Code of Practice for the West Australian Demersal Gillnet & Longline Fishery

Australian Government

Fisheries Research and Development Corporation

WA SEAFOOD QUALITY SQMI MANAGEMENT INITIATIVE

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Preface

There are 1400 licensed commercial fishing units catching a wide range of finfish species in Western Australia with a commercial value of more than $40 million (2002/03). Most of the State's 16,000 tonnes of finfish and shark production is sold on the domestic market with small volumes marketed overseas.

Improved marketing of seafood in Australia and overseas has broadened the demand base for a wide range of species. Previously under-utilised and under-valued species are increasingly being sought as new market opportunities arise. It is in response to this growing demand that Western Australia's demersal gillnet and longline fishery have sought to develop a Code of Practice for the on-board handling of fish.

To ensure that the highest degree of freshness and quality is maintained the Code addresses a number of on-board quality issues. In addition, it provides traceability guidelines – a key requirement of national food legislation. Increasingly, customers expect fishermen to meet certain criteria, which means that processes throughout the supply chain need to be documented more than ever before.

An example of a quality checklist and temperature monitoring chart is located at the back of this Code of Practice. These documents can be used as a record of the catch and operations and can be provided to processors as evidence of attention to food safety and quality.

Development of the Code

The Code was developed following observations taken aboard vessels and in consultation with fishermen between October 2000 and April 2003.

The Industry Development Unit and the Fisheries Research and Development Corporation co-funded the fieldwork and preparation of the Code. The WA Fishing Industry Council (WAFIC) and the Department of Fisheries WA Seafood Quality Management Initiative (SQMI) co-managed the fieldwork and the consultation with fishermen.

The aim of the Code is to improve food safety and quality (i.e. freshness and shelf life), and catch value from Western Australia's demersal gillnet and longline fishery.

1. INTRODUCTION

This Code describes recommended procedures and principles to be followed on board shark fishing vessels operating in the West Coast and Southern Demersal Gillnet and Demersal Longline Fisheries of Western Australia. It is intended to guide fishermen in fish harvesting, on-board processing, chilling, and handling of shark and finfish to deliver consistently safe prime quality fish, which meet the requirements of discriminating buyers and consumers.

Adoption of the Code is not mandatory. However WAFIC, the Department of Fisheries (the State Government agency responsible for managing commercial fisheries) and its SQMI service recommend it.

This Code of Practice is not a prescriptive manual covering all fish handling practices aboard commercial fishing vessels. There are alternative approaches that may be better suited to individual vessels and circumstances that can safely and efficiently meet the objectives of the code.
Each vessel has different facilities, crew, and customer requirements and because of this it is imperative that the most appropriate way to undertake each task is recognised and adhered to, whilst maintaining good practice standards.

Additional information is presented in shaded boxes.

The Code also provides a checklist and temperature monitoring chart for a range of practices aboard vessels operating in the fishery.

Much of this Code can also be applied to practices in other fisheries.

1.1 Food Safety and Fish Quality

Governments prescribe standards for food safety to prevent or minimise public health problems. Industry sets the standards on fish quality, size, grading and other marketing or non-health issues.

The target species in the Western Australian Demersal Gillnet and Longline Fishery present few known hazards to human health and are not inherently dangerous to eat when cooked. The Code deals mainly with issues relating to optimising the appearance, quality, shelf-life and value of shark and finfish.

Food safety and hygiene are best assured by providing a safe and hygienic working environment for trained crew. The Code also deals with the vessel's construction and equipment requirements for achieving and maintaining good practices, and maximising the catch's quality and returns.

The Code can be considered a training manual for new crew and a refresher for "old hands".

Guidelines on typical operating procedures are given as a checklist (reminder) for everyone on board.

1.2 A Code of Practice

A Code of Practice is a "living document" which means the standards and recommendations may be upgraded as vessel construction, refrigeration, equipment, fishing and handling, regulations or technology evolve in the industry. This document is the industry's first edition.

There are currently 34 demersal gillnet vessels operating from the west coast and south coast of Western Australia. The vessels have an average turn around time of one to four days' fishing although longer trips are undertaken (e.g. up to nine days at sea). The amount of fish being unloaded from each vessel ranges from around 0.5 to 10 tonnes per trip. The catches are predominantly thickskin, dusky whaler, bronze whaler, gummy shark, wobbegong, whiskery, school, broadnose (seven-gill), blacktip, and hammerhead shark. Also caught are thresher, shovel nose and saw sharks, porbeagles and spur dog sharks.

In addition, a range of finfish is targeted including snapper, dhufish, various cods, trevally and groper. The majority of landed finfish and shark is trucked to Perth although a small portion is trucked directly to east coast markets. There is very little bycatch as the size and quality of most of the fish ensures that it is fit for human consumption. Fish that are not retained are returned alive to the water.

Demersal gillnet fisheries provide a large proportion of Perth's fresh fish, mostly retailing as fresh fillets or for the restaurant and cooked trade (e.g. fish and chip shops).

Because chilled shark is a perishable food, which undergoes initial on-board primary processing it is more susceptible to contamination than seafood that is landed live or whole. As a result, chilled shark should be handled, processed and stored appropriately in order to minimise the growth of micro-organisms and bacteria naturally associated with shark.

There are a range of factors that make it difficult for the demersal gillnet fishery to achieve consistently good quality and prices. For example, variance in soak times of nets, the distance from some fishing grounds to the market, varying on-board cold storage facilities, varying condition of fish upon landing, and varying levels of crew experience and availability make it difficult to supply uniform quality from the fishery.

By adopting the Code's recommended practices fishermen on all boats will be able to produce the best possible quality fish. The Code will need to be revised as new vessels, equipment or practices are introduced into the fishery. Operators are also advised to ensure that they are aware of current rules and management arrangements. In particular, laws pertaining to removal of fins are subject to review.

1.3 General Aims and Principles behind this Code

The information in this Code will best be applied when the vessel owner or skipper provides or arranges for:

- A vessel with all the necessary gear, equipment and consumables to maintain a clean, safe and hygienic working environment.
- Induction and regular training on personal hygiene, cleaning programs, and the handling of catch for all crew.
- Sufficient clean sea water, ice, chilling and storage facilities, and containers to handle the anticipated catch in a safe manner.
- Fish temperatures to be monitored, utilising a calibrated* thermometer that measures to within 0.1°C, to ensure that temperatures are maintained within safe levels and so records may be kept in an orderly manner.
- The maintenance of adequate records on the catching and subsequent distribution of product from the vessel to customers for effective and efficient product traceback and recall.

* See Chapter 5 for a simple method to calibrate a thermometer.

Fish Quality and Deterioration

The eating quality of a fish will begin to deteriorate once it is caught and subjected to stress. After fish is landed, the action of bacteria, biochemical (enzymes), and chemical actions lead to an inevitable deterioration that cannot be stopped, but can be slowed. Deterioration and loss of quality can be minimised by:

- Effective spiking that kills fish humanely and extends shelf-life of the product.
- Effective bleeding of product, and rapid processing and packing help prevent physical damage (e.g. bruising) to the fish.
- Controlling temperatures. Temperatures should be kept at a consistent, low level to minimise bacterial, biochemical and chemical activity. Keep fish as cold as possible without freezing if intended for sale as fresh. An ideal storage temperature is –1°C to +4°C.
- Preventing contamination through good vessel design and construction, providing a hygienic working environment, and good handling practices. Shark has high levels of surface bacteria and to minimise potential cross contamination of bacteria shark and finfish should not be combined in the same storage facility. Damaged and first grade product should also be separated.

2. GOOD HYGIENE AND SANITATION PRACTICES

2.1 Water and Ice

Clean sea water aboard fishing vessels is essential for food and public health safety. Therefore:

- All ice should be made from potable water when using fresh water, or clean sea water and stored in hygienic conditions at all times;
- While the vessel is in harbour, sea water should not be used on fish or fish-holding containers, nor in areas where there is danger of the water being polluted;
- All equipment used for ice handling and storage should be maintained in a clean manner to minimise contamination; and
- Any ice that falls to the deck or comes into contact with unclean surfaces should not be used.

Definition of Potable Water

Potable water will:

(a) Not contain any *Escherichia coli* per 250 millilitres;

(b) Not contain any coliform organisms per 250 millilitres;

(c) Not contain any thermo-tolerant coliform organisms per 250 millilitres; and

(d) Not contain any *Pseudomonas aeruginosa* in 250 millilitres.

2.2 Fish Handling

Fish should be handled by trained crew under conditions that ensure contamination is minimised or eliminated. This can best be achieved by:

- Conducting a pre-fishing check of facilities and cleaning any soiled areas or equipment before start-up.
- Keeping facilities and equipment as clean as possible during fishing, chilling, and storage of seafood (i.e. "clean as you go"). Scrubbing with a stiff-bristled broom or brush between hauls, after processing is finished, and after unloading the catch, with a detergent and sanitiser and rinsing with a high-powered deck hose.
- Ensuring that all cleaning or sanitising chemicals are food safe, effective in an appropriate range of alkalinity (7.5-8.5pH), used in accordance with the manufacturer's instructions and comply with government regulations.
- Storing all poisonous or harmful materials such as oil, insecticides and cleaning compounds in secure and appropriately marked locations where they cannot leak into fish handling areas. Such substances should be clearly labelled.
- Storing packaging materials such as plastic bags, cartons, styrene boxes and containers in a clean dry area away from fish product, contaminants or potential soiling.

2.3 Hygiene and Health of Crew

All crew must maintain a high standard of personal hygiene whilst handling seafood or containers used for seafood. This is achieved by:

- Ensuring that crew are fully trained in the hygienic handling of food product.
- Crew thoroughly washing their hands with antibacterial–disinfectant soap, and rinsing and drying their hands before handling the catch, especially after using the toilet or tending to mechanical repairs.
- Prohibiting smoking, drinking, and eating in the processing, sorting areas and storage facilities, or wherever the catch is handled.
- Exclude crew that have hepatitis, gastroenteritis, infectious skin conditions or other contagious illnesses that may be transmitted to the product from the processing area and handling operations.
- Ensuring that any bandages (on minor injuries) are clean, waterproofed, and allow for easy detection by type or colour of bandage used.

It is important to ensure when gloves are worn by the crew, that the gloves are kept clean with no slime or nicks, are sanitised and stored in a dry and hygienic place when not in use. Gloves should be rinsed regularly during processing. After storing fish gloves must be cleaned, sanitised and stored in a dry and hygienic place when not in use. Gloves should be replaced regularly.

2.4 Pest and Animal Control

Pests such as rats, mice, birds, insects and domestic animals such as dogs and cats, should be kept off the vessel at all times. To minimise the risk of contamination from pests use a pest control schedule to ensure an effective control program. Food should be kept in sealed containers in tightly closed compartments.

Insecticides and fumigants should be:

- Used in accordance with the manufacturer's recommendations and government regulations.
- Used in a manner that does not risk contamination of seafood products.
- Not used in the brine tanks or holding-rooms before all seafood products have been removed.

3. VESSEL and GEAR DESIGN, CONSTRUCTION and OPERATION

3.1 Vessel Design and Construction

Fishing vessels should be designed and constructed to prevent contamination of fish from bilge water, sewage, fuel, oil or other objectionable substances. The vessel's toilet facilities, plumbing and waste-disposal lines should be designed to not contaminate fish. The intake of sea water for the deck hose should be well forward of, and on the opposite side of the vessel from the toilet and engine-cooling discharge. Each vessel should have an automatic or a foot or elbow operated tap dispenser with an anti-bacterial–disinfectant soap for personal hygiene use.

- Consideration should be given to protecting fish from physical damage, drying by sun and wind, and exposure to high temperatures such as engine hatches and deck areas that are prone to holding heat.
- Surfaces that come into contact with fish should be made of smooth, corrosion-resistant, easily cleaned material.
- Any wooden boards that come into contact with fish should be thoroughly coated with durable non-toxic paint or other smooth, impervious and easily cleaned coatings. This should be re-applied as required to ensure a smooth and water-tight surface.
- The fish hold and brine-tank walls should be completely impervious (i.e. water-tight) to prevent fish slime, blood and scales from being trapped in or under the walls where cleaning is often impossible. It is worth noting that the easier it is to clean something, the more effectively it will be cleaned.

3.2 Brine Tanks and Refrigerated or Chilled Sea Water

The refrigerated brine system should be designed to chill fish rapidly. Each tank should be fitted with an easy to read temperature gauge. There should be ample insulation in tank walls to minimise heat leakage and operating costs. A central drain ensures tanks are easily cleaned.

Baffles or dividers should be impervious and in good order.

There should be sufficient compressor capacity to:

- Maintain the temperature of the fish between –1°C to +4°C.
- Handle the resultant significant rise in temperature of the refrigerated sea water when a large volume of fish is put in the refrigerated sea water tank (i.e. when catches are good. It should be noted that an ice slurry can chill more efficiently than refrigerated sea water).
- Ensure that the core temperature of the fish can be reduced to around –1°C to +4°C within 3 hours of being placed in the slurry.

Fish are more rapidly chilled by immersion in refrigerated sea water or chilled sea water (ice added to sea water) at –1°C to 1°C rather than fish packed directly in ice. Refrigerated sea water or chilled sea water tanks should always be used. Hot fish packed in ice can have an "igloo" effect – insulating fish from the coolant.

Spoilage in Fish

Spoilage in fish is caused by bacteria, enzymes, and chemical action. Bacteria are mostly found in the surface slime, gills, and the gut of living seafood species. Enzymes help fish to build tissue, contract and relax muscles, and digest food. When fish die, enzymes continue to work, digesting or breaking down the flesh, and bacteria invade through the gills, along blood vessels, and directly through the skin and gut cavity lining. These changes are affected by temperature - for many species decreasing the temperature from 5°C to 0°C halves the rate of spoilage and improves the shelf-life.

When handling seafood, it is important to bear in mind bacteria occur naturally on all fish and that bacteria are able to multiply at alarming rates if not controlled. Rapidly reducing the product's temperature significantly slows most bacterial growth. The greater the drop in temperature, the slower bacteria will multiply. Temperature and bacteria have a significant impact on the shelf-life of fish. Note: While bacterial spoilage is reduced at temperatures between –1.5°C and –5°C enzymic spoilage is not.

3.3 Fishing Gear Design

Fishing gear should be designed, constructed, regularly maintained, and used in a manner to minimise damage to fish and maximise the physical condition of the catch. Gear should be designed for the targeted species and to minimise the non-retained catch.

When using gaffs and similar sharp objects try to avoid puncturing skin adjoining an edible flesh section of the fish. Precautions should be taken to ensure fish can be untangled and retrieved from nets with a minimum of physical damage, including bruising.

3.4 Trip Planning and Logistics

Trip duration and the crew's fish handling capacity should be assessed prior to leaving port in order that the fish can be handled, chilled and packed to satisfy customer's requirements. This includes provisioning with enough ice, detergents, sanitisers, antibacterial solutions, and appropriate containers and packing materials in serviceable condition. This ensures the catch can be handled, processed and dispatched in the best possible condition.

The timing of fish taken on board and processed needs to be controlled. Larger catches could mean reduced shelf-life and subsequent price reductions if there are processing or chilling difficulties due to limited capacity.

Once fish is landed, accelerated spoilage commences after a period of rigor mortis. Rapid chilling and correct handling can extend rigor up to 48 hours in some species. Once spoilage begins there is a continual and irreversible deterioration in quality. It is mainly the length of time and temperature at which the fish are held that determines this deterioration. Fishing trip length should be controlled and governed by fish condition, not by a prearranged schedule or traditional practices. In some cases the income derived from smaller volumes of premium fish is greater than larger volumes of lesser quality.

4. OPERATIONAL PRACTICES

4.1 Before Leaving Port

- Ensure that all crew have read the *Handbook for On-board Handling of Demersal Gillnet and Longline Catch*, available from WAFIC or SQMI.
- Assign a crew member as the quality assurance supervisor responsible for implementing the vessel's quality control program during the trip. This should include responsibility for sanitation of vessel and equipment, product quality, storage conditions, and the maintenance of log sheets (record keeping).
- Ensure there are at least two calibrated probe thermometers in good working order on board.
- Make sure any reusable containers are clean and in good working order. Do not place containers on the vessel until just prior to departure unless they can be stored in an enclosed area that is clean and dry.

4.2 Travelling to the Fishing Grounds

Wait until the vessel is clear of the harbour and associated bays before using the deck hose to clean the deck, equipment and storage facilities. Good practice includes:

- Releasing all surplus or waste water from brine or storage compartments. Rinsing any containers used in processing with clean sea water.
- Cleaning fish bins, deck, mats, gutting tables, iceboxes and any other potential fish contact surfaces with an approved detergent and a sanitiser as per the instructions. ***On the way to the fishing grounds it is essential that the boat be thoroughly cleaned to remove any contaminants from the wharf or previous day's fishing.***
- Processing areas, equipment and utensils should be cleared of rubbish, hosed down and scrubbed regularly throughout the fishing trip.
- Allow storage containers to dry before use or storing them. Containers used for bleeding and pre-chilling fish should also be sanitised and kept as clean as possible throughout the trip.

- Prepare ice slurry bearing in mind that warmer conditions may require additional salt to compensate for melting ice. If using refrigerated sea water fill with clean sea water and turn on refrigeration unit. ***(Using a small pre-chill slurry to bleed and keep fish prior to processing and chilling in chilled sea water or refrigerated sea water results in better quality fish. This pre-chill means a lower bacterial load in the chilled sea water or refrigerated sea water and a resultant extended shelf-life.)***
- Add required amounts of anti-bacterial agents to the refrigerated or chilled sea water tanks (if in use).

Use of Sanitisers

Sanitisers containing phenols may affect the taste and smell of seafood. They are not recommended. It is best to select compounds compatible with sea water of a pH of 7.5-8.5 at ambient temperatures of about 16-24°C.

A sanitising agent containing chlorine, such as swimming pool hypochlorite powders are often used on fishing vessels. However, the optimum pH for swimming pool powders is 7.2-7.6 and they are not effective in the high pH waters found along the western and southern WA coast (pH about 7.5-8.5). Pool chlorine should not be used for this reason. Multi-enzyme sanitizers may be effective but must always be used in accordance with the manufacturer's instructions.

Scrubbing surfaces with a brush is a critical part of cleaning. If organic material such as blood and slime is not removed it rapidly combines with and neutralises the disinfecting ability of any sanitiser solution. Scrubbing containers on a regular basis with detergent-sanitiser solutions is recommended. Soaking containers in a sanitiser is ineffective, particularly if soaking in chlorine solutions.

The *Pseudomonas* group of spoilage bacteria is found naturally in the warm waters along the West Australian coast. They also survive in the low temperatures found in refrigerated and chilled seawater tanks and grow well in an iron-rich environment (such as on a steel deck or in stainless steel tanks). *Pseudomonas* produce volatile sulphur compounds during growth and have been identified as bacteria capable of limiting export markets.

4.3 Handling of Fishing Gear and Catch

After setting nets rinse the deck thoroughly with high-pressure clean sea water, removing all debris, seaweed, corals, and fish matter. The use of a stiff-bristled broom and an antibacterial detergent is recommended.

While fishing keep the deck regularly wet and as cool as possible by leaving the deck hose running on areas of the deck that are known to heat up. Shade the deck if possible. Minimise the time that fish are in contact with the deck and never place fish on deck areas that heat up.

Landing the catch onto the deck should be done with care to minimise physical damage to the fish and to minimise warming and drying by sun and wind. Nets should be hauled slowly and fish removed as quickly and gently as possible. Remove fish from the net by stretching mesh, carefully untangling the catch to avoid tearing or pulling fish as this can cause bruising and flesh damage. Severing fins should be done as a last resort.

Do not throw fish. When removing fish from the net or sorting the catch they should be transferred carefully to a nearby icebox or chilled seawater bin to minimise flesh damage. Instead of throwing fish, organise product flow by ensuring that storage boxes are as close as possible to the fish.

Mistreated fish, or those suffering damaged skin or scale loss when removed from nets, are more susceptible to early and accelerated bacterial attack. This leads to more rapid spoilage and reduced shelf-life. A fish that has begun to deteriorate can contaminate other fish stored close by.

Nets should be cleared of fish and trash immediately upon landing on deck. Avoid leaving fish entangled in mesh while making repairs to the net.

Consideration should be given to the condition and size of each particular fish and the variability in handling different species. Some fish are more delicate than others, while smaller fish are generally more easily damaged and warm up faster than larger fish. Live fish should be spiked or bled immediately and dead fish processed immediately. Store damaged fish separately.

4.4 Storing the Catch Before Processing

A bin of refrigerated or chilled sea water positioned near the net as it is hauled aboard can be used for storing shark and fish prior to processing. This would greatly assist to:

- Take the initial heat out of the shark and fish which would make it easier to chill after processing;
- Reduce damage to fish flesh (and risk to crew) by not having thrashing shark or fish on deck;
- Reduce exposure by sun and wind, which can increase temperature and bacteria levels leading to accelerated deterioration of fish quality;
- Reduce bacterial growth on the fish prior to processing and lessen bacterial levels in refrigerated or chilled sea water storage; and
- Minimise the amount of blood and debris introduced into the stored water.

If the water in the pre-processing bin becomes polluted or above 10°C replace it with clean water from the refrigerated/chilled seawater tank and/or a combination of freshwater ice and sea water.

Scrombrotoxin is a bacterial toxin that can cause illness to consumers. It is the result of time and temperature abuse of certain fish (particularly pelagic fish such as mackerel) and is linked to the formation of histamine. Certain bacteria produce the enzyme histidine decarboxylase, which reacts with free histidine, a naturally occurring chemical in fish, which results in the formation of histamine (which can cause illness to consumers). Upon death, the defence mechanisms of fish no longer inhibit bacterial growth, and histamine-forming bacteria start to flourish (200-500 ppm of histamine causes consumer illness). The rapid chilling of fish immediately after death is important in preventing the formation of scrombrotoxin. For example, fish with core temperatures below 28°C should be placed in refrigerated or chilled sea water (<1°C) within nine hours of death – or placed in ice within 12 hours of death. With harvesting practices such as longlining and gillnets death can occur 20 or more hours before the fish is removed from the water.

4.5 Processing the Catch

Once fish and shark are landed it is critical to reduce catch temperature and to preserve catch quality. The crew can best achieve this by:

- Immediately returning to the sea any shark or fish unsuitable for human consumption.
- Placing dead finfish in an ice slurry or a refrigerated sea water tank to await processing.
- Immediately spiking (by ike jimi technique) live finfish, rinsing in sea water and placing in an ice slurry.
- Keeping soak times to a minimum. Fish begin to deteriorate immediately from the time of death.
- Processing should start without delay after the catch is removed from the net by bleeding (see below) and storing in chilled sea water before refrigerating.

Dead or live sharks should be processed in the following manner:

Euthanasia and Bleeding

If the shark is still alive, then immediately carry out iki jimi by spiking the rear top of the head, or by a knife cut across the rear top of the head to accelerate bleeding and death. These methods are regarded as more humane than employing a forceful blow.

Swiftly killing the shark once it is removed from the net will minimise its thrashing or struggling on the deck – keeping the crew safer and helping ensure the shark is killed humanely.

Bleeding is best done by severing the shark's tail fin and placing the shark in a tank of chilled sea water until bleeding stops.

When a large catch is landed it is preferable to put killed and bleeding shark into an initial refrigerated or chilled sea water tank or, at the very least, into a tank of circulating sea water.

Removal of fins

Fins should be cut to remove excess muscle bulk, while ensuring the maximum amount of fin remains. Rinse the fins and chill without delay.

Processing and Dressing

Processing includes removing the head and entrails. Remove all the viscera and entrails (guts). Take care to avoid puncturing the gut, as this may release taints and bacteria onto the flesh, and avoid penetrating the flesh with the knife during this process.

Thoroughly clean the gut cavity with a brush and flush blood from the shark's cavity and tail. Take care to rinse the caudal (central) vein of blood.

Immediately return severed heads, entrails and other fish matter to the sea rather than leaving this debris on the deck and gutting table.

Processed trunks are then stored on ice to achieve a core temperature of –1.0 to + 4.0°C. This temperature is reached within 2-3 hours, depending on the size of the fish. The trunks must be kept at this temperature until delivered for further processing and marketing.

4.6 Chilling Fish

The temperature and cleanliness of refrigerated or chilled sea water should be monitored and recorded regularly to ensure that each new load of fish and shark is rapidly cooled without substantially raising the temperature of the chilled sea water (i.e. 'overloading' the system). Refrigerated or chilled sea water temperatures should be maintained at –1.0 to 1.0°C.

The chilled water should be replaced with clean sea water and ice (if needed) when it becomes noticeably discoloured (indicating contamination from earlier loads of fish). Alternatively, it may be replaced with clean, fresh sea water and ice if the pH level rises above 8.5 (using pH strips to monitor pH levels).

Clean fish should be fully immersed in the refrigerated or chilled sea water to lower the core temperature of the fish to 0 to 1.0°C within 2-3 hours (depending on the size of the fish and catch – if unachievable you may need a greater chilling capacity). Use a temperature probe to ensure the core temperatures of fish are between –1°C and 4°C. If this temperature is not achieved return the fish to the tank.

The core temperature of fish to be sold as fresh (not frozen) must not go below –1°C. Fish colder than –1°C do not meet the Australian Seafood Standard for fresh fish.

Any ice build-up on the refrigeration plates or coils in the cold storage tanks should be physically removed or the power to the refrigeration system switched off. Monitor the temperature. Take care not to allow the temperature to rise more than 2°C above or below zero.

Ammoniation and Spoilage in Shark

Spoilage of shark is caused by ammonia in the flesh. Ammonia in animal tissues (flesh) is often due to the breakdown of nucleic bases, proteins, amino acids, amines and the build-up of bacteria. However, the high urea content of shark (2 per cent by weight) is a unique and contributing factor in ammoniation. Shark blood holds a high proportion of this urea and therefore it is important that the maximum amount of blood is removed prior to processing. As the shark ages there is a significant increase in bacteria causing urea to be converted into carbon dioxide and ammonia. It is expected that 'good' quality shark with a pH of 6 will ammoniate after 10-12 days on ice, compared to 'average' shark with a pH of 7-8 ammoniating after 4-6 days on ice. Freezing does not stop ammoniation, however fish quality prior to freezing determines the quality after it is defrosted and thawed.

4.7 Packing of Fish and Shark

Commercial fishers should consider developing a grading system especially if they intend to export the product or seek a premium from the market. Packing procedures include the following:

- Fish should be packed neatly, belly down and parallel to each other (soldier packed) in containers to a limit of between 15 and 25 kg per container (depending on container size). Ensure that product does not protrude from top of containers to avoid squashing.
- Reject any poor quality fish (i.e. significant scale loss, torn skin, bruised or damaged flesh, poor appearance or smell). This should be graded in a separate damaged category if fit for human consumption.

- Fish that are bent stiff with rigor mortis should not be straightened out. Straightening will tear the connective tissue leading to gaping (separation of the muscle bands in the flesh) when the fish is sliced into a fillet or cutlet.
- Alternative identification techniques for bulk-stored fish could include either placing a thin plastic streamer over each day's catch when it is packed in ice allowing capture dates to be identified during unloading, or tagging the fish to indicate the day it was caught.
- A polyethylene bag should be folded over the top of the fish to enclose them and minimise any drying out, and a plastic lid then fitted to the container.
- If packing in ice ensure that each layer of fish is covered with ice.
- With large fish ensure adequate protection from sun, wind and contaminants.
- Use a temperature probe to ensure the fish are being held at between –1°C and 4°C.
- Use of a data logger is suggested for resolving disputes about temperature fluctuations and documenting the integrity of your product while it is out of your control.
- Once packing is completed, remove gloves, rinse and soak in an anti-bacterial solution and store in a dry place. Discard gloves that are damaged or soiled.
- Report any irregularities in the fish or packing to the skipper immediately.

Chilling and Storing Fresh Fish

In the cooler environs of south western Australia fish in refrigerated or chilled seawater slurries (usually at –1-0°C) can reach core temperatures of around 2-4°C within 45-60 minutes (depending on the size of the fish). It can be more difficult for all of a day's catch to achieve critical temperatures (0-1°C) within 2-3 hours. This is often due to the larger quantities of ice or chilling capacity that is required as well as the regular opening/closing of the storage compartment and varying ambient temperatures. Regular monitoring of core temperatures is required to ensure that ALL fish and shark are being correctly chilled and that potential spoilage is minimised. Additional ice or adjustment of the refrigeration equipment may be necessary when high ambient temperatures or large catches are expected. Similarly, a little extra salt may need to be added to chilled sea water in warmer temperatures to prevent leaching of flavour. Note: Salt can be taken up by exposed fish flesh so be careful not to add too much as it may affect the quality of the fish.

4.8 Date Labelling and Coding of Cases

Proposed food regulations will require food businesses to be able to recall product should the need arise. This means a traceability system that operates from harvesting, wholesale and distribution through to the retailer.

A label with the name of the vessel, species, date of capture, or a date/colour code, should be affixed to cases of fish to allow for stock identification and rotation, and for better distribution of the catch according to the landing date.

Fish temperatures and quality should be monitored and documented before transport with a copy provided to the buyer.

When the catch is labelled or date coded it can be processed or distributed in order of age so that freshest fish goes to more distant markets or is processed last: "first in first out".

4.9 Returning from the Fishing Grounds

Good practice requires regular monitoring, cleaning and preparation of the vessel and its facilities. Returning to the harbour or anchorage is an ideal time to:

- Monitor the icebox and slurry temperatures and maintain at –1.0°C to 1°C.
- Avoid any practices that might create fluctuations in temperature, or take precautions to minimise any fluctuations.
- Clean the vessel thoroughly giving particular attention to:
    1. Areas used for shark handling and processing;
    2. Equipment, including aprons, boots, knives and cutting boards used in processing;
    3. The deck surrounding the roller-drum and hauling area;
    4. Iceboxes;
    5. Any containers likely to be used in transporting fish ashore; and
    6. The toilet and shower.

4.10 Unloading the Catch

- Prior to loading check that the truck is clean and suitable for carrying your product.
- The refrigeration on the truck should be operating, pre-chilling the truck to below 4°C prior to loading. Check that the thermostat is set at an appropriate level.
- Unloading of the vessel should only commence once all the necessary equipment, the catch, and crew are "ready to go" and all preparatory work is completed.
- The crew should ensure that all the fish are ready for quick unloading before the hatch cover is removed and warm air enters the hold.
- Avoid unloading during the hottest part of the day. Avoid unloading the catch well before arriving in the harbour or anchorage. Deck temperatures can often exceed 25°C. Fish placed on the deck can heat up quickly and quality will suffer.
- If using pallets, fish should be checked for species and weight, quickly loaded onto pallets with labelled end facing out, and over wrapped with plastic sheet to secure each lot.
- If using bins, ensure that adequate protection from the elements, heat and contaminants are used.

- The pallets or bins should then be transferred to a waiting truck or holding-room without delay.
- The back door of the truck should be closed between loading each pallet or bin to minimise warm air entering the refrigerated area.

4.11 After Unload

At the end of each trip, when unloading is completed, thoroughly clean and rinse the deck, brine tanks or iceboxes, fish-holding compartments, ice bins, fish-handling equipment and utensils as follows:

- Flush (hose) all surfaces, preferably with fresh water from a shore-based source.
- Scrub all surfaces with a brush or stiff-bristled broom, using a solution of antibacterial detergent (a solution that both cleans and disinfects, and is active at pH of 7.5-8.5). Pressure clean any remaining containers such as iceboxes and fish-holds.
- Rinse all surfaces with fresh water (or clean sea water) and allow to dry in the sun (fish containers can be stored in a sanitising solution in a fish bin or icebox).
- Drain and check fish-holding compartments for bacteria traps (for example: cracks, holes, fish matter stuck to walls and plates). Seek to minimise or remove traps where possible. Clean by scrubbing and high-pressure washing.
- Fish-holding compartments can be quarter-filled with clean sea water and a detergent/sanitiser to immerse containers and other bins used on deck. Close the brine lid.
- Alternatively, clean and then fill the brine tank with sanitiser solution until the next trip. Importantly, any bacteria traps should be thoroughly cleaned at the end of each trip.
- Check the iceboxes and storage compartments for any damage (cracks, holes, rust, damaged pipes, stressed fittings) and make the skipper aware of any potential repairs.

4.12 Road Transport and Temperature Checks

Product temperature should be taken from a random sample of the consignment (at least two containers from two different days or consignments) immediately prior to loading or upon lodgement at a shore depot using hand-held temperature probes.

These temperature measurements should be noted on the consignment papers and the vessel logs as a record of product temperature when possession was transferred to a depot or the road transport. This may be used to resolve disputes with customers over the temperature condition of product on arrival. This is a key aspect of traceability and proper record keeping. It is worth remembering that even though the fish is out of your control, it is STILL YOUR FISH until it reaches the end user.

Transporters should be advised of their responsibility for ensuring continuous mechanical refrigeration to maintain the consignment's temperature control until the consignee accepts delivery. Check that the temperature currently maintained within the truck's storage compartments is between –1 to +1°C.

4.13 Fishing, Temperature and Fish Distribution Records

Detailed records should be maintained of each day's fishing area(s) and fish landings to allow for efficient traceability and recall of any suspect or faulty product.

Holding compartments, iceboxes, brine tank and fish temperature monitoring records should be maintained to provide buyers and customers with an assurance of good handling practices. An example of this documentation is included at the back of this Code.

Any unusual fishing or handling affecting fish quality should also be noted in the vessel's records to facilitate the traceability of a particular day's catch. Such information is passed onto customers for their information and guidance on managing the quality of their consignment.

These records should be maintained for 12 months.

5. THERMAL CHARACTERISTICS AND USE OF ICE

5.1 Calibration of a Thermometer

To calibrate a thermometer simply take a cup, half fill with fresh water and top up with shaved freshwater ice. When no more ice will melt, insert the thermometer's probe and leave for about one minute. The temperature should read 0°C, plus or minus 0.1°C.

5.2 Use of Ice for Chilling Fish and Shark

Ice is a very efficient coolant and is widely used to cool food because it is safe to use.

Ice does not change the food; it removes a lot of heat from food when the ice melts from a solid at about 0°C to a liquid (melt water at 0°C). Ice is a very effective coolant because it has such a large reserve of cold, known as the latent heat of melting ice.

A kilogram of ice removes about 335 kJ of heat from fish or water as it melts.

An ice slurry (chilled sea water) is commonly used to chill fish immediately after harvesting, but the ice must be thoroughly melted in water to produce a slurry with uniform temperature of about 0°C. The formula shown above can also be used to determine how much ice needs to be melted in water to produce a slurry at 0°C.

Note: 1 litre of fresh water weighs 1 kg; 1 litre of sea water weighs about 1.035 kg.

How to Calculate Ice Requirements

The amount of ice needed to cool fish depends on:

- The weight of the fish to be chilled.
- The temperature reduction required.
- The specific heat of the fish (3.6 x 1,000 (J/kg °C).
- The latent heat of ice (335).

For example, to cool 100 kg of fish (or water) from 25°C to 0°C the amount of ice needed (in a box or tank without refrigeration) can be calculated by:

$$\frac{\text{weight of fish x temperature change x specific heat of fish}}{\text{latent heat of ice}}$$

i.e. multiplying the weight of the fish (100 kg) by the temperature change required

(25° – 0° = 25) and the specific heat of fish (3.6) and then divided by the latent heat of ice (335).

This is: $\frac{100 \times 25 \times 3.6}{335} = 27$ kg of ice

In this example, the 27 kg of ice will cool the fish from 25°C to 0°C, but there will be no ice left after the fish have reached 0°C. This means that 27 kg of ice in a slurry (e.g. tank with sea water chilled only with ice) will melt in cooling the fish. More ice will be required to then keep the fish at a temperature of 0°C.

(The use and consumption of ice in refrigerated brine tanks will vary according to fish volumes, temperatures and the capacity of the refrigeration system).

The ready reckoner (on the next page) will help you to quickly estimate your ice requirements.

Seawater Ice

The temperature of seawater ice is highly variable. The initial melting temperature of clean seawater ice may be as low as –6°C, but due to the leaching of salt in the melt water, the melting temperature may rise again to nearly 0°C. As previously mentioned, once fish temperatures are between –1.5°C and – 5°C bacterial spoilage is slowed, however enzymic spoilage is not.

Another characteristic of seawater ice is that the salinity is also highly variable i.e. the ice at the bottom of a bin is very salty while that at the top may not be.

There is also a risk that fish stored in seawater ice may become partly frozen and any headless, gutted fish may absorb some salt.

A key point about seawater ice is that its cooling capacity is only marginally better than that of freshwater ice despite its lower temperature compared to freshwater ice. This is because most of the cooling capacity of any type of ice comes from the latent heat – the heat absorbed when the ice melts from a solid to a liquid (water) – rather than the heat absorbed in raising the temperature of the ice itself, from about –6°C say for seawater ice, to about zero.

IT IS NOT RECOMMENDED TO USE SALTWATER ICE WITHOUT CLOSE MONITORING OF THE TEMPERATURE OF BOTH THE SLURRY AND THE PRODUCT.

READY RECKONER FOR ICE USAGE RATES

The "ice reckoner" table below provides a quick guide to the amount of ice required to chill a known amount of fish in chilled seawater slurry given the temperature of sea water (which is assumed to be very similar to the core temperature of fish).

For example, if you estimate that you will land 600kg of fish from a sea temperature of 20°C you will require no less than 129kg of ice to chill the anticipated catch (i.e. to 0-1°C within 2 hours). Additional ice would be required to maintain the core temperatures within the required level (-1 to +4°C) for the duration of the fishing trip.

Recommended Ice Usage Rates (kg) for Ice Slurry Tanks

ESTIMATED FISH LANDINGS IN kg	SEA TEMPERATURE (Deg°C)							
	12	14	16	18	20	22	24	26
100	13	15	17	19	21	24	26	28
200	26	30	34	39	43	47	52	56
300	39	45	52	58	64	71	77	84
400	52	60	69	77	86	95	103	112
500	64	75	86	97	107	118	129	140
600	77	90	103	116	129	142	155	168
700	90	105	120	135	150	165	181	196
800	103	120	138	155	172	189	206	224
900	116	135	155	174	193	213	232	251
1000	129	150	172	193	215	236	258	279
1100	142	165	189	213	236	260	284	307
1200	155	181	206	232	258	284	309	335
1300	168	196	224	251	279	307	335	363
1400	181	211	241	271	301	331	361	391
1500	193	226	258	290	322	355	387	419
1600	206	241	275	309	344	378	413	447
1700	219	256	292	329	365	402	438	475
1800	232	271	309	348	387	426	464	503
1900	245	286	327	368	408	449	490	531
2000	258	301	344	387	430	473	516	559

6. GOOD MANAGEMENT PROCEDURES: QUALITY CHECKLIST FOR THE DEMERSAL GILLNET AND LONGLINE FISHERY

The more ticks, the better the quality will be! The templates can also be downloaded at www.fish.wa.gov.au/sqmi. This is a companion template to the *Handbook for On-board Handling of the Demersal Gillnet and Longline Catch.*

Vessel_____Skipper_____Catch Dates from_____to_____

Crew_____

Prior to fishing

1. ☐ A crew member has been assigned to supervise the vessel's quality control. Name:
2. ☐ All crew are familiar with the *Handbook for On Board Handling of the Demersal Gillnet and Longline Catch.*
3. ☐ Two calibrated probe thermometers (in good order) on board – test 0ºC in ice slurry.
4. ☐ Fish boxes, tubs, brine tanks and equipment are cleaned and sanitised.
5. ☐ All fish contact surfaces cleaned with approved detergent/sanitiser once out of harbour.
6. ☐ Refrigerated seawater or chilled seawater tanks filled with clean seawater and correct amounts of antibacterial agent added (if used), as per manufacturer's instructions.
7. ☐ All crew are healthy and hygienic. Comments as required.

While fishing

8. ☐ Catch is handled immediately and humanely according to Code of Practice.
9. ☐ Catch pre-chilled in an ice slurry prior to immersion in the main tank to prevent excessive contamination of slurry.
10. ☐ Temperature, age and cleanliness of ice slurry or refridgerated sea water monitored throughout production.
11. ☐ Holding-room temperature regularly monitored and recorded (-1°C to 1°C).
12. ☐ Traceability system put in place (tags, vessel, date).
13. ☐ Fish packed in clean tubs correctly – clean, plastic liner – no overpacking.
14. ☐ Packed fish labelled to include vessel/species/catch date and weight.

Unloading the catch

15. ☐ Quality rating/inspection of fish prior to unloading.

16. ☐ Transport container chilled prior to fish being loaded.

17. ☐ Unloading completed quickly and efficiently, avoiding contamination and exposure to temperature fluctuations. Core temperature of product is not to rise above 4°C.

18. ☐ All containers are protected from dehydration and contamination, stacked with labels facing out. Number of containers and pallets recorded. Pallet wrapped with shrink-wrap.

19. ☐ Containers transferred to waiting truck or cold room without delay.

Road transport and temperature checks

20. ☐ Random sample temperature, check on at least three (3) cartons per load. Record average on consignment note.

21. ☐ Driver signs and receives a copy of documentation.

22. ☐ All records relating to catch and distribution (temperature monitoring and checklist) retained.

Monitoring of Temperature

Fishing day (coding method)	**Slurry Condition:** Soft (**S**) Firm (**F**) Hard (**H**)	**Ex-Slurry: Product Core Temperature**	**Chiller: Holding-Room Temperature**	**Chiller: Product Core Temperature on departure** (3 samples)			**Daily temperature** (maximum)	**Comments** (only if required)
Is refrigerated transport properly prepared?								
Thermostat setting on refrigerated transport.								
Destination.								
Expected time/date of arrival.								
Consignment note number.								
Driver's name (print).								
Driver's signature.								

Signed _____ (Quality Control Supervisor)

Date _____ Print name_____

WA SEAFOOD QUALITY
SQMI
MANAGEMENT INITIATIVE

Additional copies of this handbook can be obtained by contacting the WA SQMI at:

Level 3, The Atrium,
168 St George's Terrace, Perth 6000 WA
Ph: (08) 9482 7341 Fax: (08) 9482 7389
email: dnicholls@fish.wa.gov.au

or

WA Fishing Industry Council
PO BOX 55, Mt Hawthorn, WA, 6016
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Funded through the Western Australian Minister of Fisheries' Industry Development Unit and the Fisheries Research and Development Corporation, Canberra.

A Code of Practice for the Western Australian Demersal Gillnet & Longline Fishery

September 2004

ISBN 1 877098 58 2

GOVERNMENT OF WESTERN AUSTRALIA
Department of
Fisheries

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Western Australian Fishing Industry Council inc.

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