

RECOMMENDED PRACTICES FOR VESSEL SANITATION AND FISH HANDLING



UNITED STATES DEPARTMENT OF THE INTERIOR

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BUREAU OF COMMERCIAL FISHERIES

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for
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By

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Recommended Practices for Vessel Sanitation and Fish Handling

By

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ABSTRACT

Current practices aboard commercial fishing vessels have come about largely through trial and error, rather than through the application of research findings. As a result, fishermen have not always kept pace with the increasing demands by consumers for fishery products of higher quality. This report can provide the fishery industry with a measuring stick necessary for self evaluation, while supplying specific recommendations for improving vessel sanitation and fish handling techniques.

INTRODUCTION

Modern fishing techniques and gear have made it easier for the commercial fishermen to catch larger quantities of fish in a shorter time than ever before. The technology of processing and fish utilization provides the consumer with a variety of new fish and fishery products. Consumers now receive products ranging from the traditional dried and salted fish to the ultra convenient boil-in-the-pouch items. No matter how sophisticated the processing segment of the industry becomes, however, there is no way of restoring the quality

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of the fish, once it has been lost through mishandling aboard the vessel. The final product placed on sale in the market can be no better than the fish itself.

The consumer must be protected from health hazards. Because of the nature of modern fish-processing techniques and the control they offer, processed fishery products should be completely safe. When fish that are sold fresh are contaminated, however, they may harm the purchaser who prepares them inadequately. When fishery products are not completely sterile (i.e., shelf-stable), the importance of proper fish handling, sanitation, and refrigeration therefore cannot be over emphasized.

A safe and wholesome product is possible when fishermen realize that they must be continually conscious of the ways to maintain quality and control the potential pathogens in the fish.

This circular deals with the many ways that the quality of fish can deteriorate aboard the vessel, and with the practices that will allow the fisherman to land fish of the highest quality possible. Although prepared specifically for fishermen on fresh-water vessels, this circular stresses principles that can be applied successfully to other fisheries as well.

FISH-HANDLING PROCEDURES

How fish are caught and handled aboard the commercial fishing vessel will ultimately determine the quality of the final product whether it is to be sold fresh, semipreserved, or canned. Prompt and proper care of the fish must be taken from the time the fish are caught until they are refrigerated.

EFFECT OF FISHING METHOD ON QUALITY

Regardless of the type of commercial fishing gear used, the battle to preserve the freshness of a fish can be entirely lost, or greatly reduced, before the fish leaves the water.

If a fish becomes excited before it dies, it will go through rigor mortis earlier than a fish that has not been excited; as a result, the keeping quality of the fish may be shortened.

Water temperature is an important factor for quality if the fish die in the gear before being taken aboard the vessel. Temperature is particularly important when fish are caught and die in gill nets.

Warm water and delayed recovery cause the fish to deteriorate in quality. This deterioration can be attributed to one or all of the following three principal actions: (1) enzymatic or autolytic, (2) oxidative, and (3) bacterial. At the time of death, the delicate balance of

body processes and body maintenance is lost. Body enzymes continue to actively digest materials such as fats, proteins, and carbohydrates. The result is the production of less complex body materials that bacteria can use. Oxidative deterioration is produced as a result of enzymatic and bacterial actions. At the time of death, body enzymes and bacterial enzymes attack the fatty tissues of the dead fish and cause off-odors and rancidity.

Bacterial action is the most important single factor contributing to quality deterioration. Water contains numerous types of bacteria. Many of these bacteria can break down and utilize fish tissue.

During life, the skin and alimentary canal normally support large bacterial populations. As long as the fish is alive and free from wounds in the skin tissue, the fish will generally ward off any bacterial attack, since the skin acts as a natural barrier. At death, however, these barriers will be lost, and the body and bacterial enzymes begin to break down the flesh into less complex chemicals. In turn bacteria use these chemicals for growth and reproduction.

When the bacteria invade fish tissue and multiply, the fish not only loses quality but may become a public health problem. Some bacteria are capable of producing potent toxins, such as those produced by the bacteria found in the genera Clostridium, Salmonella, and Streptococcus. Some of these toxin-producing bacteria are capable of growing at temperatures of 45° F. or lower. Thus, if the water temperature is above 45° F., and if nets are not lifted frequently, the fish might become highly contaminated. If these fish are used for smoking, pickling, or marketing fresh, the consumer may become ill from eating them if they are inadequately processed or cooked.

Although most of the fish taken by pound and trap nets will be alive, it is still necessary to remove the fish that die in the nets and also any accumulated debris. Lifting the nets at regular intervals will minimize the bacterial buildup in the dead fish.

Overloading a trawl net will cause the fish to struggle and perhaps even be crushed. Fish that are wounded or crushed are more vulnerable to bacterial invasion and will, in turn, significantly reduce the overall quality of the catch.

Recommendations:

1. Gill nets should not be left in the water for more than 5 days when the water temperature, at the fishing depth, is below 40° F., and no longer than 3 days when the water temperature is 40° F. to 60° F. Nets should be raised at least once every 24 hours when the water temperature is 60° F. and above.

2. Fish taken in pound nets and trap nets should be harvested at least once every 5 days.

3. Long-duration drags should be avoided to prevent overcrowding the trawl net.

4. Fish taken by means of a trawl net should be discharged from the net immediately after the net is brought aboard the fishing vessel.

EFFECTIVE FISH HANDLING

As soon as the catch has been brought aboard the fishing vessel, effective culling, washing, and dressing operations must proceed in such a way as to prevent unnecessary bacterial contamination. Effective on-deck fish handling procedures will prevent excessive bacterial buildup and delay the onset of spoilage.

Culling

Prompt culling of the catch prevents the buildup and spread of bacteria throughout the entire catch. Fish that are damaged or are undergoing external decomposition are likely to contain millions of additional bacteria when compared with fish that are still alive or have just died. Decomposing or diseased fish will contaminate any high-quality fish near them. Placing cull fish in covered containers will minimize fish odors and cross contamination. In contrast, if cull fish are thrown into open boxes or containers and exposed to the sun and weather, their odors will attract flies and other insects, which feed and lay their eggs on such materials. Flies not only present a health hazard for the personnel aboard the vessel but they also contaminate properly cared-for fish, which then lose quality rapidly.

In the light of the efforts of responsible Federal and State authorities to control water pollution, the current practice of discharging cull fish back into the water should be avoided. Fish that are thrown overboard in or near bays and harbors, near city water intakes, or recreation areas may create a bacterial buildup or cause a public nuisance.

Recommendations:

1. Immediately after being taken from the water, each catch of fish should be placed in a large culling-washing box that is self-draining and that allows the fish to spread out over a large area. Heavy-gage 1/4-inch screening is a satisfactory material for the box. The fish should not be more than 6 to 8 inches deep in the box.

2. All bruised, diseased, decomposed, or otherwise damaged fish should be culled.

3. All cull fish should be placed in metal or plastic containers fitted with lids.

4. Cull fish should be landed and processed into meal, fertilizers, or other suitable byproducts where possible. As the last resort, cull fish may be incinerated.

5. Illegally taken fish must either be returned to the water alive or landed in accordance with any existing State or local laws governing their disposal.

Washing the Catch

By immediately washing all fish that are caught, their total bacterial population will be reduced significantly and rapid spoilage will be prevented (fig. 1).

Many bacteria on the skin of the fish cause spoilage once the fish is dead. Some of these bacteria are capable of producing disease in human beings, if they are allowed to remain on the fish that is sold to the consumer. This possible danger is particularly true of most fish caught by any fishing gear that fishes near or makes contact with the bottom of the lake. Such materials as mud, sand, clay, and gravel may mix freely with the catch. Often, other materials such as sticks, weeds, rocks, and rubbish may also contaminate the nets. Bottom sediments and other foreign materials harbor large numbers of bacteria, which contribute significantly to the total microbial population on the fish while they are in the net. Once sticks, rocks and other foreign materials have been removed from the culling-washing box and diseased, decomposed, or otherwise damaged fish have been culled, a thorough washing with clean, chlorinated water will remove much of the bottom sediments and reduce the total microbial population on the fish.

Recommendations:

1. All fish should be washed with water containing 100 p.p.m. (parts per million) of available chlorine. Water used for washing the catch should be drawn by pump while the vessel is running in open water. This pumping should be done far enough away from shore areas, harbors, and dumping grounds to avoid water polluted with sewage, oils, industrial wastes, or other contaminants.

2. All fish should be washed by spraying the water downwards. Water pressure for such operations should be 15 to 20 pounds per square inch.



Figure 1.--A good washing with chlorinated water will reduce significantly the bacterial population normally found on freshly caught fish.

Dressing Fish Aboard the Vessel

Prompt and careful evisceration of the fish will help to maintain initial quality and lengthen keeping time.

Fish tissue is essentially sterile, whereas the viscera, or guts, contain numerous bacteria of various types. Most of the bacteria

present in the viscera can cause spoilage; others may be harmful to man. When belly cuts are ragged and all traces of viscera and slime are not removed, the fish tissue can become contaminated with millions of bacteria. Smaller fish spoil more quickly than do larger fish and therefore should be cleaned first whenever practical. Washing eviscerated fish prior to storage will remove blood, slime, scales, and bits of viscera. These materials serve as food for bacteria to multiply on. During the evisceration operation, damaging the fish by rough treatment should be avoided. Wounds in the tissue will only provide pathways for the entrance of bacteria.

Recommendations:

1. Fish should be gutted immediately after capture, whenever practical.
2. Fish should be protected from sun and weather if gutting cannot be carried out immediately.
3. Belly cuts should be smooth and not excessively long. All viscera and blood should be removed completely.
4. All eviscerated fish should be washed with clean water containing 100 p.p.m. of available chlorine.
5. Fish too large to be washed adequately in a mechanical fish washer or in a wire basket should be washed by hand. Attention should be given to the removal of any remaining bits of viscera and blood. Smaller fish may be washed in wire baskets or in wash tanks.
6. Eviscerated fish should be handled carefully to avoid damaging the flesh.
7. Pitchforks, fish pews, or any other tool that punctures the fish should not be used in any of the fish-handling operations.

REFRIGERATION OF FRESH FISH

Several practical methods are available for the refrigeration and holding of fresh fish on commercial fishing vessels 75 feet in length and smaller. The method used is generally dictated by the size of the vessel, such as length, holding capacity, and functional deck space; each method will have advantages and disadvantages. The purpose of this section is to describe the proper use of each of these methods, rather than to state categorically that one method should be used and another not. The choice of which method may be effectively used remains the responsibility of the vessel operator. The following discussion of fresh-water ice, salt-water ice, bactericidal ice, and the refrigerated brine system, will help the fisherman to select the method most suited to his needs.

FRESH-WATER ICE

Both crushed or flaked fresh-water ice are excellent cooling media for fish and have large cooling capacities for a given weight or volume. Rapid cooling is achieved by the intimate contact of the fish and the small particles of ice. Fish stored in crushed or flaked ice remain moist and glossy and do not become as dehydrated as fish placed in refrigerated storage without ice.

When crushed and flaked ice is produced from potable water, it will contain few bacteria. When such ice is spread over the stored fish, it will not seriously contaminate them and will actually provide a continuing washing action. Ice stored in clean ice bins aboard the vessel will remain clean and relatively uncontaminated by bacteria. Ice bins, if insulated, prevent crushed or flaked ice from fusing into large chunks, which are damaging to soft fish tissue and prevent an even drainage of the melting ice. Chunks of ice will not contact all surfaces of the fish yet they puncture the tissue and leave inroads for bacterial invasion.

Occasionally, flaked or crushed ice becomes fused or chunky. This can be prevented by superchilling the ice to about 5° F. while it is being stored at the ice plant. Superchilling the ice permits it to be loaded aboard the vessel more easily, because it flows freely.

Crushed or flaked ice that has not been superchilled may already be near the melting point (32° F.). Once this ice has been loaded aboard the vessel it will tend to fuse and form the undesirable large chunks.

Proper icing of fish is necessary to attain the maximum benefit from the ice itself (fig. 2). Crushed or flaked ice retards the spoilage of fish in two ways: (1) under proper conditions, the temperature of the fish is reduced to 32° to 36° F., which slows down bacterial and enzymatic changes, and (2) the water from the melting ice flows down over the fish and washes away bacteria, blood, and slime.

Each vessel operator should determine how much ice is needed for each fishing trip taking into account such variables as duration of the trip, expected catch, and water and air temperatures. He should also include a reasonable safety factor. At the end of each cruise, all remaining crushed or flaked ice should be discarded to prevent any bacterial buildup between cruises. Ice bins should be washed with chlorinated water to retard bacterial growth and to prevent contamination of the new ice taken aboard for a subsequent cruise.

Recommendations:

1. Crushed and flaked ice should be prepared from potable water.
2. Crushed and flaked ice should be stored in clean, insulated rooms well removed from sources of external contamination.



Figure 2.--Proper icing of the catch will retard the onset of spoilage.

3. Block or chunked ice should not be used when it is to come into direct contact with fish tissue.

4. Crushed or flaked ice that has fused into large chunks should not be used when the ice is to come into contact with fish tissue.

5. Fish stored in boxes will be considered properly iced when:

a. 3 inches of ice covers the bottom of the box;

b. fish are laid in the box and mixed with ice, and the contents are covered with a further layer of ice 3 inches deep, or sufficient ice mixed with the fish to cool them to 33° F. and maintain that temperature during the trip; and

c. the box is not filled so full that the contents can be squashed when another box is placed on top. At least 1 pound of ice per pound of fish should be the minimum ratio of ice to fish.

6. Used and unused ice should be discarded at the end of each fishing trip, and all ice bins or containers should be hosed down with clean water containing 50 to 100 p.p.m. of available chlorine.

SALT-WATER ICE

Salt-water ice containing 3 percent sodium chloride has a melting temperature of 30° to 32° F. If this ice is prepared as flaked ice,

the sodium chloride will be uniformly distributed throughout the ice, which will then be an excellent coolant for fresh fish. However, if the ice is not made in this fashion but is made in blocks and is then crushed, the content of salt in the block may vary, since fresh water freezes first and leaves a concentrated solution of sodium chloride, which will freeze last.

Recommendation:

1. Salt-water ice should be produced from potable water to which 3 percent sodium chloride has been added and made in a flaked ice machine.

BACTERIAL ICE

The best information to date shows that such substances as sodium benzoate, benzoic acid, chloramine compounds, fumaric acid, sodium hypochlorite, sodium nitrite, carbon dioxide, hydrogenperoxide, calcium propionate, disodium phosphate, and several of the antibiotics tested increase the keeping quality only slightly. The use of either crushed or flaked ice, coupled with improved handling practices, however, will improve the keeping quality of fresh fish as much, or more, than will the use of the aforementioned preservatives.

Recommendation:

1. All preservatives, bactericides, or antibiotics intended for incorporation into ice, and used to preserve fresh fish, must be approved by the U.S. Food and Drug Administration.

REFRIGERATED BRINE

Refrigerated brine is used to cool fish because liquids provide excellent heat transfer and permit fast cooling rates. Also, such liquids have specific gravities similar to flesh, and the related buoyancy of fish eliminates losses due to the crushing caused by excessive pressures. The concentration of brine may vary from 3 percent to 5 percent sodium chloride, depending upon the temperature, the rate of salt uptake (of the fish), and the refrigeration requirements. Holding temperatures with refrigerated brine should be 28° to 32° F.

Once design and structural requirements have been determined for a liquid fish-holding system for a specific vessel, the tanks, compressor, condenser, evaporator, and built-in agitator must be properly installed, insulated, and checked for performance. Many of

the failures reported with this type of cooling system are directly related to improper maintenance of temperature and are due to inadequately designed or installed equipment. Competent technical advice is a prerequisite for a properly functioning system.

Other failures of refrigerated brine systems may be attributed directly to the lack of good sanitation practices. The brine in the tanks and in the circulation and transfer system becomes contaminated with large amounts of blood, slime, and bacteria. This contamination must be washed out, and the entire system must be suitably sanitized between loads.

Recommendations:

1. The vessel must be large enough and should be designed so that it can accommodate a refrigerated brine system, when it is filled to capacity with fish and brine.

2. Immediately after all fish have been landed, all tanks, pipes, and heat exchangers should be flushed with potable water containing an approved cleaning solution to remove slime, blood, and scales.

3. All tanks, pipes, and heat exchangers should be flushed with potable water to remove all traces of the cleaning solution, then flushed at least once with a noncorrosive disinfectant, and finally with clean water before the tanks are filled prior to fishing.

HOLDING FRESH FISH

Wooden, plastic, and aluminum fish boxes are available to commercial fishermen as holding containers for fresh fish, as are portable bulk containers and fish bins. The selection, use, and care of a proper container can, to a large extent, effect the overall quality of the landed catch. The following section will confine itself to a discussion of the relative merits of these containers.

FISH BOXES

Today, fish boxes are commonly made from either wood, plastic, or aluminum. Although similar sized boxes are produced from the above materials, they differ in their suitability to hold a perishable commodity such as fish.

Wooden Fish Boxes

Wooden fish boxes have been used since the beginning of commercial fishing itself. In the past, little or no attention has been paid to the state of cleanliness and sanitation of these containers (fig. 3). For the most part, after the box had been used, it might have been hosed out and then stacked outside where it was unprotected from



Figure 3.--Wooden fish boxes kept in an unsanitary condition will only promote cross contamination between subsequent catches.

contamination. It was used over and over. The casual hosing of these boxes cannot be considered to be adequate cleaning, for millions of bacteria remain. Any bacteria in a wooden fish box after the fish are emptied out will contaminate the fish subsequently placed in the box. Live steam and scrubbing with a hypochlorite solution will reduce markedly the bacterial population, but many bacteria, including bacterial spores, will still be present. Bacteria may penetrate deeply into the cracks and crevices in the wood and, unless extraordinary care is taken to sanitize these boxes, many bacteria and spores remain.

The weight of ice and fish may bulge the bottom of a wooden fish box and cause a gap between the sides and bottom. The wooden fish box thus is not water tight, nor does it drain uniformly. As the melting ice water flows over the fish, it washes blood, slime, and scales down to the bottom of the box. When the boxes are stacked this waste material may then be carried down through the boxes to the bottom box, which will receive much of this contamination.

We discourage the use and the reuse of wooden fish boxes. If wooden fish boxes are reused they must be washed and sanitized,

placed upside down, stacked one on another in a storage area free from vermin, and covered.

The single item that favors the use of a wooden fish box is the comparatively low unit cost, but when this cost is compared with the losses from quality deterioration, aside from the physical damage to the boxes, the initial low cost becomes less important.

Plastic or Aluminum Fish Boxes

Many fishermen who will not now compromise the quality of their catch are using either the plastic or aluminum fish box. We strongly recommend that one of the newer, high-impact plastic fish boxes be used instead of wooden fish boxes. Either polypropylene or polyethylene types are satisfactory. Several aluminum containers are also good (see fig. 2). These types of boxes are available in several sizes, are durable, withstand extremes of both heat and cold, and do not become brittle after repeated use. The most important quality of these containers, however, is that they can be cleaned and sanitized repeatedly, because they have hard, smooth, nonabsorbent surfaces. Bacteria, as well as other contaminants, would be only on the surface of such boxes and could not penetrate into the box material.

These boxes usually are also built to drain properly. Several types have holes so positioned that water and slime cannot drain from one box into another below it. These boxes are designed to be nested when not in use.

Recommendations:

1. Damaged fish boxes should not be used to store or ship fresh fish.
2. All fish boxes--whether constructed of wood, polypropylene, polyethylene, aluminum, or other materials--should be cleaned with a suitable detergent and rinsed with a hypochlorite solution containing 100 p.p.m. of available chlorine.
3. All fish boxes when not in use should be stored in areas free of vermin, stacked in the inverted position, and covered with a tarpaulin or other suitable waterproof covering.

PORTABLE BULK CONTAINERS

Fish packed in containers, capable of holding 200 pounds or more, crush easily, because of the large amount of fish and ice that they can hold. Putting fish in such containers precludes proper icing, because the ratio of fish to ice requires so much ice that the fish are damaged from the weight. Close contact between fish and ice therefore becomes impractical (fig. 4).



Figure 4.--Bulk containers that preclude proper icing.

The use of bulk containers prevents proper drainage of blood, water, and slime, which promotes bacterial spoilage.

Bulk containers are difficult to store and to handle in ship holds or on decks and may therefore be subjected to rough handling. Rough handling of fish usually results in bruising, crushing, or both.

Recommendation:

1. Drums, barrels, wooden boxes, crates, or similar portable bulk containers capable of holding more than 200 pounds of material should not be used as fish containers for holding, refrigerating, or shipping fresh fish.

FISH BINS

Because of rapid transfer of heat and inadequate icing, temperature variations are common in fish stored in bins. For this reason we strongly recommend that fish holds be insulated to prevent, as much as possible, the transfer of heat from areas adjacent to the fish hold.

Properly icing and shelving the catch requires care and experience. When fish are not handled properly, (1) the fish in the lowest areas of the bin spoil more quickly than do the fish above; (2) within each section of the bin that has been divided by shelves, the fish at the bottom spoil more quickly than the fish in the middle or top of each individual section; and (3) where too little ice has been placed at the back and sides of the bin, the fish at the back and sides spoil faster than do the fish in the middle.

Proper icing and shelving of the catch will, to a large extent, eliminate bruising and crushing, cool the fish down to a temperature of about 36° F. in 3 to 4 hours, and allow accumulated water, blood, and slime to drain through the fish and ice into the bilge.

Recommendations:

1. To the extent possible in existing vessels, the bulkheads, walls, and overheads should be insulated with a nonabsorbent, nontoxic insulation such as polyurethane.

2. Four to five inches of flaked or crushed ice should be placed on the floor of each bin, followed by the first bin shelfboard.

3. Three to four inches of flaked or crushed ice should cover the top of each shelfboard, followed with a single layer of fish 3 to 4 inches thick and then covered with a top layer of ice 3 to 4 inches thick.

4. Additional ice should be placed against the sides and next to the wing boards of each bin.

5. All fish should be placed on a slightly rounded bed of ice. This procedure permits melting ice and slime to drain to the sides of the bin.

6. Not more than two layers of fish, separated by 3 to 4 inches of ice, should be placed between any two bin shelving boards.

7. Each fish storage area should have a permanently located thermometer that can record the internal temperature of a sample fish placed in a representative fish bin.

EFFECTIVE AND CONSTANT SANITATION

The fisherman who practices good housekeeping is apt to be quality conscious. In general, the cleaner boats bring in the fish of higher quality.

Sanitation procedures differ slightly from vessel to vessel, owing primarily to their size, their differences in construction, and the method of fish handling used. Certain sanitation practices are necessary however, regardless of the manner of construction of the

vessel. In the following we discuss vessel and equipment sanitation as well as vermin control, and then give our recommendations.

THE VESSEL AND EQUIPMENT

Those areas of the deck that come in direct contact with fish during the catching, culling, and cleaning operations become heavily contaminated with bacteria. These bacteria can be transferred to other deck areas by footgear and by wind, rain, and heavy seas washing over the decks. Frequent washing of these areas with a good detergent will remove many of the bacteria and reduce the chance for them to find their way to the clean fish. Often, deck areas are covered with oil, grease, and rust. If a good detergent is not scrubbed over the deck surfaces, the dirty area will persist and contain numerous bacteria. Scrubbing works the detergent into cracks and helps to remove those materials that entrap bacteria (fig. 5).

If an area of the deck is designated specifically for culling and sorting of fish, these areas must be kept free of accumulating blood,



Figure 5.--Frequent scrubbing with a suitable detergent of all work areas will remove materials that entrap bacteria.

slime, and scales. If fish juices and bits of fish are allowed to accumulate, external contamination of the fish will become excessive. Bacteria thrive in this type of environment and reproduce rapidly.

Cleaning and sanitizing evisceration areas and related equipment is one of the most effective methods of attacking the source of bacterial spoilage. If cutting boards, knives, and counter tops are given only an occasional hosing down, millions of bacteria will still persist in the moist or dried blood, slime, and scales. Evisceration is a potential weak link in the chain of good sanitation practices. Once the fish gut has been penetrated, bacteria are released and contaminate all surfaces they touch. Fish that subsequently pass over the evisceration area pick up bacteria, which cause the fish to spoil sooner.

Between evisceration operations, all waste and gurry containers should be kept covered. Immediately after these containers are emptied, they should be scrubbed and sanitized. These steps become important parts of good vessel sanitation even though the fish may not be intended for human food. If gurry containers are not washed and sanitized frequently and are not provided with tight-fitting covers, their odors will attract flies and other insects.

At the end of each trip, storage areas and bilges should be cleaned after the catch has been discharged. During storage, the blood, slime, and melting ice mix freely and cover the floors of these areas; the liquid continuously drains into the bilge. Unless these areas are properly cleaned, the bacteria will cause offensive "bilgy odors," which attract vermin.

Recommendations:

1. At the end of each fishing day, all deck, evisceration, and culling areas of the vessel, with particular attention to corners and rough surfaces, should be scrubbed with a broom or brush aided by an acceptable detergent and rinsed with liberal amounts of clean water.

2. At the end of each fishing day, all handling or processing equipment such as shovels, boxes, knives, cutting boards, and other hand tools aboard the vessel should be scrubbed with an acceptable detergent and rinsed with clean water.

3. At the end of each fishing trip, immediately after unloading, all storage areas and ice bins should be scrubbed with a stiff broom or brush and an acceptable detergent and then rinsed with liberal amounts of hypochlorite solution containing 100 p.p.m. of available chlorine.

4. At the end of each fishing trip, and immediately after all storage areas have been scrubbed and sanitized, bilges must be pumped and cleaned with a good bilge cleaner and subsequently flushed with a liberal amount of clean water.

VERMIN CONTROLS

Insects and rodents can transmit disease to man through contamination of fish and surfaces that come into contact with the fish. Accordingly, their presence aboard a fishing vessel creates a potential public health hazard that can be guarded against only by effective control.

When proper sanitation practices are followed, vermin are deprived of food. When screens are installed over windows and outside doors are tight fitting, vermin cannot gain access to the stored fish. Sufficient metal containers, fitted with lids and placed throughout the vessel for accumulated trash and garbage, eliminate a potential source of available food for such pests.

Any foodstuffs aboard the vessel should not be left lying about but should be held in covered containers or placed under refrigeration. Insects, particularly flies and roaches, are capable of contaminating unprotected foodstuffs with bacteria which may be pathogenic to man.

Dirty lavatory facilities attract rodents and insects. When these areas are built with materials that can be easily washed and sanitized, pests can be eliminated by keeping the areas clean.

Recommendations:

1. All outside doors, windows, portholes, and exhaust vents leading into storage areas, lavatories, and galley should be tight fitting and provided with screening of 16-mesh or the equivalent to prevent entrance of insects, rodents, and other pests.

2. All foodstuffs, when not being prepared or consumed, should be placed in closed cupboards, covered canisters, or refrigerators.

3. Lavatory facilities should be scrubbed daily with an acceptable detergent and sanitized with a hypochlorite solution containing 100 p.p.m. of available chlorine.

PERSONNEL SANITATION PRACTICES

In this section, a brief discussion of communicable diseases or problems arising from relaxed personnel hygiene aboard the commercial fishing vessel will not only risk the health of crew members, but may endanger the health of those who buy the fish.

COMMUNICABLE DISEASES

It is the responsibility of vessel owners and operators to see that no crew member who is affected with any disease, in a communicable

form, works in any area of the fishing vessel where there is any likelihood of disease being transmitted. If an infected person is permitted to handle fresh fish, the product may become contaminated with pathogenic microorganisms. These pathogens become a potential public health hazard if clean fish are infected and sent to the retailer to be sold fresh. The purchaser may become infected merely by handling the fish or by ingesting undercooked portions of the product.

PERSONNEL HYGIENE

Personal sanitation requires the cooperation of each member of the crew. By washing hands after each visit to the lavatory and refraining from spitting in areas near the fish, the crew member lessens the potential hazard of contaminating fish or infecting other members of the crew. When boots, gloves, foul-weather gear, and outer garments are kept clean, bacterial growth is held to a minimum. Bacteria can grow on clothing covered with blood, slime, scales, or bits of fish viscera, so persons wearing such clothing become a source of contamination.

Recommendations:

1. No person with an infectious disease should be allowed near any fish.
2. Immediately after each visit to the lavatory, the individual shall wash his hands with soap and hot water.
3. Spitting on decks or storage area floors should be strictly prohibited.
4. Boots, gloves, foul-weather gear, and outer garments of all crew members engaged in handling fish, equipment and material used in evisceration or storage of fish should be kept clean.

VESSEL DESIGN

The following section will be concerned with existing and future commercial fishing vessels, and how these vessels can be modified or designed to improve sanitation and fish-handling practices. It would be impossible to recommend any specific practice or vessel design which could be used for all vessels and be equally effective. Therefore, the following recommendations and vessel design are of a general nature and must be considered in principle.

EXISTING COMMERCIAL FISHING VESSELS

To the extent possible, all existing commercial fishing vessels should be improved or modified in such a way that acceptable sanitation and fish handling practices are attainable. We discuss eight areas where improvements are possible.

Deck Areas

Deck areas can be made more sanitary by using mastic, concrete, or corrosion-resistant metals. Such materials should be applied to corners, cracks, and holes in and around all deck areas that are in contact with fish, blood, and slime.

All sharp, blunt, or pointed objects in or near the fish-handling area should be protected by screening or by other such devices in a way that the fish will be protected from accidental punctures or cuts.

All deck space used in handling or storing fish during the normal fishing operation should not be used for the temporary storage of materials and equipment not directly related to the immediate fishing operation.

In areas where overboard drainage is lacking, sufficient scuppers can be located to promote constant drainage. The deck cannot be kept sanitary without sufficient drainage.

Evisceration Areas

On board vessels that have facilities for gutting fish, table surfaces should be constructed of a nontoxic, nonabsorbent, corrosion-resistant material, such as stainless steel or aluminum. A hole may be made in the table and with a suitable metal container located below to collect the offal. We recommend that each evisceration table be provided with a water tap and a short hose for continuous washing the fish and table.

Mechanical Fish Washer

Located adjacent to the gutting table, a simple type of mechanical fish-washing device may consist of a rotating circular tank, with continuously flowing water, which swirls the fish around its periphery with the fish slime, blood, and scum overflowing into a discharge pipe. Eviscerated fish washed in this manner receive an excellent final wash without danger of being bruised, crushed, or otherwise damaged.

Fish-Storage Areas

All fish-storage areas should be properly built and ventilated, or at least modified to ensure that any wooden structure has an adequate supply of air and no pockets of dead air. Moisture is necessary for the growth of fungi and microorganisms, many of which spoil the fresh fish, as well as cause decay of wooden structures in vessels.

The choice of wood preservative, such as those based on epoxy- or polyurethane-resins or shellac varnish, must rest with the user, who needs to consider the location of the wood to be preserved. Wood that is likely to come into contact with fish must be treated with a preservative that does not change the flavor of fish flesh and that is nontoxic. The resulting finish must: (1) be resistant to impregnation by bacteria, fungi, blood, slime, and water; (2) be resistant to the chemical action produced by cleaning agents and the weak ammonia and amines from the fish; and (3) be nonbrittle and durable.

Hand-Washing Facilities

Hand-washing facilities should be made available to the crew members handling fish or fishing gear. This facility should be located close enough to the fish-handling area to encourage frequent hand-washing.

Lavatory Facilities

Lavatory facilities should be installed aboard the commercial fishing vessel according to existing Federal, State or local standards. This installation should include a wash basin provided with hot and cold running water, soap, and one-service disposable paper towels.

Water Systems

Separate plumbing systems must be installed for the potable and nonpotable water supplies, including separate water pumps for each system. The two systems must have no pipes or connections between them.

Pumps and Chlorinating Equipment

Sanitation, in part, depends upon the use of clean water under pressure. We recommend that all commercial fishing vessels have a pumping system capable of delivering a stream of water at least 1 inch in diameter and with a pressure of 30 to 50 pounds per square inch. We further recommend that water-chlorinating equipment be installed on each commercial fishing vessel. The requirements for this equipment should include the ability to feed chlorine automatically and accurately into the waterpipe when the water is flowing, and to automatically stop feeding when the water is shut off. Gaseous chlorine should not be used because it is poisonous.

FUTURE VESSEL DESIGN

The problem of sanitation and fish handling depends greatly on vessel design and construction. When the vessel is being designed,

the same careful consideration should be given to fish handling and storage facilities as is given to the selection of hull form, safety, and main engines. In a well-designed fishing vessel, it is desirable to carry the fish in a direct line from the point where they are brought aboard the vessel to the point where they are stored in the hold. We discuss 14 areas that are of especial interest to us.

Vessel Size

Figure 6 shows a multipurpose vessel incorporating design features suggested for effective sanitation and fish handling. The vessel, 55 to 75 feet long, could be converted conveniently for trawling, gill netting, or other fishing methods.

Washing Area

The area (1) where the fish (in this case a trawl catch) are brought aboard should have a specially constructed box, raised off deck, into which the fish are emptied and washed (to remove bottom materials and other debris). The box should be constructed of material such as stainless steel, aluminum, or synthetics (plastics) to allow easy cleaning, and should have a self-draining, corrosion-resistant bottom to facilitate the drainage of debris, slime, and other foreign material as the fish receive their initial washing. The deck area underlying the box should be provided with the proper slope and should lead to overboard drains. The box should be free of any crevices where debris could collect, and it should be permanently located away from the fishing operations.

Fish Conveyor System and Sorting Area

To keep fish from being roughly handled (thrown or peddled) while being moved from the washdown box to the sorting table (3), the vessel owner should consider the use of a conveying system (2). The sorting table and bins underneath should be constructed of metal such as stainless steel or aluminum alloy. The conveyor, table, and bins should be free of areas where scales and other materials can collect and should have adequate drainage.

Dressing Area

Adjoining the sorting area, a general work area for processing the catch should be located and should contain spaces for on-board dressing, storing offal, washing the fish, and boxing and icing. This space should have provisions for enclosure to offer protection for

the processing crew during bad weather. The dressing table (4) should be positioned next to the sorting area (3) since it is the next step in processing. This space should be free from obstructions such as piping or valves, which would collect fallen waste matter and inhibit cleanup. The dressing table should be built of metal such as aluminum alloy or stainless steel and be free of obstructions and crevices that may collect and hold offal during the cleaning process. The surface of the table should contain offal-deposit holes fitted with chutes leading to removable offal containers located below the table, for the deposit of visceral material as the fish are cleaned. A water-jet system (using chlorinated water) (11) would be desirable to provide a continual thin film of running water over the surface of the gutting table during the fish-cleaning process. The surface of the table should be slanted slightly to carry the overflow water away from the operator and the offal-depository holes. Dressed fish can be slid into the entrance of the mechanical fish washer (5) as they are processed. The dressing and offal storage areas should lend themselves to easy cleaning and sanitizing, should be free of obstructions or projections that may collect waste materials, and should have adequate drainage.

Mechanical Fish-Washing Tank

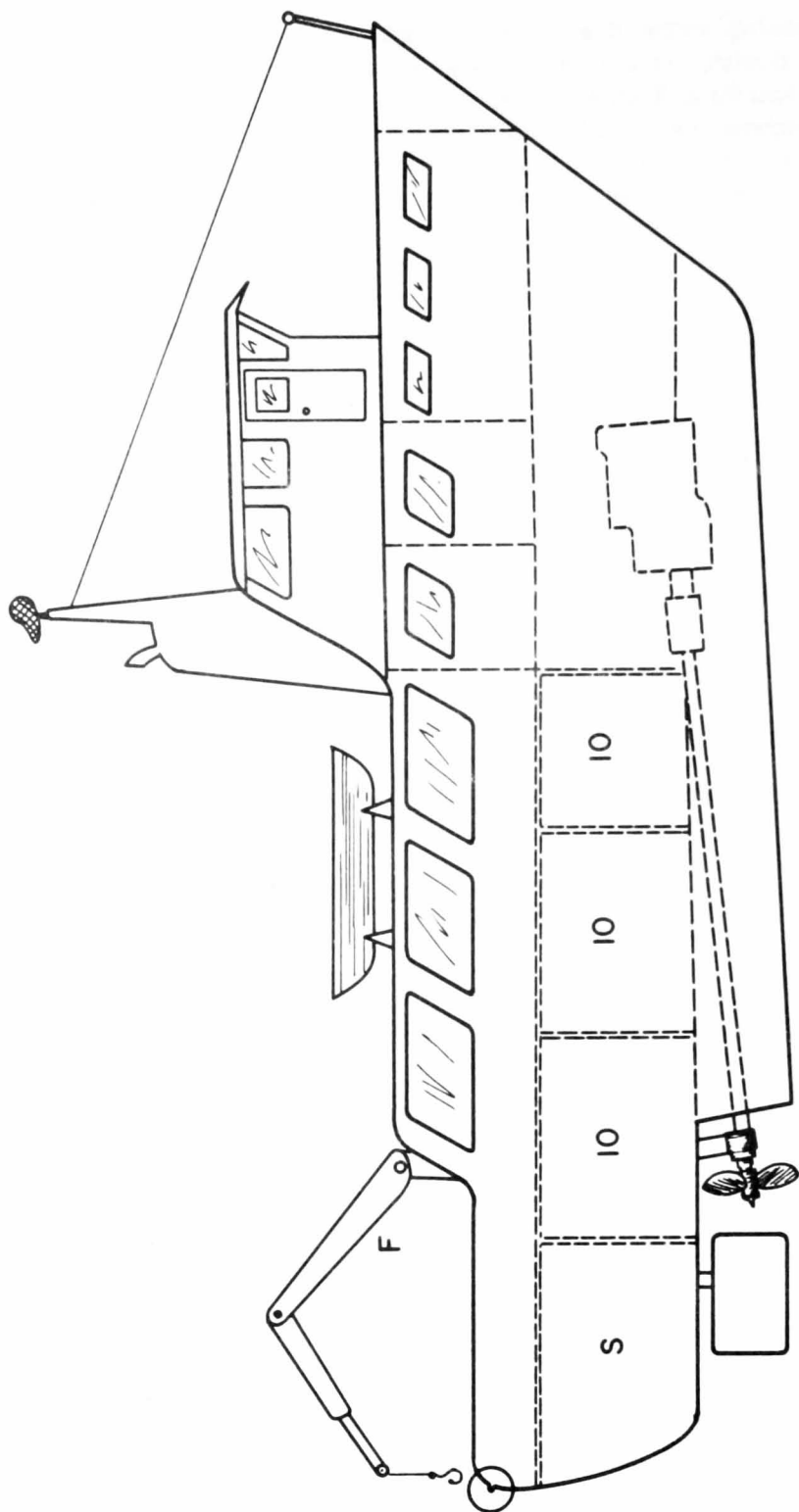
The fish-washing area (5) should be equipped with a mechanical washer for washing the fish after they have been gutted or otherwise cleaned. There are many fish-washing machines available; the choice is regulated largely by the size and type of fish caught.

Icing and Boxing

Near the fish-washing area are facilities (6)(7) for packing and icing the fish after they have been washed. Improved-type packing containers can be nested in a small space. Ice used in icing the fish should be kept in a cold-storage area below deck (10) where it is out of the weather and free from potential contamination from main deck operations. Ice may be brought to the main deck (7) as needed, with a mechanical hoist or conveyor. Because residual amounts of fish slime and water may collect during boxing and icing, the areas should allow for efficient cleaning and draining overboard once the fish have been packed and stored below.

Chlorinated Water System

A water-pumping system (11) incorporating a chlorinating unit, which includes a motor-driven sodium hypochlorite metering pump



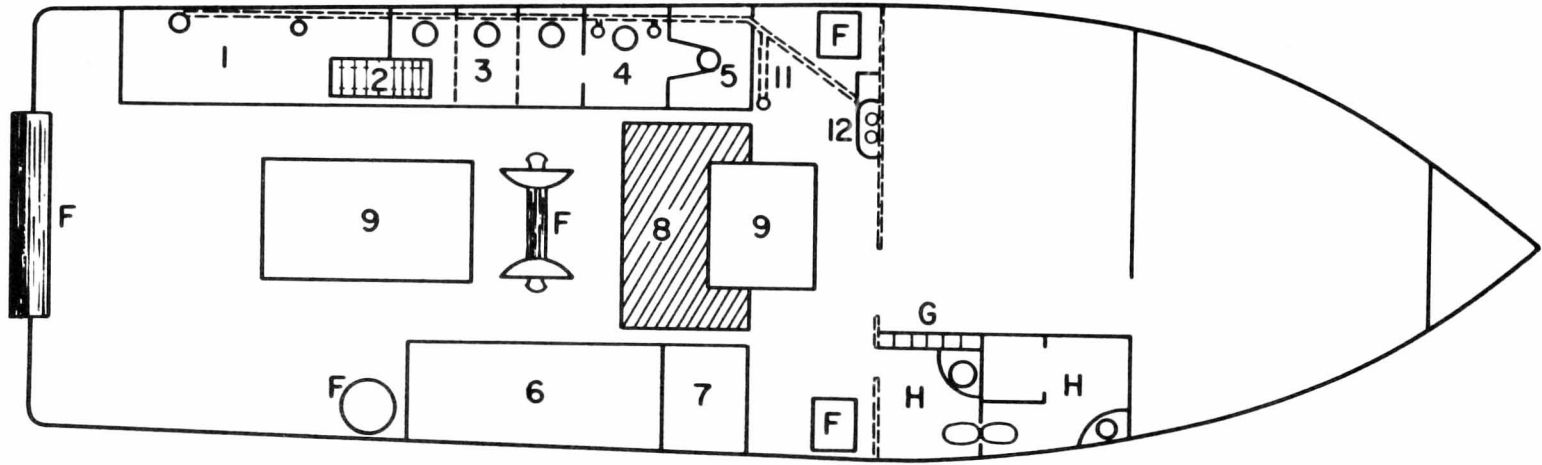


Figure 6.--Diagram of a stylized, modern multipurpose fishing vessel for use in inland waters showing recommended fish handling sequences and related equipment arrangement.

Legend:

- | | |
|---|---|
| 1. Catch storage and washing box | 9. Hatches |
| 2. Conveyor | 10. Insulated cold storage and ice storage hold |
| 3. Sorting table, bins under | 11. Chlorinated water system |
| 4. Dressing table, gurry containers under | 12. Work area wash basin |
| 5. Mechanical fish washer | F. Fishing system deck equipment |
| 6. Packing containers | G. Foul-weather gear locker |
| 7. Main deck ice storage | H. Head |
| 8. Packing and icing area | S. Steering, fuel, stores |

and a storage tank, should be located on the main deck and should have outlets leading to the washing, culling, sorting, and processing areas. Outlets should also be placed wherever necessary for a sanitary cleanup. This system must be entirely separate from any other shipboard discharge lines (bilge, galley, sink, lavatory). Operations using this water supply-system should be carried out while the vessel is underway in areas free from polluted water.

Hand-Washing Facilities

Hand-washing facilities (12) should be made readily accessible to the crew and should be conveniently located to permit frequent use by crew members. The space should contain a wash basin supplied with hot and cold running water under pressure, soap, and disposable hand towels.

Fish-Holding Area

Fish holding facilities (10) should be located below deck and away from the engine room. The hatch (9) leading to the fish-storage area should not be excessively large and should be insulated. Rapid transit (conveyor, chute, or hoist) of packed fish from the icing and boxing area on the main deck to the fish hold should be provided. Similar provisions should be made for rapid movement when packed fish are unloaded at the dock. The interior of cold storage units, including the shelving, should be constructed of metal such as aluminum alloy. Metal-lined holds and shelves can be much more effectively cleaned and sanitized than wood. The interior of the fish hold should be free of obstructions and provide for an uncluttered space. Shelving, if used, should permit melting ice from the packed fish to be carried away from the fish to the sides of the hold without draining down over other packed fish. Melting ice should be drained to a sump located outside of the hold. It is essential that drainage be unhampered and that free flow to the sump be provided. The sump should be of sufficient capacity, watertight, and isolated from the bilges. Provisions should be made for emptying the sump by means of a power-driven pump that is independent of the bilge pump(s). The end bulkheads, overheads, and floors of the fish hold should be adequately insulated, using such thermal insulating material as glass fibre, aerated rubber, or polyurethane foam.

Ice-Storage Area

The main ice-storage area (10) should be located below deck and be adjacent to the fish hold, so as to prevent contamination of the ice from any maindeck operations. The ice chest or storage room

should be metal-lined to allow easy cleaning and sanitizing and should be provided with adequate drains. All overheads, bulkheads, and floors should be well-insulated as should also the fish hold. Mechanical systems with conveyors may be used to deliver ice to the main deck for icing fish during packing.

Mechanical Refrigeration

If a mechanical refrigeration system is used aboard the vessel in the storage area or hold, the plant and its layout should be as simple as possible (automatic operation, standard parts for replacement, etc.) so that regular engine room personnel can service the system as required. The system should be frequently inspected by refrigeration specialists. In case of accidental leakage, the refrigerant used should not be toxic or give off-flavors or odors to the fish.

Refrigerated Brine System

If a refrigerated brine system is used, care must be taken to see that all pipes carrying chilled brine do not pass through the engine-room without being insulated. Insulation will prevent sweating and heat absorption from the engine room air. Circulating pumps must provide for adequate circulation of the brine in the tank. The entire system should be designed for efficient and thorough cleaning when emptied. Piping must be designed so that a full flow of water is maintained through all pipes at all times.

Locker and Lavatory Areas

Adequate facilities such as lockers (G) should be provided for the orderly storage of foul-weather gear and other clothing. This space should be located apart from the fish-handling and storage areas. Lavatory facilities (H), including water closet, should be located in the forward part of the vessel.

Steam Generator

If vessel space permits installation, such supplemental equipment as a small steam generating boiler, along with steam hose, would be desirable for general cleanup work on deck spaces, processing areas, and fish boxes.

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