A Recommended Procedure for Assuring the Quality of Fish Fillets at Point of Consumption

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Introduction

Although this discussion is limited to fish fillets, it might well apply to most seafoods in some cases and to all seafoods in other cases. Fish fillets, like meats and poultry, are perishable commodities that lose their eating quality relatively quickly. The rate at which fish fillets spoil depends on the temperature of the environment to which they are exposed (Charm et al., 1972; James and Olley, 1971; Spencer and Baines, 1964).

Fresh-caught fish that are iced immediately and held in ice thereafter will remain of high quality (U.S. Grade A) for 8-9 days and of edible quality for about 2 weeks. Held at room temperature on a hot day, the freshest fish will become inedible within 1 day.

At the other extreme, if fish are properly packaged, brought to a temperature of −20°F (28.9°C), and held at that temperature or below, they will retain their high quality for more than 1 year and will remain edible for much longer. Thus, 100 percent of the eating quality of fish will be used up in only 1 day, 2 weeks, or more than 1 year, depending on the product temperature.

Currently, in the United States, fish are not held at a constant temperature throughout their distribution. Instead, they may be held at one temperature on the vessel, at another temperature in the processing plant, and at yet another temperature in the retail outlet. So, as fish proceed through the distribution chain, they are constantly losing quality, quickly or slowly, depending on their temperature. And, once the good quality is completely lost, the fish will soon become objectionable and, for all practical purposes, inedible.

The quality of fish is officially defined by the grade standards set by the U.S. Department of Commerce Inspection Service. The official standards for grades of quality of fish fillets are divided into three categories (Table 1): U.S. Grades A, B, and C. There is also a Substandard Grade that may be wholesome and of acceptable quality but does not meet physical specifications.

While we know that the quality of fish passes through Grades A, B, C and eventually to spoilage within 2 weeks at 32°F, and that fish fillets remain at U.S. Grade A level for 8-9 days, we do not know when fish go from Grade B to Grade C or when they fall below the Grade C level. However, the known facts suggest that these unknown times would be relatively short. For this reason and as an added insurance to assure quality at point of consumption, we are recommending that the intent is to have seafoods reach consumers while the seafoods are still of U.S. Grade A quality.

This paper outlines the handling procedures that will deliver U.S. Grade A fish fillets to the consumer and will generate a general attitude that recognizes the value of U.S. Grade A quality, the dietary and economic values of seafoods, and the economic value of eliminating spoilage and waste. Attainment of this goal should lead to:

1) That part of the U.S. seafood industry dealing in the commerce of fish fillets will earn a new image of prestige both at home and abroad.

2) That part of the U.S. seafood industry dealing in the commerce of fish fillets

Table 1.—Descriptions of U.S. Grade Standards for fish fillets (U.S. Department of Commerce, 1979). Greater detail on grading criteria is given in Official Grade Standard paragraph 203.104 (U.S. Department of Commerce, 1979).

Grade	Description
A	Good flavor and odor characteristics of the species; must comply with the limits for defects for U.S Grade A.
B	Reasonably good flavor and odor characteristics of the species; must comply with the limits for defects for U.S. Grade B
C	Minimal acceptable flavor and odor characteristics of the species with no objectionable off-flavors or off-odors; must comply with the limits for defects for U.S. Grade C
Substandard	Minimal acceptable flavor and odor characteristics of the species with no objectionable off-flavors or off-odors; fails to meet the limits for physical defects for U.S. Grade C

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will become a more significant element in the U.S. economy, which should improve the U.S. position in international trade.

3) U.S. consumers will probably eat more fish, and this should tend to improve the overall health, especially in that proportion of the population who have an increased susceptibility to cardiovascular disease.

4) U.S. and foreign consumers of U.S.-produced fillets will get more for their purchase price which should increase the demand for U.S. fish fillets.

5) The introduction of some underutilized marine species to the U.S. seafood market may be facilitated.

Based partly on the rationale in the above discussion and partly on our experience in a study by Gorga et al. (1979), the strategy described below is recommended as a vehicle for obtaining the benefits listed above.

Rationale for the Recommended Procedure

It should, first of all, be noted that the spoilage patterns in unfrozen fish differ from those in frozen fish. In unfrozen fish, spoilage is due to the digestion of small protein particles (amino acids) by bacteria, and this type of spoilage results in the development of strong, objectionable odors and flavors. In frozen fish, spoilage is usually due to the action of certain enzymes on the protein and/or oxygen on the fats, and these types of spoilage may result in rancidity which can be detected in the odor or flavor (but may or may not be objectionable, depending on intensity) or they may result in toughening of the texture. Later in this paper we will recommend that fish displayed as fresh may be frozen and displayed as frozen as a means of removing the economic risk that the product might spoil before it can be sold, and we want the industry to be aware of the difference in spoilage patterns between frozen fish and unfrozen fish.

Figure 1 shows the sequence and the basic elements of the distribution chain that takes fish from the sea to the point of consumption. Although the figure shows only five distribution elements, it must be remembered that dock workers and transportation personnel are also involved to degrees that vary with a variety of possible situations to unload, reload, and transport the product from element to element. The product to be sold as fresh should be held at 32°F (0°C) or less (but not so cold that it freezes; otherwise, it has to be sold as frozen). The only element where the temperature can be allowed to rise (and then only up to 40°F (4.5°C)) is at the processing plant. This is because colder temperatures might not be tolerated by the plant's employees. (This is a factor which should be considered when evaluating the option of automated processing, such as mechanical filleting, which could be done at 32°F).

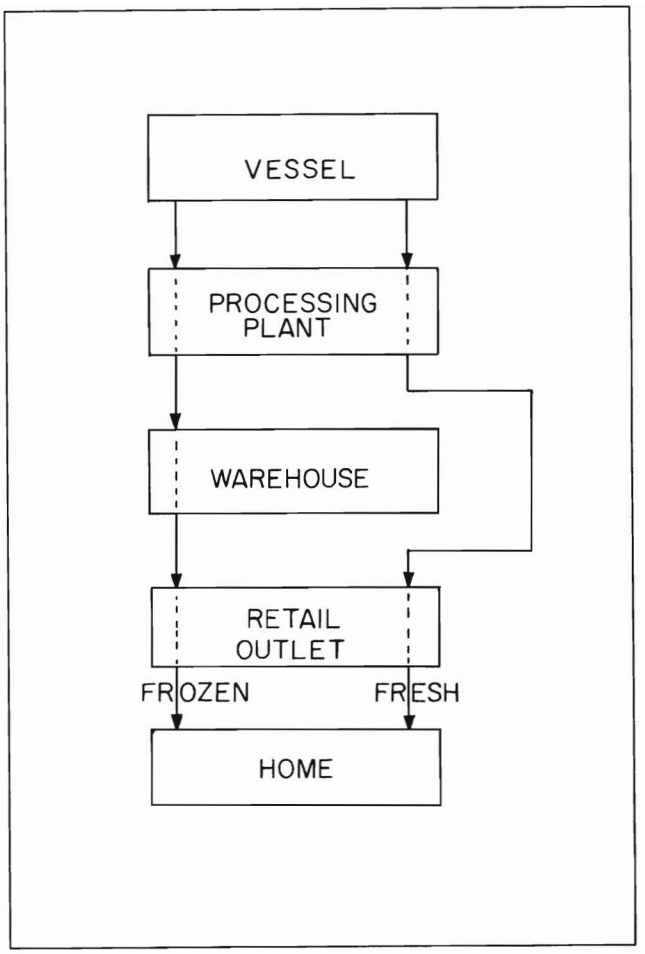

Figure 1.—The sequence of distribution elements that take fish from the sea to the table.

The figure shows that the fresh product does not go to a warehouse. This is because the total shelf life of fresh fillets is so short that there is no time for warehouse storage. The elements of the distribution chain will be described in more detail below; at this time, we should focus on the maximum times that the product can be held at each of the distribution elements. Table 2 provides insight to the limits of shelf life and Table 3 summarizes the maximum temperatures at which either fresh or frozen

Table 2.—The shelf life of fillets of gadoid species at some selected temperatures (no special packaging or other variables).[1]

Temperature		
°F	°C	Shelf life
90	26.7	1 day
60	15.6	2.5 days
42	5.6	6 days
32	0	2 weeks
29	−1.7	3-4 weeks
10	−12.2	~2 months
0	−17.8	~1 year
−10	−23.3	~2 years
−20	−28.9	>2 years
−40	−40	indefinitely

[1]It should be noted that the periods during which the fresh products remain at the U.S. Grade A level are shorter by about 40 percent than the shelf life times shown.

Table 3.—Maximum times that fish or fish fillets can be held at each distribution element when temperature is maintained at 32°F (0°C) and 0°F (−17.8°C), except at the vessel and on their first day at the processing plant.

Temperature	Vessel	Processing plant	Warehouse	Retail outlet	Home
32°F (0°C)	2 days	1 day		5 days	1 day
0°F (17.8°C)	7 days	1-2 days	6 months	3 months	3 months

products can be held at each of the elements of distribution.

The data in Table 2 cannot be relied upon to be accurate for every occasion since many variables, which include species and season, exert an influence on what occurs under actual conditions, but they are as reliable as any set of single values that can be assembled for this purpose. The important consideration is the time/temperature relationships that are expressed and the implication of the potential economic penalty for being lax about temperature control. From Table 2, we can see that the time during which fillets of gadoid species remain at U.S. Grade A at 32°F is 8-9 days (60 percent of the shelf life which is about 14 days). This means that limits have to be placed on the times that the fish can be held at each of the distribution elements.

Table 3 shows the recommended maximum times that fish or fish fillets can be held at each distribution element when the temperature of the product is controlled to hold at 32°F (0°C). These data lead us to conclude that fish which are more than 7 days out of the water have no place at all in a guaranteed Grade A quality program for either fresh or frozen products. Only the catch from boats which fish for up to 2 days and the top of the catch from boats that fish for longer periods should be considered for the fresh market. The times in Table 3 may, to some, appear impractical or unattainable; and in some situations, this may well be the case for one or more of the elements. However, because of the time limitation which is unalterable, for every time increase allowed in any distribution element, there must be an equal time decrease in the rest of the system. The only element in Table 3 from which time can be subtracted is the retail outlet, but this is the only one of all the elements which cannot fix the time that it requires to carry out its responsibility—to sell the product. And, it is the element that will suffer the economic loss if it cannot sell the product. The retail outlet has no direct control over the consumer's decision to buy, and it should be remembered that part of the 5 days allowed at the retail outlet may have to be spent in the holding room from where no sale can be made. In order to extend the overall allowable time of 9 days shown in Table 2, the product temperature must be lowered to below 32°F, to perhaps 29°F (−1.7°C), where feasible (e.g., in the retail outlet holding room and display case). At 29°F, the spoilage rate is considerably slower than at 32°F.

Table 3 also shows the maximum times that fish or fish fillets can be held at each distribution element when the temperature of the product is controlled to hold at 0°F (−17.8°C). There should be no problem with the holding times shown in the table when the fish are properly packaged. By lowering the product temperature, the times can be extended. The only element that may be controversial is the vessel. Despite the opinions of some who contend that fish can be held for 10 days or more in ice before putting them into the distribution chain, it is just not so. Fish older than 7 days in ice will probably not be at U.S. Grade A at point of consumption, except under unusual circumstances. This does not mean that vessels should not make trips that are longer than 7 days or that fish older than 7 days are of no value. It only means that fish older than 7 days in ice should not be scheduled for a distribution system which is expected to deliver to the consumer either fresh or frozen fish fillets of U.S. Grade A quality. In the following section, which includes a description of the vessel's role in more detail, recommendations are made for fish that are 8 days or more out of the water.

Elements of Distribution

Vessel

Theoretically, the optimum method of handling fish is to freeze them immediately after catching. By freezing the fish at sea and holding them at sufficiently low temperatures (no higher than 0°F or −17.8°C), they will remain at high quality for months. Freezing to and holding at even lower temperatures (e.g., −20°F or −28.9°C), will maintain high product quality for more than 1 year. However, since most of the vessels harvesting groundfish off the U.S. coasts do not freeze their catches, this section will deal only with handling fish at 32°F (0°C).

The species of concern may be caught by hook and line, otter trawl, trap, or gill net. Regardless of the method, the important thing is that the fish are brought to the temperature of melting ice as soon after death as possible. Thus, it can be seen that fish trapped in a gill net that is left in the water for a long period may undergo considerable quality degradation before they are brought on board the vessel. On the other hand, fish that are trapped or hooked may be alive and of prime quality when hauled on board. Fish that do not struggle retain their blood sugar, which is subsequently broken down to lactic acid which slows the rate of spoilage (Amlacher, 1961).

Fish caught by long line or traps have better keeping quality than fish caught by trawling. In the latter process, the fish are dragged along the ocean bottom and, in addition, they are subjected to considerable pressure when the net is hauled out of the water. This not only damages

the texture but also may force some of the intestinal contents out of the fish, thus contaminating the surfaces of surrounding fish. Sophisticated methods of handling fish, such as stunning them in an electrical field and then pumping the stunned fish on board, are already developed, although they are little used at present.

As stated, the most critical of all the deck handling operations is lowering the temperature of the fish as soon as possible after catching to retard spoilage. The temperature of the fish is usually lowered by icing the fish in the hold. However, if this is improperly done (i.e., if the fish are allowed to be pressed against the pen boards without an intervening layer of ice), the fish may develop a bilgy flavor and odor. Also if the fish are piled too high, excessive pressure on the bottom fish damages them. This can be prevented by stowing the fish iced in boxes or in refrigerated seawater. The latter offers the additional advantages of rapid heat removal and lowering of the temperature of the fish very close to its freezing temperature, resulting in an increase in storage life. Of course, there is no place in a guaranteed quality program for fish that are not adequately cooled, such as occurs when ice or other refrigerant is not used or when the amount of ice or other refrigerant is inadequate. The use of boxes and proper icing is highly recommended. Also, the boxes should carry the date when they are filled.

The fish should be eviscerated, since the stomach contents may contain feed with high proteolytic activity which can rapidly digest the belly area. Ideally, the viscera should be removed intact, as rupturing results in inoculating the abdominal cavity and accelerating spoilage, but this is admittedly not practical with present techniques. Vacuum evisceration (Connors and Baker, 1968) would be one way to remove the viscera with a minimum of contamination of the gut cavity with its contents, but there are no reports of the current use of this process.

The value of washing freshly caught fish is questionable. The growth of bacteria on round fish occurs principally on the external slime layer as well as in the gills. On fresh-caught fish, this slime layer is firmly bound and washing does little, if anything, to remove it (Castell et al., 1956). Bleeding the fish is a good practice since it results in a lighter colored flesh and it removes heme compounds which accelerate oxidative rancidity. Peters (1969) showed that a side benefit of vacuum evisceration was the simultaneous bleeding of fish.

For short-term storage, the use of refrigerated seawater and chilled seawater systems are among the best that can be used because of the rapidity with which they can cool fish and the thorough temperature control that is possible. Because of the buoyancy effect of such systems, fish are not pressure damaged and they are easier to unload, especially by pump. For more information on these systems, the reader is referred to Peters et al. (1965) and Hulme and Baker (1977).

Until recent years, the pitchfork was extensively used for transferring fish from the pen to unloading systems and sometimes within the processing plant to unload fish from boxes. This was a poor practice which bruised and contaminated fish muscle and is now virtually eliminated. Where it is still used, evidence is seen in the blood spots and discolorations of the muscle. What is not immediately evident is the extent of bacterial inoculation.

When fish are boxed and iced at sea, the boxes are hauled out by a mechanical hoist, and this is an ideal method of unloading. The power hoist and basket is a satisfactory system for unloading fish from pens, but transferring the fish from the pens to the basket is still a time-consuming and inefficient task.

Many fish are landed at dockside processing plants, and in those cases, the only cause for concern should be that the product be moved as quickly as possible. Even when, for some reason, the product must wait, its temperature should not be allowed to rise. This means that it must be sufficiently iced to keep it at 32°F (0°C).

Much of the landed fish is moved to plants that vary in distance from the dock, so a variety of transporting devices may be used. These range from manually pushed carts that travel short distances to trucks which may have to travel long distances. Regardless of the mode and distance of travel, the emphasis must be on temperature control and rapid handling.

Having covered the specifications and limits recommended at the vessel, it is now time to discuss the fate of fish that are more than 7 days old when landed. First, it should be reasserted that there just is not enough high quality remaining in iced fish that are 8 days or more out of the water to last them through the distribution system and to be of U.S. Grade A quality at time of consumption.

As this entire recommended handling procedure depends entirely on the premise that all activities will be aimed to achieve and maintain a respectable image for the seafood industry, there can be no compromise of the established protocol. This means that vessels which have no facilities to maintain the temperature of the catch at less than 32°F (0°C) should not stay out longer than 7 days at sea, or they should plan another way to handle that catch portion that will be more than 7 days old when landed.

There may be a specific buyer who has the facilities to handle the fish quickly, e.g., a shoreside restaurant that has a high demand and quick turnover for seafood entrees and whose employees are expert in seafood quality and are reliable enough to cull out an inferior product. Or, a shoreside processing plant may be found which has the facility to quick-freeze the high quality part of the catch and has personnel with the expertise to assess accurately the quality of fish and the reliability to cull out fish that will compromise the image that we are trying to make for the U.S. seafood industry.

Another alternative for vessels that plan to fish for more than 7 days is to handle the first part of the catch to preserve its quality. Here, there are two practical possibilities. One way is to freeze the first part of the catch. This can be done by installing a small freezer on board the vessel. The second possibility is to salt the first part of the catch at sea. Either alternative is more economical and more practical than putting the first part of the catch into the normal fillet distribution chain as is done now.

Another alternative is to consider a technique that has been proposed in the past for the U.S. fleet, and is already practiced by the Japanese and possibly others: Use fast transport vessels that take fish from fishing vessels before the fish become too "old" to safely put into the distribution system.

Fishermen must constantly remember that it is not enough to bring in fish that is of high quality when landed, because that is not where the quality judgment is made by the consumer. Landed fish must have a reserve of high quality to last it to the point of consumption.

Processor

Processing room temperatures should be no higher than 40°F (4.5°C). The product should be handled quickly, and there should be no delays in the plant. The plant should be under U.S. Department of Commerce inspection to insure that good manufacturing practices are observed. The refrigerated holding room should be at 29°F (−1.7°C) but not higher than 32°F (0°C), and the freezer holding room temperature should be as low as possible and feasible but not higher than 0°F (−17.8°C).

The product should be prepackaged at the processing plant. This would insure that the product could not subsequently be exposed to pathogenic microorganisms (as can readily occur when handled under uncontrolled conditions). Individual packaging would also permit the application of the U.S. Department of Commerce inspection seal, the U.S. Grade A label, the company identification mark, a logo, a code to tell by which time the product should be used, weight, and other relevant information. The package should be transparent to help consumers evaluate the product at time of purchase. At the processor level, U.S. Grade A fresh fillets could be transferred to the freezer just before their quality fell to below U.S. Grade A. In this way, none of the fillets would be lost to spoilage. It should be emphasized that only fillets that are still of U.S. Grade A should be frozen. Once they fall to below U.S. Grade A, they should be discarded.

Relevant to the merchandising of U.S. Grade A fillets is the current concept that fresh ones are of higher quality and command a better price than frozen ones. Because of this concept, anyone who processes or otherwise handles fillets anywhere in the distribution is compelled, for economic reasons, to sell his inventory as fresh if he can. Also, because of this, fillets produced in the United States are only handled as frozen when their quality is such that they could not be sold in the fresh market. Thus, the concept that fresh is better than frozen is propagated. There is a need to demonstrate the higher value of frozen fillets over fresh fillets, because ultimately the best quality fillets and the best overall economic benefits will come from freezing the highest quality fish and fish fillets.

Processors must constantly remember that it is not enough to produce seafood products that are of high quality, because that is not where the quality judgment is made by the consumer. Products must have a reserve of high quality to last to the point of consumption.

Warehouse

There is little likelihood that any product quality will be lost at the freezer warehouse as long as temperature control and product rotation are maintained and there are no delays in loading and unloading at the warehouse dock. The product temperature should never exceed 0°F (−17.8°C), but it should be obvious that lower temperatures provide a better protection of product quality. Temperature fluctuation should be minimized.

There is no provision for storing fresh fillets in warehouses because of the limited time that they have as U.S. Grade A product. However, for distribution in supermarket chains, they may be sent to the chain's perishables distribution center. This is not for storage, but to facilitate distribution. The product must be moved in quickly as soon as the supply trucks arrive and out just as quickly to the delivery trucks that distribute the product to the retail outlets. Trips to the retail outlets must be short so that deliveries are made within just a few hours. Trucks should maintain a temperature of about 29°F (−1.7°C) but not higher than 32°F (0°C). Supplies can arrive by truck only as long as deliveries from the processing plant can be made within 1 day. Deliveries requiring more than 1 day by truck should be made by airfreight. The temperature during delivery should be maintained at 29°F (−1.7°C), but not higher than 32°F (0°C).

Retail Outlet

Product handling at the retail outlet is shown in Figure 2 in isolation from the rest of the distribution chain, to show the details of the recommended pattern for handling fish fillets. Fillets received at the retailer's unloading platform should be transferred immediately to the holding rooms. This step should not wait because of a lunch break, coffee break, or any other reason.

Holding room temperatures should be strictly controlled. The freezer room should maintain as low a temperature as possible, but under no circumstances should it be higher than 0°F (−17.8°C). The refrigeration room should maintain a temperature of about 29°F (−1.7°C), but under no circumstances should it be higher than 32°F (0°C).

Since fresh fillets have only a limited time that they can be held at the retail outlet (about 5 days under favorable circumstances), it can be seen that every day that they spend in the holding room means 1 less day on display, and those not displayed cannot be sold.

Seafoods generally provide a retailer with a relatively high return. Therefore, the retailer should devote adequate time to see that the display cases are held at the proper temperature; that the display cases are not overloaded (so proper product temperature can be maintained); that the fillets are rotated; and, especially, that fillets which are lower than U.S. Grade A quality are removed and discarded and not frozen for subsequent display in a freezer case or sold at a lower price. Either of these latter practices simply propagates the relatively low image of seafood quality and provides no economic advantage for the long term unless they are properly done as described in the following two paragraphs.

Transfer of fresh seafoods to a freezer or to the freezer display case should be done no later than 1 day before the pull date. Assuming that the packaging material is suitable, only the pull date and

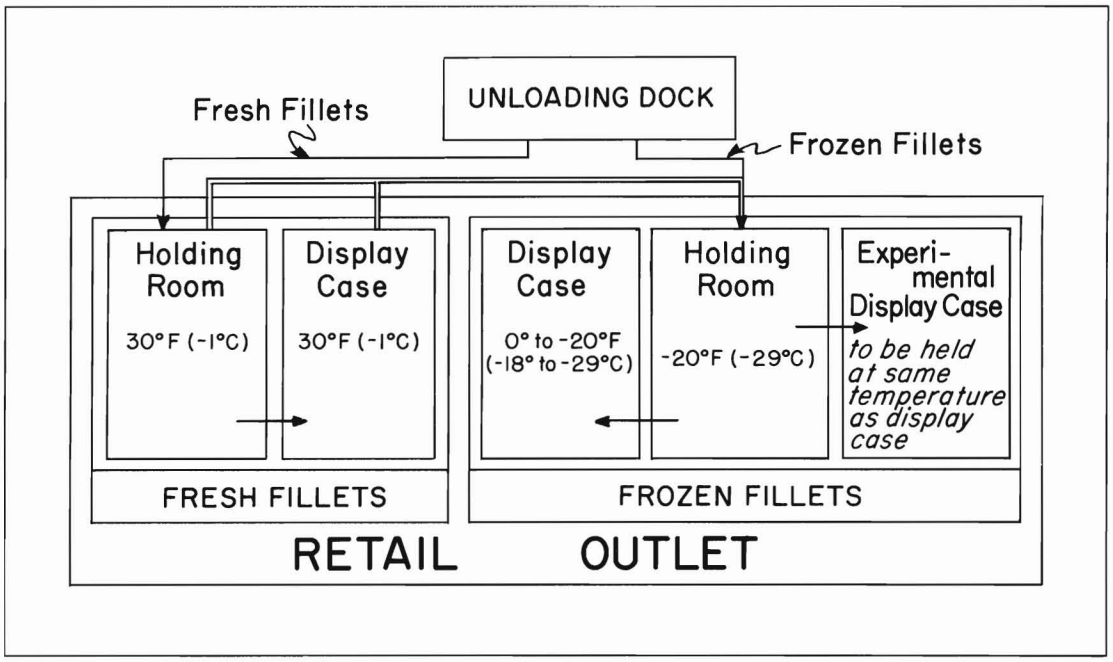

Figure 2.—Recommend handling of fish fillets at the retail outlet to maximize quality retention and minimize losses due to spoilage.

any reference to freshness need be changed. Even if the freezing process is slow, by starting it 1 day early, spoilage reactions will be slowed and finally come to a virtual halt soon enough so that the product will retain its U.S. Grade A quality. In Figure 2, the double lines refer to fresh fish that are transferred to the freezer section 1 day before the pull date. Times to allow for pull dates on frozen products can be obtained from Table 1.

It should be perfectly all right to sell at discount those seafoods that do not have much U.S. Grade A quality left. However, the retailer must be sure to discard the product once its quality falls to below U.S. Grade A.

It is important that the retailer remove seafoods of less than U.S. Grade A from display because of the current poor image of seafoods. Quality assurance of seafoods can increase the consumer demand for them, but because of the poor image of these products, the industry has to exercise even greater care than is now exercised for meats and poultry, both of which have an image of good quality among consumers.

The experimental display case cited in Figure 2 refers to a new concept in frozen fish merchandising which was designed to minimize heat gain from the outside of the box (i.e., to minimize loss of refrigerated air to the outside) and to make rotation of the product fail-proof. This is accomplished by loading the product onto a one-way track in a completely enclosed case much like a vending machine used for the automated sales of candy bars and cigarettes. A description of the case and of the details of seafood display are described in greater detail by Nickerson and Ronsivalli (1979).

As we are concerned only with packaged fillets, the package makes it convenient to put a date on it, such as a pull date. This is already being done in some cases. The reason for the pull date (the date by which time the product will have reached near the end of its U.S. Grade A quality) is to let a consumer know how soon the product must be used to insure that it is Grade A at time of use, and it lets the market personnel know when it must be removed from the display case if unsold.

Having covered the justification for the pull date (sometimes a use-by date is used which is self-explanatory), its disadvantage and possible alternative strategies should be considered. Its disadvantage is that customers are bound to look for the newer product making it difficult to sell the older product and perhaps even losing it to spoilage. A better alternative to the use of a pull date is to use a code for the pull date. The customer would not be misled because, regardless of the pull date, every package on display would contain U.S. Grade A product, and the market manager would still be able to tell when a package should be removed from the case and which products should be sold first.

In addition to the responsibilities of the retail outlet personnel described above, there are other measures that they can take since they make up the single element in the distribution chain that interacts directly with the consumer. They are in a good position to impart information regarding methods of preparation, dietary facts, facts on preservation of quality, etc., to the consumer. One way to help protect perishable commodities like seafoods is by designing

the market layout to minimize exposure of the product to high temperatures. Recognizing that the layout design serves many purposes, it should also be recognized that in most supermarkets, a most important consideration has been overlooked. Currently, perishables can be found at any point in the store, and, except for occasional arrows in the aisles (which very few people observe), one can enter a supermarket, start shopping at any end of the store and end up at the opposite end. Thus, regardless of the pattern used when a general grocery list is sought, there is a high probability that one of the first items to be put into the shopping cart will be perishable. This helter-skelter shopping pattern is not helpful. Market layouts should be designed so that a customer should be confined to a one-way passage through the store, and the store should be in sections such that the first section encountered contains the least perishable commodities, the final section contains the most perishable commodities, and all other sections to be in a sequence consistent with the obvious pattern.

The retailer is the key to the image of the seafood industry. He gets customer feedback, and he can apply pressure to suppliers. He can educate the consumers and the suppliers as well.

Retailers must remember that when they receive seafood products of high quality, that alone does not insure that the product will be of high quality when the consumer eventually eats it, and that is where and when the quality of the product is eventually judged.

Consumer

Fillets may be purchased fresh or frozen. In either case, once the purchase has been made, the consumer should make every effort to keep them at the desired temperature until consumed (32°F (0°C) if fresh and 0°F (−17.8°C or lower) if frozen). The cart or carriage used to contain supermarket purchases is not refrigerated and the car or other means of conveyance to bring the food to the home is not refrigerated. Therefore, from the moment that fish and other perishables (e.g., meats, eggs, and milk) are placed into the shopping cart, no time should be lost to get them into a refrigerator or freezer. This means that shopping for food requires a little planning. A shopping trip that is to include groceries should be scheduled so that the food market is the last stop before going home, especially when the outside temperature is high. Also, the trip through the food market should be planned so that the selection of perishable foods is left for the end of the trip. By this type of planning, the good quality of fillets will have a better chance of being maintained.

Once fish is in the home, it must be refrigerated immediately and before any attention is paid to the nonperishable purchases. Frozen seafoods should be placed in the freezer (which should be at 0°F (−17.8°C) or lower). Attention should be paid to the package. It may offer sufficient protection so that the seafood could be stored in its original package. The ideal package prevents the loss of water. The package should prevent the entry of air when it contains fatty fish. Even frozen seafoods eventually undergo quality deterioration, albeit very slowly (Table 1).

Unless fresh fillets are to be prepared within minutes, they should be put into the refrigerator immediately; and, if they are to be held in the refrigerator for more than a few hours, they should be imbedded in ice in a leak-proof container such as a large bowl. This is because most refrigerators are held at temperatures that are too high for fish fillet storage. Only fish that are to be consumed within 24 hours should be stored unfrozen unless it is known for certain that the fish have been caught recently.

The point at which the quality of a fish fillet really counts is when it is being consumed. At any other point, quality is important only as an indicator of what can be expected when the fillet is consumed.

That fact that fish coming out of a vessel's hold look and smell good indicates (but does not assure) that it will be good to eat. The fact that an inspector judges a fillet to be U.S. Grade A quality at the processing plant indicates (but does not assure) that it will be good to eat. The fact that a consumer buys a U.S. Grade A quality fillet indicates (but does not assure) that it will be good to eat.

Only at the point of eating does one sense the quality of the fillet. When a fish is of high quality at the time of preparation, but does not give the impression of high quality when it is consumed, the implication is that it was not properly prepared. This discussion will not address the preparation of seafood since that information is available elsewhere. But, it appears that seafoods do require special attention during preparation, and this step should not be underestimated in importance.

There is very little excuse for U.S.-produced seafood products to be anything but good eating quality, and consumers can help to bring this about by returning to the vendor any seafood that has off-odors (i.e., ammonia, sulfide, or the odor often described as "fishy"), off-flavors (i.e., rancid), or poor texture (i.e., tough and/or dehydrated).

The Need for Monitoring

Of all the fresh and frozen flesh foods available to the U.S. consumer, only seafoods are not produced under mandatory inspection; and of all fresh and frozen flesh foods available to the U.S. consumer, only fish have a high degree of unreliable and inconsistent quality (Anonymous, 1973). It is the human tendency to wander from committed and/or expected performance unless there is some sort of mechanism to monitor performance.

The handling procedure recommended in this paper has considerable potential, but it is unlikely that the full potential will be realized or that whatever level of success is reached can be sustained unless a provision for monitoring the procedure is included. Nothing is more disappointing to all concerned than a commitment which is not met consistently. The image of the U.S. Department of Commerce Inspection Service, the image of the company that produces U.S. Grade A fillets, and the image of the logo which identifies the U.S. Grade A product will all suffer unless consumers

find the products to be consistently of U.S. Grade A quality.

Therefore, it is strongly recommended that a private monitoring organization be established. Such an organization may receive its income from a fee to be paid by the processor on a per pound basis, the cost of which can be passed on through the retailer to the consumer. The monitoring organization would use its income to catalog all processors, retailers, etc. that handle the product identified by a logo or mark and to spot check the performance of its members for compliance. It would spot check retail outlets and vessels, and it would assume the responsibility of assuring the product quality level at point of sale.

Note: This recommended procedure is not to be construed as a policy of the National Marine Fisheries Service.

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