Recommended Procedures

for

Handling Troll-Caught Salmon

Dear Reader:

Competing in today's marketplace requires a top-quality product. Ford Motor Company recognized this concept by incorporating the word "quality" in their slogan. The seafood business is no different. Competition from pen-raised fish has enhanced the level of quality to include uniformity and consistent supply. Delivering high-quality troll-caught salmon takes skill, determination and collective efforts from all sectors of the fishery.

The California Salmon Council has embarked on an effort to increase awareness of salmon quality. Marketing troll-caught salmon begins on the boat. Each fisherman must take proper care in landing, dressing and storing the fish. Dockside handling is equally important, because all the care taken at sea can be lost in an instant if the fish are improperly handled.

The commitment to quality is a shared effort by fishermen, buyers, processors and distributors. This brochure reviews fundamentals of producing quality troll-caught salmon. It represents the first phase of an education process to increase awareness of California's vital salmon resource.

Sincerely,

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California Salmon Council

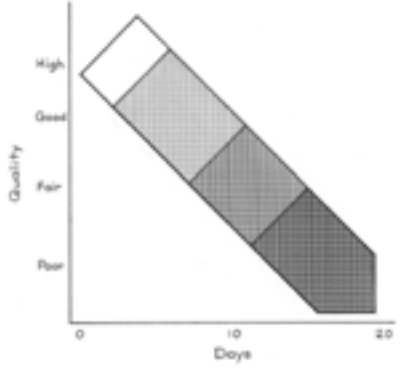
RECOMMENDED PROCEDURES FOR HANDLING TROLL-CAUGHT SALMON

INTRODUCTION

West Coast wild-caught salmon compete in the market place with farmed salmon and Alaska salmon. It is imperative that West Coast trollers deliver high quality salmon to insure best market position and top price. Good handling procedures throughout the production cycle will yield high quality salmon with a maximum shelf life.

SALMON SHELF LIFE

Total shelf life is defined as the maximum number of days a salmon remains edible. Salmon and other fish begin to lose quality as soon as they die, but will retain high quality for about nine days at 32°F (Figure 1). After this time undesirable changes in flavor, odor and texture become apparent as quality decreases. The maximum edible shelf life for salmon at 32° F is about 14 days. Delayed chilling or dressing, or improperly dressing or bleeding, result in both a shorter period of highest quality and shorter edible shelf life.



Why Fish Spoil

As soon as fish die, spoilage begins. Spoilage is the result of a series of changes that take place in the dead fish. These changes are caused by the fish's own enzymes, by bacteria, and by chemical action.

Bacterial spoilage:
Bacteria are the most important cause of fish spoilage. Millions of bacteria are present in the surface slime, on the gills, and in the gut of living fish. These bacteria do not harm the live fish, but soon after the fish dies, bacteria invade the tissues through the gills, along blood vessels, and directly through the skin and belly cavity lining. When this happens, the fish begins to lose quality.

Enzymatic breakdown:
When a fish dies, natural substances in the fish called enzymes breakdown or digest the fish flesh. This causes softening and lowers the quality. It also produces more food for bacteria to feed on, increasing the rate of decay. The most common effect of enzymatic breakdown is belly burn. Enzyme activity can be controlled with proper temperature. (See "Temperature and Spoilage.")

Oxidation:
The action of air on the fat in fish can cause off-flavors and rancidity. Oxidation is especially important in fish with high fat content such as salmon, mackerel and herring.

Temperature and Spoilage
The shelf life of fish varies directly with storage temperatures. The rate of fish spoilage increases as the temperature rises. Ice or refrigeration slows bacterial growth, enzymatic breakdown, and oxidation. Fish held for 14 days at 32°F are equal in quality to fish held for only 2½ days at 60°F. For each hour fish are held at 60 F (not refrigerated on-board), about six hours of refrigerated shelf life is lost. Salmon begins to freeze at 29° or 30°F. While 31° or 32°F is an ideal storage temperature, good controls are needed to insure that the temperature does not drop further.

Trip Time
The maximum time fish should be held refrigerated at sea is three days and delivered on day four (Crapo, 2004). Liquid chilling systems do not increase total shelf life, and cannot justify increased trip time. Fish held in most liquid chilling systems at 32°F for four days can be of equal quality to those held an equivalent time on ice. Refrigerated sea water (RSW) is the exception because significant salt uptake and shrinkage can occur in as few as four days. If you place salmon into a holding tank(s), the temperature in that tank must not be allowed to rise above 32°F.

Trips of a maximum of three days and delivered on day four are recommended (shorter is better) because it may take an additional six days for the product to move from the buyer, through a retail chain store, to the consumer. If fresh salmon are destined for a chain store after being held on board for three days plus one day of delivery, only four days maximum of edible shelf life may remain for the consumer if ideal refrigeration temperature is maintained. Shorter fishing trips can minimize sacrificing the highest quality shelf life at sea and during distribution.

LANDING AND HANDLING

Landing
For best quality fish, stun fish in the water before carefully lifting with a gaff onto your vessel. If a landing net is used, the fish should be stunned immediately upon landing.

1) Immediately stun fish in the water to ease hook removal and to prevent thrashing which leads to bruising and gaping (flesh separations).
2) Fish should be gaffed only in the head. Gaffing the fish in the body lowers the fish grade.

Handling

Careful handling (e.g., do NOT step on, drop, or throw fish), proper dressing, and temperature control (see “Chilling the Catch”) are essential to the delivery of high quality salmon. The surfaces (including the cleaning trough) that the fish may contact should be smooth and moist before landing the salmon. This precaution will help keep the fish moist and prevent excessive scale loss which damages their appearance.

1) Immediately sever the gills to allow the heart to pump out most of the blood.
2) Handle the fish by the head, or the head and body (Figure 2). **NEVER PICK UP A FISH BY THE TAIL!** Handling fish by the tail often breaks the backbone, resulting in blood spots, severe bruising, gaping and mushiness.

Bruises are a hidden problem unseen by the fishermen or receivers. Retailers who fillet or steak salmon can readily observe when fish were improperly handled based on bruising, gaping and mushiness. Bruised portions of salmon are unmarketable and must be discarded. This loss adds to the overall cost of the fish and ultimately lowers the price paid to fishermen. Remember, when salmon bruises, everyone loses: handle with care (Doyle, 1995).

Figure 2. Handle Salmon Carefully.

DRESSING AND CLEANING

Always gut a fish as soon as possible to avoid decomposition of the belly wall (belly burn) by digestive enzymes present in the gut. Belly burn softens the belly walls and causes an objectionable red-brown discoloration of the belly cavity, resulting in a sour odor and a bitter flavor. In extreme cases, the belly walls will burst and rib bones will protrude. Belly burn can occur within ten minutes if fish have been feeding heavily.

Sharp knives are essential for proper dressing. To open the belly, insert a knife at the vent at an angle almost flush with the belly (Figure 3). Maintaining this angle, make a smooth, shallow cut along the center line to the base of the pectoral fins, or about 1½ inches behind the "V" of the neck (Figure 4). Prevent injury by cutting away from yourself.

Figure 3. Insert knife without puncturing viscera.

Figure 4. The shallow belly cut should end 1 – 1 ½ inches behind the "V" of the neck

A shallow cut at the correct angle prevents slashing of the belly wall (Figure 5) and puncturing of the viscera, which would release spoilage agents onto the flesh.

Figure 5. Careless cutting can result in a slashed belly wall

Remove the viscera intact by severing the organs which extend into the head and the connecting tissue on either side. Grasp the viscera firmly, pull them up and toward the tail of the fish.

Completely remove the gill arches because this is an area where bacteria and spoilage enzymes are concentrated. Remove the gill arches in such a way as to leave the throat firmly attached to the lower jaw. The attached throat will prevent the head from breaking off during later handling. Some fishermen prefer removing the gill arches before gutting the fish.

Remove the blood in the veins which run down the sides of the belly cavity by gently sliding the back of the spoon, tip of a cleaning knife, or your fingers along the veins to the backbone. The kidney is the deep red mass which runs along the backbone. Carefully slit open the kidney along the backbone from the head to the tail with the tip of the knife, and scrape the kidney (blood line) out with a spoon (Figure. 6). Avoid cutting into the flesh along the backbone, particularly toward the tail, because the flesh below the kidney is soft and very susceptible to bacterial spoilage. Never use the spoon roughly because it can easily cut the flesh of the belly and loosen the rib bones. Attempts to remove discolored flesh by hard scraping will only case more damage. To insure complete removal of the kidney and blood, using the knife **carefully** cut or break the last two to three vertebrae ("knuckle bones") while avoiding cutting into the belly wall in the rear of the belly cavity. It is better to leave bones intact than to cut the belly flesh (Seafood Producers Cooperative, 2002). Removing the kidney allows all blood and remaining viscera to be washed out of the tail and collar sections when fresh sea water under low pressure is used.

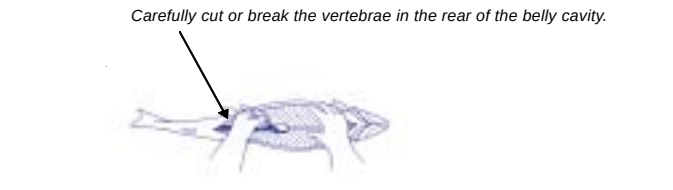


Figure 6. Carefully scrape out the kidney with a spoon.

"Pressure bleeding" can be used after dressing the fish to remove blood and produce a high quality fish. Pressure bleeding involves using a hose cut at an angle and placed over the knuckle area of the spine with water gently circulating through the vascular system which forces virtually all blood from the entire fish (Troller Point Fisheries, 2004). Pressure bleeding must be done with a low pressure hose or else water is forced into the flesh. If fish are frozen at sea in this water logged condition, the accumulated water forms an ice ball. Upon thawing, the flesh in the ice ball area breaks down and becomes soft and mushy (B. Lester, 2004).

Wash the gutted fish thoroughly with clean, running water. (Do not wash the salmon with water from the harbor or from any other questionable source. Contaminated water can add illness-causing bacteria and toxic chemicals to the salmon.) Loosen and wash off all the slime, blood and attached shreds of viscera. Be careful not to remove scales. Remove any residual slime which remains on the body of the fish after washing. Slime contains many bacteria which will accelerate fish spoilage.

Wash boxes

Wash boxes should only be used to wash fish and not for fish storage. Avoid soaking salmon in a wash box because this prevents complete draining of blood due to hydraulic backpressure from being submerged. Prolonged wash box storage results in reduced shelf life. For each hour a fish is held in a non-refrigerated wash box, about six hours of shelf life are lost.

CHILLING THE CATCH

Proper handling and storage of fish at sea insures that the catch stays as fresh as possible until it is landed. The important requirements are to:

1) chill the fish rapidly as soon as they are caught;
2) keep them chilled; and
3) maintain a good standard of cleanliness on deck and in the fish room or stowage area.

Note: If you are freezing the salmon onboard, they should be frozen pre-rigor or post-rigor, but never during rigor which distorts the frozen fish, increases gaping, and results in a dry, tough, cooked product (Doyle 1995).

The importance of good practice at sea cannot be over-emphasized because fish begin to spoil the minute they die. **Neglect on board, even on short fishing trips can result in poor quality fish after only a few hours**. The time the fish is on board the vessel is often longer than the time on shore between landing and consumption. Therefore, the fisherman bears much of the responsibility for the freshness of fish reaching the consumer.

Ice

Ice has the unique characteristic of removing large amounts of heat as it melts without changing its temperature of 32° F. This makes ice an effective “heat mop.” It is the act of ice melting that preserves fish. As ice surrounding fish melts, cold water runs over the fish, continuously draining toward the bilge. It is this cold meltwater that reduces the temperature of the fish rapidly.

Generally, one ton of ice is required to cool two tons of fish, but the actual quantity of ice necessary to properly store fish varies among vessels. Sea and air temperature, the amount of insulation of the fish room or container, the size and temprature of the fish caught, and the length of the trip affect the amount of ice required. To judge the amount of ice needed, examine the catch when off-loading. Check to see if adequate ice remains to cover the fish completely, paying particular attention to vulnerable parts of the fish hold such as the bulkhead, bin boards and top ice. Make adjustments as necessary.

Fish room temperature should be 34° to 35° F. This allows the ice to melt slowly. If the air temperature is maintained too low with refrigeration (for example, 29° to 30°F), uncontrolled slow freezing of the outermost fish may occur, while fish in the middle of the bin may receive inadequate meltwater resulting in insufficient cooling.

Bulk Stowage

This method of icing is the most common and allows maximum use of available space in the fish room. The following recommendations are designed to insure efficient cooling, and to prevent damage and weight loss:

1) Place a layer of ice eight to 12 inches deep, depending on the amount of insulation, in the bottom of a clean bin. Make it smooth and level, breaking up lumps which could damage fish.

2) Place the fish on the ice bed facing the same direction, side by side, loosely, with some space between each fish for ice. The common practice in the salmon fishing industry is to place the fish belly up with the fish sloping slightly down towards its head to facilitate drainage. Keep fish from touching the bin surfaces.

3) Shovel broken ice gently over the entire layer of fish. Pack the belly cavities loosely with ice, and work ice between the fish and along the sides of the bin. Do not overfill the belly cavities or damage may result. Use enough ice so that the layer of fish is barely visible. Smooth off the ice layer. If available, use an ice blanket (an easily cleaned piece of insulation) as a temporary cover to conserve top ice.

4) Place another layer of fish on the ice, nose to tail and over the spaces left between the fish in the first layer. Surround the second row of fish with ice as above. Continue to a maximum of three layers. The top layer of ice should cover the fish completely. Again, an ice blanket will conserve ice and keep fish moist. Check the top ice periodically, and replenish as necessary.

5) If fish are bulked more than three layers, considerable weight loss, mushy flesh, and/or gaping of the belly cavity may occur due to compression. If more than three layers are necessary, shelves which do not bear directly on the lower bin are recommended.

6) At the end of a trip, discard ice which has been in contact with fish, especially the bottom ice. The fish hold should be cleaned and sanitized. (See “Cleaning and Sanitizing.”)

Liquid Chilling System

Liquid chilling systems use water chilled by refrigeration to store fish. These systems are popular because less work is required to chill the catch, and this frequently results in the catch being chilled sooner. Also, the expense for ice is eliminated or reduced, and the crushing and related weight loss usually experienced with improper icing is avoided.

Temperature control is the most important factor affecting the quality of salmon using liquid systems. A system must be capable of maintaining water at 31° to 32° F with a minimum of temperature fluctuation. Inexpensive, good quality thermometers are available at most spa stores. The following sources of temperature fluctuation must be considered in designing and maintaining a liquid chilling system:

1) The system should be insulated to minimize heat gain when the

when the refrigeration is turned off at night. If heat gain becomes a problem, ice should be added in the evening.

2) Fish should be introduced to chilled water throughout the day, and divided evenly among containers. Too many fish placed in a single container (barrel) at one time will warm the chilling water, resulting in slower chilling rates.

3) Avoid freezing fish. Fish start to freeze between 29° and 30°F. Partial freezing and thawing causes cells to burst and bacteria to infiltrate, resulting in soft flesh and reduced quality.

4) Mix water when possible to avoid hot pockets and temperature stratification. This can be done manually using a clean plastic paddle, or automatically using air or water pumps.

5) Measure the temperature of the system periodically to identify possible problems, especially in the morning before starting.

Clean freshwater, or a combination of 1/3 sea water and 2/3 freshwater, is recommended as chilling media in preference to sea water. This is because fish absorb salt to objectionable levels and shrink significantly in 100% refrigerated sea water. Available information indicates that fish chilled in clean freshwater (or ice) do not shrink.

A solution of 1/3 sea water and 2/3 freshwater can be used to achieve lower holding temperatures. This solution will freeze at 30° to 31° F, resulting in a colder storage temperature. Some salt is absorbed by the flesh using 1/3 sea water, but less than 100% sea water. Some fishermen have indicated that a sea water/freshwater mixture may preserve the true color of salmon flesh better than freshwater alone.

Fish held in any liquid system absorb water rapidly. This can lead to a 3% weight increase after four days. All of this increased weight may be lost when fish are later stored on ice.

At the end of each trip, the water containers used for liquid cooling should be cleaned and sanitized. (See “Cleaning and Sanitizing.”)

CLEANING AND SANITIZING

After delivery of fish, thoroughly clean and sanitize all work areas and fish contact surfaces in your vessel. (Some scientists also recommend cleaning and sanitizing before leaving on the next fishing trip.) Examples include: boat deck, checkers, fish hold, bin boards, cleaning tables, mats, knives, gaff hooks, gloves, and rain gear.

Proper cleaning involves:

1) flushing all fish contact surfaces with potable fresh water when at dockside or clean sea water when offshore.
2) applying a suitable detergent (many household laundry detergents are suitable; however, a commercial alkaline-based detergents used in food processing plants are recommended) using stiff plastic-bristle brushes;
3) rinsing thoroughly with potable fresh water or clean sea water.

A sanitizing solution can be prepared using ¼ to ½ cup (7 to 14 capfuls) of bleach per five gallons of water which gives a chlorine concentration approximating 25 - 100 parts per million (D.E. Kramer, 2004). Do not use straight bleach or higher concentrations than recommended. Chlorine solutions should be made just before use because chlorine evaporates quickly, usually within 24 hours.

After the three cleaning steps, a three-step sanitizing treatment should be used to kill bacteria which have not been removed:

1) apply sanitizing solution to all fish contact surfaces previously cleaned;
2) let stand for 5 -10 minutes;
3) thoroughly rinse with potable freshwater or clean sea water.

Store cleaning and sanitizing agents in a specific site off the working deck and away from the fish to avoid accidental contamination of the fish with cleaning agents.

References

Crapo, C. 2004. Alaska Sea Grant Program. Personal Communication.

Doyle, J. P. 1995. Care and Handling of Salmon: The Key to Quality. Marine Advisory Bulletin No. 45. School of Fisheries and Ocean Sciences, University of Alaska Fairbanks. 66 p. http://nsgl.gso.uri.edu/aku/akuh92001.pdf

Fisher, R.A. 1990. On-Board Quality Control, Preparing Mid-Atlantic Fisheries for the Future. Virginia Sea Grant Marine Advisory No. 38. Virginia Institute of Marine Science, The College of William and Mary. 10 p. http://nsgl.gso.uri.edu/vsgcp/vsgcpg90004.pdf

Kramer, D.E. 2004. Alaska Sea Grant Program. Personal Communication.

Kramer, D.E. and Paust, B.C. 1985. Care of Halibut Aboard the Fishing Vessel. Marine Advisory Bulletin No. 18. University of Alaska Sea Grant College Program, University of Alaska Fairbanks. 30 p. http://nsgl.gso.uri.edu/aku/akuh85002.pdf

Lester, B. 2004. Consultant. Personal Comunication.

Seafood Producers Cooperative. 2002. “Troll Salmon – Iced” In: Fish Handling Guidelines. 9 p. 2875 Roeder Ave., Bellingham, WA 98225.

Troller Point Fisheries. 2004. http://www.trollerpoint.com/ (February 12, 2004).

Related Web Publications for Further Reading

Hilderbrand, K.H. 2000 Calculate Slush Ice Needed for Fishing. Oregon Sea Grant Extension Program, Oregon State University. (An interactive Excel file).
http://seafood.ucdavis.edu/pubs/slushice.xls

Price, R.J. 1999. Calculate Wet Ice Needed for Fishing. California Sea Grant Extension Program, University of California, Davis. (An interactive Excel file).
http://seafood.ucdavis.edu/pubs/wetice.xls

Price, R.J. 1989. Why Seafood Spoils. California Sea Grant Extension Program, University of California, Davis.
http://seafood.ucdavis.edu/pubs/spoils.htm

Price, R.J. and Melvin, E.F. 1995. Recommendations for Onboard Handling of Albacore Tuna. California Sea Grant Extension Program. University of California, Davis. .
http://seafood.ucdavis.edu/Pubs/albacore.htm

Seafood HACCP Alliance. 2000. “Condition and Cleanliness of Food Contact Surfaces” In: Sanitation Control Procedures for Processing Fish and Fishery Products.
http://nsgl.gso.uri.edu/flsgp/flsgpe00001/flsgpe00001index.html

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