore only briefly mention highlights at this time.

To provide more perspective, there are, at the present time, approximately 150 mechanically refrigerated RSW-equipped ships and barges in the B.C. fleet and about 20 CSW (slush-ice) systems. Our fishing fleet has expanded steadily during recent years, and a high percentage of these additions to the fleet are "tanked" vessels. Relatively few old-style holds are to be seen among new additions to the fleet, nearly all of which have insulated and tanked holds.

Our "big-boat" RSW fleet is made up mainly of:

(a) relatively few large tenders (converted vessels) used for salmon and roe herring;

(b) many combination or multi-purpose fishing vessels of 65 to 125 feet in length used for seining, trawling and long-lining; and

(c) a few barges--mostly of 200- to 500-tons capacity.

The significant advantages demonstrated by these RSW installations have proven to be: (1) rapid chilling rates virtually unattainable by other methods; and (2) the capability for bulk handling of fish in the truest sense, with consequent labor savings in loading (by pumps, brails or "splitting" from trawl nets), stowing, unloading and the virtual elimination of pughing.

The importance of rapid and complete chilling and the detrimental effects of delays prior to chilling cannot be overemphasized. The effects of storage conditions and handling prior to processing are invariably reflected in both the yield and quality of the product after processing, whether by canning or freezing.

Our studies of the operations of RSW systems have shown that all too frequently the systems do not perform properly and that insufficient refrigeration capacity and/or poor design of the tank circulation system are the most common faults.

RSW Equipment

In B.C. we use freon refrigerant exclusively. Almost all installations are equipped with Carrier compressors which are most commonly direct-driven through a clutched power take-off from a diesel auxiliary engine. We employ external heat exchangers fabricated of copper and brass. Each individual "chiller" is rated at about 5 tons of refrigeration with an 80-gpm flow requirement. We install an appropriate number on each job--matching their combined refrigeration capacity to the compressor and the RSW circulation requirements. The larger Carrier compressors are equipped with a built-in capacity control system which allows unloaded operation to as low as 25% or rated capacity. This is a useful feature which I will enlarge upon later.

Tanks

The size and number of tanks are important factors which affect design and operation of the other system components. Insulation is now universal in new installations, and linings are extremely important. Fiberglass is currently the most popular meterial although some failures have been reported. Our shipyards now are able to install reliable, leak-proof linings, but great care must be exercised for failures can prove very costly.

Circulation Systems

Here I will refer only to the tank circulation system. Any determination of cooling capacity presupposes that good circulation of the refrigerated brine is maintained over every fish in the tanks at all stages of loading. From extensive study in recent years, we found that most of the older systems with a top-to-bottom tank circulation configuration were equipped with inadequate suction screening. As a result, excessive by-passing of the brine often occurred and the bulk of the fish were poorly chilled. With salmon, this situation does not often occur when the tanks are loaded slowly and to a maximum density of 45 pounds per cubic foot. But during rapid or heavy loading conditions, particularly for small pink salmon, the bottom screens are quickly blocked and poor circulation results. This situation has been aggravated by the recent trend toward loading tenders by fish pumps on the grounds and is best remedied by converting the tanks to an "upwelling" circulation system which provides much better and more uniform cooling of the fish.

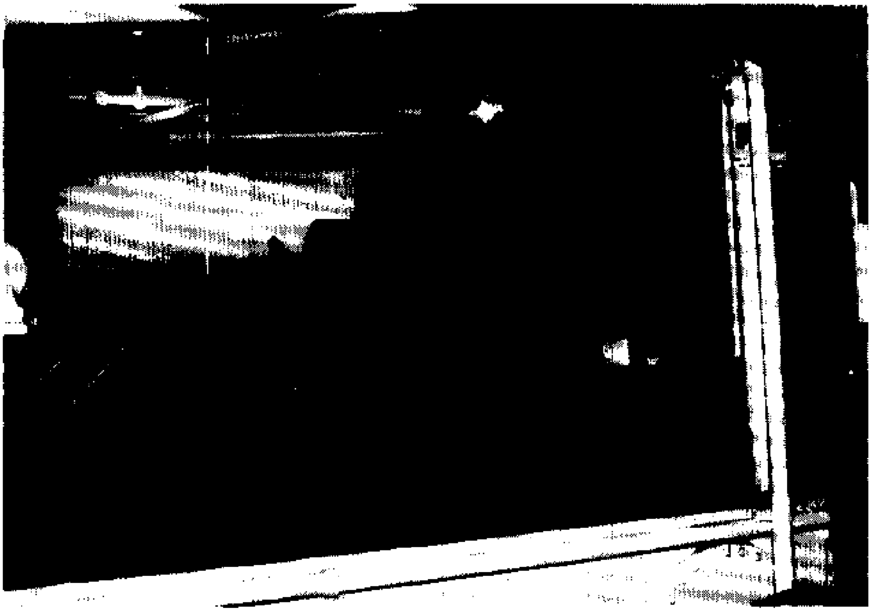

Figure 1. Freon 22, 1899 rpm, 30-ton compressor, V-belt driven from an auxiliary diesel.

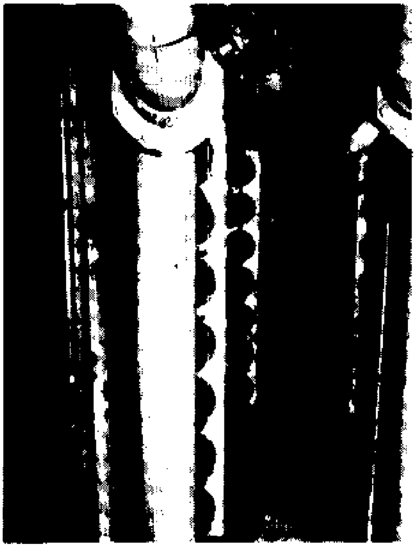

Figure 2. Two identical banks of seven chillers racked horizontally, one above the other, in shaft tunnel of a large combination fishing vessel.

Figure 3. Vertical electric driven centrifugal circulating pumps for dual RSW system.

Design of the suction screening is very important and we have devoted a great deal of effort to resolving tank circulation problems which require careful attention to the selection of screen area, screen location and construction materials, and to the structural design to ensure that the screens can withstand heavy loading. We recommend approximately 50 to 60 feet of open screening for 500 gpm flow.

Split Chiller System

A single compressor with two equal banks of chillers and two pumps provides increased versatility with little increase in the installation costs so that two (or even four) tanks can be chilled simultaneously--even if they are at different temperatures. This provides very real advantages during periods of rapid loading, i.e., continuous cooling of more than one tank per refrigeration compressor.

Thermometers

Rapid and complete chilling to the deepest point in each fish is essential for best results, which means that brine temperatures should be monitored regularly at different points in each tank. We have learned that readings in the external brine lines are often meaningless and also dangerous in that they can give the ship's engineer a false impression of the temperatures within the fish matrix in the tanks.

The time required to completely chill a fish is fixed relative to its initial temperature and the efficiency of the RSW system. Operators must understand this and learn to recognize the importance of relating the refrigerant suction temperature to the other factors: loading rate, initial fish temperature, and the initial RSW temperature. They also should learn to estimate the refrigeration load and the time required to chill a tank of fish thoroughly, and this means at least 5 hours.

Salmon

The upwelling system and the split-chiller system have been very useful developments. Our report "Standards for an RSW System" summarizes the procedures that we recommend for salmon operations.

In a summer fishery, salmon must be rapidly chilled on the tender because of delays on the catchers. Some fish have very little storage life remaining when received on the tender and can, under suitably adverse conditions, spoil other fish in the same tank.

Rating systems (to match potential loading rates) are extremely important. Training for operators is also needed, together with workshops for industry.

Groundfish

We have acquired considerable experience and expertise in the application of RSW to the storage of groundfish. For convenience, I will refer frequently to the operations of the FV Eastward Ho, which we have been able to monitor closely since the owner has been very cooperative. We have encountered some serious and unexpected problems in applying RSW to the storage of groundfish but fortunately have been able to derive solutions to most of them. Following are the more important findings.

Figure 4. View of a vertical RSW tank bulkhead showing discharge manifold and deckhead section screening with vertical screening covered for trawl operation.

(a) The introduction of electronic, remote-reading, multi-station thermometers, for monitoring temperature in the fish tanks. Thermometers of this type are essential for RSW trawlers which often hold fish for 8 days or even longer. Maintenance of constant low temperature is vital to avoid accelerated growth of bacteria and premature spoilage.

(b) The application of an electronic thermometer system on the Eastward Ho immediately demonstrated that the procedures used by the ship's engineer in operating the RSW equipment can have an important effect on the quality of landings. A record of tank temperatures during a typical trip indicated that the refrigeration system had previously not run long enough to chill all of the catch rapidly at 31°F and that the RSW system was often completely shut down for long periods. During these intervals the temperatures rose appreciably in the tanks and even more seriously in the external piping. Prior to the installation of the thermometer system, operating procedures for the RSW equipment had become routine and were not nearly as effective as they must be.

The situation was corrected by changing operating procedures to include fully unloading the compressors (reducing refrigeration capacity to 25%) and running the circulation pumps continuously. In normal trawl operations, loading is slow and steady. Adoption of this procedure has effectively eliminated temperature rise in the external piping during refrigeration "off cycles." As a result, an impressive improvement in landed quality has been observed.

(c) The upwelling system is highly effective for trawl fish which sink to the floor of the tank soon after loading; but some species, including rockfish, float. This can result in "by-passing" of the brine around the fish within the tanks unless certain precautions are taken. One effective way of dealing with the problem has been to install two suction intakes in each tank: an upper one behind the overhead suction screens, which is used during fish chilling operations; and a lower one for pre-chilling a partially filled tank and for pumping out the tank.

(d) Strainers have been eliminated on most new installations.

(e) For multi-purpose vessels with four or more tanks and two refrigeration systems, or for two-pump, "split" systems, detailed plans of the piping system with all valves coded and clearly marked should be available. Our systems are often piped to permit a variety of operations which can include backflushing chillers, filling and emptying tanks, closed circuit cleaning and disinfecting, and series or parallel flow, and may include 30 or more valves.

We have designed many piping layouts for vessels to provide the desired versatility and also have prepared plans showing the valve locations and the settings for various pumping operations. I believe that every RSW trawler should keep such tables readily available to advise the engineer and to simplify training a successor in the event of a change in engineers for the vessel.

(f) RSW has proven very useful and effective for preserving Alaska pollock which can be caught in large quantities using the mid-water trawl. The Eastward Ho has made numerous large landings of this fish in excellent condition. Care must be taken not to overfill the tanks and thereby impair circulation.

Finally, some further observations on groundfish: (1) Full tanks early in a trip are a problem; more, smaller tanks are a solution; and (2) Piping and valving to permit dumping of surplus tank water from a position on deck are very desirable.

There are also a few problems relating to trawl-fish species:

- salt and water absorption--particularly in gutted fish and non-oily species
- mixed fish--abrasion
- pollock and herring caught with a mid-water trawl (overloading and time required for pre-cooling)
- rockfish--floating up into gratings in hatch coamings
- sole--salt and water uptake are possible, unless care is taken
- blackcod--must be eviscerated
- Japanese market--difficulties in meeting the rigorous quality standards

Sanitation--Backflush and Cleaning Lines

Every RSW piping system should be equipped with suitable circuits so that the chillers and strainers can be backflushed overboard. We also strongly recommend that the piping include a cleaning loop between the delivery and suction manifolds along with filling connections so that concentrated solutions of cleaner and disinfectant can be circulated in the piping system independently of the tanks.

Herring

In Europe, RSW is used extensively for preserving food herring at sea, and we also have demonstrated its workability here for both food herring and roe operations. On the Eastward Ho, no trouble has been encountered in chilling both food and roe herring, and this has been done with fully loaded tanks. Despite this evidence, I continue to encounter resistance from vessel owners regarding the use of RSW in our fisheries for herring.

We have studied the situation carefully and proven that the main problem area is in the RSW circulation system, and specifically with the strainers and the chiller backflushing capability. Overloading must also be avoided since space must be provided for water to circulate, and therefore the normal fish-to-RSW ratio must be maintained. Strainers are incorporated into many RSW systems to remove debris ahead of the chillers. These can be back-flushed and work well enough in salmon operations. However, herring scales tend to cling or, in some cases, become wedged into the screens and cannot be back-flushed. When this situation occurs, a mass of scales and other particles builds up on the strainer screen which eventually collapses, allowing the mass of accumulated debris to enter the chillers. The capability for backflushing the chillers is therefore mandatory for herring operations,and on most recent RSW installations backflushing can easily be carried out when necessary.

Chilled Sea Water

We have developed a version of the CSW method which consists of chilling fish in totes using ice and seawater with agitation by low-pressure, compressed air. This is a simple and practical method for rapidly chilling fish in containers, following which the totes may be drained and shipped in insulated vans or reefers with little or no further icing.

An installation of our version of the CSW method was made on a small salmon collector in the summer of 1976. This installation was designed as a substitute for a conventional RSW system. The vessel had a single insulated and fiberglass-lined hold but lacked sufficient engine-room space for installation of a mechanical refrigeration system.

The installation proved very successful,and as a result a few more similar installations were made last year. These included collectors, large tenders and several seine boats, and several more will soon be in service. We have had many inquiries from vessel owners for technical information,and most of these have been from owners already convinced of the worth of the system. Incidentally, it has been christened the "bubble-up" or "champagne" system.

Initially, I was somewhat reluctant to endorse the CSW system for wide-scale application because of certain problems previously encountered with the so-called "slush-ice" systems which have been used in B.C. for many years. Most of the older versions on "slush" vessels or barges do not have insulated holds, and this has been a basic problem. I will enlarge on this.

The "slush" barges (often YMS hulls) are dispatched with large cargos of ice to deal with "peaks" of the salmon runs in the years of large runs. Because of uncertainty in predicting the exact timing of the peak runs, the barges sometimes may wait for several days or even a week before loading. During this time, the ice sets up into a solid mass. When seawater is pumped in, the result is the formation of "icebergs" which reduce capacity, impair ice-melting efficiency and create loading and unloading problems.

The newer (and smaller) vessels (seiners and small packers) now beginning to adopt CSW are all tanked and well insulated. This means that the flake-ice charge can be carried in a small quantity of seawater from the beginning of a trip. This eliminates the "iceberg" problem and is perhaps the most important factor in the recent success of the system.

Other "Plus Factors"

1. Relative to RSW storage.

Both RSW and CSW can provide immediate rapid chilling, but RSW systems must have sufficient capacity to match the fish-loading rate and/or must prechill large quantities of water. We all know that our RSW systems are seldom operated ideally and that the vital aim of rapid chilling of the catch is not usually achieved. CSW provides virtually unlimited stored refrigeration (in the form of ice), which can be utilized immediately. This very desirable situation is seldom possible using RSW. Fish-to-water ratios also appear less critical, but we are approaching this with caution.

2. CSW and "icing" can also be compared

"Well-iced" fish is an expression commonly used by technologists, but such careful icing is seldom seen today, except on salmon trawlers and long-liners which have low catch rates. Seine-caught fish and fish from collectors are loaded at a very high rate so icing is uneven and often completely ineffective, e.g., on most "food" herring seiners.

CSW chilling rates exceed even those of ideal icing. Surplus ice can be on top, not spread throughout the load. If necessary, the hold can be drained to avoid the "soaking" effects sometimes associated with RSW stowage, i.e., swelling, salt uptake and leaching.

3. Economic factors

If replacing RSW, CSW eliminates mechanical units, most piping and valves, and hold-screening which represents savings of about $30,000 for a modern seiner, since the air-blowers are relatively inexpensive. Providing ice is available for purchase, the costs for several trips are offset just by current interest charges on capital invested in the RSW equipment. I don't believe that CSW will replace RSW for the proven applications, e.g., large salmon packers and trawlers, but for barges, seiners and collectors it certainly can and it should usefully compliment RSW in some applications.

4. Salinity

Finally, there is the question of reduced salinity (of the CSW) solution caused by dilution from ice melting. Work at our lab and elsewhere indicates that bacterial growth rates are lower in 1/2-strength seawater and salt penetration also is reduced markedly. This also eliminates the need for carrying salt to offset seawater dilution on "slush-ice" barges.

In conclusion, I foresee the installation of many new CSW systems here in the near future. The greatest need is probably in the herring fisheries--certainly for food herring operations, if we continue to employ a large fleet of fishing vessels of various sizes, and also probably in the roe herring fishery. I believe that the system can also be very useful for salmon collectors and for the very large barges employed in the roe herring and salmon fisheries.

Unloading Systems

I will conclude with a brief discussion of fish-unloading systems. We use a great variety of types including brails, bucket elevators, air unloaders (e.g., Temco), centrifugal pumps with food impellers (Hidrostal, Marco--capsule pumps), siphon pumps and air-lift pumps (which are unique and not commonly used elsewhere except perhaps in Russia), and the peripheral, discrete jet pump (Hillis), a small, 6-inch herring transfer pump.

In our fisheries, the unloading of salmon, herring and trawl fish from the holds of fishing vessels is now being done by fish pumps to an increasing extent. Much of the fish landed at processing plants has been pumped at least once, and often twice, and portable systems which transfer fish rapidly on the grounds have become a standard feature of our industry. This development has contributed to increased efficiency and improved quality of deliveries by eliminating delays before processing. As the demand for high-quality fish for fresh and frozen markets increases, it is apparent that even greater attention must be given to transferring fish from fishing vessels to processing plants rapidly and without abuse in handling.

Research into the automation of unloading procedures for medium-and large-sized fish began at the Vancouver Laboratory in 1961, at which time the wide-scale adoption of RSW by salmon canners stimulated research into automated unloading from RSW fish carriers at the canneries. In the course of our investigations, several novel types of pumps were developed, all employing water to move fish through pipes. The siphon and air-lift pumps employ water to move fish through pipes or hoses. The designs for these pumps were based on our laboratory studies in which models were used. The most significant findings were:

(1) that 10 inches appears to be the optimum pipe size for passing salmon of most species; and

(2) a linear velocity of 4 feet per second is required to lift salmon in a stream of water.

As a consequence of our studies, considerable industrial development work was carried out and, at the present time, pumps are being used at all major B.C. canneries for unloading salmon. These pumps are capable of transferring bulk fish from either RSW or ice. After a year or two, it seemed that this industry's requirement for pumps had been satisfied, but the situation has changed lately, largely due to increased market requirements for high-quality and high-priced fishery products. Improved efficiency in handling fish is therefore necessary to increase the supply of high-quality fish for freezing and to prevent damage to the extremely valuable by-products such as the roes of both salmon and herring. Although the pumping systems now used here may seem cumbersome, they are neither complicated in concept nor costly to construct. It is simpler to build a limited number of facilities, capable of unloading fish from vessels of most common sizes, carrying bulk fish either dry, in ice, or in RSW than to provide an individual pump for each vessel.

We have carefully studied and developed industrial-scale designs for air lifts and siphons for use independently or in combination, when utilized as fish-unloading devices. Here in B.C, these pumps are always installed on barges to eliminate the problem of tidal variations.

Siphon Pumps

These are literally siphons which transfer a mixture of fish and water from the hold of a vessel into a vertical, cylindrical chamber or "caisson" in which the inlet is situated below the ship's keel. The fish are removed from the chamber by a high-capacity bucket elevator. Auxiliary equipment includes a liquid-ring vacuum pump for priming, hydraulic power for maneuvering the flexible suction hose, a centrifugal pump with discharge manifold for directing and controlling the recirculation water at rates of up to 1500 gallons per minute and automatic float valves in the vacuum line to prevent loss of prime during pumping. The pumps are mounted on small barges which can be moved, and these are also towed to the fishing grounds when required. The volume of flow, and consequently the fish-unloading rate, is regulated by maintaining a constant differential between the water levels in the hold and in the chamber containing the elevator.

B.C. Packers now has five siphon pumps, Canadian Fishing Co. has three and there are two or three others in use.

Air Lift Pumps

An air-lift pump is a device for raising liquids or a mixture of liquids and solids (mostly water) through a vertical pipe, partially submerged in the liquid, by means of compressed air introduced into the pipe near the lower end. The density of the column of air and liquid in the pipe is thus reduced below that of the liquid outside the pipe and flow results.

The unique feature of this system in its development for use in elevating fish was the creation of a "false" submergence by connecting a second vertical tube to the first with a return bend. By introducing air into the discharge leg of this U-tube at a suitable depth, a mixture of water and fish can be pumped from near the surface to a higher level. Further, by adding a siphon to the intake leg of the U-tube, fish can be pumped from the hold of one vessel onto a wharf, providing the water is deep enough to obtain the necessary submergence. This depth of water can also be obtained by sinking a caisson beside a wharf.

The "air-lift" fish pump is essentially a low-lift pump since the minimum effective lift-to-submergence ratio is about one to three. Commercial installations usually require a submergence of 24 feet. The auxiliary equipment is similar to that required by the siphon pump, plus a high-volume, low-pressure air blower. In the latest installations, the U-tube is fastened to the barge by a swivel mount to simplify raising the leg for traveling.

Some Necessary Features of a Fish Pump

1. High capacity (needed for salmon canneries and for unloading roe herring)

2. Ease of starting (and stopping)

Brief periods of unloading at high rates are useful in most operations to produce a desired average rate. A skilled operator can also slow the flow of fish by adjusting the suction hose. However, some stopping and starting is always necessary, and it often is necessary to re-prime the siphon (for the water pumps). Several different systems are used for priming these siphons. We ran a series of trials last year and have developed a simple and effective manual system which is suitable for salmon and food herring operations,and we believe it will work equally well for roe herring.

3. Ability to unload from a variety of vessel types

The pump must lift fish from the hold of the vessel onto the plant wharf, regardless of tidal conditions. The large new vessels have very deep holds and lie very low in the water when all tanks are full. Removing the last fish from the first tank can be difficult since it requires a very high lift.

4. Self-feeding

Ideally, none of the unloading crew should have to go into the hold until the final stages of unloading, or, in other words, only for "clean-up." However, some holds are difficult to unload, e.g., very large ones or long, narrow ones of those with pen boards. The water pumps pick up or self-feed very well as the fish are swept to the suction intake in the strong flow of recirculating water (1000 gpm).

5. Small unloading crew

The basic reason for the introduction of automated unloading equipment has been to reduce labor costs. The crew for a well-designed pumping system consists of a trained pump operator and one or two helpers, and this number is about the minimum we can hope for.

6. Simple to operate

Priming of the water pumps does create problems, and this feature must be carefully watched when these pumps are used for unloading herring. Plugging by large fish can also be a problem, for 10-inch pipes don't leave much clearance for large fish to pass. Systems should have as few 90-degree elbows as possible, and these should not be less than 30 inches in radius. Some method for flushing back is desirable.

7. Versatile

The water pumps are now being used for unloading salmon, groundfish and herring, although in some processing plants more than one type of pump is used for the different operations.

8. Cleanable

Pumping equipment must meet Canadian Fisheries Inspection Branch standards as does all other plant equipment.

9. Low requirement for clean water (in applications requiring recirculation)

Large volumes of water are needed to prime most water pumps (3,000 to 5,000 gallons), although RSW packers usually carry ample water and not much more is needed. Siphon pumps require a large volume of prime water. We are currently working on a method for reducing this requirement. At some locations where the surrounding water is polluted and freshwater mains are inadequate for supplying large volumes in a short time, this can be difficult to resolve.

10. The pump must not damage fish

I have deliberately made this the last item on my list, for this requirement has recently been the subject of some controversy. The assessment of damage depends on the fishery. For example, no visible damage is acceptable for high-value fish such as salmon intended for fresh or frozen markets. Visible damage can readily be assessed, e.g., cuts, scaling, doubling-over. However, internal damage to flesh, organs and bones is more difficult to measure, although equally undesirable for some products, e.g., fish fillets and herring roes.

Q. *To what temperature are you lowering your fish when at sea?*

A. To avoid freezing either the flesh or the roe, we recommend 31°F.

Q. *Do you recommend a constant exchange of water?*

A. I recommend the constant recirculation of the RSW in each tank containing fish, if possible.

Q. *You mentioned that in preserving fish the eggs should not freeze. Do I take it then that the eggs are not good after they are frozen?*

A. Yes, salmon eggs are devalued considerably if they are frozen or partly frozen. This must be avoided if the roe is mature and of high value.

Q. *At what temperature do salmon eggs freeze?*

A. Between 29-30°F.

Q. *With herring roe, is there a problem bringing it down close to 28°F?*

A. Very slow or partial freezing can produce "spongy" roe, which is a very undesirable condition. An advantage of chilled seawater in which ice is used is that the CSW or brine is diluted by the melting ice. This lowers the salinity of the CSW so that its freezing point is at or above 30°F, which is a safe temperature for storage.

Q. *What temperature do you recommend for holding herring?*

A. The same as for salmon, about 31°F.

Q. *Do you see any application for the spray brine work of some years ago?*

A. I consider that brine-spray chilling offers no real advantages relative to conventional RSW storage and that brine-spray systems have serious drawbacks, particularly in fisheries with periodic high catch rates.

Freezing Seafood at Sea—
The British Columbia Experience

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The previous paper has covered the chilling of fish on British Columbian vessels, primarily on the tenders carrying the fish from the fishing grounds into the canneries. I would now like to look at the B.C. experience in freezing fish at sea. In our fisheries, this has been primarily on the trollers, freezing mainly salmon and some incidental halibut and ling cod. Some of these larger trollers have also frozen albacore tuna, and a few other vessels have been equipped to freeze prawns and black cod.

These boats are primarily in the 42- to 50-foot class (75%), with only about 15% being larger than 50 feet. We have found that 42 feet is about the minimum size of vessel on which freezing equipment can be practically installed; that is, there must be enough space available to install sufficient equipment to effectively freeze the catch and still leave enough room to stow the fish after it is frozen. For these reasons we have discouraged the installation of equipment on the smaller vessels, but we find now that, because of the changing economic situation with the boats catching fewer fish but getting higher prices for them, several owners of vessels 42 feet or smaller are beginning to look at the suitability of putting on freezers.

In the B.C. fishery, the first freezers were installed on trollers in the late 1950's. Development was slow until about 5 years ago when about 40 were operating, but since then the number has doubled about every 2 to 3 years to the extent that we now have about 150 freezer boats operating in B.C. We are also finding that second- and third-generation freezing systems are being installed. Some owners who put in systems several years ago have had problems of one sort or another and are now moving on to bigger and better or to different types of equipment.

The reasons why they are installing freezer systems is not always obvious. The high cost of installing this machinery ($10,000 to $20,000 for a good freezing system) is offset by little, if any, extra on the price they are paid for the frozen fish. The buyers are wary of all sea-frozen fish, because a few boats are not handling their fish well enough and are landing a poor-quality product. As a result, no increase in price is offered for what, in most cases, is top-quality fish. The advantage that it does give to the fisherman is in allowing him to stay on the fishing grounds through slow fishing and poor weather until he has a load, rather than having to return to town every 10 to 14 days as with iced fish. In addition, because the price of salmon tends to increase as the season progresses, they are able to hold their fish over for a better return.

There are three basic types of freezers being used on these vessels. The first and most common is a forced-air or "blast" system using a standard blower coil as shown in Figure 1. Many of the early installations were transport truck units installed without modification on the fishing vessels. These finned-tube coils are usually mounted in the fishhold on the engine room bulkhead, and aluminum or stainless-steel shelves are placed in front of the coil to hold the fish. These systems can produce a nice-looking, reasonably fast-frozen fish if they are carefully placed on the shelves in the blast of cold air directly in front of the blower; however, because of the limited frontal area of many of these coils, there is space for only 400 or 500 pounds of fish in this ideal freezing zone. Because the fish must be left on the shelves for several hours to be completely frozen and since the fish will often be caught at a faster rate than the freezer can handle them, procedures are often used that could result in poorly frozen fish. Either: (1) the fish on the shelves in front of the blower are taken off much too soon in order to make room for the next batch; or (2) the extra fish are placed on the floor or on shelves away from the area of good air flow where they would freeze ununiformly and at a slower rate. In both cases, incomplete or very slow freezing could result, particularly if the fish are then immediately stored away in the side pens.

The other problem inherent with air-blast systems is dehydration. When the fish are being frozen, moisture is picked up by the air blowing over them. In addition, because the same air is circulating through the hold to maintain the storage conditions, the fluctuations in temperature that occur every time a new load of warm fish is put down also produce a condition that results in drying of the stored fish. With a well-designed system and a few precautions, the dehydration can be reduced to less than 0.5%, but in some cases it can be 2% or more.

Since the blower coil and freezer shelves occupy a lot of space in the fishhold, some boats have installed their blast freezers in separate, insulated boxes or in the hatch coamings at deck level, as shown in Figure 2. These systems again have limited shelf space for the freezing of the fish, but because they usually use a separate refrigeration system in the fishhold employing deckhead coils or plates, a much better constant temperature, still-air storage situation results.

The second type of freezing system employs plate shelves as shown in Figure 3. Racks are made up using the familiar Dole refrigeration plates as shelves on a minimum spacing of 7 inches to allow use with albacore tuna. Unlike the horizontal plate freezer used in other parts of the world, these are fixed shelves so that the fish are simply laid on trays and freeze from one side only. This produces a nice-looking, undistorted frozen fish, but because the freezing rate is quite slow it is

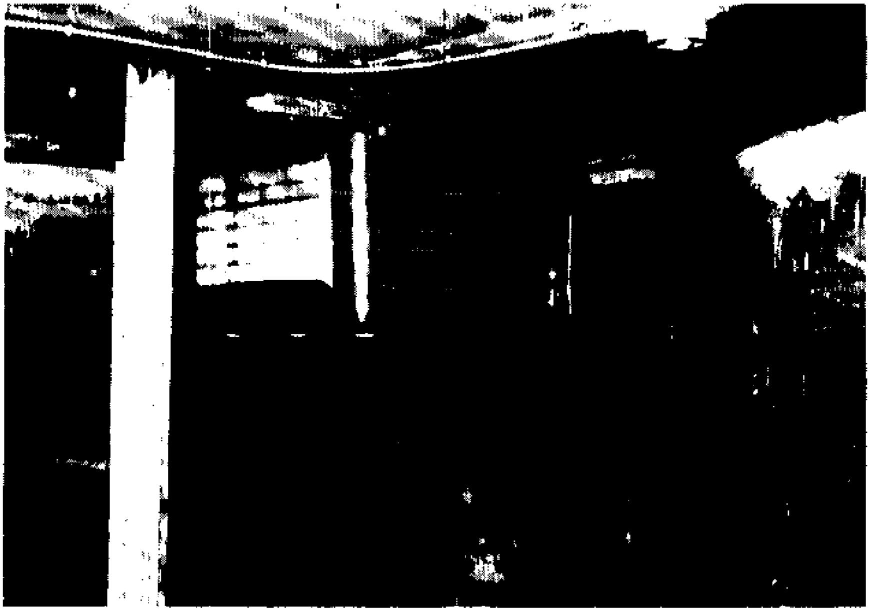

Figure 1. A forced air or "blast" freezer system with standard blower coil.

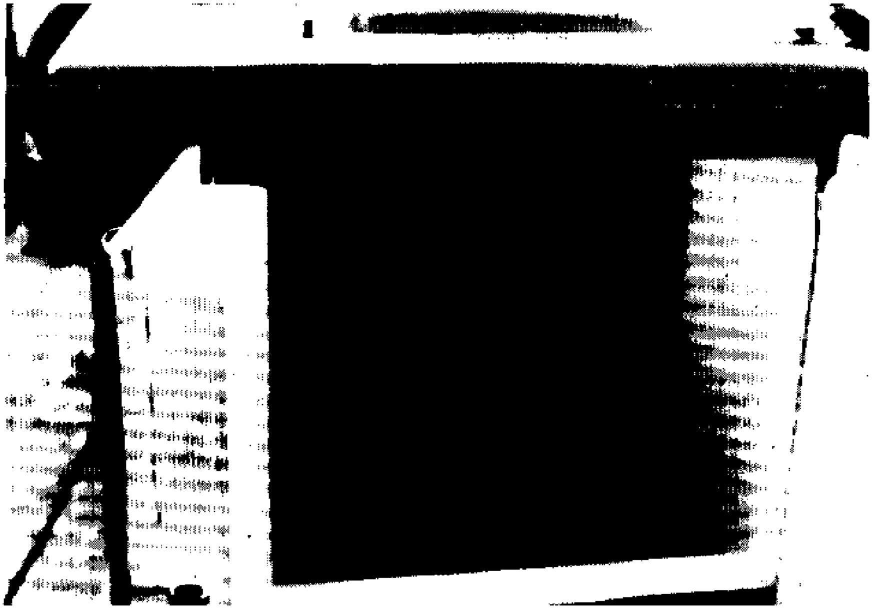

Figure 2. An insulated blast freezer at deck level.

often difficult to provide enough shelf space to handle the catch and yet leave the fish on the shelves until they are completely frozen. We have found that these plate freezers can be improved by installing a fan and arranging it to blow air over the fish on the shelves. This not only gives a better heat-transfer coefficient over the fish but more effectively makes use of the bottom surfaces of the Dole plates. When the fan is installed, we recommend that a curtain be used to confine the moving air to the freezer section and not through the rest of the hold which is refrigerated by a separate deckhead, Dole-plate system.

Because the plate shelves also take up space in the hold and because it is difficult to load and unload the shelves toward the end of the trip when the pens in front of the freezer may be filled with fish, a number of our boats have mounted their plate-stand in an insulated box on deck. One example of this is the portable, plate-freezing box shown in Figure 4.

Figure 5 shows an example of the brine freezing tanks that have been installed on a few of our boats. Brine freezing is commonly used for tuna and is effective for black cod for some markets, but experience has shown that it should not be used for salmon because of the salt absorbed by the fish. Besides affecting the taste, the salt makes the application of a good glaze difficult and promotes the development of rancidity in the fish in frozen storage. The technique is very attractive from the heat-transfer, power-efficiency and cost points of view, but the salt is a problem that must be overcome. Sealing the fish in evacuated plastic bags is a possible answer to this, but when we tried this experimentally we found that the loose flaps of the plastic bags prevented the good circulation of brine over the fish and the freezing rates were very much slower, losing the major advantage of brine freezing. In addition, the buyers did not like the fish in the bags as they made inspecting the product difficult.

The tanks that have been used on the earlier installations were mainly deck-mounted, insulated boxes with an inner lining wrapped with coils of refrigerant tubing. Agitation of the brine depends entirely on the motion of the vessel. Figure 6 shows a much better designed tank installed recently for freezing black cod. In this case the brine is pumped from the bottom of the tank through external chillers for good heat transfer and then circulated through a distributor around the top of the tank. The refrigeration compressor and circulating pump are mounted in the end of the box at the left.

Vessels with these brine freezers have used separate holding systems for some time, but in the last few years there has been a trend with any type of freezer toward using one system for freezing the fish and a separate system for the storage area. This is a development which we have encouraged. This produces a still-air, constant-temperature holding area which then minimizes dehydration and enhances the potential quality of the fish. Figure 7 shows an installation of Dole plates covering most of the deckhead of the fishhold, while in Figure 8 an installation of coils covering the same area is shown. These are the two most common types of holding systems used.

The equipment installed in our vessels has had freezing capacities ranging from about 1,000 to 5,000 pounds of fish, with the largest percentage of them being around 2,000 pounds per day. These figures, however, are

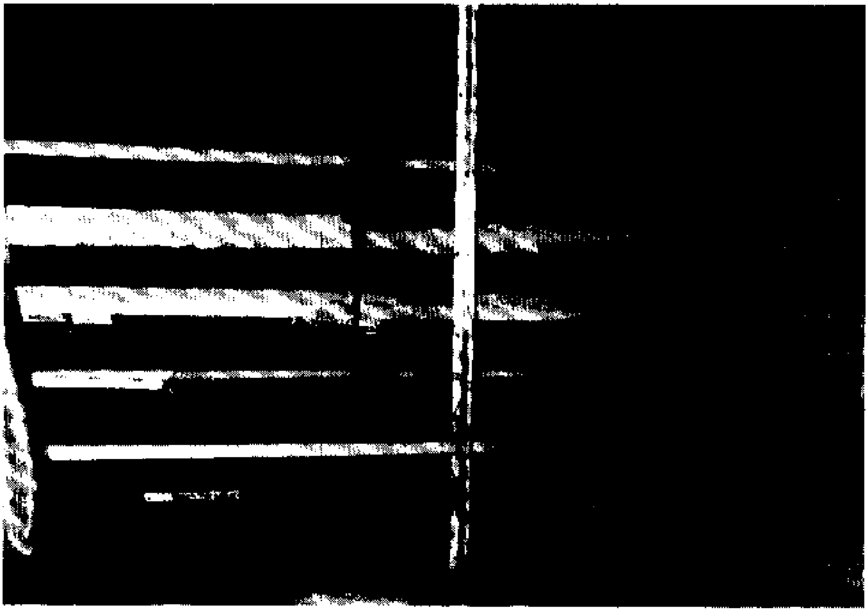

Figure 3. A freezing system that employs plate shelves.

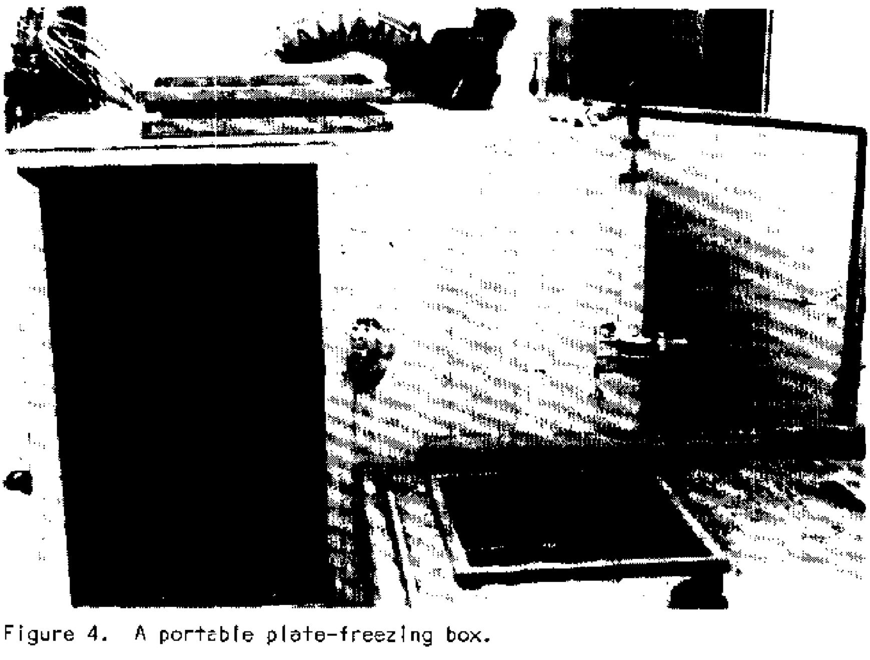

Figure 4. A portable plate-freezing box.

Figure 5. Brine freezing tanks used aboard Canadian fishing vessels.

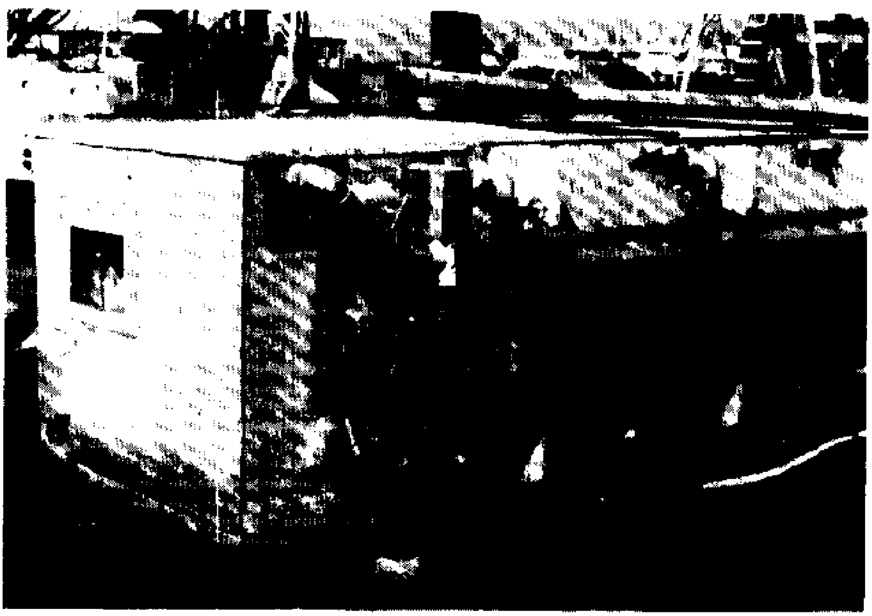

Figure 6. Tank for freezing black cod.

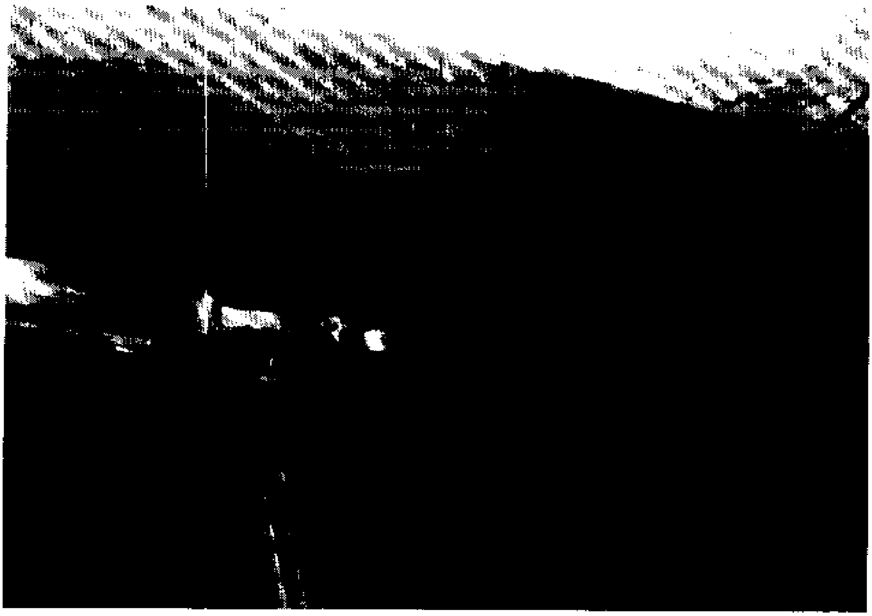

Figure 7. Dole plates covering deckheads of a fish hold.

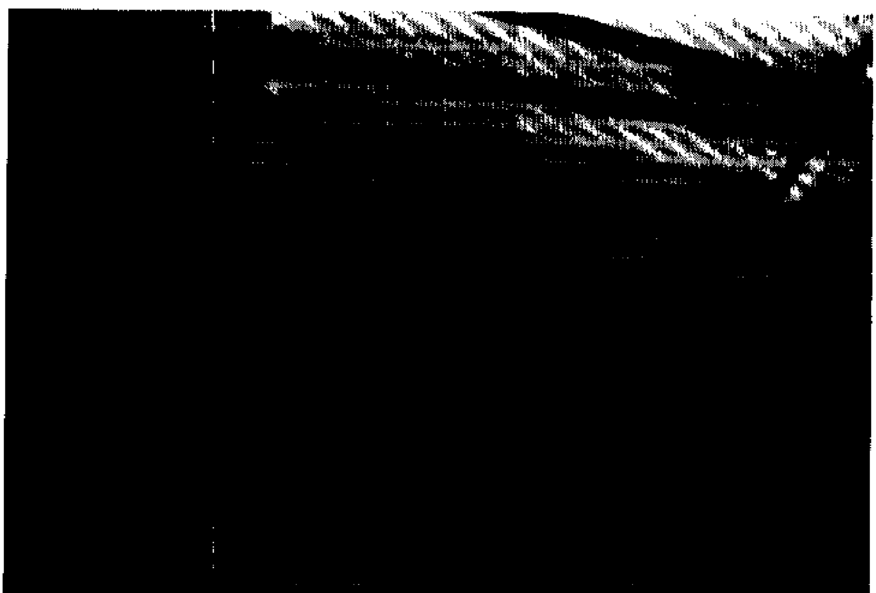

Figure 8. Coils covering deckhead of a fish hold.

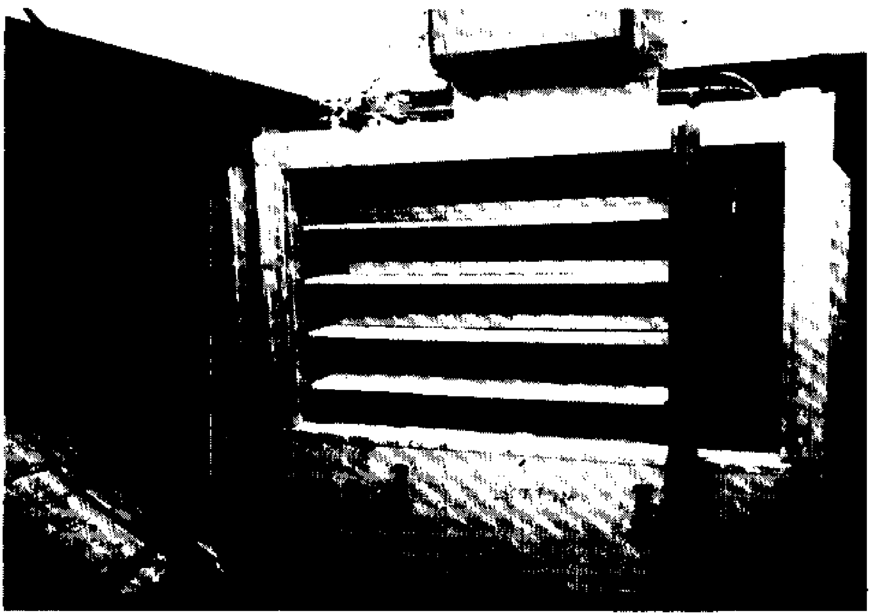

Figure 9. A freezer combining a Dole plate freezing stand with an air blast coil mounted in an insulated box.

based on a 24-hour day which really is not realistic. Time is required for engine servicing and defrost cycles. Moreover, the day's catch often comes aboard over a shorter time period, and freezer space must be available for it in reasonable time. Very often, at peak times, the systems are overloaded and the fish can be slowly or incompletely frozen, and fluctuating storage temperatures can result. Because of this it is recommended that the systems be designed to handle and freeze the required catch rate, based on a 16-hour operating day. This then provides some overload capability in case unexpectedly large catches are made.

If I am giving the impression that all of these systems are not very good, it is because I am pointing out the few weak points in each of them to help avoid problems in the future. In actual fact, most of the boats have adequate equipment and, with a little care in operation, are producing a good quality product.

As a means of overcoming some of the problems and particularly to produce faster freezing rates, we have developed what we call our combination freezer (Figure 9). This combines a Dole-plate freezing stand with an air-blast coil, all mounted in an insulated box. (The finned coil and fan are in the left end of the box.) If this were installed in a freezer hold, only a light partition around the freezer would be needed. In this freezer, the fish are now effectively frozen from both sides by contact with the plates and by air blowing over them so that very much faster freezing rates, and as a result faster through-put, are achieved. In the model freezer shown, the six freezer shelves are 5 feet long by 44 inches wide, and the unit has a capability of freezing 2,500 to 3,000 pounds per day, comfortably. Another capability built into this experimental freezer is that the various components can be isolated to allow for operation in any one of four modes:

- Plates only
- Plates plus fan
- Blower coil and fan only
- Full combination plates and coil

Using this freezer and thermocouples in the fish to record temperature, we have developed a series of freezing curves to show what can be expected on a typical freezer installation (Figure 10). In each case, the freezer is operated at optimum conditions (i.e., it is not overloaded and the refrigeration compressors are running at prescribed speeds and pressures) so that this is about the fastest that fish can be frozen in each particular type of freezer. The slowest freezing rate is in still air and would be representative of fish that are spread out on the fish-hold floor because there is not room for them in the prime freezing area. For the size of fish we are concerned with here (3 1/2 inches thick), 24 hours or more would be required to freeze. On plate shelves, freezing from one side only, the freezing is also reasonably slow (approximately 10 hours), but we can greatly improve the situation by adding a fan to move the air over the fish to produce a freezing time of about 6 hours. Air blast is a little faster again (4 1/2 hours), and the combination of blast and plates is the fastest rate obtainable.

Figure 11 is a similar set of curves showing the effect of fish size on

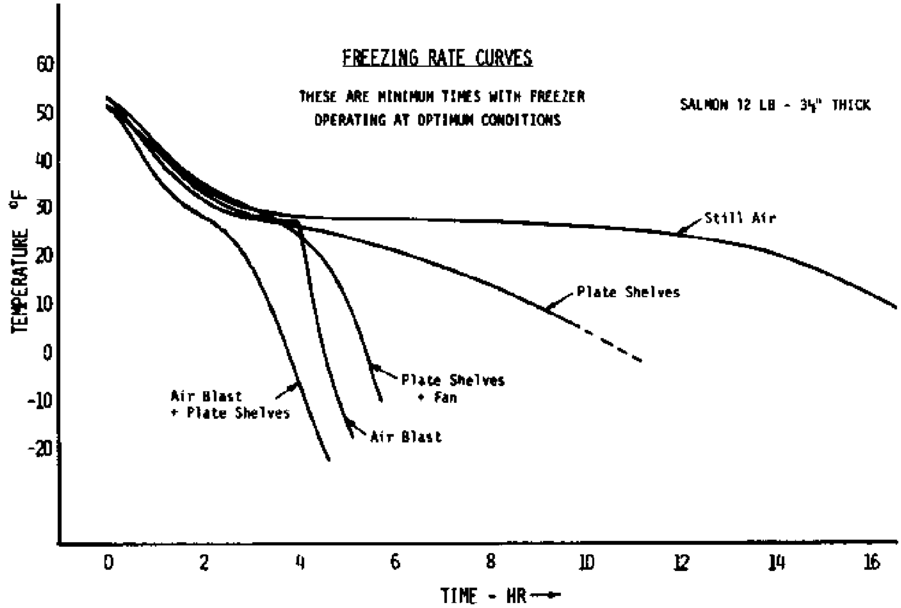

Figure 10. Freezing rate curves.

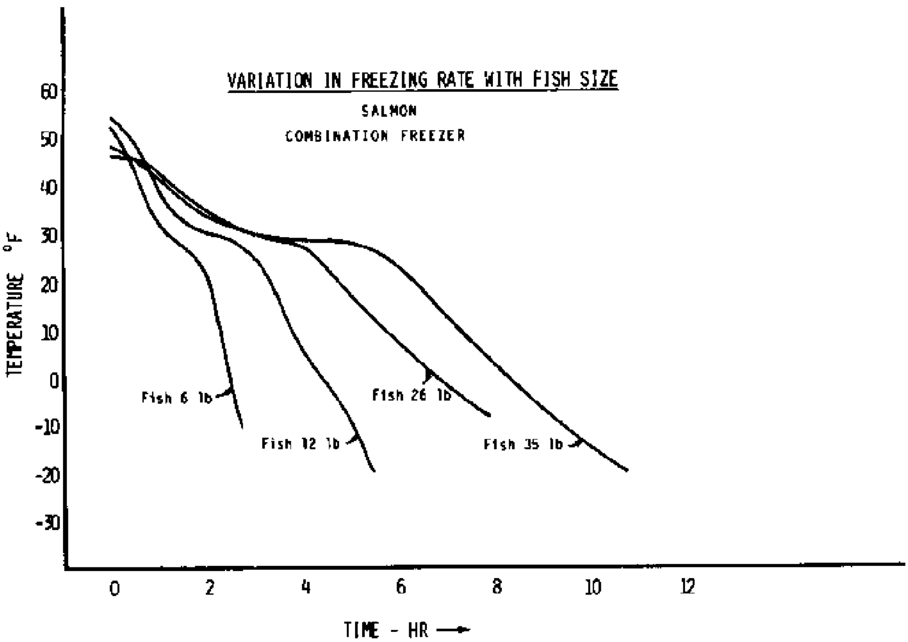

Figure 11. Variation in freezing rate with fish size.

freezing rate. In each case the fish are frozen in the fast combination freezer. The freezing rate is approximately proportional to the square of the fish thickness (i.e., a fish twice as thick takes four times as long to freeze). This points out a potential problem when freezing a load of fish of mixed sizes. If the freezer is unloaded when the smaller fish are frozen through, the large fish could be still mainly unfrozen. Leaving them in for one more cycle of the freezer may still not be nearly enough. If the partially frozen fish is then stored away in the side pens with other fish around it and plastic sheets over the pile, the subsequent freezing rate would be extremely slow and, in the extreme case, the center of the fish could spoil before it is frozen. Similar freezing curves were obtained for halibut with a 100-pounder requiring 12 hours to freeze in the best freezer that could be used.

Figure 12 illustrates the results of work done under the direction of Dr. E. Bilinski at the Vancouver laboratory on the effects of slow freezing of salmon on its quality as measured by thaw drip (Bilinski, 1977). With large amounts of thaw drip, not only is weight lost but the fish is also dry and tough. We have been saying for some time that salmon should be frozen reasonably quickly, but until this work we had little proof that slow freezing was detrimental. The graphs show the results of two series of tests. In the top series, the fish were held in ice for various periods of time and then frozen by one of two different ways and held in frozen storage for up to 12 months. Similarly, the bottom curves are for fish held in refrigerated sea water. In each case the first of the three sets of curves is for control fish gutted and frozen immediately and represents the fish frozen on the trollers. In each case, the top curve of each pair is for slow- and the bottom for fast-frozen fish. The results can be summarized as follows:

1. The least amount of thaw drip (i.e., the best quality) was obtained from fish frozen quickly, immediately after capture and held for the shortest length of time.

2. In every case, the slow-frozen fish produced considerably more drip than the fast-frozen, and the difference between the two became greater with the duration of frozen storage.

3. The amount of drip increased with increasing storage either before freezing (in ice or RSW) or in storage after freezing.

I indicated earlier that the salmon buyers have pointed out a number of problems they have encountered with the sea-frozen fish they have been receiving. As a result of these problems, the buyers are not able to offer a higher price for it. Most of the problems come from handling of the fish on vessels. Fishermen must realize that the fish they are producing could, in many cases, go directly to the consumer without further handling and therefore should be given the same care as they would receive in shore plants. Not only should fish be well bled, properly gutted, headed and washed, but they must also be well frozen (completely and quickly), glazed and securely stored away. I understand there are some legal problems with heading fish at sea in some areas, but in our fishery, except for some special market requirements, the head is removed before freezing. Glazing has been a problem either because of not enough (with some fish having been landed with little or no glaze and obviously dehydrated) or because of excessive glaze. Some fishermen

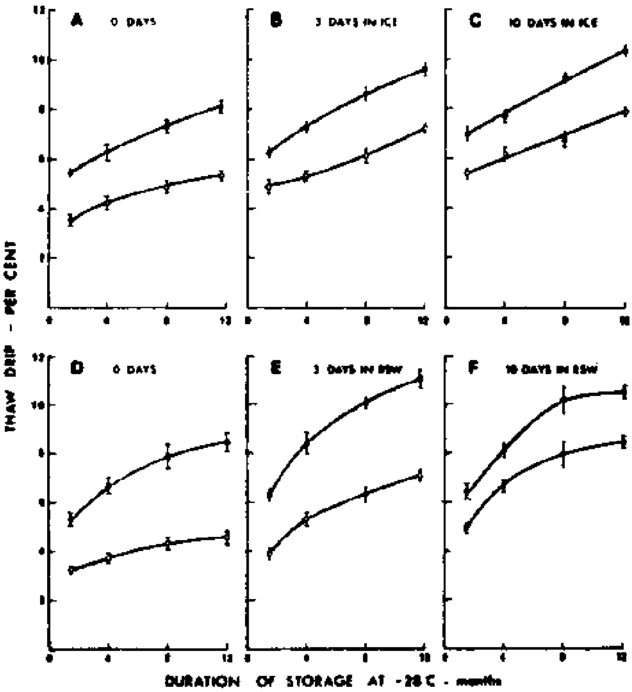

Figure 12. Duration of storage curves.

have discovered that heavy glazing can mean as much as thousands of dollars extra being paid for the boat load--just for frozen water. The buyers are anxious to set some sort of standard for judging the thickness of glaze on the fish they buy. They are also concerned about the storage temperatures on the vessels. Are the temperatures low enough (we recommend a temperature of -15°F or lower for this), and what are the temperature fluctuations?

The solution to these problems will come through education. Fishermen need to learn about the things I have been discussing, and buyers need to set standards for fish that they will accept and refuse to buy those that don't measure up. Buyers are going to have to spot-check things like glaze thickness and measure temperatures of some of the fish as they are landed. In recent meetings we have had with our buyers, they indicated that not only would they like to see a recording thermometer in each freezer hold, but also they would not be unhappy if a few of the fish had small holes in them indicating temperature probes had been used to check the internal temperature of the fish as it was being frozen.

The development of freezers on vessels in the B.C. fishery has been an interesting one. In the beginning, primarily single-blower units, including some used truck equipment, were used; but now the smaller, poorer systems are being weeded out, and the trend is to bigger units and to two or more units for separate freezing and holding. Plate stands are also becoming more popular. For the Washington/Oregon area just getting into freezing salmon at sea, I would advise installing good equipment to begin with and educating buyers and fishermen that the best quality fish can be landed only if freezing equipment and fish are handled correctly.

Q. *You indicated that you found slower freezing times with fish in cryovac. Could you draw on that? Did you run that for shrimp? In Europe, they have machinery to bag the fish.*

A. Not on shrimp. We did herring in bulk and single salmon in evacuated plastic bags. The flap on the bag is what causes the circulation problem. The bagging equipment is expensive and somewhat bulky to put on small fishboats, and extra labor is required to operate it. Some years ago, some of our trollers tried packing their fish in plastic bags (not evacuated) in order to avoid glazing. When they landed at the dock, there was no end of problems with the graders not able to see how well the fish were cleaned, what species they were or whether they were red or white springs. They ended up having to take all the fish out of the plastic bags.

Q. *Can you tell us the weight of the combination where you have air-blast and shelf plates; also what the horsepower is?*

A. The unit that you saw is the freezer box and would weigh about 1,500 pounds. The auxiliary compressor unit that goes with it is driven by a 10-horsepower electric motor in our installation, but could have any other convenient drive and would weigh a few hundred pounds.

Q. *What size cubic capacity does the freezer have?*

A. There are six shelves on 7-inch centers. Each shelf is 5 feet long and 44 inches wide. Therefore the outside dimensions of the insulated box would be about 4 feet by 4 feet by 6 feet.

Q. *What is the optimum temperature for holding fish? You said -15°F.*

A. I say 15°F because this is the requirement that our shoreplants must meet under our Inspection Branch regulations. Therefore we would like to see our vessels do at least as well. We like to tell our fishermen that the optimum holding situation is a steady -20°F temperature.

Q. *You spoke of some of these freezers for halibut. Is there any example in your fisheries where this has been used commercially?*

A. If you are speaking of our combination freezer, the answer is no. A few of our freezer boats (all three types of freezer) have frozen halibut commercially, successfully, but with the new halibut season system of 16-or 18-day openings they are not bothering with the freezing and just using ice. We had intended to install one of our combination freezers on a halibut boat so that they could keep fishing until they got a full load before they took their lay-up, but with the new system there is no further interest in it.

Q. *Are the trollers making any attempt to salvage the roe, and, if so, how?*

A. They are, usually by putting the roe in plastic bags ("barrier bags") and holding on ice or freezing on the boats we have been talking about. They are generally handling more immature roe than the seiners or gillnetters so they are of less quality, and the freezing does not affect them too much.

Q. *I believe I understood you to say that you had experienced a problem in the use of cryovac bags.*

A. The problem is with the circulation of the brine over the fish when they are in the bags. The flaps of the bags that stick out from the fish tend to interlock and prevent the flow of brine through the mass of fish in the tank. Just a few days ago, we experimented with herring and found that an individual fish in the middle of a mass will freeze in about 45 minutes, whereas, if we put 10 kilograms in a plastic bag and spread them out only two fish thick, it takes 5 hours to freeze--an inordinately long time.

Q. *What type of glazing method do you use? A bucket?*

A. They use a bucket or plastic garbage can, usually using 50-50 sea water and fresh water. The buyers like to see the use of more fresh water, but there is a difficulty carrying enough on these small boats. The fish are usually dipped two or three times to make sure they get a good glaze, particularly near the beginning of a trip.

Q. ***What do you think is an adequate reduction for glaze allowance?***

A. The buyers like to see a 4% or 5% glaze to prevent dehydration and to ensure good storage life in the freezer.

Reference

Bilinski, E. et al. 1977. "Treatment before frozen storage affecting thaw drip formation in Pacific salmon." Journal of Fisheries Research Board of Canada. Volume 34, No. 9, pp. 1431-1435.

Selecting a Refrigeration System

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The decision to invest in a mechanical refrigeration system for a fishing vessel should be made carefully. In some cases, it may be wise to stay with ice. Considerations like vessel size, the construction of the vessel--particularly in a conversion--the species that you're going to fish for, the length of your trips, how far you're going to range from port, and what your long-range objectives are in the fisheries need careful thought. There are some who may never recover their investment in the mechanical system if their long-range objectives don't conform with that investment.

It is also important to take a close look at what the market is willing to accept. You heard what Glen Gibbard had to say in regard to some of the frozen fish being delivered. I know that some buyers and their customers have been disenchanted with some of the fish frozen at sea that they have received. Moreover, the economics of the whole situation needs a close look. Along the Pacific Coast, most fishermen have a choice between conventional icing, refrigerated seawater, or freezing at sea. But when we get into other areas, it may be that mechanical refrigeration is not a choice but essential. Where ice is available, the main concerns are ice cost and labor associated with icing. I believe it would be worthwhile to study methods of improving ice application. I know that some research was done on automated icing in Scandinavia. What's the possibility of having a blower unit to apply ice instead of having to shovel it? Such a unit could be somewhat like a miniature ice-delivery system similar to those used at the plants.

In some remote areas, you have no choice because no ice is available. In other situations, there is insufficient time or insufficient labor on the fishing boat itself to do an adequate icing job. For example, on salmon tenders it would be impractical to attempt to ice the fish, and it's essential here to use mechanical refrigeration. I think that in the future we're also going to see some situations where the product itself will not tolerate icing. In some of the trawl-caught fish, particularly in the Gulf of Alaska and the Bering Sea, we're going to find that it's just not practical to use ice, particularly in the way that we've been using it in the past. Last of all, the economics of some of the developing fisheries are going to dictate that we use mechanical systems.

Assuming that we have decided the mechanical refrigeration is the way to go, how do we go about the selection process? First, we must identify the problem and then consider, point by point, the job that needs to be done. The most important elements are vessel size, species to be taken, problems peculiar to those species, expected daily maximum catch, total catch per trip, the amount of labor required to handle, space required for onboard handling, and the effect of subsequent processing and storage.

This brings me to my first point and my first plea, if you will. Don't wait until the vessel is sliding down the ways to think about what kind of a system you're going to put in to preserve the fish. This may seem like a frivolous statement on my part, but it's not. I have spoken to a number of fishermen who come in at the last minute. They already have a vessel built and they say, "Oh, yeah. I've got to think about how I'm going to preserve the fish." The time to think about and consider the systems to be used is during the planning stages before you make commitments on the vessel that can't later be altered.

John Liston mentioned the problem of vessels being designed for fishing. They do a good job of fishing, and you can't blame fishermen for building them, because they catch fish to have a product to sell. So there is a natural tendency to let other considerations go until there's absolutely no other way around them. Although fishing vessels aren't really the best platform on which to go about a preserving job, improvements can be made on them, and I think more thought should be given to this.

We (talking about the organization I work for) should pay more attention to this, I believe. We should have a program similar to what we've heard about from our neighbors in Canada. We've not had that type of program in the past. By and large, our effort has been in a catch-as-catch-can fashion; we have accumulated most of our knowledge through association with others.

I don't think that is really the way that we would go about obtaining information to be used to make recommendations. I think we should have a well-financed, well-thought-out, well-staffed program in order to study some of the questions for which we now wish we had answers.

There were a couple of things that struck me in listening to the other speakers this morning. We have two categories of information: hard facts and soft information. The hard facts are relatively easy to deal with. Once we make a refrigeration decision, we can calculate how much fish a certain well or hold is going to haul. Once we decide what we're going to do, the laws of physics are going to dictate our procedures or our limitations. But what worries me at this point is what I'll call, for the lack of anything better, "soft information." This is where we are right now. We're coming to the point where we're going to have to deal with some intangibles. I'll try to list some of these things and spend a little time on them, because I think they are extremely important. They're the problems for which I can't provide satisfactory answers, and this bothers me.

Factors that I include in the soft-information category are: effect of the system on appearance; bacterial spoilage vs. enzymatic or autolytic decomposition; use of chemical additives, if any, and their side effects; whether to gut the fish; whether bleeding is essential; freezing pre-rigor; problems of salt and water up-take; product weight changes associated with the system; effect on the final product such as inducing rancidity; and problems associated with unloading at the end of the trip.

In considering a refrigeration system, the physical appearance of the fish--whether the system does physical damage--is one factor you must think about. You need to think about spoilage caused not only by bacteria but also by the enzymes or chemical changes that take place within the fish.

We hear questions like, "Should the fish be gutted?" It is my observation that fish should be gutted. But what are you going to do when twenty, thirty, or forty thousand pounds of fish are dropped on your deck and your gutting machine can handle only forty fish a minute?

These are the problems that the fisherman will have to consider very seriously before he commits himself to a program. There is the business of sorting a mixed bag, as in trawl fisheries, for a single catch may consist of rockfish, pollock, cod, and several species of flatfish. It would be good if these could be sorted and stowed separately.

Bleeding is another consideration. Of course, if you're planning to gut, you don't have to worry about bleeding. However for some species (flatfish, for instance) gutting is impractical so you may want to consider bleeding by cutting the tail. Another consideration is how are you going to handle fish that haven't gone through rigor. This is particularly important to answer if you're going into a freezing system. Freezing a fish in rigor, particularly salmon, results in a distorted frozen fish.

How are you going to handle the fish once you get it to the plant? Recently I've been talking with some people who are thinking of the bottom fishery in Alaska and are talking huge quantities of fish at each delivery. Since it may be impractical to ice this fish aboard the vessel, the best alternative appears to be refrigerated seawater. But when you bring a load of refrigerated seawater-held bottomfish into a plant, how are you going to unload? Undoubtedly, vacuum-pumping systems will be used. But I didn't like seeing a fellow standing on the fish and using his feet to push the fish into the pump intake. We've a hard enough job maintaining the quality of the fish without their being tramped on.

In selecting a mechanical system for holding fresh fish, the current choices are limited to: (1) refrigerated seawater immersion; (2) refrigerated seawater spray; or (3) refrigerated hold plus ice (ice-saver system). The major problem with the combination of mechanical refrigeration and ice is that the labor for icing is not eliminated. This narrows the choice to RSW. RSW immersion has been the most common system for salmon, and it is still the best choice for cannery salmon. RSW has a variable reputation for holding bottomfish. The problems of salt up-take, weight change during storage, and the effect on the storage properties of the product following exposure to RSW have yet to be resolved in most instances.

There has been a lot of interest in holding shrimp in refrigerated seawater. In fact, there are three or four vessels operating on the Oregon Coast that are using refrigerated seawater spray. I don't know how they are handling these shrimp once they get to the plant, but I know from past experience that you cannot handle them the same way you handle iced shrimp. Peeling characteristics are a little bit different. That's not to say that it can't be done. The important thing is that you need to consider these factors in advance. Don't install a system and then run up to the plant and say, "Well, now I've got 100,000 pounds or 200,000 pounds of product. How much are you going to give me for it?" The plants and the fishermen are going to have to work together on some of these systems.

There has been a pretty good history of the combination of ice and mechanical refrigeration. It is in use in our halibut fleet--so-called ice-saver coils. I see nothing wrong with this, particularly if handled right; however, caution must be exercised to prevent partial freezing of the load. This system has worked pretty well in maintaining ice up until the time it's needed and in controlling the ice loss once the fish has been iced.

A comment was made about slush ice. You can go down to 31°-33°F quite readily by using slush ice. You do change the salinity unless you add salt. I'm enthused over the possibilities of slush because of its rapid chilling. I'm curious about the modifications that we might make, not only to the slush ice system but to the refrigerated system.

We have done some work with modifying the seawater. From a bacteriological standpoint, we've obtained good results so far as maintaining the quality of the fish. But I'm worried about something else at the present time. I worry that if we're able to extend the storage life of some of these fish, what is going to happen once they're in the frozen condition? I worry about extending the fresh storage life of salmon--say beyond 14 days--which I know can be done from the standpoint of the bacterial changes. But we really haven't looked into what chemical changes are taking place, and we haven't looked into the development of oxidative rancidity. I think these are things that should be considered before we come up in some future time with a set of recommendations or at least a set of alternatives for the fishermen.

Let's not get ourselves into a situation where the fisherman holds his fish for 14 days and then the processors find it becomes rancid in a few months. I think this could happen, so we must watch out for it.

In general, fish cannot be held longer in RSW than in ice, even though the temperature is lower in RSW. An alternative to RSW worth considering is slush ice. Slush ice is a combination of freshwater ice and sea water. The ice provides the necessary refrigeration to lower temperatures to about 31°F.

In the area of freezing systems for on-board application, the choices are blast freezing, shelf freezing, brine immersion, brine spray, or some combination of these. Blast freezing has been used to some extent but has the serious drawback of dehydrating the product. Immersion freezing in sodium chloride brine has the advantage that space requirements are minimal and freezing rate is excellent. However, immersion freezing can cause problems relating to salt up-take and subsequent frozen storage deterioration related to salt in the fish. In addition, maintaining proper shape in individual fish during immersion freezing is frequently a problem.

I don't believe there is any point in re-examining the combination shelf and moving-air system for on-board freezers as we've just heard an excellent presentation on that system. It's obvious that this would be the preferred technique in situations where the quantity of fish to be frozen would be compatable with the capacity of the system. Sizing of the system to meet the maximum daily freezing requirement is extremely important. Some thought should be given to installing dual systems because this would provide both a margin of safety if one unit broke down and increased capacity during peak loads.

In summary, vessel refrigeration systems for fresh, unfrozen fish are currently limited to either ice plus a mechanical system for conserving ice or refrigerated seawater. Freezing on board requires a substantial labor input and a commitment to multiple handling of the fish in order to get it through the several steps from freezing to storage. The preferred freezing method is a combination of freezer shelves and moving air, but a serious drawback of the system is its relatively small capacity. Large-volume freezing systems, such as brine immersion, too frequently result in unacceptable quality because of distorted shapes, salt pick-up, and development of rancidity in frozen storage.

Two Hundred Miles and Tomorrow

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My assignment is to review some effects that the 200-mile economic zone may have on the Northwest fishing industry. As I see it, one significant effect may well be the exploitation of U.S. fishery resources other than salmon. This may surprise some people because we in the Northwest have paid so much attention to salmon for so long that we sometimes are surprised to find out what an insignificant part of the world's catch is represented by our "first love." Twenty years ago, most people in a meeting of this nature would have been talking salmon, especially canned salmon. Today the situation is changed, so I do not intend to talk about salmon. I do intend to talk about new horizons and about logistics, which is a limiting factor in all fisheries.

The present situation in Northwest and Alaska fisheries is similar to that of other relatively unexploited resources--in the immediate future, the catch will not appreciably affect the unit fishing cost. This does not mean that heretofore no pressure has been put on the resource but that now the United States has a much greater chance to harvest the resource. Unfortunately, the immediacy of this opportunity is not well understood by the industry. We often hear that foreign fishing fleets will be phased out of the U.S. economic zone over a 5- or 10-year period. In reality, this phase-out could be much more imminent, particularly if one considers the economics of fishing long distances from home port. A 20% or 30% reduction in catch will mean that many foreign fleets will be forced to quit fishing in this zone almost immediately.

Taking advantage of this new opportunity in U.S. fisheries seems logical; however, there are problems to be dealt with. The basic problem confronting the fishing industry is not one of developing new processing technologies but rather that of resolving logistics--the problem of transporting raw materials from one place to another while maintaining inherent high quality and wholesomeness. Our ability to can, freeze, refrigerate, dry or otherwise process food depends on adequate supplies of raw materials.

There is an enormous resource off U.S. shores--the estimates are that from 20% to 30% of the present world's fish catch is within 200 miles of the continental shelf or the continental limits of the United States and its possessions. Today, I want to point out some of the pressures--both political and technological--that will affect future uses of this resource and examine a few questions that must be considered as we expand efforts in our off-shore fisheries.

One of the first factors to be considered is the U.S.-Foreign Trade in Edible Fishery Products. There is a tremendous deficit in our balance of trade shown by the fact that imports amount to $2.5 billion per year while exports amount only to $360 million. Previously, much of the fish imported into this country was caught within our 200-mile economic zone. Thus the 200-mile zone provides not only a potential for significantly increased catches but also an incentive for improving our trade balance. If we do not immediately initiate a sizable effort to catch the fish formerly caught by other nations, we are going to be under unbelievable pressures from the rest of the world. We cannot prevent other countries from fishing in this area if we do not harvest the fish ourselves.

Annually, there is a worldwide animal protein shortfall of more than 7 million tons, and an expanding world population demands the most efficient use of food resources from the sea. Until 1650, the world population increased only about 1/25 of 1% increase per year, and from 1650 until the late 1800s there were population increases of about .5% to 1% per year. Since the late 1800s, the average increase has been about 1.9% per year. At this rate (there is nothing to lead one to believe it will change), the world population, shortly after the turn of the century, and most certainly by the year 2020, will be in the neighborhood of 6 billion people compared with the 4+ billion people today. Much of this population increase will be in developing countries where food is critically short and where there are inadequate sources of balanced protein, particularly animal protein.

In order to solve the world's nutrition problems, one might conclude that we should come up with only cheap fish products. This is possible because there are techniques available for totally utilizing raw materials. Relatively high-priced items such as fillets can be furnished to markets and presently unutilized portions processed into inexpensive products. Whether you are producing a high-quality product for an exclusive U.S. market or an inexpensive yet high-quality protein product for low-income groups, you are still helping meet the world's protein requirements. Thus, I believe that it is important for industry to realize that there is a demand for both types of seafood and that it does not have to produce only cheap products in order to improve the world's food situation.

An interesting survey was made several years ago (Table 1) of eating habits of families throughout both developing and developed countries, including the United States. Families surveyed had income levels of $50 per capita per year and $2600 per capita per year. Survey results showed that family food purchases were comparable within each income group, regardless of the economic state of country of residence. The survey also showed that the more affluent people are the more likely they are to eat more separated edible fats, more unseparated animal fats, and fewer complex carbohydrates. They are also likely to increase significantly their consumption of animal protein. In areas of the world where higher

Table I. Source of calories (percent of total) according to income.

SOURCE	Income ($U.S./Capita) $50	$2,600
Separated edible fats	2	18
Unseparated edible fats	8	2
Unseparated animal fats	1	20
Complex carbohydrates	75	30
Separated sugar	3	18
Animal protein	1	8
Vegetable protein	10	4

income groups are increasing, an increasing quantity of higher-priced meat products and fish are being sold. If you study the developing areas of the world, you will find that although the majority of the population needs cheaper food, there is a portion of the population that has in recent years acquired the buying power of the American public. Therefore, even in developing countries there is a market for expensive seafoods as well as for the cheaper products. We have the technology but can we solve the logistics of supplying both markets in the different areas of the world?

Let us reflect for a moment on the world agriculture situation. Figure 1 shows the acreage being used for crop production. The top line shows the amount of unirrigated land in the world. Note that the amount of acreage that is unirrigated is not changing appreciably and that the amount of irrigated land is declining. Now look at the third line and you will see the amount of inorganic fertilizer that was used to increase yields. You will notice that the percentage increase in inorganic fertilizer used is much higher than the percentage increase in land cultivated. The amount of irrigated land started to decrease in the early '70s as a direct result of increased petroleum prices. This trend has continued because most of the world's fertilizer comes from inorganic materials that are made from petrochemicals. What it boils down to is that millions and millions of acres of land that are still available in the world for agriculture are not especially good farm lands, while the increasing costs of fertilizers and irrigation mean that there is not likely to be an appreciable increase in world crop production. Bear in mind that the world population is increasing 1.5% to 2% per year.

Figure 2 shows the shortfall of cereal grains worldwide. This deficit will continue unless production is increased by about 4% a year. Unfortunately, there is no foreseeable way there is going to be more than a 1% increase in total annual yield in world food production. Nor is there going to be an appreciable increase in yield per acre because most of the developing countries cannot afford the necessary fertilizer and also because many developed countries have reduced fertilizer applications because of high prices and petroleum shortages. Thus, there probably will be decreased per-acre yields in many areas of the world

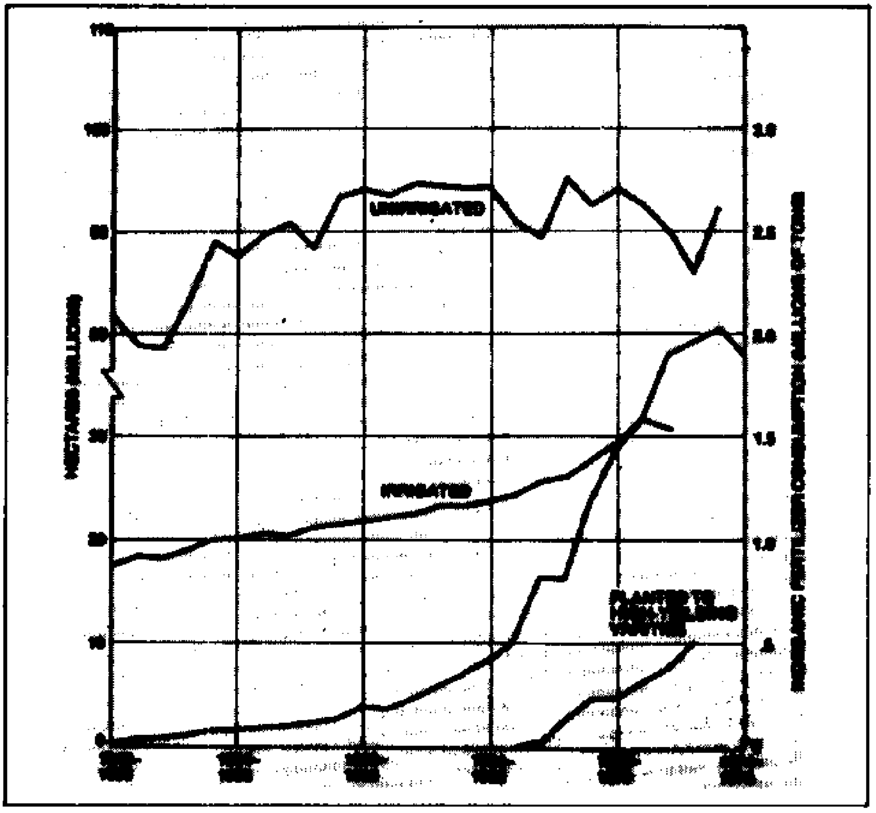

Figure 1. World agricultural land use.

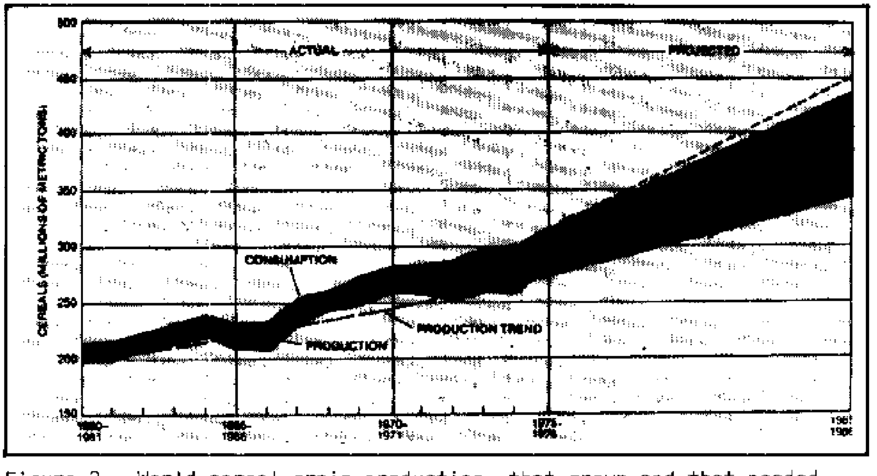

Figure 2. World cereal grain production--that grown and that needed.

over the next few years. These factors suggest that the U.S. fishing industry is in a rather unique position for that industry is faced with the increased availability of a high-protein food resource.

Let us turn to some of the technological factors that will affect our exploitation of the fishery resources in our economic zone. Sales of frozen and dried seafood products are increasing rapidly. Frozen products are most like fresh fish, and rapidly improving transportation and storage accommodations facilitate delivery of a quality product. However, the dried product is easier to package, store, and transport. Furthermore, dried products can be shelf stable and do not have to be held in an energy-consuming atmosphere such as a freezer.

Now, let's take a look at what is going on with battered and breaded products in the United States (Figure 3). Fish-stick production was in the neighborhood of 60-70 million pounds in 1960, peaked in the early '70s and then dropped. A great disservice was done to the future of this type of product in the United States by processors who produced fish sticks from cheap, poor-quality frozen blocks. The results temporarily ruined the market for fish products in many areas. Fortunately, today modern technology is being used to process quality raw materials so the trend is reversing itself,and breaded seafood products are again starting to move.

The leading product among breaded foods is chicken. Chicken is a product that people like, a product that is available on a year-round basis and a product that keeps well. Furthermore, chicken has been well merchandised--much better than fish. Interestingly, one of the main reasons that chicken is one of our cheaper meats is the development of inexpensive fish meal which allowed a heavy addition of high animal protein to broiler rations. Sales of breaded onion rings have peaked and are starting to fall, but sales of seafood specialties and battered and breaded fish portions are starting to increase. Predictions are that in the next few years there is going to be a tremendous increase in sales of these items, stimulated by growing retail and institutional markets.

I want to expand a little on the potential for the Northwest getting heavily into, and possibly even dominating, the production of battered and breaded fishery items due to the availability of fillet fish. These kinds of products have a good future because institutional fast-food chains are expanding rapidly. You have all heard that it is not going to be very many more years before well over 50% of all the meals eaten in the United States will be away from home. The fast-food chains, whether they be semi-local like Skipper's or national like MacDonald's, have caught the fancy of U.S. citizens as well as citizens in many other countries, including Japan. Besides the appeal of fast service and convenience, the cost of fast-food items means that a family can afford to go out to dinner. As a result, young people are developing an appetite for these kinds of products which presumably will continue as they grow older. (Note that today's young people do not have an appetite for canned salmon!)

Recall that the annual world fish harvest is approximately 70 million metric tons. To date, we have been taking only a small fraction of that as the U.S. catch. However, 20% (14 million metric tons) or more is now available to the United States as a result of the 200-mile zone.

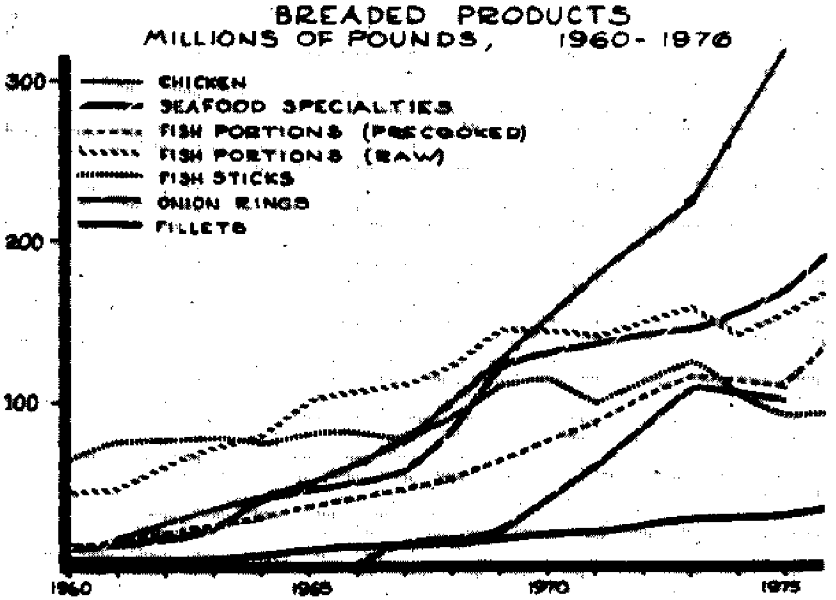

Figure 3. U.S. growth of selected battered and breaded foods.

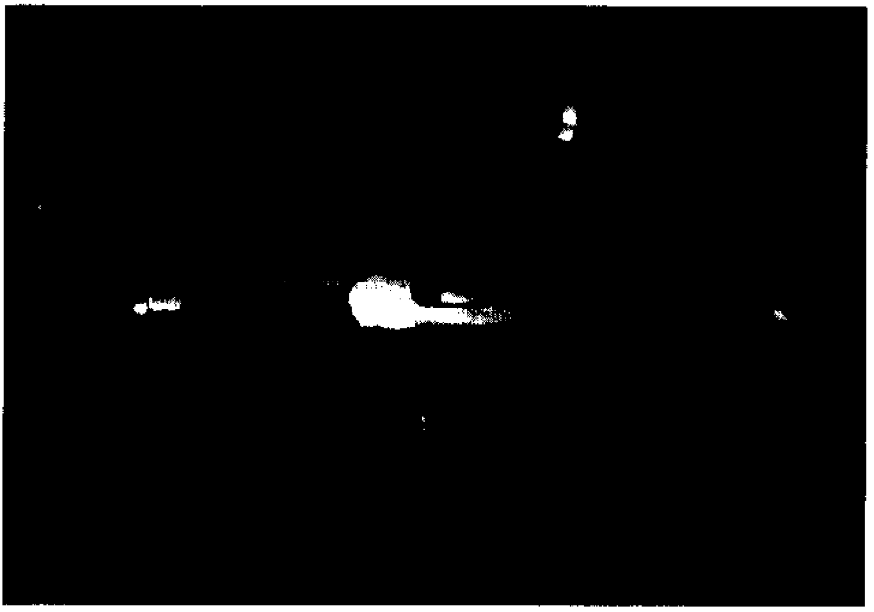

Figure 4. Typical fish flesh recovery by machine deboning.

Most edible portions of the world's fish are processed into products that involve filleting or other procedures to remove the meat from the bone. Using a fillet operation as a basis, 100 pounds of fish will yield roughly 25 pounds in fillets (although big fish like lingcod can yield up to 35% in fillets and, if you are machine filleting, in many cases the yield will be less than 25%). Of the 75 pounds remaining after filleting, there will be an amount of flesh left on the frame that is equal to or greater than the amount of fillets removed and that is of exactly the same nutritional quality as those fillets. At the present time, this remaining fish flesh is either being wasted or is being sold at a low price for pet or commercial animal feed. From the point of view of world protein demand, we are misusing more than half our bottomfish catch. If we are going to fish the 200-mile zone to its fullest extent, economic success could depend upon what we do with this 75% portion that now is either unutilized or underutilized.

Because the flesh is comminuted by the deboning process, complete utilization of this raw material must come through the manufacture of high-quality formulated foods. For those unfamiliar with the deboning operation, Figure 4 shows one of several deboners on the market. The theory behind the deboning process is to put a headed and gutted fish carcass under tremendous pressure which forces the soft flesh through a drum or plate, thus separating it from skin and bones. This flesh can be used as a base for formulated foods similar to those reclaimed from poultry, lamb, and beef.

Although the major outlet for deboned fish flesh in the United States seems to be formulated processed and frozen products, this is not necessarily the best use of the raw material in many parts of the world that lack refrigerated transport and storage facilities. Salted or hard-smoked fish, however, can be left on the shelf until prepared for consumption. At the University, we have developed a good line of products from deboned waste or scrap fish. One example,is a product that combines herring with fresh rock fish, cod and other miscellaneous catch species into a smoked, dried-salted product. Sensory testing has shown this type of product is highly acceptable in developing countries where people do not have refrigeration.

Another plus factor for these products is that they are economical and can be afforded in many parts of the world. When you can sell to private markets, you are better off as a private enterprise than when you have to go through a government organization or an aid program.

Although the technology for making battered and breaded formulated products has been developed to the extent that highly acceptable products can be made, there is still the problem of subsequent deterioration due to poor cold storage practices. Sometimes, when we analyze the quality of frozen foods, we find that we are right back to what we were talking about 30 years ago. That is, a big problem in marketing seafood is what happens to that food after it leaves the plant. Even in our so-called sophisticated food distribution systems--from the truck that delivers to cold storage holding through the retail displaying--there are too many people involved who do not appreciate good frozen food handling practices.

Consider the difference between a natural food and an extruded product that is battered and breaded. For example, the natural clam strip is sliced, battered and breaded, prefried and frozen. The extruded strip, utilizing a larger fraction of the clam, is chopped before being battered and breaded. This procedure givea a high-quality product with considerably higher yield. Likewise, if you use the by-product flesh from a filleting operation, the reclaimed flesh for the extruded-formed fillet would be in addition to the fillet that is being produced. These are some of the possibilities of increasing raw material utilization, but again we face the problem of maintaining the high quality of the fresh fish. The future of total utilization probably involves at least preprocessing on the high seas or in the processing plant. This is particularly true of products like hake that have a high proteolytic enzyme content. A fish that gets soft rapidly because of enzymatic action or other causes of deterioration must be cooled as soon as it comes from the water. Even then, if frozen and left in the freezer for a few months, the fish will become very soft and spongy. However, if the enzyme is inactivated by heat prior to freezing, at the end of several months' storage the fish will be essentially the way it was when you put it into the freezer. This is one reason why prefrying of battered and breadec extruded fish products is preferable.

One area that has hurt the consumer's image of deep-fat fried foods is the inconsistent output of fast-food chains where there are no chefs and inexperienced personnel are hired as cooks. If foods are fried properly in a dry fryer, they absorbe very little oil--like 6-7% oil which is not high when compared with other animal protein food. But improperly fried foods often absorb as much as 20% or more oil as the result of incorrect cooking temperatures or times.

In summary, the United States should plan the exploitation of its 200-mile economic zone with "total utilization" of the harvested materials as a primary concern. This does not mean we must operate Japanese or Russian type mother-ship fleets because we do not have the logistic problems those fleets encounter so far from home. However, we definitely must build many vessels larger than those now in existence. In order to take advantage of our economic zone, construction or refurbishing of vessels and the various products that will permit total utilization of our fishery resources must be coordinated with the opportunity afforded the United States fishing industry by the worldwide need for protein from the sea.