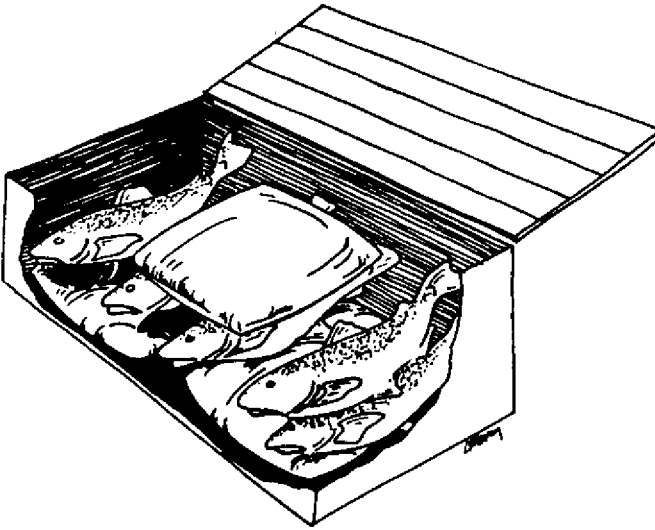


Air Shipment of Fresh Fish: A Primer for Shippers and Cargo Handlers

By
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University of Alaska Fairbanks
November, 1987


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AIR SHIPMENT OF FRESH FISH
A Primer for Shippers and Cargo Handlers

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INTRODUCTION

Supplying fresh seafood has become a significant market for the Alaska processing industry. In 1981, 4 million lb of fresh fish were shipped from Alaska. In 1985, the amount exceeded 12 million lb. These fresh markets continue to expand, becoming more important to the industry.

While West Coast suppliers use trucks, Alaskans operating a fresh fish business use air freight to ship product to market. The air freight carrier plays an important role and, in many cases, airline shipping and handling procedures will determine success or failure for the small processor.

Successful fresh fish marketing depends on several factors. The most important is providing a good quality product on a timely basis at an acceptable price. In order for the shipper and airline to deliver quality seafood to the markets, handlers must be familiar with the product and its requirements for proper care. A good working relationship between the fresh fish processor and the airline is essential for assuring delivery of high quality product. If good quality is not delivered, both the processor and airline suffer.

Another factor critical to marketing fresh seafood is producing consistent quality so that the customer knows exactly what to expect. Meeting special market requirements may also be necessary. These can include bleeding the fish at sea and special processing techniques as well as stringent packaging requirements. Finally, there is a need for contingency plans when shipments are delayed or customers refuse the product. These plans should include lists of alternate customers, brokers, expeditors and local cold storage facilities where the product can be held and repacked, if necessary.

SHELF LIFE, QUALITY AND QUALITY LOSS

Fish are highly perishable. Their flesh is an ideal medium for bacterial growth. It has a soft muscle structure that can be easily damaged and is highly sensitive to temperature changes. Because they are so perishable, fish are acceptable as a food for a limited time. This time period is called shelf life.

The shelf life for foods can vary considerably (Table 1). Some foods (apples and potatoes) have a shelf life of months and others, such as fresh fish, have a short shelf life of no more than 10 to 14 days. These figures assume carefully controlled temperatures and handling conditions. If the product is abused, shelf life is shortened dramatically.

Table 1. Shelf life of fresh foods

Food	Storage temperature (°F)	Shelf life
Strawberries	36	2-5 days
Cherries	34	1-3 weeks
Apples	34	4-6 months
Beans	50	1-2 weeks
Potatoes	42	5-9 months
Eggs	30	6-7 months
Beef	40	1-4 days
Chicken	40	6-7 days
Fish	32	10-14 days
<u>High fat fish</u>		
Salmon		10 days
Sablefish		10 days
<u>Low fat fish</u>		
Cod		14 days
Halibut		14 days
Rockfish		14 days
Shellfish	32	5 days

Shelf life is determined by the initial quality of the product and the handling it receives between the fishermen and consumers. Quality of fish is best when it is harvested and it declines at variable rates thereafter. The most important quality loss factors are bacterial spoilage and physical damage.

There are many ways quality and shelf life are lost. For example, it can be lost because of the way the fisherman handles his catch or the method the processor uses to store the product. These losses can be attributed to bacterial spoilage, enzyme activity, physical damage, dehydration, chemical reactions, and contamination (Table 2).

Quality loss due to bacterial spoilage, enzyme activity, chemical reactions, and dehydration depends on time and temperature. In general, the lower the temperature of the product, the longer its shelf life.

When planning fresh fish shipments, it is important to remember that everyone in the handling chain needs a product that has a reasonable shelf life. The wholesaler and retailer need good shelf life in order to sell the fish product, which may take a few hours or even a few days to get to the consumer.

The product would need a seven or eight day shelf life when it is shipped. Because the shelf life of salmon is ten days or less, the shipper must receive and process it within two or three days of harvest. You must understand the needs of the marketplace to set up a proper delivery and shipping system that assures adequate quality and shelf life.

The consumer may need shelf life if the product is going to be refrigerated after purchase before it is prepared.

Table 2. Causes of quality loss in fish

Bacteria

Bacteria grow easily on fish, attacking it and producing acids that destroy texture and quality. Too many bacteria result in spoilage. Bacteria are most active at temperatures greater than 40^oF. The higher the temperature, the higher the growth rate of bacteria.

Enzyme activity

While fish are alive, body enzymes necessary for life are held in check. After death, these enzymes attack the fish flesh causing unwanted texture changes. Bellyburn is a common result of enzyme action. Enzymes are most active at temperatures greater than 40^oF. Enzyme activity increases in direct proportion to increases in temperature.

Physical damage

Rough handling such as carrying the fish by its tail, hard knocks and undue abuse causes soft flesh and bruising. The delicate muscle structure is easily destroyed by excessive and rough handling.

Dehydration

This is the loss of moisture from the surface of the fish. Dehydration causes the flesh to toughen and slowly dries the fish.

Chemical reactions

Rancidity develops when body fats react with oxygen, causing objectionable odors and flavors.

Contamination

Adulteration of fresh fish with substances such as fuel, dirt and cleaning chemicals usually renders the fish inedible.

Consider an example where it takes one day to get a salmon to a retailer, the retailer needs four days to sell the salmon, and the consumer wants a couple days before using it.

The three quality factors that fresh seafood handlers can most influence are:

1. Proper packaging
2. Time/temperature control
3. Physical handling

PROPER PACKAGING

Proper packaging is necessary to maintain the quality of fresh fish. Packaging protects the fish from physical damage and temperature abuse. It must also protect the aircraft from fouling by blood, slime and drip water. Many different types of cartons are available. A brief description of construction, sizes and suppliers can be found in Appendices A and B. The following packing procedures are recommended:

1. Use a proper sized box for the product being shipped. It is important that the box be easy to handle and provide adequate space for both the product and the gel/dry ice packs used to keep it cool. In most cases, boxes with capacities of 80 lb or less are most suitable. Boxes of 100 lb or larger are more difficult to handle and easier to abuse. Most air carriers require that wetlock boxes with gusseted corners be used. The box should have at least three staples per corner to maintain strength. The use of strapping tape instead of staples is not recommended.
2. Use plastic liners in the box to protect against leaks. Air carriers require a minimum of 4 mils of plastic in the box. The common approach is to use two 2 mil liners. Precautions must be taken to prevent punctures of the liners.
3. Chill the product before packing it in the box. The target temperature must be 32⁰F. To protect product quality, it is

important to maintain proper temperatures. Prechilling can be accomplished using slush ice/chilled sea water (CSW), refrigerated vans and cold storages. Advantages and disadvantages of some of the popular methods are discussed in Appendix C.

4. Careful attention should be given to packing the fish into the box. The visual quality of the product is an important consideration. Fish should be placed flat and straight so they look natural. The box should fit the fish rather than making the fish fit the box.
5. Use gel packs or dry ice to protect the product from outside heat. Placement of the packs is critical to maintaining the temperature inside the box. Most shippers recommend using gel packs on the bottom and top of the box (Figure 1). This will help intercept heat coming into the box. Extra protection can be provided by placing gel packs in the center of the fish and along the sides of the box.

The visual quality of the product is important. Gel packs must be completely frozen and leak free. A leaky gel pack will taint product, rendering it unusable. If there is a question about the integrity of the pack, throw it away. Use four 1.5 lb gel packs in an 80 lb box and two 1.5 lb packs in a 50 lb box. Use of wet ice is strictly regulated by most domestic air carriers.

6. Securely tie the plastic liners so there is no chance of leakage if the box is tipped. Airlines frequently conduct "tip tests" to determine whether containers are properly packed and sealed. Shipments that fail this test are usually returned to the processor for repacking.
7. Use strong plastic or metal strapping to secure the box. Plastic strapping should be sealed using metal clips rather than friction welds, which are weaker and may break during handling. At the very least, use two straps. Extra pro-

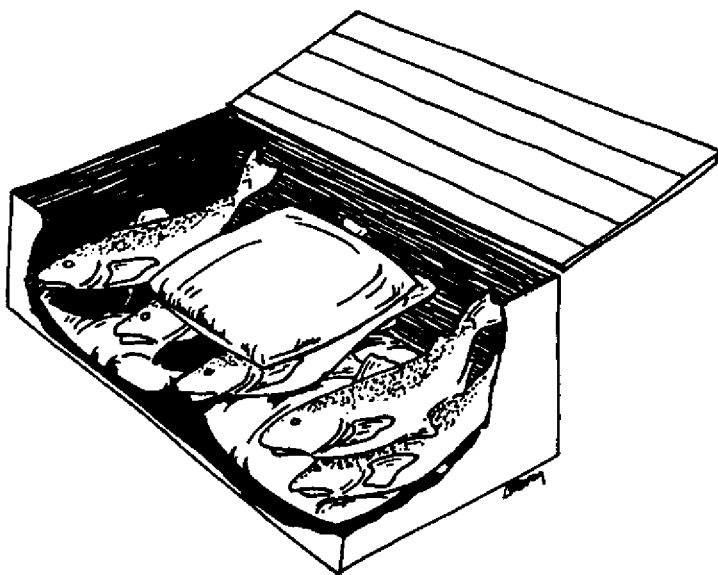


Figure 1. Placement of gel packs in shipping cartons containing fresh fish.

tection is provided by lengthwise strapping. Using filament tape is not recommended since it can fail during handling.

8. All boxes should identify the product, shipper, and receiver and should carry a warning to keep the carton chilled. Some shippers also include handling instruction sheets for new customers and specific information on the shipment, such as area caught and gear type.

These practices should be considered the **MINIMUM** needed for proper protection of air shipments where transit times are short and no problems are anticipated. However, there are many situations such as extra long transit times (in excess of 36 h), complex airline transfers or shipping into hot weather areas when the minimum packaging is not sufficient. In these cases,

extra packaging is needed to maintain product quality and prevent "leakers."

Among the packaging extras are quilted pads placed in the bottom of the cartons to absorb excess water and fish juice that accumulates during shipment. These pads can be used to wrap individual fish to prevent scale loss and shifting within the box. Fish may also be protected by individual plastic bags. Additional gel packs are insurance for long or difficult shipments. They provide extra cooling sources to protect product quality by maintaining the temperature inside the box. Another innovation in packaging fresh fish is the use of a horizontal divider in large boxes to separate layers and prevent crushing.

An important part of packaging is the level of insulation in the box. Good insulation will help maintain refrigerated temperatures and protect product quality. Cardboard and wetlock boxes have a very low insulating capacity.

Most commercial products provide 3/4 to 1 in. of insulation. Extra insulation, if needed, can be provided by styrofoam. Sheets of styrofoam cut to line the sides, top and bottom will provide a protective layer of insulation and help prevent temperature abuse. Usually styrofoam of 1/4 to 1/2 in. is suitable. Although it reduces the volume and carrying capacity of the box, it provides considerable protection.

Styrofoam insulation should be considered necessary when shipping to areas where the product may be unprotected during transfers in airports or in hot weather, when shipping by unknown freight handling systems, and when the product is to be transported beyond the airport. The best practice when packaging fresh fish is to provide as much protection as possible to insure against physical and temperature abuse. The value of most product far exceeds the extra cost incurred in protecting it properly.

Table 3. Effects of temperature on shelf life

Storage temperature (°F)	Shelf life (days)	
	High fat fish ¹	Low fat fish ²
32	10	14
40	5	7
50	2.5	3.5
60	1.5	2
70	1.2	1.7

¹High fat fish include salmon and sablefish

²Low fat fish include halibut, cod and pollock

TIME/TEMPERATURE CONTROL

Time and temperature govern the rate of quality loss. The higher the fish's temperature, the faster quality is lost and the shorter its shelf life will be (Table 3). The closer the product temperature is to 32°F, the longer its shelf life will be. For every ten degree increase in temperature, shelf life is halved. Controlling the product temperature and holding time will minimize quality loss and maximize shelf life. The practical implications for air shipments are:

1. Prevent temperature abuse by keeping all boxed fish as cool as possible. The ideal temperature is 32°F.
2. Hold boxed fish in a cooler, cold storage or reefer van until it is delivered to the airport or put aboard a plane. If it is delivered to the airport early, the shipment should be placed in a cooler if one is available.
3. Wetlock boxes commonly used for shipping fish are excellent heat absorbers. They are dark, heavily waxed, and ab-

sorb heat rapidly. Heat builds up in the box, warming the product. After several hours of abuse, the temperature inside the wetlock box will be greater than the outside temperature. This "greenhouse" effect can be lessened by using lighter colored wetlock boxes. White and silver boxes will not absorb as much heat as the dark boxes, but abuse can still occur.

4. Gel packs are designed to protect the product from outside heat sources, not to chill the product in the box. Gel packs can handle small amounts of constant heat by melting slowly and protecting the fish. Any temperature abuse can quickly overwhelm the gel packs, rendering them useless.
5. An increase in the temperature of the boxed product increases the rate of bacterial spoilage, enzyme actions, chemical reactions, and dehydration (Table 3).

Ideally, all fresh fish should be kept in chilled storage at 32^oF until the last possible moment, then delivered to the airport or airplane shortly before shipment and loaded as the last cargo.

PHYSICAL HANDLING

Package handling also affects product quality. Handling methods can prevent or cause physical damage, a major cause of quality loss. The seafood handler should be aware of some problems with packaging.

Most seafood is shipped in wetlock boxes. At present, these are the most cost effective containers. They provide good structural protection, but are not the ideal seafood shipping container for proper temperature control. The waxed surfaces absorb heat easily and without protection from gel packs they can easily warm the product inside. Even with these disadvantages, the wetlock will remain the basic box for shipping fresh seafood for many processors.

The most serious problem facing handlers is the use of under-strength boxes. Generally, most shippers use cartons having a burst strength of 250 lb. This has been the industry standard for many years. But, as costs have risen, some have cut corners by using understrength boxes with as low as 150 lb bursting strength. These boxes are about 40 percent weaker than the standard, presenting potential problems in handling. Dropping the 150 lb box even a short distance may cause ripped seams.

Unfortunately, it is not easy to distinguish between 250 lb and 150 lb test boxes during handling. Major carton manufacturers test the strength of their boxes and print limits on the bottoms that can tell handlers if the proper weight box is being used. A weight seal is shown in Figure 2. However, many boxes do not have this testing seal and the handler cannot be certain of the box strength.

The wetlock box is rigid because of wax impregnation. While wax imparts strength, it also makes the box somewhat brittle. With rough handling, sides and seams can easily break. Problem areas are the fold creases, where maximum stress occurs. Any box dropped on its corner can easily rupture. This is another reason to use staples instead of filament tape to construct the box. The staples help maintain the strength of the box.

Product can also suffer damage from poor packing. Loosely packed fish can shift during shipment, losing scales and becoming bruised and soft. This damage can be minimized or eliminated by careful packing. Using the proper sized box and filling it to capacity will avoid many of these problems. Individual fish bags or packing material such as quilted pads will also help to prevent scale loss. The best recommendation for handling boxes of fresh seafood is to do so carefully. It is especially important not to drop the boxes on their corners. The result could be a leaker.

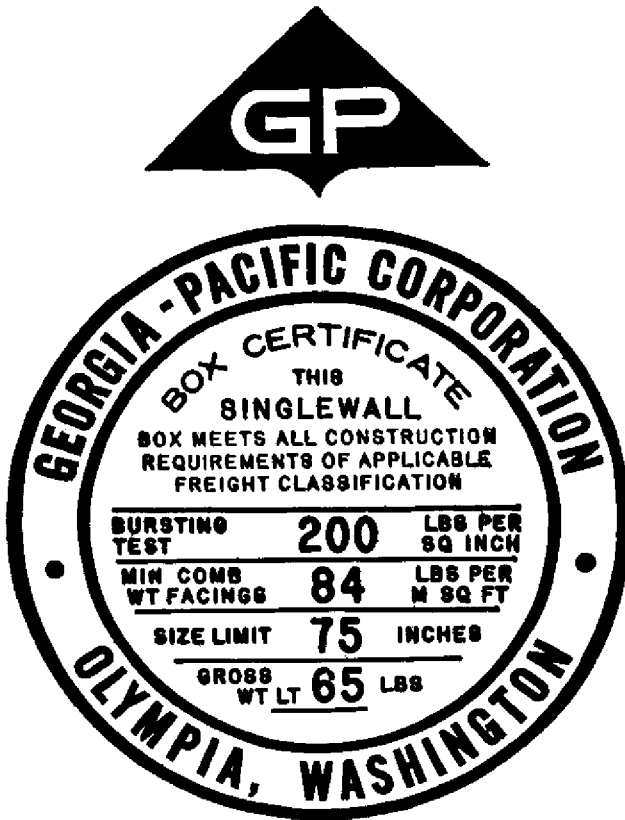


Figure 2. Example of a weight seal. Courtesy Georgia Pacific Corporation, Olympia, Washington.

Leakers

Liquid leaking from boxed seafood is not corrosive to metal. Yet each year "leakers" in the cargo holds of airplanes cause substantial damage. However, it is not the fish juice that causes this damage, it is the bacteria that grow in the liquid. These bacteria secrete acids that corrode the metal of the plane.

If a spill is cleaned up immediately and thoroughly, there is little problem with corrosion. The recommended cleanup is to scrub the spill with a neutral detergent (like dishwashing soap), then rinse the area with a weak chlorine solution. A weak chlorine solution can be made by adding 1 cup bleach to 7 gal water.

OTHER FACTORS

There are several other concerns that should be mentioned when planning fresh fish shipments. Among these are shipment planning, insurance coverage and limits, contingency plans and use of freight forwarders.

SHIPMENT PLANNING

Successful fresh fish shipments require careful and thorough investigation of the many factors that can affect the quality of the product. These may include airline schedules, weather at the destination, plane transfers and documentation. Having good, constant communication channels among shippers, carriers and receivers is probably the point most stressed by carriers and shippers who handle large amounts of seafood. The following is a list of questions that should be answered when planning shipments:

- * Which air carriers serve the area where the fish are being shipped?
- * Is there a particular airline with a good reputation in handling fresh seafoods? Are airline personnel competent in handling fresh seafoods? Does the air carrier offer freight-only flights or is the product shipped on passenger flights?

- * Are the schedules convenient to both shipper and receiver?
- * Are direct flights available or must product be transferred between planes or air carriers? How many transfers will be needed to get the product to its destination?
- * How long are the layovers if product must be transferred? Which air carriers have cool rooms or cold storage facilities where product can be held during layovers and at its final destination?
- * What arrangements must be made to assure that product is shipped on particular flights? Must space be reserved on planes? When will the product arrive at its destination?
- * How is the product to be shipped? Will shipment be by individual box? Will it be in a large unitized container such as an LD-11?
- * Will product be held at the airport for pickup or be delivered? Who is responsible for delivery? What local freight companies have good records in handling fresh seafood shipments?
- * What information must be on the box in order to assure correct shipment and delivery?
- * What documentation must be provided for the shipment?
- * Does the shipment need to be insured? What are the coverages, limits and costs? Does the airline have insurance provisions for their customers?
- * What are the weather conditions at the destination? Is there a chance for product abuse? Does the shipment require extra protection?
- * What additional precautions should be taken to insure product quality? Are extra gel packs needed? Should the box be insulated with styrofoam sheets? Is extra packing material needed to prevent shifting?
- * When does the customer prefer the product to arrive?
- * Does the customer have special packaging requirements?
- * Are communication channels with the air carrier, customer and freight forwarder well established, so that everyone involved knows the schedule and arrangements?

This is not an all-inclusive list, but assembling the answers to these questions and others will help the shipper understand the system and how he can use it to his best advantage. It will also

help the shipper, customer and airline anticipate problem areas and prepare for them. By knowing as much as possible about the freight system and points of destination, fresh fish shipments will go more smoothly. Probably the most important elements of planning are to have a good relationship with the air carrier and to understand the system (Table 4).

INSURANCE COVERAGE AND LIMITS

One of the most overlooked aspects of shipping fresh seafood is insurance coverage. Each air carrier has slightly different insurance policies. Some may provide free insurance, while others charge for coverage. It is necessary to understand the policies of each airline and use them to protect the product being shipped. In general there are three levels of coverage available: no declared value, declared value and full insurance coverage. If no value is declared, air carrier liability is set at a fixed value with an upper limit usually around \$50 per shipment. Declared value coverage protects the shipment against loss and is an additional charge. Full insurance protects the shipment against loss, damage and spoilage.

Declared value coverage usually costs about \$0.40 per \$100 value while full coverage is about \$1.00 per \$100 value. Considering the value of the product being shipped, the cost of insurance is small, and can help recoup losses when product has been delayed or lost. For insurance to be effective, shipments must be checked at the airport by the customer because claims have to be put in immediately if a problem exists. When a customer puts in a claim after the product has left the airline cargo office, the chances of payment are greatly reduced.

CONTINGENCY PLANNING

In shipping fresh fish, things do not always go as expected. There may be times when the shipment is delayed, misses a connection or the customer refuses the product. When this occurs it is important to have a backup plan to handle the product.

Table 4. General rules for shipping fresh seafood

1. Understand the air freight system. Establish good working relationships with the cargo people at the airline.
 2. Plan all shipments carefully. Know the market and customer requirements.
 3. Have contingency plans to handle problems.
 4. Maintain good and timely communications with airline people, freight forwarders and customers.
 5. Ship on nonstop flights when possible.
 6. Use proper packaging materials and anticipate handling problems.
 7. Pack product at the desired temperature.
 8. Insure the shipment.
 9. Provide a good quality product with adequate shelf life for customers.
-

Being prepared for the unexpected will save countless hours of panic and rushed planning. A contingency plan should include the following:

- * Addresses and phone numbers for alternate customers, brokers or markets for the fish
- * Locations of local cold storages that can handle and repack the product if necessary
- * Alternate transportation and routes to the final destination
- * Pertinent information on the shipment (airbill number, flight number transfers and routing) so that it can be traced
- * Contact numbers for airline personnel

- * Local representatives that can personally handle the product
- * Procedures to retrieve the product from the destination quickly
- * Insurance information

Having this type of information available will speed the handling of problem shipments and save money.

FREIGHT FORWARDERS

Using freight forwarders to handle product shipped from Alaska is another form of insurance that may be worth the cost. Freight forwarders act as agents for the shipper and insure that the perishable shipments are handled properly at transfer points and destinations. They provide personal service that may be essential when establishing new markets or dealing with large volumes of fish.

In choosing a forwarding company there are several things to consider. Companies should be chosen for their track record in handling seafood shipments. The size of the operation may be important in getting personal attention for problems. The facilities of the freight forwarder are also important. The company should be able to hold product and repack it if necessary. And, of course, the costs for services are also important.

There are at least two good guides for people shipping from Alaska. One is the Alaska Shippers Guide, printed annually by Alaska Northwest Publishing, P.O. Box 4-EEE, Anchorage, AK, 99509. Another is the Air Freight Directory, printed annually with monthly updates, and published by Air Cargo, Inc. of Annapolis, Maryland.

CONCLUSION

In order to be successful in the fresh fish business, you must maintain control of the three most important factors in maintaining fish quality and shelf life: proper packaging, time/temperature control and careful handling.

Keeping seafood as cool as possible and preventing rough handling will eliminate the majority of problems encountered in shipping fresh fish. Proper planning for shipments, understanding the freight system and having contingency plans are also important parts of the total program for handling fresh seafood. Good communications with customers, air cargo people and freight forwarders are also essential for insuring that fresh fish shipments get to their destination successfully.

The three basic rules of fish handling that apply to fishermen, processors and retailers also apply to fresh seafood handlers:

KEEP IT COOL

KEEP IT CLEAN

KEEP IT MOVING

APPENDIX A SHIPPING CARTONS

CONSTRUCTION

The typical shipping carton for fresh seafood is the single wall corrugated box. It consists of two linerboards glued to a fluted corrugating material (Figure A-1). Both the linerboard and corrugating material are available in a variety of thicknesses or weights. In addition, the corrugating material is available in different flute sizes (Figure A-2). Each provides slightly different properties, but all give the box some stacking strength and puncture resistance. The combination of liner and corrugated board weight, flute size and adhesives gives the box its strength. Depending on the use, any size and strength of box can be constructed.



Figure A-1. Schematic of typical box construction. From *Packaging your own seafood*, New Zealand Fishing Industry Board, 1984.

The components of the box can also be treated with special coatings to protect against moisture. This can be done during or after manufacture. The linerboard can be treated with a plastic coating to make the container moisture resistant or the box can be made into a wetlock box by impregnating it with wax. Both types of containers are used in seafood shipments.

STYLES

There are countless styles of boxes available to the shipper. Figure A-3 shows some of them. This is not a comprehensive figure, but should illustrate the wide variety of possible designs. Both the intended market and the intended use will affect your choice of box.

SIZE

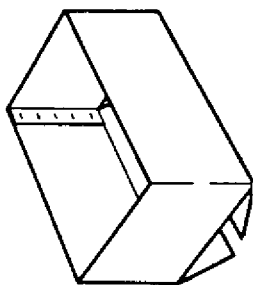
There are a wide variety of sizes available and almost any size can be manufactured. For fresh fish shipments, the size is limited to what can be easily handled. The most popular box sizes have a 50 to 80 lb capacity. Boxes with 100 lb capacity can also be used, but should be considered the upper limit for shipments since they are more susceptible to abuse.

Figure A-2. Flute sizes. Modified from *Packaging your own seafood*, New Zealand Fishing Advisory Board, 1984.

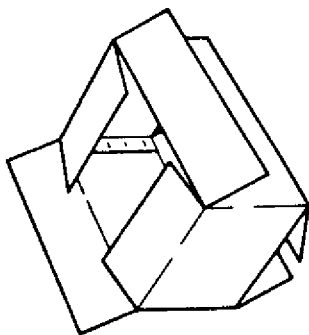
	Flutes per linear foot	Characteristics	Approximate height ¹ (in.)
A-flute	36	greatest compressive resistance good cushioning material	3/16
B-flute	50	greatest crush resistance	3/32
C-flute	42	good stack strength greatest shock absorbance	9/64
E-flute	94	designed as a good substitute for solid fiber board	3/64

¹Not including thickness of facings

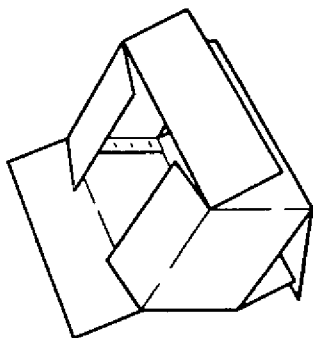
Figure A-3. Schematic diagrams of typical box construction. Modified from *Packaging your own seafood*, New Zealand Fishing Industry Board, 1984.



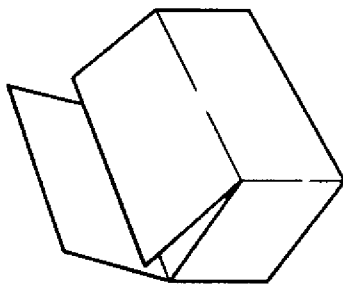
1. Regular slotted case or tray. Flaps on one end only.



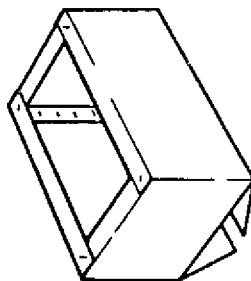
2. Regular slotted case. Outer flaps only meeting.



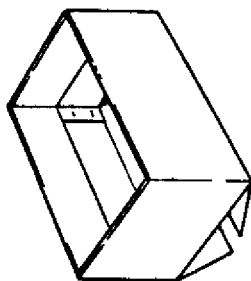
3. Regular slotted case. Outer flaps partially overlapping.



4. Regular slotted case. Outer flaps fully overlapping.

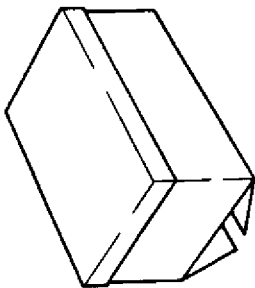


5. Regular slotted case or tray. Reduced top flaps from stacking flange if stretched by customer.

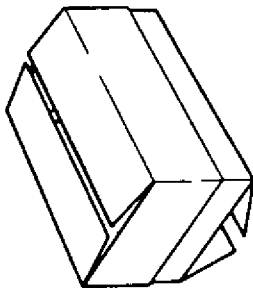


6. Regular slotted case or tray. Top flange provides rigidity. Handholes can be provided in end panels if required.

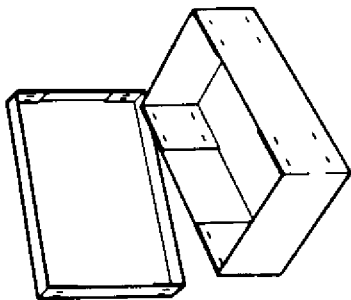
Figure A-3 (Continued)



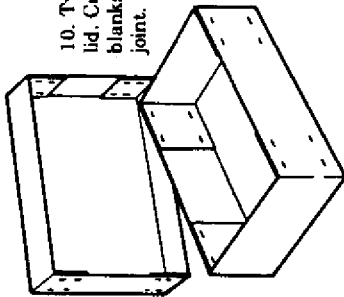
7. Two piece box and lid.
Base: regular slotted tray or case. Flap on base only. Lid: greased and slotted blank. No manufacturers joint.



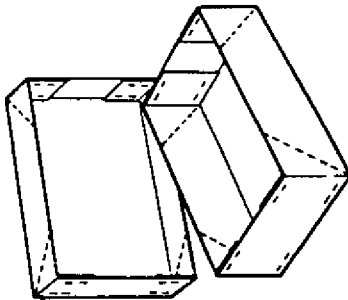
8. Two piece telescopic case.
Base: regular slotted case. Flaps on base only. Lid: Regular slotted case. Flaps on top only.



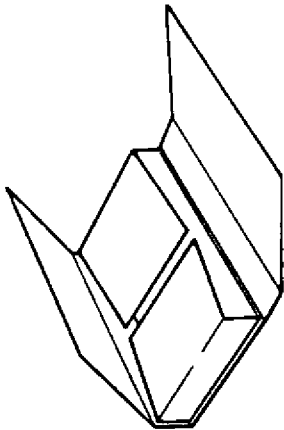
9. Two piece box and lid with reduced depth lid. No manufacturers joint.



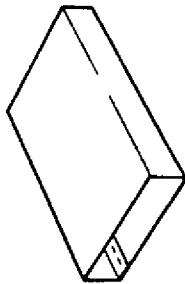
10. Two piece box and slotted lid. Creased and slotted blanks. No manufacturers joint.



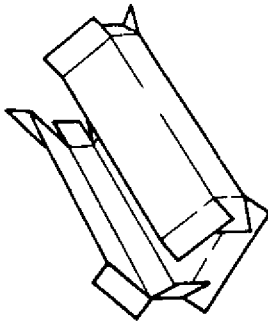
11. Two piece collapsible box and lid. Creased and slotted blanks. Diagonal creases allow box and lid to be collapsed after stitching by customer or manufacturer. If space is at a premium this box is most useful.



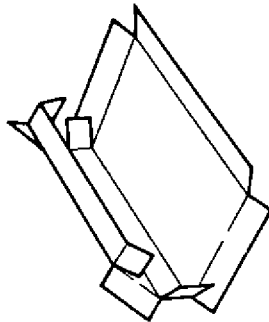
12. Two piece folder. No manufacturers joint.



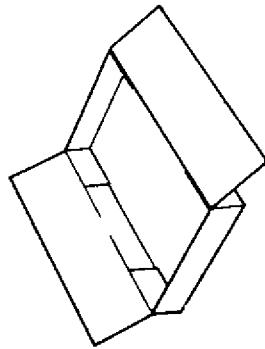
13. Sleeve with end opening.



14. Five panel folder. Slotted on ends. No manufacturers joint.



15. Five panel folder. Slotted on ends. Two corners cut out. No manufacturers joint.



16. Five panel folder. Slotted on sides. No manufacturers joint.

APPENDIX B SUPPLIERS

There are many companies outside of those listed here that sell cartons, gel packs, styrofoam, plastics and other shipping materials. Consult your yellow pages or trade directories for other suppliers.

CARTONS

Accurate Packaging Inc.
3405 Lincoln Ave.
Tacoma, WA 98421
(206)383-1563

Allpack Container Inc.
480 Andover Park E.
Tukwila, Washington
(206)575-0900

American Dry Ice Corp.
672 South Orcas St.
Seattle, WA 98198
(206)767-6671

Dick Anderson Co.
P.O. Box 4
Bellevue, Washington
(206)747-3722

Boise Cascade Corp.
P.O. Box 592
Kirkland, WA 98083
(206)882-0236

Commencement Bay
Corrugated Box Co.
600 Alexander
Tacoma, WA 98421
(206)223-0144

Container Corporation
of America
7000 S. 143rd St.
Seattle, WA 98168
(206)235-3344

Georgia Pacific Corp.
1203 Fones Road
Olympia, WA 98501
(206)491-1310

W.R. Grace
P.O. Box A
Auburn, WA 98004
(206)833-2555

**LeDuc Packaging
Enterprises**
3623 6th S.
Seattle, WA 98134
(206)622-89128

Longview Fibre Co.
5901 E. Marginal Way S.
Seattle, WA 98134
(206)762-7170

Nelpack Corp.
P.O. Box 136
Wauna, WA 98395
(206)922-3566

Northwest Paper Box Co.
644 N.W. 44th
Seattle, WA 98107
(206)782-7105

Seattle Packaging Corp.
3701 S. Norfolk
Seattle, WA 98118
(206)725-3000

Seattle-Tacoma Box Co.
23400 71st Place S.
Kent, WA 98031
(206)854-9700

Solomon Container Co.
620 S. Spokane St.
Seattle, WA 98134
(206)622-5076

Sound Container, Inc.
19030 West Valley Hgwy.
Kent, WA 98032
(206)251-5100

Western Kraft Paper Group
1899 120th N.E.
Bellevue, WA 98005
(206)455-1111

Weyerhaeuser
P.O. Box 101
Olympia, WA 98507
(206)491-1200

GEL PACKS

American Dry Ice Corp.
672 S. Orcas
Seattle, WA 98108
(206)767-6671

**LeDuc Packaging
Enterprises**
3623 6th South
Seattle, WA 98134
(206)622-8918

Tempress, Inc.
701 S. Orchard
Seattle, WA 98108
(800)426-2600
(206)762-1410

STYROFOAM

Allpack Container Inc.
480 Andover Park E.
Tukwila, WA 98188
(206)575-0900

Cellular Packaging Inc.
22431 76th St. South
Kent, WA 98032
(206)872-7633

Cork Insulation Sales, Inc.
P.O. Box 3822
Seattle, WA 98124
(206)622-1094

Tempress Inc.
701 S. Orchard
Seattle, WA 98108
(800)426-2600
(206)762-1410

PLASTICS

Cascade Bag and Supply
Co.
800 Mercer
Seattle, WA 98107
(206)625-1410

Cello Bag Co.
17100 West Valley Hgwy.
Kent, WA 98032

Elkay Plastics Co.
6110 6th St. S.
Seattle, WA 98108
(206)763-3730

Mohawk Northern Plastics,
Inc.
701 A, N.E.
Auburn, WA 98002
(206)939-8206

Shields Bag and Printing
Co.
2535 152nd N.E.
Redmond, WA 98052
(206)883-4146

John T. Vlasic Co.
412 W. Mercer
Seattle, WA 98119
(206)282-5551

APPENDIX C PRECHILLING SYSTEMS

The systems used for chilling fresh fish prior to air shipment include chilling rooms, refrigerated vans, cold storage blast freezers, slush ice or chilled seawater (CSW) tanks. These systems can be classified as dry chilling (chilling rooms, vans and blast freezers) and liquid chilling (slush ice and CSW). Each has its own advantages and disadvantages.

DRY CHILLING

Dry chilling methods consist of putting the product in a cool room, refrigerated van or blast freezer until the temperature is reduced to 32°F or slightly lower. This can be done before or after packing. This system has several disadvantages that may reduce product quality. Cooling is slow because air has a low heat transfer coefficient. Air circulation in vans and blast freezers can dry the product surface, causing weight loss. Dry air will pick up moisture from the wet fish. Using blast freezers for product cooling is discouraged because partial freezing can occur and damage flesh texture. For the small shipper, these systems are expensive since they require mechanical refrigeration and adequate space for the cooling rooms. However, they can be effective if the product is properly protected and carefully monitored so that it spends no longer than necessary in these rooms.

LIQUID CHILLING

Liquid systems are more suitable for chilling fresh seafood. Slush ice consists of a container of ice and water in which the fish are immersed until the temperature is reduced to 32°F or slightly lower.

The CSW system uses an air pump and grid to agitate the slush ice mixture for quicker chilling. These systems have several advantages over the dry systems. Chilling is much faster and

more uniform. They require a source of ice, can be set up anywhere and do not require expensive equipment.

A simple slush ice system can be prepared using a fish tote, water and ice. Enough ice should be added to get the temperature to 32°F and maintain that temperature during the chilling process. Fish should be added a few at a time so that no crushing occurs. Chilling will occur rapidly, usually within 30 minutes, depending on the size of the fish. Internal temperatures should be taken to assure the desired temperature is reached.

More rapid chilling can be achieved with a CSW system bubbling air to provide circulation, but it is more expensive because it requires an air pump and piping to the tote. A disadvantage of the liquid system is that the water has to be drained from the product before it is packed to prevent it from adding extra weight and unwanted water.