AIR SHIPMENT of Fresh Fish

A Primer for Shippers and Cargo Handlers

By Chuck Crapo and Brian Paust

Alaska Sea Grant College Program • Marine Advisory Bulletin No. 32 • Revised 1991
Air Shipment of Fresh Fish

A Primer for Shippers and Cargo Handlers

Chuck Crapo
Fishery Industrial Technology Center
Kodiak, Alaska

Brian Paust
Marine Advisory Program
Petersburg, Alaska

MAB-32
Revised 1991
Price: $3.00
About the Authors

Chuck Crapo is assistant professor of seafood technology for the Fishery Industrial Technology Center (FITC) and the Sea Grant Marine Advisory Program in Kodiak, University of Alaska. He has published numerous reports on seafood quality, and has worked eight years in quality control for the Alaska seafood industry. Brian Paust is assistant professor of fisheries education for the Sea Grant Marine Advisory Program in Petersburg. He has held positions in fisheries outreach in Alaska since 1978, and has written several publications on underutilized species and other fisheries topics.

Acknowledgment

Thanks to R.N. Cunningham, general manager of the Georgia-Pacific Corporation in Olympia, Washington, for the weight seal figure used in this book.

The first edition of Marine Advisory Bulletin No. 32 was published in 1987. Text formatting for the revised edition is by Lisa Sporleder and cover design is by Susan Burroughs. This booklet was produced by the University of Alaska Sea Grant College Program, which is cooperatively supported by the University of Alaska with state funds and by the U.S. Department of Commerce, NOAA Office of Sea Grant and Extramural Programs, under grant number NA90AA-D-SG066, project numbers A/71-01 and A/75-01. Alaska Airlines provided additional support for printing costs. Printed on recycled paper.
Table of Contents

Introduction .................................................. 1

Shelf Life: Quality and Quality Loss ................. 1
    Proper Packaging ........................................ 4
    Time and Temperature Control ...................... 8
    Physical Handling ..................................... 9
    Leakers .................................................. 12

Shipment Planning ........................................... 12

Insurance Coverage and Limits ......................... 14

Contingency Planning .................................... 15

Freight Forwarders ....................................... 16

Conclusion .................................................. 17

Appendix A: Shipping Cartons ....................... 18
    Construction ............................................ 18
    Style .................................................... 18
    Size ...................................................... 19

Appendix B: Suppliers .................................... 24
    Cartons ................................................ 24
    Gel Packs ............................................. 26
    Styrofoam ............................................. 26
    Plastics ............................................... 27

Appendix C: Prechilling Systems .................... 28
    Dry Chilling .......................................... 28
    Liquid Chilling ...................................... 28

Appendix D: Box Insulation Values
and Gel Pack Effectiveness .......................... 30
    Box Insulation Values ................................ 30
    Gel Pack Effectiveness ............................... 31
Introduction

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

Successful fresh fish marketing depends on several factors. Providing a good quality product on a timely basis at an acceptable price is most important. So that the processor and airline can deliver quality seafood to market, handlers must be familiar with the product and its requirements for proper care. A good working relationship between the processor and airline is essential to assure 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 providing consistent quality. Meeting special market requirements may also be necessary. These can include bleeding fish at sea, special processing techniques, and stringent packaging requirements. Finally, contingency plans are needed when shipments are delayed or customers refuse the product. These plans should include lists of alternate customers, brokers, expedites, and local cold storage facilities where the product can be held and repacked.

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 food for a limited period called shelf life.
Table 1. Ideal shelf life of fresh seafood stored at 32°F.

<table>
<thead>
<tr>
<th>Food</th>
<th>Shelf life (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High fat fish</strong></td>
<td></td>
</tr>
<tr>
<td>Herring</td>
<td>10</td>
</tr>
<tr>
<td>Salmon</td>
<td>10</td>
</tr>
<tr>
<td>Sablefish</td>
<td>10</td>
</tr>
<tr>
<td><strong>Low fat fish</strong></td>
<td></td>
</tr>
<tr>
<td>Cod</td>
<td>14</td>
</tr>
<tr>
<td>Halibut</td>
<td>14</td>
</tr>
<tr>
<td>Pollock</td>
<td>14</td>
</tr>
<tr>
<td>Rockfish</td>
<td>14</td>
</tr>
<tr>
<td><strong>Shellfish</strong></td>
<td></td>
</tr>
<tr>
<td>Crab</td>
<td>5</td>
</tr>
<tr>
<td>Mussels</td>
<td>5</td>
</tr>
<tr>
<td>Scallops</td>
<td>5</td>
</tr>
<tr>
<td>Shrimp</td>
<td>5</td>
</tr>
</tbody>
</table>

The shelf life for fish varies between 10 and 14 days if the fish are carefully handled (Table 1). If the product is abused, shelf life is shortened dramatically.

Practical shelf life is determined by the initial product quality and the handling it receives from the fishermen to consumers. Fish quality is best when it is harvested, and it declines at variable rates. Frequently the practical shelf life is less than the ideal shelf life.

There are many ways quality is lost and shelf life shortened. For example, quality can be lost by poor handling during catch or inefficient temperature control during processing. Quality losses are caused by bacterial spoilage, enzyme activity, physical damage, dehydration, chemical reactions, and contamination (Table 2).
Table 2. Causes of quality loss in fish.

**Bacteria.** Bacteria grow easily on fish, digesting its flesh and producing acids that destroy texture and quality. Too many bacteria result in spoilage. Bacteria are most active at temperatures between 40°F and 140°F. The higher the temperature, the faster the growth rate of bacteria.

**Enzyme activity.** While fish are alive, body enzymes necessary for life are held in check. After death, these enzymes can consume the fish flesh causing unwanted texture changes. Bellyburn is a common result of enzyme action. Enzymes are most active at temperatures greater than 40°F. Enzyme activity increases in direct proportion to 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.** Contamination of fresh fish with substances such as fuel, dirt, and cleaning chemicals usually will taint the flesh.
Quality loss due to bacterial spoilage, enzyme activity, chemical reactions, and dehydration depends on time and temperature. The lower the product temperature, the longer its shelf life.

When planning fresh fish shipments, it is important to remember that everyone in the handling chain needs a product with marketable shelf life. The wholesaler and retailer need sufficient shelf life to sell the product. It may take a few hours or days to get the fish to the consumer. And the consumer needs shelf life if the product is going to be refrigerated after purchase before it is prepared.

If it takes one day to get a salmon to a retailer, if the retailer needs four days to sell the salmon, and if the consumer wants a few days before using it, seven or eight days shelf life are needed. Thus for fish shipped from Alaska, the processor must process it within two or three days of harvest to give the fish the needed shelf life. Understanding the needs of the marketplace and setting up a proper delivery and shipping system will help assure quality and shelf life.

**Proper Packaging**

Proper packaging is necessary to maintain fresh fish quality. Packaging protects the fish from physical damage and temperature abuse. It must also protect the aircraft from fouling by blood, slime, and drip. Many different types of cartons are available. Most fish are shipped in wax-impregnated “wetlock” cartons. For this reason, the discussion focuses on wetlock boxes. A brief description of construction, sizes, and suppliers are in Appendices A and B.

The shipper should consult the airline company for specific requirements. The following general packing procedures are recommended:

1. Use a proper size box for the product being shipped. It is impor-
tant that the box be easy to handle and provide adequate space for both the product and the gel or dry ice packs. In most cases, boxes of 80 lbs or less are most suitable. Larger boxes are more difficult to handle and easier to abuse. Most air carriers require that wetlock boxes have gusseted corners. The box should have at least three staples per corner to maintain strength. Do not use strapping tape in place of staples.

2. Use plastic liners 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 to 32°F before boxing. To protect product quality, it is important to maintain proper temperatures. Pre-chilling can be accomplished using slush ice or chilled seawater (CSW), refrigerated vans, and cold storage. Advantages and disadvantages of some of the popular methods are discussed in Appendix C.

4. Fish must be packed carefully. The visual quality of the product is important. 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 maintain the temperature inside the box. Most shippers recommend using gel packs on the bottom and top of the product (Figure 1). This will help intercept heat. Extra protection can be provided by placing gel packs in the center of the fish and along the sides of the box.

Gel packs must be completely frozen and leak free. A leaky gel pack will taint the product. 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 to prevent 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. At the very least, use two straps. Extra protection is provided by lengthwise strapping. Don’t use filament tape 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 sheets for new customers and specific information on the shipment, such as area caught and gear type.
These practices should be considered the \textbf{minimum} needed for proper protection of shipments where transit times are short and no problems are anticipated. However, during long transit times (in excess of 36 hours), complex airline transfers, or shipping into hot-weather areas, minimum packaging is not sufficient. In these cases, extra packaging is needed to maintain product quality and prevent "leakers."

Quilted pads placed in the bottom of the cartons will absorb excess water and fish juice that accumulates during shipment. These pads can be used to wrap individual fish, preventing 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, providing extra cooling sources. 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. Insulation properties and effects of gel packs are discussed in Appendix D.

Most wetlock boxes provide 1 to 1 inch of insulation. Extra insulation 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 \( \frac{1}{4} \) to \( \frac{1}{2} \) inch is suitable. Although it reduces the volume and carrying capacity of the box, it provides considerable protection.

Styrofoam insulation is 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
Table 3. Effects of temperature on shelf life.

<table>
<thead>
<tr>
<th>Storage temperature (°F)</th>
<th>Shelf life (days)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High fat fish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>50</td>
<td>2.5</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>1.5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>1.2</td>
<td>1.7</td>
<td></td>
</tr>
</tbody>
</table>

1High fat fish include salmon and sablefish.
2Low fat fish include halibut, cod, and pollock.

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.

*Time and Temperature Control*

Time and temperature control the rate of quality loss. Higher storage temperatures result in shortened shelf life (Table 3). For every 10-degree increase in temperature, shelf life is halved. Controlling the product temperature and holding time will minimize quality loss and maximize shelf life. Following are recommendations for controlling time and temperature of air shipments:

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 are excellent heat absorbers. They are dark, heavily waxed, and absorb heat rapidly. Heat builds up in the box, warming the product. After several hours of abuse, the temperature inside the wetlock box can 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, although 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 protect the fish by absorbing small amounts of constant heat as they melt. Any temperature abuse will quickly overwhelm gel packs.

5. An increase in the temperature destroys quality by increasing the rate of bacterial spoilage, enzyme action, chemical reactions, and dehydration (Table 3).

Ideally, all fresh fish should be kept in chilled storage at 32°F 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. The seafood handler should be aware of some problems with packaging.

Most seafood is shipped in wetlock boxes, 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. Styrofoam boxes are also being
used but because of high cost are not as popular as the wetlock.

A serious problem facing handlers is the understrength box. Generally, shippers use cartons having a burst strength of 250 lbs. 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 seams to rip.

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 tell handlers if the proper weight box is being used. A weight seal is shown in Figure 2. Unfortunately, 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 brittle. Rough handling can easily break sides and seams. Fold creases, where maximum stress occurs, cause problems. 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 maintain the strength of the box.

The product also can 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 size box and filling it to capacity will avoid many of these problems. Individual bags or packing material such as quilted pads help 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 of 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. It is not the fish juice that causes this damage, but the bacteria that grow in the liquid. These bacteria produce acids that corrode the metal of the plane.

If a spill is cleaned up immediately and thoroughly, there will be little 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 gallons of water.

Shipment Planning

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

- Which air carriers serve the area where the fish are being shipped?
- Which airline has 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 the 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 the product must be transferred? Which air carriers have cool rooms or cold storage facilities where the product can be held during layovers and at its final destination?

- What arrangements must be made to assure that the 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 the product be held at the airport for pickup or will it 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 provide insurance for customers?

- What are the weather conditions at the destination? Does the shipment require extra protection?

- What 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?
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.

This is not an all-inclusive list, but assembling the answers to these questions and others will help the processor understand the system and how it can be used to best advantage. It will also help the processor, customer, and airline anticipate problems and prepare for them. Learn as much as possible about the freight system and points of destination, and fresh fish shipments will go smoothly. 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. In general there are three levels of coverage: 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 less than full coverage. 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 must be made immediately if a problem exists. If a customer puts in a claim after the product has left the cargo office, the chances of payment are greatly reduced.

Contingency Planning

When shipping fresh fish, expect the unexpected. The shipment could be delayed, or miss a connection, or the customer could refuse the product. It is important to have a backup plan to handle the product.

Being prepared for the unexpected will save many 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 needed.
• 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.

Forwarding 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 the costs for services should also be considered.

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

To be successful in the fresh fish business, you must control packaging, time and temperature, and product handling.

Keeping seafood as cool as possible and preventing rough handling will eliminate most of the problems encountered in shipping fresh fish. Proper planning for shipments, understanding the freight system, and having contingency plans are important parts of the total program for handling fresh seafood. Good communications with customers, air cargo employees, 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. Any size and strength of box can be constructed.

![Figure A-1. Typical corrugated box construction. From Packaging Your Own Seafood, New Zealand Fishing Industry Board, 1984.](image)

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 coated with plastic or impregnated with wax to make the container moisture resistant. Both types of containers are used in seafood shipments.

Style

Figure A-3 shows some of the many styles of boxes available to the shipper. This figure illustrates the wide variety of designs. Both
the intended market and the intended use will affect your choice of box.

Size

A wide variety of sizes is available, and almost any size can be manufactured. For fresh fish shipments, the size is limited to what can be handled easily. 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.
<table>
<thead>
<tr>
<th>Flutes per linear foot</th>
<th>Approximate height$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A-flute</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Greatest compressive resistance. Good cushioning material.</td>
</tr>
<tr>
<td><strong>B-flute</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Greatest crush resistance.</td>
</tr>
<tr>
<td><strong>C-flute</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Good stack strength. Greatest shock absorbance.</td>
</tr>
<tr>
<td><strong>E-flute</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Designed as a good substitute for solid fiber board.</td>
</tr>
</tbody>
</table>

$^1$Not including thickness of facings.

Figure A-2. Corrugated box flute sizes. Modified from *Packaging Your Own Seafood*, New Zealand Fishing Advisory Board, 1984.
1. Regular slotted case or tray. Flaps on one end only.

2. Regular slotted case. Outer flaps meet.


5. Regular slotted case or tray. Reduced top flaps form 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. Drams of typical box construction. Modified from Packaging Your Own Seafood, New Zealand Fishing Advisory Board, 1984.

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.


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.

Figure A-3. (continued)
12. Two piece folder. No manufacturers joint.

13. Sleeve with end opening.


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


Figure A-3. (continued)
Appendix B
Suppliers

These and many other companies 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, WA 98188
(206) 575-0900

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

Dick Anderson Co.
P.O. Box 4
Bellevue, WA 98003
(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

Fleenor Paper Co., Inc.
155 W. 1st Ave.
Anchorage, AK 99501
(907) 277-5403

Frontier Packaging Inc.
1301 E. 1st Ave.
Anchorage, AK 99501
(907) 274-4400
(800) 478-0040
Georgia Pacific Corp.
203 Fones Road
Olympia, WA 98501
(206) 491-1310

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

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

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

LeDuc Packaging Enterprises
4740 44th S.W.
Seattle, WA 98105
(206) 932-3744

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

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

Western Insulfoam
628 Western Dr.
Anchorage, AK 99501
(907) 279-9407

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

Western Kraft Paper Group
1899 120th N.E.
Bellevue, WA 98005
(206) 456-1111

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

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

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

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

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

LeDuc Packaging Enterprises
4740 44th S.W.
Seattle, WA 98105
(206) 932-3744

Fleenor Paper Co., Inc.
155 W. 1st Ave.
Anchorage, AK 99501
(907) 277-5403

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

Frontier Packaging Inc.
1301 E. 1st Ave.
Anchorage, AK 99501
(907) 274-4400
(800) 478-0040

STYROFOAM

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

Western Insulfoam
628 Western Dr.
Anchorage, AK 99501
(907) 279-9407

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

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

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

Cello Bag Co.
17100 West Valley Hwy.
Kent, WA 98032
(206) 251-8666

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

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

Western Insulfoam
628 Western Dr.
Anchorage, AK 99501
(907) 279-9407

Fleenor Paper Co., Inc.
155 W. 1st Ave.
Anchorage, AK 99501
(907) 277-5403

Frontier Packaging Inc.
1301 E. 1st Ave.
Anchorage, AK 99501
(907) 274-4400
(800) 478-0040

Mohawk Northern Plastics, Inc.
701 A. N.E.
Auburn, WA 98002
(206) 939-8206
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, and 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. 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 is in these rooms no longer than necessary.

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 advan-
tages over the dry systems. Chilling is much faster and more uniform. Liquid chilling systems 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 to prevent crushing. Chilling will occur rapidly, usually within 30 minutes, depending on the size and volume of fish. Internal temperatures should be taken to assure the desired temperature is reached.

Faster chilling can be achieved using a CSW system equipped with 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 must be drained from the product before it is packed to prevent adding extra weight and unwanted water.
Appendix D
Box Insulation Values and
Gel Pack Effectiveness

Two factors that maintain temperature control during transit are the insulation level of the container and the value of gel packs. Product quality depends on minimizing the temperature rise during shipment. What is the insulation or R value of wetlock or styrofoam boxes? How useful are gel packs in keeping fish cold? In recent tests, shipping containers were evaluated for their insulation rating and gel packs for effectiveness.

Box Insulation Values

Fifty pounds of salmon, prechilled to 32°F, were loaded into wetlocks, one insulated with a 3/8 inch styrofoam insert and another uninsulated. The boxes contained no gel packs and were held at 60°F. After 6 hours the fish temperature rose to 40°F in the wetlock box. After insulation was added to the same box, the temperature rose to 40°F in 12 hours. Adding insulation doubled the maximum transit time for product in the insulated box. With the data from these experiments, R values were calculated. Similar tests were done on styrofoam boxes ranging from 25 to 125 lb capacity.

The R values of wetlocks, insulated wetlocks, and other styrofoam boxes are presented in Table D-1. Adding styrofoam to any container is very effective in maintaining temperature. Generally, the styrofoam boxes have better insulation characteristics than wetlocks. The thicker the wall of the styrofoam box, the higher the R value. The effect of shipping container insulation is shown in Figures D-1 and D-2.
Table D-1. R values for shipping containers.

<table>
<thead>
<tr>
<th>Box</th>
<th>R Value Average</th>
<th>Range</th>
<th>Box wall thickness Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>50# Wetlock</td>
<td>3.12</td>
<td>2.76–3.32</td>
<td>3/8–5/8&quot;</td>
</tr>
<tr>
<td>50# Insulated wetlock</td>
<td>4.18</td>
<td>3.77–4.32</td>
<td>3/4–1&quot;</td>
</tr>
<tr>
<td>25# Styrofoam box</td>
<td>4.20</td>
<td>3.74–4.61</td>
<td>3/4–7/8&quot;</td>
</tr>
<tr>
<td>50# Styrofoam box</td>
<td>6.31</td>
<td>5.51–7.16</td>
<td>7/8–1&quot;</td>
</tr>
<tr>
<td>100# Styrofoam box</td>
<td>6.45</td>
<td>5.80–7.12</td>
<td>1–1 1/4&quot;</td>
</tr>
</tbody>
</table>

*Gel Pack Effectiveness*

The positive effect of gel packs is illustrated in Figure D-2. This test was similar to the box insulation test, except that 1.5 lb gel packs were placed in the top and bottom in each container. The gel packs were effective in intercepting heat and slowed the warming of the product. In about nine hours the product warmed from 32°F to 40°F with gel packs in the uninsulated wetlock. This was a 50% increase when compared to the box without gel packs. The temperature inside the insulated wetlock with gel packs rose to 40°F in a little less than 21 hours, a 75% increase in storage time.

These studies indicate the use of styrofoam insulation and gel packs greatly extend the time seafood can be kept at acceptable temperatures. This becomes important as consumers demand higher quality fish.
Figure D-1. Temperature changes in 50 lbs salmon without gel packs, in uninsulated and insulated wetlocks held at 60°F.

Figure D-2. Temperature changes in 50 lbs salmon with two 1.5 lb gel packs in uninsulated and insulated wetlocks held at 60°F.