The Australian Tuna Handling Manual

A Practical Guide for Industry

The Australian Tuna Handling Manual: A Practical Guide for Industry
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DISCLAIMER

Foreword

This project has been carried out by industry, for industry. The idea to create a manual to teach Australian crews how to handle their tuna catch to obtain the best quality came originally from Erica Starling.

However, good ideas don't just get up and walk out the door. They need to be brought alive with energy, commitment, and resources. It was Erica who provided the energy and commitment. The resources came from a number of sources, all of which should be acknowledged.

The initial funding source for this project was the Rural Industries Research and Development Corporation, through the agencies of the Rural Woman of the Year Competition of which Erica Starling was a winner.

These funds were augmented by funding provided by the Fisheries Research and Development Corporation through the Seafood Industry Development Fund which is administered by Seafood Services Australia.

All who have worked on this project would like to express our sincere thanks to these funding bodies who have helped to bring this project to fruition.

The research team also found help unbidden along the way as we worked through the early drafts. In particular, we have drawn on the excellent research and clear presentation style of the South Pacific Council who have produced a range of manuals and learning aids to teach crew about the correct handling of longline caught tuna. The SPC gave us open access to the text and graphics contained in these works.

We are grateful to SPC staff Michel Blanc, Aymeric Desurmont, Lindsay Chapman, Andre Capiez and Steve Beverley for their openness in this access, and for their invaluable feedback on the drafts.

This has been a rewarding project to work on, and all of us hope that you, the Australian tuna industry, can draw benefit from it as we strive to produce top quality seafood for our international and domestic customers.

Geoff Diver
May 2005

Acknowledgements

Many people were involved in the production of this manual. In particular, we would like to thank the following:

Alan Snow for editing, Alistair Ewan Douglas, our technical specialist, for advice and comments;

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Gary Burke and Sam Blight for their artwork and design.

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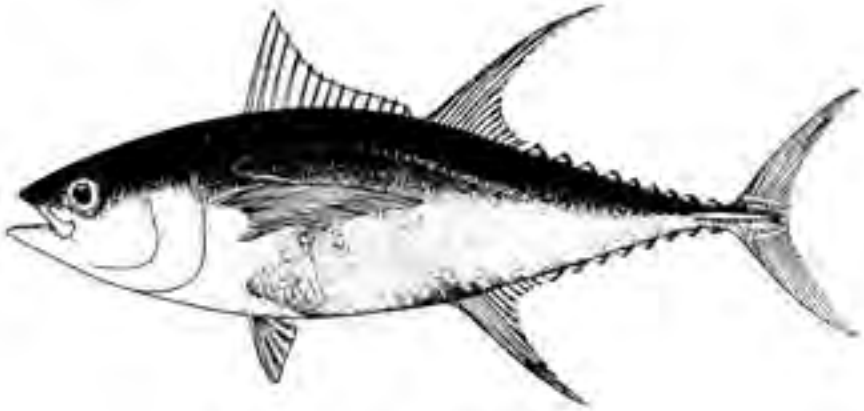
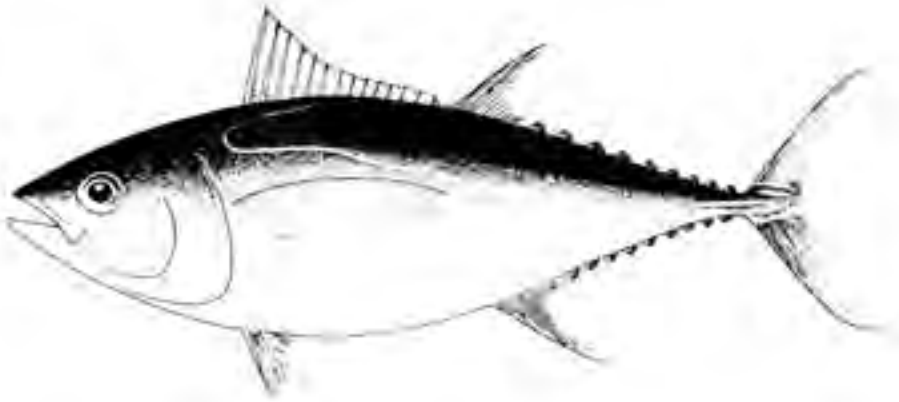


Thunnus albacares (yellowfin)



Thunnus obesus (bigeye)

Thunnus alalunga (albacore)

Part 1

Introduction

Introduction

The Australian tuna industry provides premium quality products to very particular markets. Delivering quality product to the tuna market is how we earn our living. Better quality results in higher prices. All efforts are wasted if the tuna arrive at the market place in poor condition.

When working on an Australian tuna vessel, you become part of the chain delivering these quality seafood products. The way you handle the catch from when it is hooked, to when it is landed, cleaned, chilled and stored will affect its quality. Your work in managing the deck and storage spaces of the vessel before fishing, during fishing, and after unloading can influence the quality of the product coming from your vessel. Everything you do on the deck of the boat, from cleaning to the storage of chemicals, bait, and product, has the potential to affect the quality of the catch.

Quality products attract higher prices at both domestic and international markets. Higher prices mean higher returns to the boat, and higher wages for the crew.

Importantly, the deck of a boat is a food preparation area. It is no different from a restaurant kitchen in this respect. We wouldn't expect to see the chef's pet dog in the kitchen, or someone smoking, or spitting on the floor. We would expect the kitchen hands to wash their hands after using the toilet, and to wear clothes which aren't contaminated by yesterday's food scraps.

Our customers don't expect boat crews to act like that either.

This manual is designed to provide you with simple, easy to follow instructions on how to handle tuna in a manner which will allow you to deliver the best possible quality product.

The manual should be kept on the vessel and used as part of the induction process for crew new to tuna fishing, and for review purposes for experienced crew.

Tuna is a quality product: Making sushi (above); Sushi for sale (below)

Using This Manual

The manual is divided into topics that cover the skills and knowledge needed to become competent in handling tuna and swordfish on a longline vessel. In particular, the manual provides a practical guide for:

- training new crew and standardisation of practices for existing crew.
- understanding the key factors involved in producing sashimi grade product.
- understanding the factors affecting shelf life of the catch.
- describing how to add value to the product by using documentation to demonstrate safe and consistent handling practices.

For best use of the manual:

- Read through each topic carefully. If training is not 'on-the-job', use the Manual as a study guide and companion for materials delivered in classroom-style sessions.
- Talk to the skipper about how to best organise your training using this manual.
- Ask for help or clarification when you need it. Your skipper will explain and show you the correct way to do things. Talk to more experienced colleagues and ask for their guidance.
- Practice your skills on-the-job, or in a practice or simulated workplace environment. Make sure you practice your skills regularly to improve your confidence and performance.

After working through the manual, we expect that all crew members will be able to:

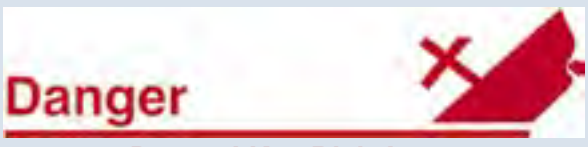
- Understand and apply safe hygiene practices when working on tuna longliners.
- Correctly prepare the longline vessel before a fishing voyage.
- Understand and apply correct landing and cleaning practices.
- Understand the rationale and procedures for the initial chilling of product.
- Understand the rationale and correct procedures for long term cold storage of product.
- Correctly manage the 'cold chain' during unloading of the vessel.
- Apply appropriate vessel cleaning practices after the vessel is unloaded.
- Document all stages of the catch, landing, refrigeration and unloading phases.

Where are the standards used here drawn from?

The practices outlined in the manual are designed to assist in obtaining compliance with the new rules and regulations regarding safe food production and handling, both domestically and internationally. Increasingly compliance with these standards is becoming a prerequisite to market access and good market prices. The regulations and publications of various industry and government bodies have been considered in the development of this manual. These include:

- The Australian Seafood Standard (a voluntary standard)
- The Food Standards Code administered by Food Standards Australia New Zealand
- The Primary Production Processing Standard for Seafood
- The Seafood Industry Training Package
- AQIS/EU Market Access Registration

Throughout this manual you may see these symbols.
This is what they mean:



Danger! Key Risk Area

Remember this! It is important.

Tuna Biology

Tuna are fast swimming, migratory fish. They require a large and constant supply of energy to sustain their activity. They are warm-blooded and their internal temperature remains constant at about 28°C for their whole life.

Their average body temperature changes according to the ambient water temperature and their feeding and activity rates. Under certain conditions, such as during stress and struggle during capture, their body temperature may rise for short periods to 35°C to 40°C.

Unlike mammals, tuna have few temperature control methods. One way they lower their temperature is to position themselves in colder water. This can be done by diving deeper when needed, or locating cooler water in surface features. They can conserve their internal heat by a combination of managing their blood flow and body cell function. As a result tuna are usually hotter in their core and cooler toward the extremities. This is known as the fish being 'regionally endothermic'.

After death, this elevated body temperature is detrimental to flesh quality as it can speed up the onset and progression of bacterial growth and biochemical deterioration. Before death, tuna can suffer a build up of metabolic products such as lactic acid. This is formed during the struggle as the fish is landed.

Lactic acid is a waste product of muscle exercise and needs to be removed before it causes damage to the exhausted muscle tissue. This damage can include a change in meat appearance from translucent to cloudy, softening the texture and giving a bitter flavour to the meat. These aspects of the fish are used by buyers grading tuna that is to be sold for sashimi.

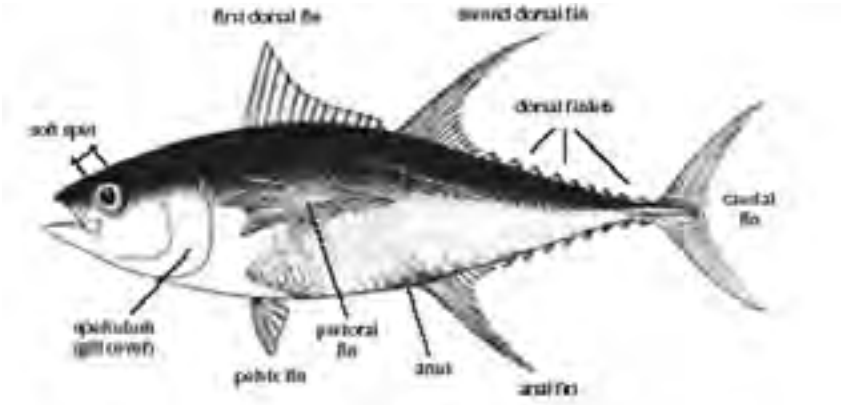


Fig. 1 External anatomy of Yellowfin Tuna (SPC Manual On On-board Handling of Sashimi-grade Tuna)

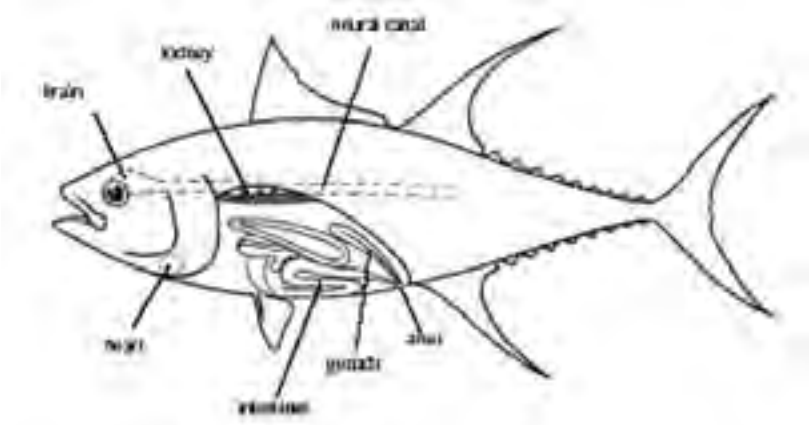


Fig. 2 Internal anatomy of Yellowfin Tuna (SPC Manual On On-board Handling of Sashimi-grade Tuna)

How Does Biology Affect Quality?

Why is Tuna flesh red?

The flesh of tuna is red due to a large blood supply and the presence of a higher proportion of red muscle tissue.

Fish have two types of muscle fibres, white and red, which are named for their predominate colour. White muscle tissue has a low blood supply and works strongly for a short period of time before it becomes exhausted. It is used for quick pulses of activity. Red muscle tissue has a much larger blood supply, hence its colour, and is used for prolonged activity such as long distance swimming.

The muscle fibre types are present in different proportions in different species of fish because of the way the fish swim and feed. Swordfish stalk their prey and then sprint to attack from a short distance away and so have predominately white flesh while the tunas chase their prey down over longer distance and so need much more red muscle tissue. In this respect flesh of the warm-blooded tuna resembles beef more than it does the flesh of other finfish.

What happens when a fish dies?

When a fish dies a temporary stiffening of the body muscles occurs. This stiffening is called *rigor mortis*. After *rigor mortis* the flesh once again becomes soft. Postponing or prolonging *rigor mortis* in seafood, which can be achieved by chilling it, is highly desirable. This is because significant bacterial spoilage of the flesh will occur after *rigor mortis* has passed, therefore postponing the onset of *rigor mortis* will assist in extending the shelf life of the fish.

How does this affect the quality of the meat?

The oxygen carrying molecules found in the blood is called haemoglobin and the oxygen carrying molecules found in the muscle fibres is called myoglobin. Haemoglobin is responsible for carrying oxygen from the gills to the myoglobin in the muscle tissues and for carrying carbon dioxide in the reverse direction, similar to the haemoglobin found in humans and other animals. Fish with red muscles have large amounts of oxymyoglobin (oxygenated myoglobin) in its tissues, which develops the red colour. When the oxygen is consumed by the muscle, the myoglobin turns into oxygen free myoglobin, called deoxymyoglobin. While the fish is alive these changes can be reversed.

A fish that thrashes around will use up all the oxygen in the muscles, producing lactic acid and the flesh can become a dark red to purple colour. When the fish dies the deoxymyoglobin molecules degrade to form brown metmyoglobin turning the colour of the flesh dark. By reducing the stress during harvest and handling, the exercised muscle can recover and the oxygen replaced, preserving the red flesh colour.

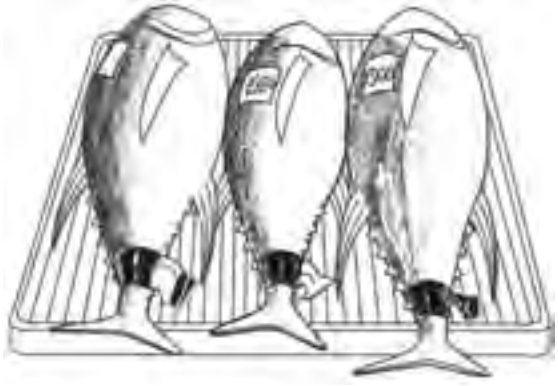


Fig. 3 Tuna with tail cut exposed for inspection at auction

What is Sashimi Quality Tuna?

Sashimi is a traditional Japanese dish made from thin slices of premium quality raw fish. The most popular fish are red meat fish, particularly tunas. Sashimi means more than just raw fish, with specific requirements regarding freshness, appearance, presentation, texture and taste.

Only premium quality fish will return a good price on the sashimi market. Sashimi markets are not just confined to Japan but occur throughout the world, servicing both Japanese style eating houses as well as Western forms of cooking.

Determinants of Fish Quality

Fish quality is determined by biological and non-biological factors. This manual provides information to control the non-biological factors that impact on the sashimi quality of the catch.

Biological Factors

Biological factors include species, age, size, degree of sexual maturity and the presence of parasites or diseases. Other factors in the fish's environment which can influence the condition of the fish include water temperature before capture and the availability and type of feed consumed prior to capture.

All of these factors are important because they determine the fat content and flesh quality of the fish. The tuna with the highest fat content and best meat colour usually attract the best prices in the sashimi market. A fishing crew can exercise little control over the biological factors.

Non Biological Factors

The non-biological factors affecting tuna quality include the fishing method used, as well as the handling, chilling and storage techniques applied to the fish after capture. *The non-biological factors are within the crew's control.*

Tuna auction in Japan: Different buyers look for different qualities of fish

Grading Sashimi Quality Tuna

How a fish is graded in the market depends on a number of factors, including the size and body shape of the tuna, as well as the firmness, colour, texture, clarity and oil content of the flesh. The table below gives guidelines for fish attributes and how the grade is effected. However, grading is relative and is always subject to the market conditions of the day.

Fish Attribute	Grading Impact
Size	Larger fish generally return the higher prices for equivalent grade
Oil Content	Oil and fat reserves depend upon the recent feeding history, breeding history of the fish and the surrounding water temperature. Fish deposit fat in colder water temperatures and grow in length in warmer water temperatures. Prior to spawning, fish build up stores of fat and after spawning these reserves are lower and the value of the tuna on the sashimi market can be at its lowest.
Body Shape	Well-rounded fish generally provide a better yield (recovery) of flesh and can command a higher price in the market. In figure 4 an 'A grade' fish (top) is shown to have a deep, well rounded body, while a 'C grade' fish (bottom) is more slender.
Flesh Colour, Clarity and Texture	Colour varies between species and different parts of the flesh. In the ideal tuna, the outer layers of the flesh (Chutoro and Otoro) are a delicate pink and the interior (Akami) is a deep red. In high grade fish, the toro of the belly flap (Otoro) is permeated by small fat lines (marbling). (See Fig 5, page 14).

(Table from Blanc, Michel, et al., 'On-Board Handling of Sashimi-Grade Tuna: A Practical Guide for Crew Members', South Pacific Commission, New Caledonia, 1996)

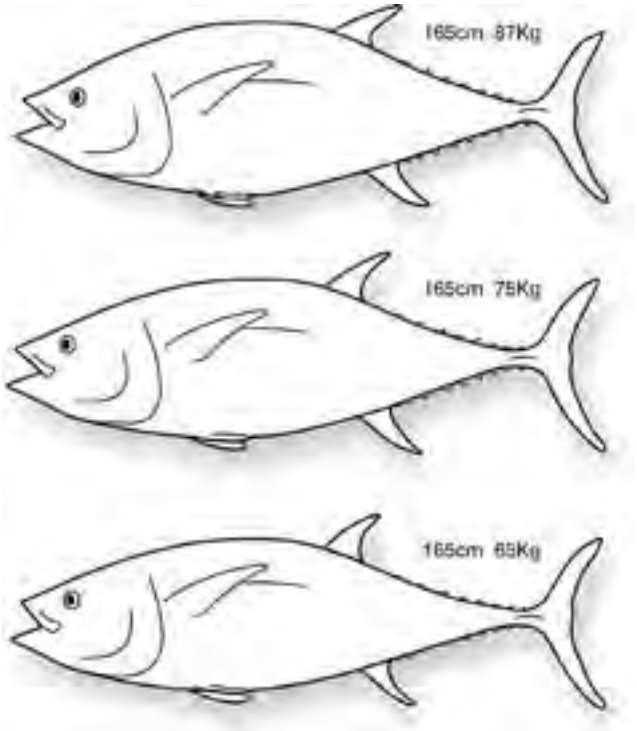


Fig 4. Shows three tunas of the same length but different weights. The 'A Grade' fish (top) has a deep, well rounded body. The 'C Grade' fish (bottom) is more slender than the others. Each of these tunas are likely to attract a different price on the export market.

Quality Issues Specific to the Japanese Tuna Market

What Buyers Look For

At the market, the buyer can only inspect the tail section and the thickness of the belly flaps of the fish and must estimate the colour and fattiness of the carcass from both of these areas.

Different buyers look for different qualities of fish: One buyer may prefer high fat content fish, such as Southern Bluefin Tuna. Another buyer may prefer longer lasting fish with clear flesh colour, not necessarily with high fat content, such as Yellowfin Tuna.

Generally, tuna flesh should be bright and clear, with a slight sheen and a silky texture. Any signs of darkened or 'muddied' flesh can indicate a problem with flesh quality, such as 'Yake', or 'flesh burn'.

Flesh colour, clarity and texture are affected by handling techniques. In the absence of oxygen, deoxymyoglobin is dark red but when exposed to oxygen it returns to a bright red colour. The change in flesh colour from dull red to bright red is an indicator of the freshness and handling history of the fish.

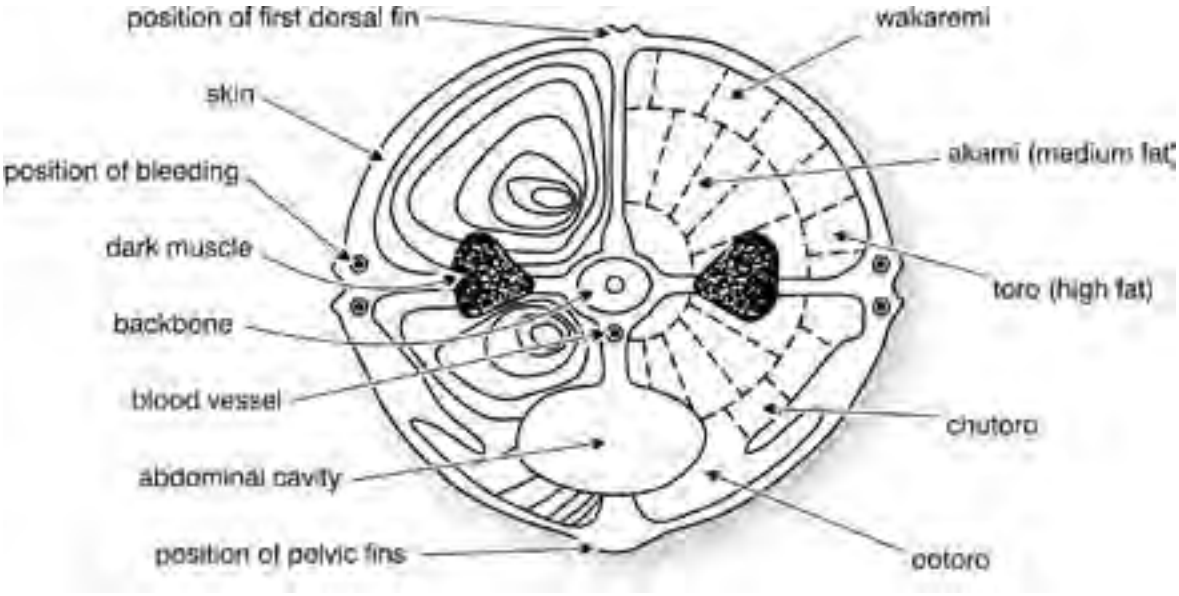


Fig 5. This shows a cross section of a tuna with the various anatomical and quality-determining components labelled.

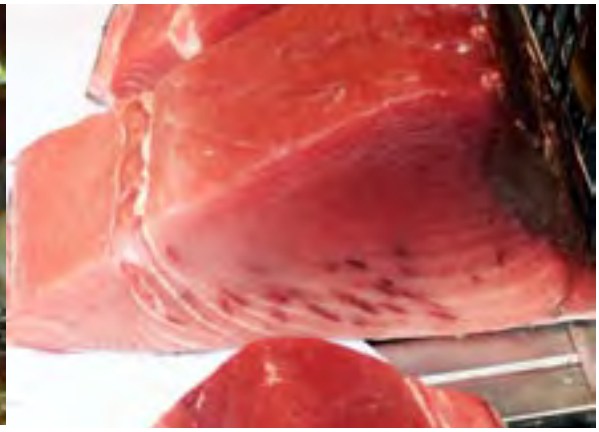
There are English and Japanese names used in the Japanese tuna market to describe tuna quality. These terms originated in Japan but are now commonly used by processors and buyers to describe fish quality. It is useful to familiarise yourself with these terms so that market feedback on fish quality can be better understood.

The tables on pages 15 to 17 give a description of the condition, the cause, and preventative actions that may be taken. There are three main types of causes: handling, biological, and a combination of handling and biological. The problems caused by biological factors are beyond human control. They may be due to factors affecting fish in the wild, for example shark bite damage or parasites.

Problems that originate through incorrect handling practices are preventable. Handling plays an important role: good handling practices can ensure good quality and help to minimise these problems. Better quality means better prices.

Terms Used	Description	Preventative Actions
English: **Body damage** **Japanese:** **Kizu** (cut or scratch) **Morikizu** (harpoon or gaff damage)Samekui (shark bite) **Jyukon** (bullet wound)	• May be a biological problem or consequence of bad handling practices. • Physical appearance damage caused by external factors such as harpoon damage, shark bite, hook damage, line marks etc.	• Careful handling. • Use of wet, shock absorbing matting and accurate use of the gaff or harpoon.
English: **Burnt Meat** **Japanese:** **Yake** (all sections of the fish) **Shinyake** (core meat only)	• May be a biological problem or consequence of bad handling practices. • The colour of the meat will turn opaque with varying states of colour from pale reddish pink to darkish grey and the meat texture will lose its tenderness. Caused by insufficient cooling of the fish immediately after killing. Often happens to larger fish. Can also occur when fish is extremely vigorous at capture, heating his body and building up lactic acid.	• Minimise the amount of thrashing or movement of the fish once on the deck to prevent lactic acid build up. • Possible to reduce onset of Yake by allowing a vigorous fish time to 'recover' prior to killing and chilling rapidly after killing. • Cover the eyes and kill by ikijimi quickly. See "Killing" section for more information

Nice Tail Cut - BE



Stain

Terms Used	Description	Preventative Actions
English: **Blue Meat** **Japanese:** **Aotan**	• Dull blue/grey/green colour just under skin. Often seen on tail cuts. Particularly evident in Swordfish. Can occur as fish ages or if fish was dead on line for some time and exposed to sun. • Caused by bad handling.	Haul line as soon as possible to avoid dead fish being held on a line for extended periods in the sun.
English: **Blue Belly** **Japanese:** **Hara go Aokunata**	• Stomach lining has changed from fresh, pink white colour to dull grey/blue. A key freshness indicator used by buyers to assess the value of a fish. • Caused by bad handling.	• Process and handle as quickly as possible prior to chilling. • Rapid chilling. • Pack gut cavity with ice when storing if possible.
English: **Brown/ Chocolate Meat** **Japanese:** **Henshoku Iro Warui**	• Meat colour turns very dark. Can easily occur in tropical yellowfin. • Caused by bad handling.	Rapid handling and storage will help to minimise.
English: **Pale Meat** **Japanese:** **Aozameta Iro Nashi**	• Meat colour is very light pink/red. Caused by a lactic acid build up from vigorous movement of the fish. • Usually caused by bad handling.	Minimise the amount of thrashing or movement of the fish during hauling and landing to prevent lactic acid build up.
English: **Spread (in swordfish)** **Japanese:** **Nijimi**	• Blood line (red muscle tissue) spreads into white meat. • Caused by bad handling.	• Correct and complete bleeding of fish. • Correct chilling & storage
English: **Split Meat (Gaping)** **Japanese:** **Miware**	• The meat splits along the muscle rings in flesh. This is caused by bending or dropping the fish when in rigor, or insufficient chilling. More prone in fatty fish. • Caused by bad handling.	• Ensure fish are completely cooled prior to placing in storage hold. • Ensure ice is tightly packed in and around the fish to prevent air spaces forming between the ice and the fish. • Do not bend the fish when placing in storage or unloading.
English: **Stain**	• Blackish red spot spread around the meat. Direct result of the rupture of internal capillaries, causing bruising. Can be caused by dropping or knocking the fish during capture, while the fish is still alive, or incomplete bleeding. • Caused by bad handling.	• Take care not to mishandle or drop fish at any time. • Use a mat on the deck to prevent the fish from injuring itself. • Ensure the fish are bled completely prior to chilling.

Terms Used	Description	Preventative Actions
English: **Jelly Meat** **Japanese:** **Yamai**	• Generic term to describe damage caused by sickness of the fish. Flesh usually has a jelly like appearance and deteriorates over time. Often hard to detect. • A biological problem.	None. An internal sickness that is not preventable.
English: **Melting Meat** **Japanese:** **Sashi, Toroke & Azuki-Nagare**	• Part of the body has degenerated. It could be a hole inside the meat or part of the body is empty. The cavity is a direct result of the melting of the meat. • A biological problem.	None. Damage is affiliated with a parasitic infection and is not detectable or preventable.
English: **Skinny** **Japanese:** **Rakkyo & Gari**	• Fish that have no fat and the flesh colour is dark red. Found in fish that have recently spawned or that have had insufficient feeding. • A biological problem.	None. The result of environmental conditions during the life of the fish.
English: **White spot** **Japanese:** **Hoshi, Goma & Azuki**	• Small hard white dots scattered throughout the body or in one section. This is caused by a parasite inside the body of the fish. • A biological problem.	None. A parasitic cyst that is not detectable or preventable.
English: White Cloud Meat **Japanese:** **Shirakumo**	• Cloudy white meat spread around the body, caused by sickness of the fish. • A biological problem.	None. An internal sickness that is not detectable or preventable.
English: **Dull Meat** **Japanese:** **Konnyaku with or without Miware**	• The flesh colour is still red, but a dull, lacklustre red. The clarity of the flesh has changed to opaque. The meat will often look like beef. Can easily happen to larger fish when they lose fat. Can sometimes be identified in exceptionally skinny fish in the tail. • A biological problem.	None. Seasonal deterioration of the flesh that can also result in Miware (see above).

Taking tail cuts from frozen tuna

Fish Flesh Conditions

100y

Bloody

Damaged Flesh Fin

Healthy Pink Stomach, Good Lining

Opaque

Milky, Pale 300y

Fish Flesh Conditions

Rainbow

Parasite

Milky Loin

Rotten Loin

Soft Flesh

Torn Stomach Lining - blue

Handling and Fish Quality Issues

Fish handling affects quality and price.

Fish sales and prices achieved in the marketplace are dependant on the quality of the fish. Poor handling can easily turn a fish of natural high quality into one that is sold as poor quality.

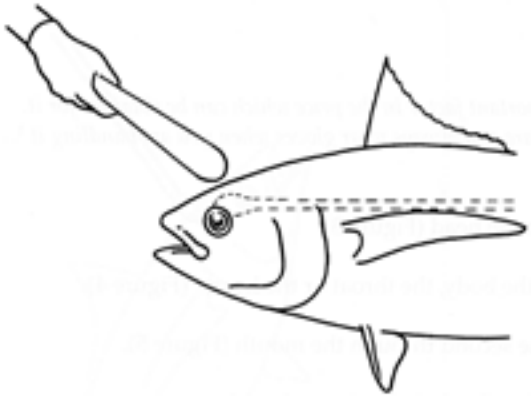
However, problems arising from bad practices of landing, handling and refrigerating the catch are preventable. It is important for the skipper, deck supervisor, or any crew member involved in handling tuna to be aware of potential problems. Strategies need to be in place to prevent these problems occurring. Prevention is better than cure.

Potential Problems Arising from Poor Handling

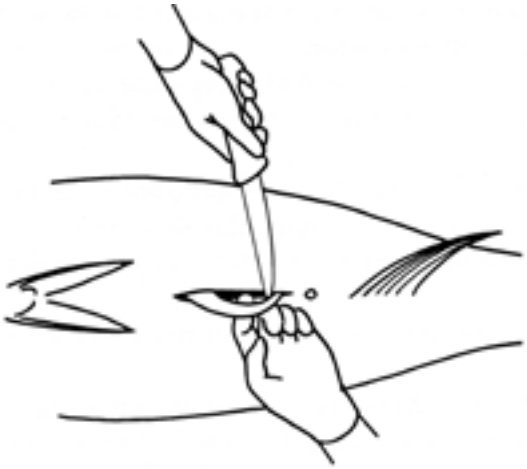
The tables on the previous pages have summarised some of the quality issues that arise from poor handling. Figure 6 illustrates the actual handling activities and risk areas where problems may occur. Be alert to methods that could be used to prevent the problems from occurring in your operation. New preventative strategies are always worth discussing and good communication between skipper, crew and your processor can help identify any problems that are actually occurring.

1. Gaffing

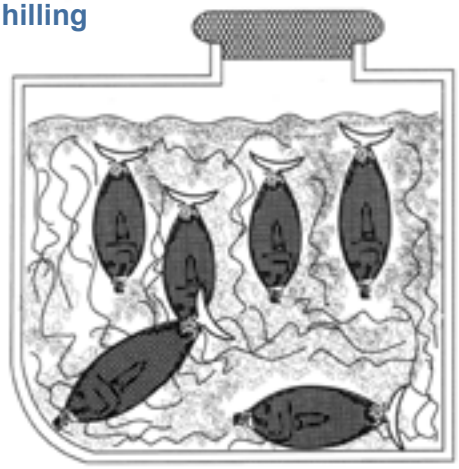
2. Killing



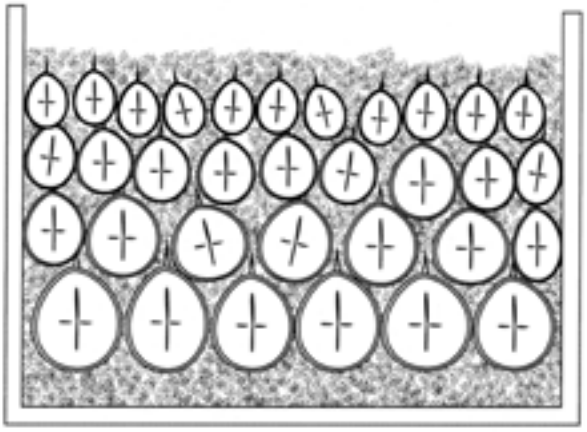
3. Bleeding & Evisceration



4. Chilling



5. Storage



6. Unloading

7.Clean up

Fig. 6 Unless done properly, each of the 7 Stages is a potential problem area when handling catch

Remember

Bad handling can damage a fish of naturally high quality and make it worthless at the market. Careful handling will can prevent unnecessary losses.

Spoilage In Fish

Tuna spoils due to a number of factors, including:

- The action of internal enzymes
- The natural bacteria living on the fish, and the bacteria picked up during landing and sorting procedures

Chemical reactions within the blood and muscles of the animal which cause the flesh to look like it has been “burnt”.

Spoilage can be defined in two main ways:

1. Spoilage which makes the tuna unfit for human consumption; and
2. Quality spoilage where the tuna is still edible but is of undesirable quality. .

Bacteria

Bacteria are found on the surface, slime, gills and gut of living fish. They are single celled organisms that multiply at alarming rates in the right conditions. Under optimal conditions bacteria may double in numbers every 20 minutes, so that a single bacteria cell can multiple to approximately 1,000,000 bacteria after 8 hours.

Bacteria need warmth, moisture, food, and time to grow. Most spoilage bacteria also need oxygen (air) but some, particularly poisonous bacteria, can grow in the absence of oxygen.

The longer a food product – particularly fish – is left in temperatures above 4°C, the more bacteria multiply. Over time the bacteria levels may become so high that the fish becomes ‘off’. Cooking or chilling cannot make it edible. If the temperature of the product can be rapidly reduced, then growth of most bacteria can be slowed significantly. The greater the drop in temperature, the slower the bacteria multiply. Temperature and bacteria have a significant impact on the shelf life of fish.

Even when stored in ice the numbers of bacteria present in the first 10 millimetres of flesh around a ‘cookie cutter’ shark bite will be excessive by the end of the trip. During processing at least 20 millimetres of flesh should be removed from around any bite or cut surface to produce safe flesh for consumers.

Some bacteria are harmful in large numbers, while others produce toxins (poisons) even at low numbers. In these cases the tuna may not smell or taste ‘off’ but can still make people ill. Some tuna are eaten raw, so the presence of these bacteria has serious implications for food safety. Correct handling of the fish at all times can minimise the risk of this occurring.

Enzymes

Enzymes help fish to build tissue, contract and relax muscles, and digest food. When fish die, the enzymes continue to work at digesting or breaking down flesh. This breaking down creates a food source for the bacteria which invade the flesh through the gills, along blood vessels, directly through the skin and gut cavity lining, along knife cuts and through shark bites.

The breaking down processes can be slowed by chilling or freezing - the colder the tuna, the slower the breakdown. Controlling the temperature of tuna once it has been landed has a direct impact on fish quality. Decreasing the temperature from 5°C to 0°C can halve the rate of spoilage. Rapid chilling or freezing reduces bacterial growth and is critical to maximising freshness, shelf life and saleability of the catch.

Remember, although bacterial spoilage is reduced between -1.5°C and -5°C, spoilage from enzyme activity continues. This is because enzymes still work at freezing temperatures and thus cause a breakdown of the flesh.

Histamine

Some bacteria produce the enzyme histidine decarboxylase, which reacts with free histidine, a naturally occurring chemical in fish, resulting in the formation of histamine. Upon death, the defence mechanisms of fish no longer inhibit bacterial growth, and histamine-forming bacteria start to flourish. It is impossible to know on the vessel or in the factory if a fish has unsafe levels of histamine. Histamine testing can only be carried out at specially certified laboratories in Australia is now an AQIS requirement for export to some countries.

The limits for histamine in fish or fish products are defined in the Food Standards Code. The limit must not exceed 200 mg/kg (i.e. 200 ~ 500 ppm of histamine causes consumer illness).

Scombrotoxin

Scombrotoxin is a toxin produced by certain bacteria that can cause illness to consumers. The rapid chilling of fish immediately after death, and subsequent chilled storage, is important in preventing the formation of Scombrotoxin.

Chemical Spoilage: 'Burnt' Tuna

In terms of marketability, a major defect in tuna meat is 'burnt' tuna. In Japanese, this is known as 'yake', which translates as 'burnt' flesh.

Good quality tuna meat is bright red, oily, firm, slightly translucent, with a fine, creamy texture and delicate flavour. In contrast burnt meat is musty, watery, turbid and muddy brown in colour, with a sour flavour and unpleasant after taste. Affected tuna is unacceptable for sashimi or sushi, and obtains only a fraction of the price that would be paid for prime condition tuna.

Factors that cause these changes in the muscle tissue are not well understood, but the widely held view is that burnt tuna is caused by two simultaneous factors:

- Build up of lactic acid in the muscle tissue leads to a decrease in muscle pH. The low pH damages the structural muscle proteins and pigments, leading to less rigid, more watery, soft tissue.
- Increased body temperature, as a result of vigorous muscle activity, accentuates the adverse affects of increased acidity.

Once the fish is on board, the 'burning' process continues at a faster rate because:

- The fish is highly stressed.
- The muscles continue to function.
- The heart (and body) cannot dissipate heat through the gills.

To minimise temperature increase and acid build up, it is essential that appropriate on board handling techniques are employed. These include:

- Minimising deck delays: keep the fish in the water.
- Prevent violent flapping: Catch, land and process the fish as quickly as possible.
- Ensure killing is swift and effective.
- Chill as soon as possible.

Fish are graded by buyers according to freshness. A loss of freshness reduces the value of a fish. Controlling the temperature of tuna once it has been landed has a direct impact on freshness.

Fish Spoilage: Key Risk Areas

Everyone involved in any stage of the landing and handling of the catch has a vested interest in maintaining quality standards. Everyone should familiarise themselves with 'Risk Areas' to ensure preventable damage does not occur.

Problem Indicators	Why it occurs	Prevention
Flesh Damage	• Bad handling when hauling and landing • Gaffing/harpoon damage • Slamming into the side or deck of vessel • Line damage.	• Extra care when hauling and landing fish • Only gaff through the head. If the fish is large, use 2 gaffs. • Hold fish against side of vessel before lifting. • Lift fish as vessel drops in rough conditions. • Use carpets or mats to land, slide and rest fish on. • Use de-hooking devices
Bullet damage	• Poorly aimed shot	Aim shot to head at close range to avoid flesh damage & bullet contamination of the fish.
Gill/Gut Contamination	• Not eviscerated and cleaned correctly	• Take care when killing, bleeding and eviscerating • Remove the gills & internal organs as quickly as possible after landing the fish. • Take care not to puncture the gut.
Histamine production in fish flesh (refer to the section on 'Histamine and Scombrotoxin' for more information)	• Incorrect chilling, storage and unloading practices • Temperature abuse	• Chill rapidly after capture and processing. • Store fish under constant temperature - avoid fluctuations in storage temperatures. • Do not unload until the transport vehicle is at the wharf and containers have been unloaded. • Have ice ready to cover fish when placed into containers. • Ensure all fish are iced properly so that ice totally covers the top layer of fish. • Do not leave fish sitting on the wharf once unloaded. • Unload out of direct sunlight if possible.
Slimy fish - fish discoloration	• Bad chilling and storage practices • Chilling water not clean, or tanks not cleaned • Water temperature too high or fluctuations in water temperature	• Ensure brine tanks, RSW units are clean, with fresh brine, prior to hauling first shot. • Pre-chill prior to hauling the catch. • Monitor & record tank temperatures - keep water temperature near 0°C always. • Add ice to help maintain temperatures. • Do not overload tanks. • Monitor compressor shutdown times & holding times in chill tanks.

Fish Spoilage: Key Risk Areas (continued)

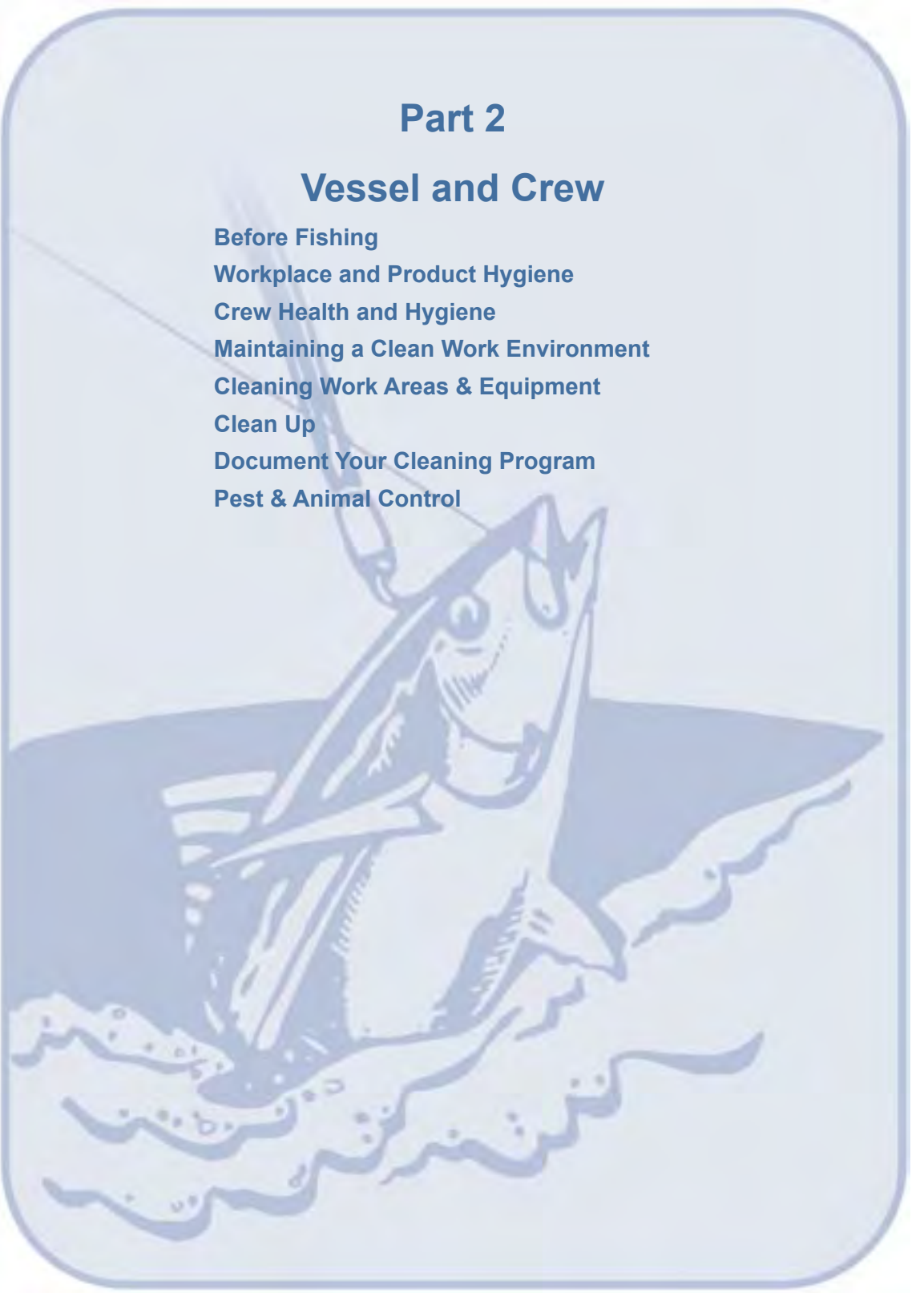
Problem Indicators	Why it occurs	Prevention
Bleached fish skin/scale damage	• Bad chilling and storage practices • Rubbing of fish together, or on bottom/side of tank or leaching of colour from skin	• Protect the fish by wrapping in clean cheesecloth sleeves or plastic bags with slits or holes to allow water movement.
Smelly fish: • "Unclean" smell; • 'Off' odours developing	• Inadequate chilling • Unclean equipment or facilities • Inadequate cleaning/ removal of guts, etc, (contamination) or along those lines	• Ensure all chilling tanks and storage areas are clean prior to fishing. • Clean carpet, mats and tools daily as per cleaning schedule. • Follow cleaning procedures (see "Clean Up" section). • Always follow directions for use provided on containers of cleaning chemical.
Temperature of fish too high prior to removing from chilling method to storage	• Bad chilling and storage practices • Chilling temp not correct. • Chilling time not long enough. • Overloading capacity of chilling method	• Ensure the brine tanks or RSW units are pre-chilled prior to hauling catch. • Monitor & record tank temperatures & chilling time. • Add ice to help maintain temperature. • Do not overload tanks. • Monitor compressor shutdown times & holding times in chill tanks.
Temperature of fish too cold	• Bad chilling and storage practices • Evidenced by icicles in tail cuts, frozen eyes • Fish chilled or stored too cold. • Flesh beginning to freeze	• Monitor & record tank temperatures. • Monitor holding times in chill tanks
Temperature rise when unloading	• Fish not covered with ice if intending to store or transport. • Fish not insulated when transported (for short transit only)	• Do not unload until the transport vehicle is at the wharf and containers have been unloaded. • Have ice ready to cover fish when placed into containers. • Ensure all fish are iced and that ice completely covers the top layer of fish. • Do not leave fish sitting on the wharf once unloaded. • Unload out of direct sunlight if possible.

Setting deck of a longliner (FV Alcyone II)

Part 2

Vessel and Crew

Before Fishing
Workplace and Product Hygiene
Crew Health and Hygiene
Maintaining a Clean Work Environment
Cleaning Work Areas & Equipment
Clean Up
Document Your Cleaning Program
Pest & Animal Control



Before Fishing

The quality of fish is determined by a range of variables including the facilities of the vessel and crew practices on the vessel. Although the skipper is ultimately responsible, everyone on board contributes to the quality of the fish coming in from the vessel.

Skipper's Responsibilities

To ensure safe delivery of the catch, the skipper's duties include:

- Making an accurate estimate of the expected duration of each trip.
- Ensuring there are sufficient and appropriate cleaning materials for the trip.
- Ensuring there is sufficient ice for the trip (if the vessel has no ice making facilities).
- Having a proper assessment and understanding of the skill level of each of the crew.
- Assigning each crew member duties in line with their level of skill and training.
- Ensuring that any goods brought aboard are clean and intact, i.e. not leaking or damaged. This includes bait and supplies.
- Ensuring that the vessel is clean and able to be kept clean during all the stages of fishing: catching, chilling, packing and storage of seafood ('clean as you go'). This includes all fishing equipment, brine / chilling tanks, storage hold / tanks and crew protective wear.
- Making sure refrigeration and ice machines are clean and working efficiently.

Workplace and Product Hygiene

Good hygiene on board a tuna boat is essential to protect tuna from contamination and deterioration. This means cleaning tools, decks, chilling tanks, freezer areas, and any packaging materials or processing machinery that comes into contact with the product.

Good detergents are necessary to remove proteins, fat, slime, and blood. Sanitisers are needed to kill bacteria, moulds, and viruses. The following actions can help prevent contamination:

- Have a designated handwash station located on the deck with adequate liquid handwash soap and sanitary supplies on board.
- Have proper cleaning equipment, detergent and sanitiser onboard.
- Poisonous, harmful materials or contaminants, such as oil, insecticides and cleaning compounds must be stored in secure and appropriately marked locations where they cannot leak into fish and handling areas.
- Packaging materials such as plastic bags and cartons must be stored in a clean, dry area, away from fish product or contaminants. Ensure they are free of insects and rodents.
- Keep separate containers for waste line and waste materials in the work area.
- Keep knives, brushes, gaffs and wire free of rust and organic matter.
- All mats, foam and landing areas must be kept clean.
- Snap rooms, freezer rooms, refrigerated seawater tanks and brine tanks must be scrubbed with detergent and sanitised before the catch is processed.
- Make sure the refrigerated seawater tank pipework has been flushed and sanitised.
- Keep toilets in a clean condition.
- Ensure bait is stored in a separate area away from fish storage areas and crew supplies.

Crew Health and Hygiene

Seafood is a food product and poor personal hygiene and handling practices can cause the seafood to become unsafe for human consumption. All crew must maintain a high standard of personal hygiene when handling seafood or containers used for holding seafood. All crew must follow basic hygiene requirements:

- All crew should be fully trained in hygienic handling of food product. There are a number of training options delivered as part of the Seafood Industry Training Package.
- Any crew member who has hepatitis, infectious skin conditions – or other illnesses that may be transmitted – **must be excluded** from contact with the product, the processing area, other crew members and from all handling operations.
- Ensure crew are aware they must advise the skipper if they have been suffering from food poisoning or any other gastro-intestinal illness.
- Prohibit smoking, drinking and eating while handling and processing the catch, in storage facilities, or wherever fish are handled.
- Crew must thoroughly wash their hands with fresh water and liquid handwash soap, rinsing and drying their hands, before handling seafood – especially after using the toilet, removing or handling waste or attending to mechanical repairs.
- Tie back loose hair before you start handling product.
- Avoid touching your hair, nose, mouth, ears and eyes while handling product.
- Keep cuts and sores well covered with a waterproof dressing. Ensure that any bandages are clean and coloured so that it is easily detected if it falls off. Bandages and injuries on the hands should also be covered with a glove.
- Ensure wet weather gear and clothing are clean before use. Clean thoroughly after each use to prevent build up of bacteria.
- All gloves worn by the crew must be clean, with no slime, nicks, or tears. Rinse gloves regularly during processing and after storing processed fish. Gloves should be replaced when showing signs of deterioration.

Remember

Everyone is responsible for ensuring good personal hygiene practices.

Have notices detailing hygiene standards laminated and fixed in prominent locations.

Seawater Quality

Clean water is essential for food safety. Harbour water is not clean and should not be used to either fill brine tanks, make ice or clean fish holds. If you need to use water for any of these purposes while still the harbour, use fresh water from a clean source.

Where practical fishers should:

- Not start the ice machine, fill brine tanks or use deck hoses until well clear of the harbour - where clean seawater is available.
- Start brine refrigeration once the tanks are full.

Danger

Contamination can take place if chilling equipment is not clean.

The quality & safety of the product will suffer if water used for chilling is not clean.

Maintaining a Clean Work Environment

The best way to eliminate contamination is to ensure that the vessel is clean. Crew members must clean the landing areas, processing tables, tanks, knives, utensils and other processing equipment, before they begin fishing for the day. Wash and hose down decks with seawater prior to the first catch and then after each haul.

Effective cleaning is a 4 step process. An effective cleaning program is essential if potential food safety risks are to be controlled. The four step cleaning process applies to: knives, brushes, gaffs, all rubber mats, foam mats, landing areas and the complete deck.

Step	Action	Description
Step 1	Remove loose dirt	Brush or hose surfaces, baskets etc. This removes dirt and reduces chemical use. Simply soaking tubs, knives and processing equipment is not effective. Scrubbing with a stiff broom or brush, using an appropriate detergent and sanitiser is the only way to maintain a proper level of cleanliness in an environment that is naturally loaded with organic material and bacteria.
Step 2	Wash	Wash with detergents that help break down fats and grease. Washing does not necessarily remove all bacteria. Rinse off the residue.
Step 3	Sanitise	Sanitising chemicals reduce bacteria to low levels. Follow sanitiser instructions carefully, as there may be a minimum contact time for effectiveness and the sanitiser may need to be rinsed off afterwards.
Step 4	Dry	Bacteria thrive in water. Drying prevents them growing or being transferred between wet surfaces. Obviously drying is not always possible on a vessel so leaving surfaces to air dry is acceptable.

Skippers may choose to use a detergent and then a sanitising (disinfecting) solution instead of a combined detergent-sanitiser to scrub facilities and utensils.

Cleaning with a combined detergent-sanitiser product is not as effective as using separate detergent and sanitising chemicals. This is because where there is heavy soiling, grease and dirt build up, such as encountered on fishing vessels, the active component of the sanitiser is broken down by the organic material before it has had a chance to do its job.

Cleaning with detergent removes grease and dirt

Effective cleaning is achieved using water and a detergent to break down fat and dirt from fish handling, blood, slime and other organic materials built up on work surfaces, knives and utensils as well as the deck. If this is not removed during clean up, bacteria can remain on the surface and cause contamination and spoilage of your next catch.

Sanitising kills bacteria

After cleaning with detergent, sanitisers are used to kill bacteria remaining on a surface. If a detergent is not used first, grease may stop a sanitiser from reaching the bacteria.

Sanitisers are usually diluted before use, so you must follow the directions on the label carefully. Too much chemical will contaminate the fish and waste your money. Too little sanitiser will not kill the bacteria and your fish may spoil more quickly.

Remember

If everything is cleaned at the end of the day / night's fishing, re-cleaning and sanitising is unnecessary the next day.

Selecting a Detergent

There are many types of detergents. They differ in the types and amount of chemicals they contain. As they vary greatly in their effectiveness in removing different soils, it is important to select the correct detergent for a particular task.

Alkaline detergents are recommended for the removal of fat and protein materials found in fish. There are chemicals available that can be used for cleaning using seawater. These are generally based on alkaline salts such as caustic or chlorinated alkalis.

Some of these chemicals have a foaming action to assist with the removal of fat and protein. A brush should be used to scrub the area being cleaned with the detergent. If using hoses, use on 'high pressure' so they dislodge dirt and grime from surfaces that may contain bacteria.

Whatever type of detergent is selected, carefully follow the manufacturer's instructions for use and dilution rates. Always wear protective clothing when using any cleaning chemical. Some examples of appropriate detergents available for use on fishing vessels are listed in Appendix 8.

Danger

Always Use Appropriate Cleaning Chemicals

Inappropriate use of chemicals can damage the product and injure the crew.

Ensure you obtain a Material Safety Data Sheet (MSDS) for any chemical you use for cleaning and sanitising. This is available from your supplier. The MSDS will detail specific information regarding the chemical, safe use and handling as well as first aid instructions in the event of an accident or spillage. Display this in a prominent position on your vessel.

The use of pool chlorine (sodium hypochlorite) alone does not have a detergent action and does not work effectively with seawater due to the higher pH. It is very corrosive and is not recommended.

Remember

Always use cleaning chemicals at the correct rates. More chemical is not necessarily better. Over use of chemicals will cost more due to wastage and may corrode your equipment or surfaces.

Selecting a Sanitiser

Sanitisers are chemicals that are used to reduce the number of micro-organisms left on a surface to a level at which they present a minimal risk to the health of the consumer, or the safety and quality of the product. Sanitisers are used after cleaning with a detergent.

There are many types of chemical sanitiser available. It is very important to choose a sanitiser that complements the detergent used and works effectively with seawater.

The best types of sanitiser to use with seawater are those that require no rinsing after use. This is because the water used to rinse the surface after applying a sanitiser is likely to be seawater and this may re-contaminate the cleaned surface. It is recommended that the active component of the sanitising chemical is used at a concentration of less than 200ppm. This concentration of sanitiser is classified as a 'no rinse sanitiser'. The most common type of 'no rinse sanitisers' are based on quaternary ammonium compounds or hydrogen peroxide.

Sanitisers containing phenols (such as 'Pine-o-clean') may impart undesirable odours to seafood which may affect the taste and are not recommended.

The use of pool chlorine is also not recommended because chlorine is relatively inactive in the higher pH of seawater.

Sanitisers need time to work. The manufacturers instructions must be followed for the appropriate 'contact time'. This can vary from a few seconds to minutes.

Some sanitisers can be used as foam and sprayed onto a surface after cleaning.

Ask your supplier for a sanitiser that will suit your needs and operational conditions. Some examples of appropriate sanitisers available for use on fishing vessels are listed in Appendix 8.

Sanitiser Check List

- **Check that the sanitiser chosen conforms to your work practices.**
- **Check that the sanitiser will still work if you need to dilute it with seawater.**
- **Check that the type of sanitiser you select will not harm the surface on which it is to be used.**

Handwash Products

Handwash products are also important cleaning chemicals. Use an antibacterial liquid handwash that is appropriate for the situation. These products can be obtained from cleaning chemical suppliers.

Bars of soap can breed bacteria and are not recommended for use in food handling environments. A commercial liquid soap dispenser is more useful and can be obtained from your chemical supplier.

Products that are suitable for use in the home are generally not suitable for use in food handling environments because they do not contain enough active antibacterial chemical to be effective when constantly handling food products.

Never store chemicals in food bottles or unlabelled containers.

Cleaning Work Areas & Equipment

The following cleaning program can be used as a checklist for work areas and equipment.

Deck Areas

- Clear and clean all deck areas, benches and equipment thoroughly using a high-powered deck hose. A high pressure nozzle can help dislodge debris. Clean from top to bottom for effective cleaning. Scrubbing with a brush is an essential part of cleaning. If organic material such as blood, slime and gut is not removed, it rapidly neutralises the disinfecting ability of any detergent / sanitiser solution.
- Use a 'food approved' detergent to scrub and clean all deck areas, benches and equipment, fish holds and storage tanks.
- Rinse thoroughly with seawater or fresh water as specified in the manufacturer's instructions.

Tools

- Clean and sanitise all knifes, brushes, spikes, mats, aprons, gloves, boots and cloths with a food approved detergent and sanitiser.
- Dry these tools in the sun if possible and store in a dry area that is free of dust and other possible contaminants.

Holding Room, Iceboxes and Refrigerated Compartments

- Thoroughly clean and sanitise the holding room or refrigerated compartments using fresh water. Do not use the deck hose unless you have access to clean seawater. Pay careful attention to corners and fittings.
- Check holding room and iceboxes for cracks, other damage to the walls, floors etc.
- Report any damage or potential bacteria traps to the skipper who should make arrangements for repairs as required.
- Allow holding rooms and storage facilities to dry, then close or lock them to avoid contamination.

Containers

- Ensure all containers brought aboard for the next trip are clean and fit for use. Reject any dirty, damaged or unsuitable containers.

Carpets and Foam Pads

- Carpet and foam pads are often difficult to clean and should be discarded if they cannot be cleaned & sanitised adequately. Replace carpet and especially foam pads regularly to ensure no bacteria build up.

Freezers

- If freezers are used, they should be scrubbed out when they are turned off, especially the blast freezer where blood and juices may have dripped from the fish during freezing.

Water supply

- To avoid the intake of contaminated water turn off the water supply to all deck hoses and ice machines before entering the harbour. Cleaning a vessel with contaminated water is pointless.

Remainder of the Vessel

- Clean the remainder of the vessel, including toilets, shower and washbasins before entering the harbour.

Clean Up

After the vessel is unloaded it should be cleaned thoroughly and made ready for another fishing trip. The clean up process must be thorough to ensure there is no risk of contamination from the previous fishing trip.

Make a cleaning checklist will help ensure that no jobs are missed and that the crew share the tasks. All vessels should have a cleaning schedule in place which clearly identifies the tasks and the cleaning methods to be used (See Appendix 7). This cleaning program needs to be adhered to and should be monitored continuously to ensure it is being followed.

Document Your Cleaning Program

Develop a cleaning schedule for your vessel to ensure that the cleaning process is carried out correctly and consistently every time you clean. If your vessel is licensed to export, you will be required to keep a written program in place.

You can use the example below as a guide, or you can develop your own system. See Appendix 7 for a blank cleaning schedule template that you can complete for your own vessel.

Task / Area	Method (State exact method of cleaning and any chemicals to be used)	Frequency	Responsibility
Deck Area		Daily, after each haul	John M
Carpets/ Rubber Mats / Foam Pads		Daily, after each haul	John M
Knives, Spikes, etc		Daily, after each haul	All crew
Crew Protective Gear		Daily, after each haul	All crew
Storage Hold		After unloading at port	
Ice Machine		After unloading at port	
Brine Tanks		After unloading at port	
Amenities		After unloading at port	
Bait Store		After unloading at port	
Kitchen / Galley		Daily, after meals	
Toilet Area		Daily	

Remember

Cleaning programs often fail because:

- **Cleaning methods are not effective.**
- **Crew do not know how to clean properly.**
- **Cleaning tools or chemicals are not suitable.**

Pest & Animal Control

Pests such as mice, birds and insects, and domestic animals such as dogs and cats should be kept off the vessel at all times. Food should be kept in sealed containers or in tightly closed compartments to prevent pest infestation. Precautions should be taken and procedures maintained to minimise the risk of contamination from pests.

A pest control schedule can be used to ensure an effective program of pest control.

If pesticides or insecticides are used, care should be taken to prevent contamination of seafood, handling & storage areas as well as food supplies.

All pest control chemicals should be used in accordance with manufacturer's recommendations and government regulations and in a manner that does not risk contamination of seafood products.

Before using any pest control chemicals you should ensure that all seafood products have been removed from brine tanks or holding rooms.

Remember

Pest control notices should be laminated and fixed in prominent locations.

Danger

Poor hygiene practices will lead to contamination and deterioration of the fish.

Poor hygiene practices can lead to food poisoning.

Loining tuna at Tsukiji, Japan

Part Three

Fish Handling

Preparing the Vessel: Good Deck Practices
Landing the Fish
Killing the Fish
Bleeding the Fish
Gutting (Evisceration)
Removing the Intestines
Cleaning the Catch
Disposal of Offal and Unused Bait
Identification of the Catch
Further Processing On Board – Loining
After Each Catch
Chilling and Chilled Storage
The Chilling Process
Chilling & Refrigeration Methods
Freezing
Stages of the Freezing Process
On Board Freezing Procedures
On Board Storage Procedures
Storage of Other Products
Unloading in Port
Temperature Control
Avoiding Damage
Documentation
Defining Responsibility for the Catch
Transportation

Preparing the Vessel: Good Deck Practices

Good deck practices allow fish to be landed and handled quickly. A properly prepared deck can greatly aid in the processing and chilling of the catch. A quality product depends on having a system in place that is consistent, flows well and accounts for any limitations of vessel layout. Most importantly, the system must be clearly understood by all crew members.

Before hauling in the longline, the crew should prepare and arrange the necessary equipment and processing utensils to deal rapidly with fish when they are hauled aboard.

The Tools Needed

- Gaffs to retrieve the fish from the sea to prevent losing the fish or damaging them when caught.
- A Tuna missile is used to land large tuna and is a useful alternative to gaffing. The missile is attached to a heavy line and runs down the leader where it clamps onto the tuna's head when it hits. The fish is then hauled up using the heavy line.
- A rubber mat or foam pad to lay the fish on.
- A fish club or mallet to stun the fish.
- Gloves – preferably cotton – for all handling purposes.
- Meat hook to assist in landing the fish and moving fish around the deck or fish hold.
- A spike or corer to destroy the brain of the fish after it has been stunned. A spike with a handle is easier and safer to use.
- Tanaguchi tool to destroy the spinal cord: A length of stainless steel wire or monofilament nylon cord is inserted into the hole where the spike was inserted and pushed down the neural canal.
- A sharp knife with a guard and a very short blade (3cm max.) to bleed the fish.
- A sharp knife to gut the fish.
- Stiff brushes, to scrub out the gill cavity.
- Elasticised cheesecloth sleeves, "socks" or plastic bags with holes/slits, to protect the fish during chilling and allow good chilled water circulation.
- Ice shovel.
- Meat saw for cutting fins from tuna.

Essential procedures for good deck practices

- Keep equipment such as gaffs, clubs, spiking tools, knives and fishing gear near the area they will be used.
- Ensure that there is clear and easy access to the chilling tanks.

Landing the Fish

Landing

It is important that the area where the catch is to be landed does not damage or contaminate the fish. The ideal surface for landing a fish is one that will absorb shock and is smooth enough to prevent scratching or damage to the body of the fish. The slightest impact will leave a mark on the fish.

Rubberised mats with drainage holes are the preferred option. They have good shock absorption which prevents bruising of the flesh. They are easy to keep clean because water, blood or debris can easily fall through the holes in the mat. This helps to keep contamination away from the fish. Thick pieces of foam can provide protection of the fish from damage but they soak up blood and debris and are more difficult to keep clean.

Gaffing

The appearance of the fish when it is delivered to the market is an important factor in determining the price it gets.

Remember

Clean all landing mats or foam after each haul to prevent contamination of the fish.

- Always treat fish with great care.
- Wear gloves when handling fish. Bare hands can leave oily handprints on a fish.
- Always gaff a fish through the head.
- Never gaff a fish through the body, throat or heart.
    - A gaff mark in the body (Morikizu) will reduce the retail value because the tuna appears less attractive. Also the flesh damaged by the gaff will have no value on the sashimi market.
    - The throat is a fragile area and the heart is a small blood pump, which must continue to work during bleeding for the blood to be properly drained.
    - The throat should not be damaged on tunas as they will lose their shape and the meat will gape if the isthmus is broken. Gaping is when the layers of muscle in the flesh separate. If the isthmus does break loose from the jaw, it should be re-attached with a small piece of scrap monofilament line before the fish is chilled.
- Use two gaffs for a big fish, the second through the mouth.
- Carefully fold the pectoral fins under the fish so they are not damaged.
- Carry out any subsequent handling of the fish on the foam or mat.

Fig. 7 Always gaff the fish through the head

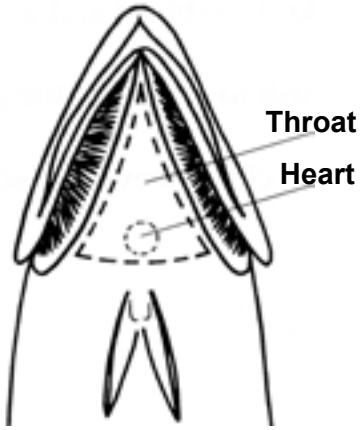


Fig. 8 Never gaff the fish through the throat or in the heart

Fig. 9 Use 2 gaffs for big fish

Killing the Fish

Killing should be carried out as soon as the fish has been hauled aboard and landed on a rubber mat or piece of foam. Killing should be quick and professional.

The method described here (Figs 10-13) makes it possible to kill and core the fish in a single operation. It is advisable to pith the fish (using the Tanaguchi method) after killing it.

To 'pith' is to completely destroy the spinal cord running in the neural canal. This stops biochemical reactions, which contribute to flesh deterioration. The skull and canal entrance remain intact when the tanaguchi tool is inserted. This insertion should always be easy.

- Stun the fish with a sharp blow to the top of the head between the eyes using a fish club or other blunt instrument.
- Stand over the fish, steadying it with your legs braced against the pectoral fins.
- Locate the soft spot (Fig 11) by running your thumb over the top of the head.

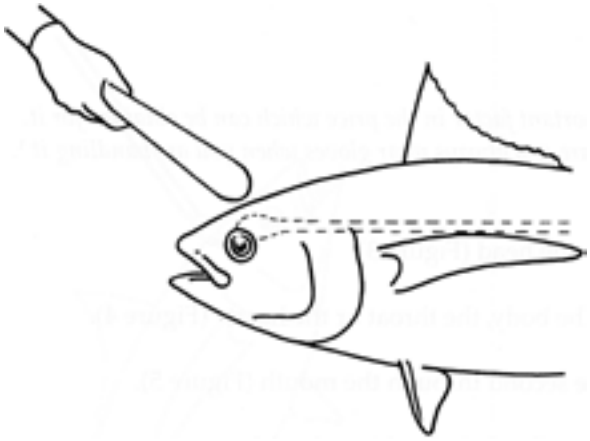


Fig. 10

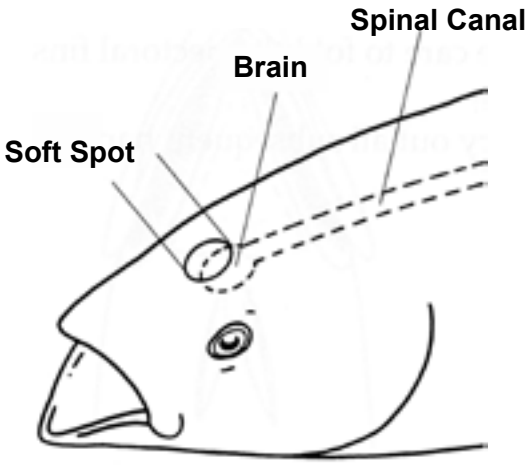


Fig. 11

- Use a very sharp knife to make a 3-4cm cut over the soft spot. The incision must be deep enough to expose the brain (Fig. 12). The incision or hole on the head should not be obvious so that the fish retains a better appearance.
- Alternatively, a coring tool or saw edged knife can be used to puncture a hole just above the soft spot and remove a plug of skull to expose the brain (Fig. 13).

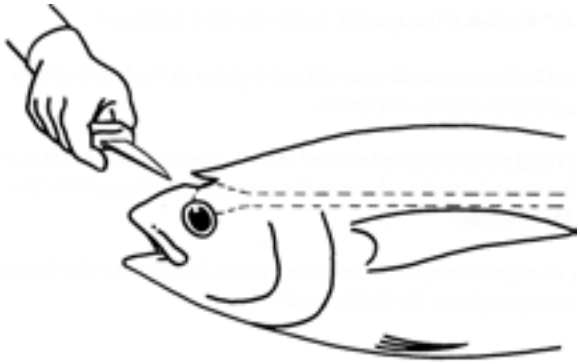


Fig. 12 Make a cut over the soft spot

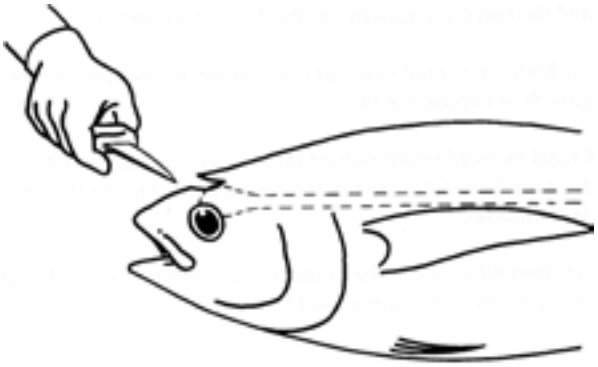


Fig. 13 Cut out a piece of flesh just above the soft spot

- Insert a length of sterilised monofilament nylon or stainless steel wire into the brain and push it as far as possible into the neural canal to destroy the spinal cord (Fig 14). Take it out and compare with the length of the fish to ensure that it penetrated most of the length of the fish.
    - If stainless steel wire is not available, nylon line of 2-2.5mm diameter is recommended for the Tanaguchi method.
    - Crew can prepare these from old longline snoods.
    - The tools used in this procedure must be cleaned to remove adhering tissue and blood.
    - Always sterilise the stainless steel wire or nylon in a cleaning/ sanitizing solution before each use, to prevent the introduction of bacteria into the core of the fish.
- The fish should give one last shudder as the wire or nylon destroys the spinal cord.
- Use the fish club to disengage the hook from the mouth or a de-hooker.

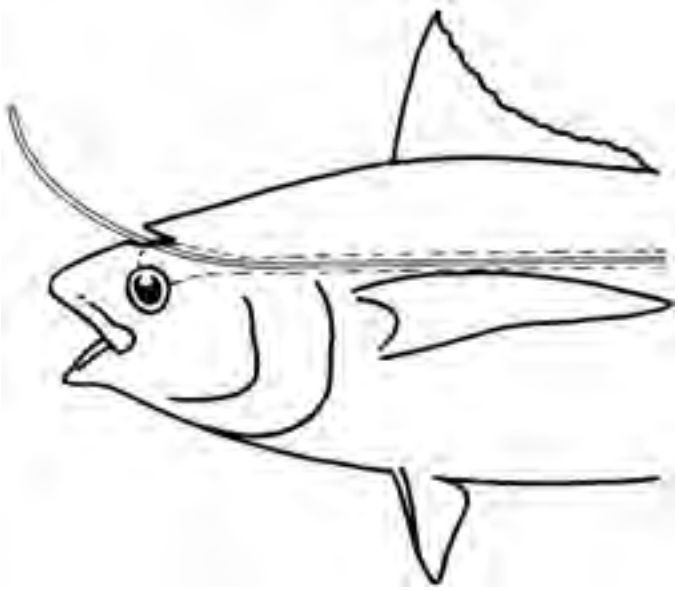
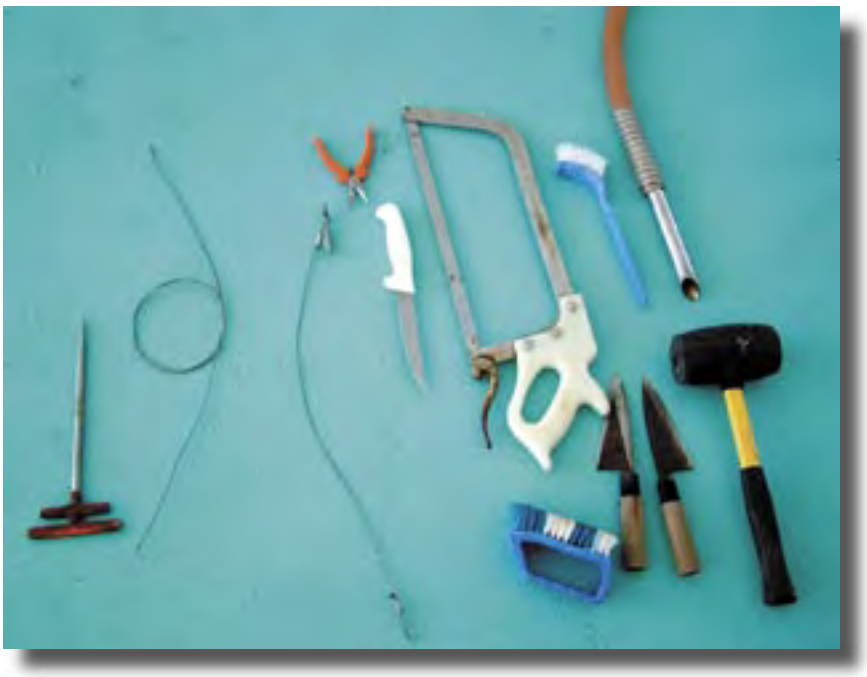


Fig. 14 Push a length of monofilament nylon into the neural canal.
***Note:** Some fishers choose to use lengths of monofilament which they leave in the fish. Others use a stainless steel wire which is withdrawn after use from each fish and used again on the next. Figures 15, 17, 26 & 27 show fish where the line has been left in.*



Bleeding the Fish

Bleeding is a vital stage for ensuring the quality of the fish and the price it fetches on the sashimi market. Any sashimi grade tuna specialist will recognise a tuna that has not been bled (or only partially bled) because of the presence of unattractive dark red veinlets in the flesh.

Bleeding the fish immediately after killing is important to maintain quality. This is because after the brain has been destroyed, the heart continues to beat for a few minutes. These cuts should be made as quickly as possible, to allow the last heartbeats to pump the blood through the wounds. This will improve the appearance of the flesh and keeps it fresh. During the tuna's struggle against being hauled aboard, the blood attains a high organic waste content (lactic acid) and rises in temperature. Bleeding removes the wastes and cools the body. The fish can then be refrigerated more quickly and will have better quality flesh.

Bleed the tuna by making a cut in the fish's side with a knife, 2-3 fingers long and 2cm deep behind the base of the pectoral fin. This first cut, should be made perpendicular to the pectoral fin recess, on both sides of the fish (Fig 15).

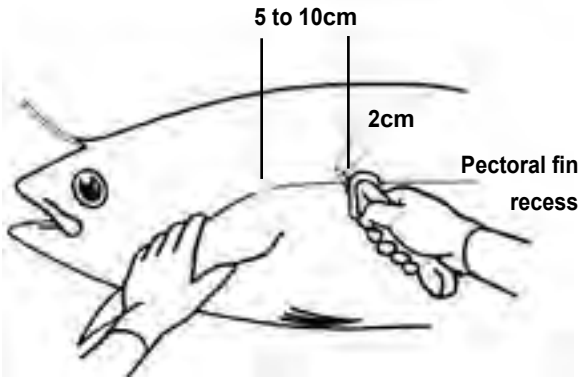


Fig. 15 Make a cut in each side of the fish behind the pectoral fin

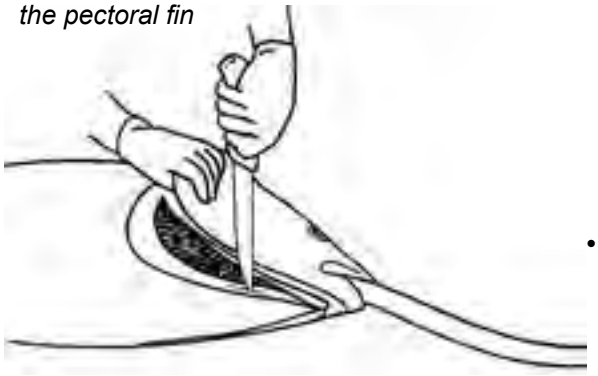


Fig. 16 Make a cut between the gill collar and the gills, and place a hose pipe carrying seawater into the mouth (above), or side of the gill (below).

- Blood should flow freely from these cuts. (Note that care is necessary when making these cuts as a pair of major blood vessels run along the pectoral fin recess, immediately under the tuna's skin. These can easily be severed if the knife is inserted at 90º to the recess. Also, a mark left on the fish will be visible to the buyer, who will not have to lift the fin to look for it).
- At this point an additional technique is to make 2 tail cuts at the base of the tail severing the arteries and veins below the skin. This cut, between the third and fourth tail finlet may assist with bleeding as the heart is still beating well and the muscle contractions from the ikijime body shudder help purge blood from the fish.
- It is possible to accelerate the bleeding process by force bleeding a fish. This is optional and usually carried out by inserting a deck hose into the fish after the pectoral fin and tail cuts have been made.
- A second cut is made in the membrane between the gill collar and gills, to sever the arteries supplying the gills. Then place a deck hose into the fish's mouth to wash blood out of the gill cavity (Fig 16).
- The fish can be left to bleed while gutting is being carried out. This will minimise handling and processing time and enable the fish to be placed in the chilling medium quickly.

Gutting (Evisceration)

The internal organs (intestines, gills etc) contain bacteria that accelerate the deterioration process in fish and, therefore, should be removed as quickly as possible.

- Insert a knife behind gill cover and cut 10cm towards the eye (Fig 17). Repeat on the other side. This cut gives better access to the gill cavity and makes the next steps in the gutting process easier.
- Cut the connection between the gills and lower jaw (Fig 18). For aesthetic reasons, it is very important not to cut the connection between the fish's throat and lower jaw.
- Cut the membrane between the gills and the gill collar along its whole length, on both sides of the fish.
- Cut the connection between the gills and the base of the skull (Fig 19).

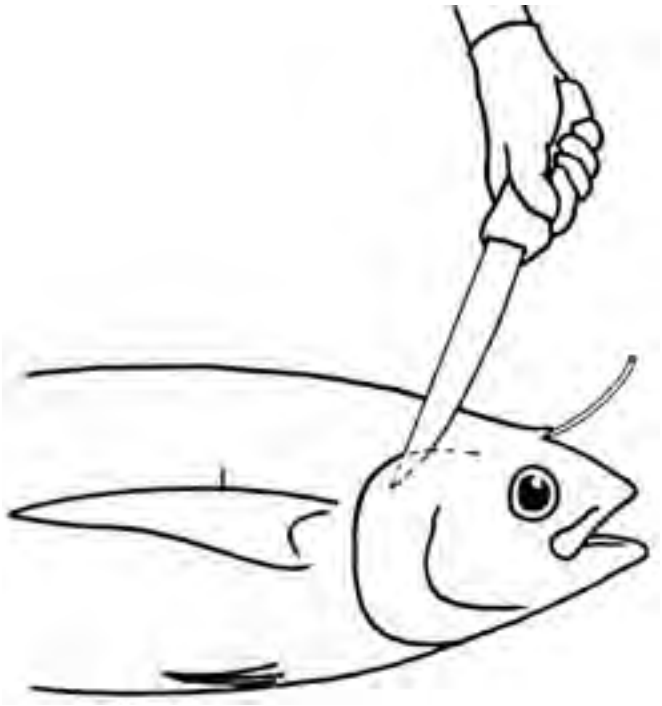


Fig. 17 Cut the top edge of the gill cover

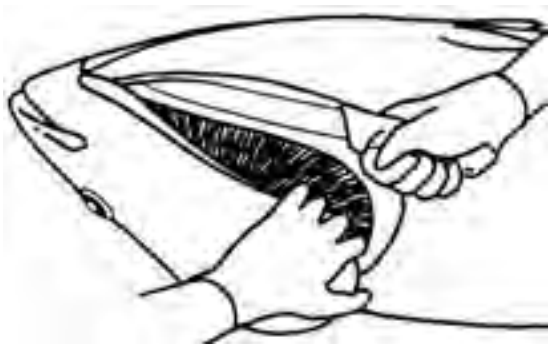


Fig. 18 Cut the connection between the gills and the lower jaw

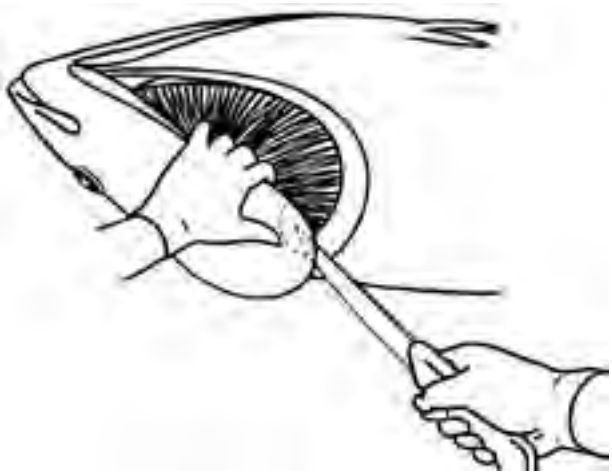


Fig. 19 Cut the connection between the gills and the base of the skull

Removing the Intestines

Method 1 (Recommended)

- Make a circular cut around the anus (Fig 20), without severing the digestive tube and gonads. This method is recommended because it makes it possible to remove the intestines, without having to cut them out. It therefore avoids spreading bacteria around the abdominal cavity.

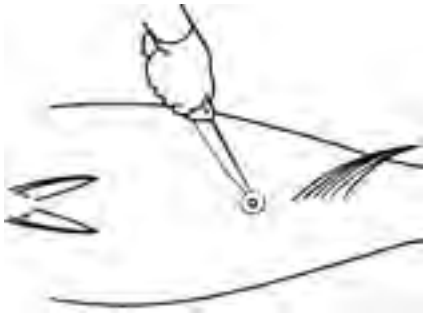


Fig. 20 Make a circular cut around the anus

Fig. 21 Cut to 1 cm from the anus

Method 2

- Make a small shallow lengthways cut in the fish's stomach, up to 1cm in front of the anus. Take care not to make the cut too deep, as this will leave knife damage to the flesh. This cut should be made in the direction in which the scales lie, i.e. towards the anus (Fig 21). It is important to make the ventral cut as short as possible, so that heat exchanges between the ambient air and the abdominal cavity are limited during transport to the place of sale.
- Cut off the end of the digestive tube and gonad near the anus (Fig 22).

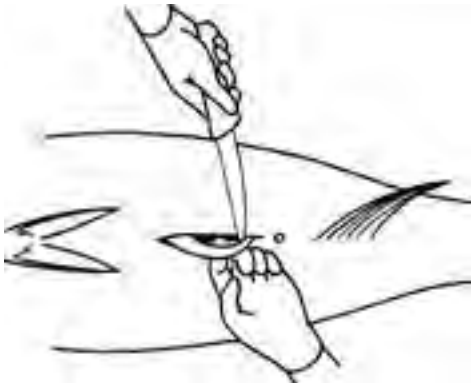


Fig. 22 Cut off the end of the digestive tube and the gonads

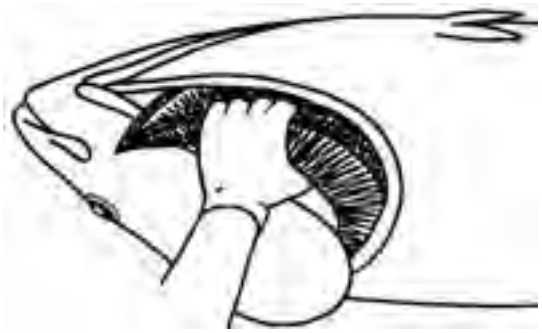


Fig. 23 Remove the gills and the internal organs

- **For both methods**, remove the gut through the gill cavity. Twist the gills and gut around several times to tear loose from the gut wall. Pull the digestive tube and gonads out through the gill cavity.
- Remove the gills and internal organs in one piece through the gill opening (Fig 23). This stage is sometimes difficult due to the membranes that connect the gonads to the abdominal wall. These should be pulled free once the gut has been removed. It is recommended the gill covers **not** be cut off. (It is also possible to bend back the gill flap on one side to allow more room for gutting). The practice of cutting off gill plates is only used for sashimi freezing as it allows air to circulate in the gill cavity more readily. However, with fresh tuna the same practise would accelerate the heating process when the fish is unloaded.

Cleaning the Catch

- Carefully cut the membrane attaching to the gill collar. With a knife, scrape the edge of the collar, until you get down to the white bone. (Fig 24). This membrane turns black if not removed, giving the fish an unhealthy appearance.
- Remove all pieces of flesh, tendon and membrane from the gill cavity and the inner cheeks of the gill plate.
- Scrub the base of the skull and vertebrae to remove all coagulated blood and kidneys (Fig 25).
- Scrub the inside of the abdominal cavity, without removing the white membrane (the swim bladder) which covers the backbone.
- Carefully rinse the fish, inside and out. Remove as much slime as possible without damaging the scales or flesh. Removal of slime is important because slime contains bacteria, which will speed up the spoilage process and contaminate the chilling water.

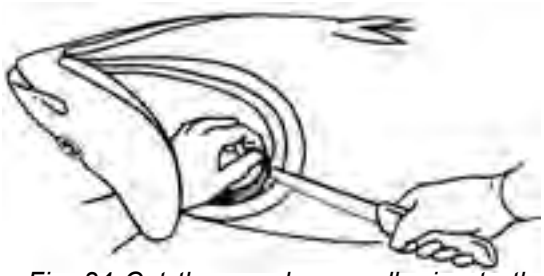


Fig. 24 Cut the membrane adhering to the gill collar

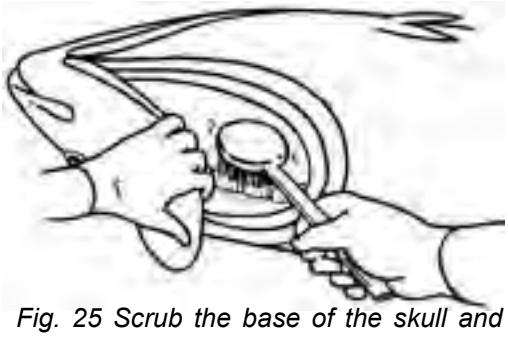


Fig. 25 Scrub the base of the skull and the vertebrae

- The two lobes of the caudal fin may be cut off. Some buyers request a special way of preparing yellowfin tuna; the second dorsal and anal fin, which are very long in adults, should be cut half way through their base using a saw-edged knife or saw (Fig 26). With bigeye, dorsal and anal fins are short – even in adults. It is recommended these fins be left intact, so buyers can recognise the species easily.
- To prevent skin damage, tuna will need to be wrapped in cheesecloth or plastic bags. This will prevent the fish rubbing against each other and causing damage or marks.
- The fish is now ready to be placed in brine or ice (Fig 27).

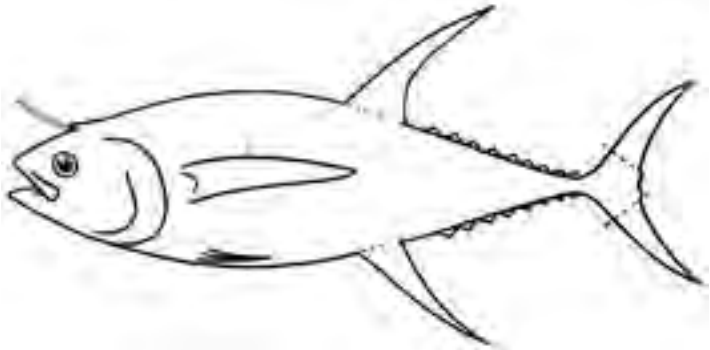


Fig. 26 Sever the lobes of the caudal fin and, with large yellowfin tuna, make a cut in the dorsal and anal fins

Fig. 27 The fish is ready for refrigeration

Disposal of Offal and Unused Bait

Fishers must not discharge offal or unused bait from the boat while hauling. If it is not practical to store offal until the crew has finished hauling, it may be discharged:

- while the vessel is not fishing
- from the opposite side of the vessel to that where the line is being hauled.

Remember

There are official AFMA Regulations relating to the Seabird Threat Abatement Plan (TAP). Breaching them can result in prosecution. Refer to the *'Deck Manual Western Tuna Code of Practice'* for further details.

Identification of the Catch

For traceability and recall purposes, processors now need to be able to identify and trace fish from when it is landed on a particular vessel to when it arrives at the market. To make this possible, each fish must be tagged immediately after cleaning and prior to chilling. Use tags that are waterproof, for example cow ear tags or pre-printed waterproof paper (See photo below). Attach the tags with a clean plastic cable tie.

The tag must identify each fish with a vessel name and catch date. If pre-printed tags are not being used make sure a waterproof permanent marker pen is used to write the information onto the tag.

Fish tags

The details of the catch must then be recorded on catch sheets that can be accessed for traceability purposes. Ensure that the following information is recorded:

- the tag number (if using pre numbered tags)
- details of the fish species
- estimated size
- life status at capture
- shot number or date of capture.

This information should be given to your processor for their identification and traceability requirements, as well as to assist when grading and assessing your fish. Ask your processor for feedback on your fish and your handling in case there are any practices that need improving. Appendix 5 is an example of a feedback sheet. This is filled in by the processor of the fish and returned to the boat so any quality issues can be detected straight away. Sometimes skippers are unaware of how well fish are being cleaned (or not) by crew, etc, until the processor tells them.

Remember

AFMA requires that you always carry your logbook on the vessel. The logbook must be filled out for each shot. You must record both retained and discarded catch.

Photo Carl Bevilacqua

Further Processing On Board – Loining

Some longliners may further process the fish on board. This may include loining or portioning of the fish into smaller units which are then packed into cartons with liners and frozen on board.

Whenever further processing is carried out on board, extra care must be taken by the crew to ensure that the cut portions are not contaminated. Cutting into a whole fish increases the risk from a food safety point of view, because more of the fish flesh is exposed to potential contamination from the work surface, equipment and crew.

Remember to follow these simple rules:

- Only process fish on a surface that is easy to clean and can be sanitised. Stainless steel work surfaces are recommended. Other work surfaces such as plastic or melamine cutting boards should be cleaned and sanitised before and after use as they have deep grooves from knife marks making them difficult to clean effectively.
- Always clean and sanitise the work surface and any knives or other cutting tools prior to use.
- Wash your hands with soap and hot water.
- Wear clean disposable gloves.
- Follow the crew hygiene requirements in Section “Preparation for Fishing”.
- Only pack the cut portions into clean, unused cartons with plastic liners.
- Process and chill or freeze the cut portions as quickly as possible to reduce the risk of bacteria being able to grow.

After Each Catch

The working deck of a longliner should always be kept clean during fishing operations.

- Blood, gut, scales & slime should be rinsed away as fish are being cleaned, and should not be allowed to accumulate on the deck, carpet, or foam pad used for landing fish.
- Heads, fins and leftover baits should be discarded as per the disposal of offal and unused bait requirements (See previous section ‘Disposal of offal and unused bait’).
- Clean knives and other tools with water between processing each fish, to minimise the risk of cross contamination, causing deterioration, from fish to fish.
- At the end of each haul, the deck and carpets should be cleaned and scrubbed, using deck brushes or scouring pads, seawater and detergent.
- All tools used in fish handling, including gloves, knives, corers etc, should be cleaned. Use an appropriate detergent. Follow the cleaning instructions provided by the manufacturer to ensure that fat residues from the fish are effectively removed.
- After cleaning, every surface should be sanitised.
- Finally, surfaces should be rinsed thoroughly to remove all chemical traces. (Refer to Section “Clean Up” for details of chemicals to be used in cleaning).

Contamination can take place if areas and equipment are not re-cleaned.

The Chilling Process

The chilling ***process*** and chilled ***storage*** are two very different concepts. When a fish goes through the chilling *process*, we are trying to actively remove body heat and reduce the temperature of the flesh to the desired limit. Once that temperature has been reached, chilled *storage* is used to ensure that the fish is maintained at the correct temperature.

In order to keep the fish in top condition, the core body temperature must be lowered to 0˚C as quickly as possible, and maintained until the fish reaches the market: that is, while stored on board, while unloading and packing and during transport to market. Any temperature variation at any stage in the process runs the risk of damaging the product and reducing quality.

Once chilled, the tuna must be kept under chilled conditions until arrival at port. Tuna can be stored in a fresh or frozen state.

All crew should be aware of all the potential hazards of the chilling process. For instance, a fish will spoil eight times faster if it is kept on the deck of a boat at 20˚C, than if it is stored between -1ºC and +4˚C. You should also be aware of other potential sources of heat within the catch that can disturb optimum chilling temperatures. For example, *rigor mortis* occurs in fish after death and this generates heat inside the tuna. This heat source needs to be taken into account when managing the chilling process because the extra heat can create an increase in lactic acid which causes the 'burnt tuna syndrome' which affects quality. (See the section on *Chemical Spoilage: 'Burnt' Tuna* on page 23.)

Never add warm fish to fish that are already chilled, or still in the process of chilling. Adding warm fish will increase the temperature of the fish already present in the chilling medium, which will cause deterioration in quality and an increase in the numbers of bacteria present. Always remove the chilled fish and place into the storage area prior to chilling the next catch.

The Stages of the Chilling Process

Chilling occurs in two stages:

1. **The surface of the fish will chill first**, because it is in direct contact will the chilling medium. It is important to ensure that the chilling process is monitored regularly to keep the temperature moving down as quickly as possible. Keeping the chilling process happening may involve stirring the ice slurry or adding more ice.
2. **Chilling to the core of the fish takes much longer**, because the body heat needs to be drawn outward through dense muscle tissue and skin. This happens much more slowly than at the surface of the fish. The rate of heat loss depends on the efficiency of the chilling system and how quickly the meat and skin can conduct heat. The chilling process relies on the chilled outer muscles of the fish to chill the inner muscles.

Danger

Do not allow temperatures to fall below –1.5°C, as fish will start to freeze.

Rubber mats on the wall of the RSW tank protect fish. The holes are to ensure that circulation is even.

Chilling Time

The time taken to chill depends on the size of the fish. 6 to 12 hours is advisable for small sashimi tuna (30-40kg). It is preferable to leave larger fish in longer, up to 36 hours, to make sure they are chilled to the core. Although fish can be left in brine for several days, it is generally recommended that they be removed after 24-36 hours, otherwise their colour will fade and the eyes will go white. This will affect market price.

Using Ice to Chill Fish

There are two ways that ice cools its surroundings. Firstly, ice absorbs heat as it changes form from solid to liquid (latent heat). 'Latent heat' is the heat absorbed from the surrounding environment (the fish) that causes the ice to melt from a solid to a liquid (water). Secondly, it absorbs heat to increase temperature.

Most of the cooling capacity of any type of ice comes from the way it absorbs latent heat as it changes from solid to liquid. Less heat is absorbed in raising the temperature of the ice itself. The temperature range is usually from about -6°C (for seawater ice), to about 0°C.

Ice is very efficient at cooling, is safe to use, and doesn't change the taste of the fish. An ice slurry is often used to chill fish immediately after they are caught. The ice must be melting and thoroughly mixed in water to produce a slurry with a uniform temperature of about 0°C.

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

Remember

The larger the fish, the longer it will take to chill. The chilling process can take up to 36 hours, depending on the type of fish, the number of fish being chilled, and the type and efficiency of the chilling medium.

Using Seawater Ice

The chilling capacity of seawater ice is only slightly greater than freshwater ice. This is despite the lower temperature of seawater ice compared to freshwater ice.

There are risks involved in using seawater ice. Fish stored in seawater ice may become partly frozen, and headless, gutted fish may absorb some salt. This impacts on quality.

Salt concentration affects the freezing temperature of seawater, so the temperature of seawater ice varies. The initial melting temperature of clean seawater ice may be as low as -6°C, but as the salt leaches away in the melting water, the melting temperature may rise again to nearly 0°C.

The salinity of seawater ice is also variable. This means that the ice at the bottom of a brine tank may be very salty compared to that at the top of the tank. (Fresh water is lighter than salt water, so it 'floats' on seawater).

Remember

Although fish can be left in brine for several days, it is recommended that they be removed after 24-36 hours. Otherwise their colour will fade and the eyes will go white. This affects quality and price.

Chilling & Refrigeration Methods

Different vessels have different chilling facilities and capabilities. Whatever method of chilling is used, it is important to chill the catch as soon as possible after capture to maintain safety of food product, quality and prevent deterioration. There are three main methods used for chilling the catch.

1. **Chilled Seawater/Brine Tanks (CSW)**
   In this method fish are usually individually hung in a slurry of ice and fresh seawater and extra salt added if needed.
2. **Refrigerated Seawater (RSW)**
   In this method fish are individually hung in seawater that is chilled and recirculated by a refrigeration unit.
3. **Direct Icing**
   In this method fish are chilled by direct contact with ice placed within the cavity and around each fish.

In general, fish are chilled more rapidly by immersing them in refrigerated seawater (RSW) or chilled seawater (CSW - with ice added to seawater) than if they are packed in ice. RSW or CSW tanks are commonly used on Australian vessels.

Chilling Method Options

1. Chilled Seawater (CSW) & Brine Tanks

The Chilled Seawater (CSW) method uses a brine slurry to chill the fish in a tank. The best tanks have several compartments and a drainage hole. In heavy seas, the compartments help limit the movement of the fish and prevent damage to product. It is advisable to have 2 brine tanks on board.

Making a Slurry of Ice and Seawater

Before handling begins, fill the tank with flaked or crushed ice and mixed with seawater. Any ice that freezes into clumps should be broken up to ensure even temperature distribution.

The result should be a slurry of ice and seawater, in a 2-1 ratio of ice to water. In tropical waters with higher water temperatures the ratio of ice to seawater may need to be 4-1.

The slurry should have the consistency of wet cement. The mixture should be stiff enough so that fish do not move around much. The slurry needs to be stirred often to keep it well mixed and to avoid the formation of warm ‘pockets’ of water. Recirculating pumps can be used to facilitate this process, however care should be taken to check that nozzles do not block up.

Adding Fish and Maintaining the Ice

A fish is first cleaned, dressed and wrapped in a cheesecloth sleeve or plastic bag. In most brine or CSW tanks the fish is placed on its side or back directly into the tank.

As more fish are added, the ice melts and more ice will need to be added. A CSW tank should always contain some ice. Too little ice in a slurry, or too many fish in a tank, leads to poor cooling, and loss of quality.

With adequate ice in the tank, the temperature should be close to -1°C. The addition of salt to the water will help to reduce to temperature to below 0°C. The brine should be topped up with clean seawater as needed.

Adding extra salt to the brine lowers the temperature by several degrees. This chills fish more rapidly but adding too much salt may cause the fish to begin to freeze if the temperature drops too far.

2. Refrigerated Seawater (RSW) or Brine Tanks

Refrigerated seawater (RSW) is a recirculating refrigeration system that uses the chilled water. The water can be a mixture of water and seawater, or just pure seawater. In a RSW system, temperatures should be kept between -0.5 and -1°C. Fresh water ice gives a controlled temperature at 0 °C, and there is some risk with RSW system if using seawater as this medium freezes at between approximately -4ºC and -6ºC. Tuna can freeze at these temperatures. In most RSW systems, a fish is first cleaned, dressed and wrapped in a mutton cloth or plastic bag, and then hung vertically, by the tail, in the tank.

RSW systems work best with circulating pumps which minimise ice build up on refrigeration coils and ensure even temperatures. Brine tanks that do not have circulation pumps risk the build-up of ice on the refrigeration plates/coils. This increases chilling times and operating costs. If ice builds up, temperatures may rise substantially above zero and damage product. Any ice build up on the refrigeration plates/coils in the brine tank should be physically removed or the power to the refrigeration system switched off.

Each brine tank should be fitted with a temperature gauge that is easy to read to ensure accurate temperature control. There should be ample insulation in the walls of the tank to minimise heat leakage - and operating costs. There should be sufficient compressor capacity in the refrigeration system to:

- maintain the temperature of the fish at the desired level;
- prevent a significant rise in temperature of the water when the tank is being loaded with freshly-caught fish; and
- ensure that the core temperature of the fish can be quickly brought down.

Preparing a Tank for Chilling Tuna

- Tanks must only be used for chilling the tuna catch.
- Tanks must be thoroughly cleaned and sanitised before use.
- The tank should be filled with potable (drinkable) water and food grade salt, or clean seawater.
- When using seawater, fill the tanks at a minimum of 5km from the coast or harbour. If you have to fill tanks alongside the wharf for stability reasons, make sure the tanks are flushed at sea with clean seawater prior to being filled for using to chill fish.
- The tank temperature should be monitored several times a day, with either a built in gauge or hand held thermometer.
- A hand held digital thermometer is useful for checking tank temperatures, and can also be used to check the core temperature of fish during unloading and processing.

Beware of 'hot spots'

Circulation of water is critical to ensure an even temperature distribution and even-ness in the chilling process. Temperatures can rise to 10°C in static holding seawater tanks due to different water densities that develop when ice melts.

Efficient systems use a pump to circulate the water from the bottom around the tank to ensure there are no 'hot spots'. Some tank designs may need several pumps operating to ensure full mixing. These pumps should operate frequently during the holding period of the fish.

3. Direct Icing

Direct icing probably produces the widest variability of all of the chilling methods. For this reason it is the least reliable in terms of guaranteeing a quality product. Direct icing is most often used to store fish after they have been chilled by one of the other chilling methods. Direct icing involves the following procedures:

A bed of soft ice approximately 10 cm thick is placed on the bottom of the hold. Fish are then placed on top, packing the ice in the cavity and around the body.

There should be no heads or bodies sticking out of the ice – although tails and fins are okay.

More ice is then shovelled over the fish until there is a 4 to 5cm of ice covering them. Then another layer of fish can be laid out.

Fish should not be buried more than 3 layers high. Usually, only 1 or 2 layers are used.

Large fish should be put on the bottom layer and the smaller on top.

The same thickness of ice around the fish should be used as the pre-icing.

Buried fish should be checked once a day. Any melt water should be pumped out of the fish hold and the top layer should get a new cap layer of ice when necessary.

Sharks should not be buried in the same bin with other species – especially sashimi tunas – due to the risk of bacterial cross contamination and ammonia taint.

Air Pockets, Ice Caves and Igloos

Because the fish are still warm at the start of the process, the ice covering them will melt and air pockets will form around the fish. These air pockets, also known as ice caves or igloos, can cause increases and/or unevenness in temperature. More air pockets are formed if ice made from seawater is used.

To prevent the formation of air pockets the fish need to be turned and re-iced. To completely eliminate any air pockets, the icing procedure needs to be started over again after 24 hours.

Removing Air Pockets (Igloos)

There are two ways to remove air pockets (igloos). In both methods the fish have to be iced twice. In the first method, the air pockets are broken up with a stick or shovel handle. Ice is then re-packed around the fish. This does not work well if there are several layers of fish.

The second method is to dig the fish out of the icing bin and re-bury them in another bin. After the fish are re-buried, they should require no more handling, as no more air pockets (igloos) should form.

Remember

Ensure that the fish are completely chilled prior to icing to prevent the formation of air pockets or ice cave.

Freezing

Some operators have freezing facilities on board to meet special customer demands. For example, some Japanese markets require frozen sashimi tuna to be maintained at ultra-low temperature (ULT) of around -65ºC. For cannery fish -18ºC is usually sufficient.

The same principles apply to freezing as for chilling. Freeze the fish as fast as possible. Fish should be frozen in a blast (snap) freezer (this is true of whole or loined fish). Some boats have separate freezer holds to store fish after initial freezing.

Stages of the Freezing Process

There are three key stages in the freezing process. Stage 1 is a relatively rapid stage during which the temperature of the tuna falls to around -1ºC.

The second phase is called the latent heat phase, or period of thermal arrest (see Fig 28a). It is the phase when water changes from liquid to ice. It is the period when ice crystals form.

The latent heat phase takes much longer and the temperature only changes slightly (from around -2º to -4ºC). The longer this stage takes the larger the ice crystals grow. Larger ice crystals mean greater cell damage to the fish, resulting in loss of texture and drip loss during thawing.

Fish have a high water content so it is critical that there is no fall in temperature when water is changing from liquid to ice. Most problems associated with freezing occur during this phase, usually because the freezing process takes too long.

In stage 3 the product temperature falls rapidly compared to the temperature of the freezer.

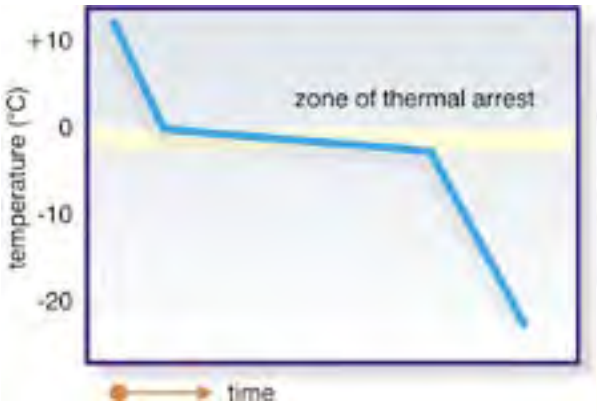


Fig. 28a Freezing curve for seafood

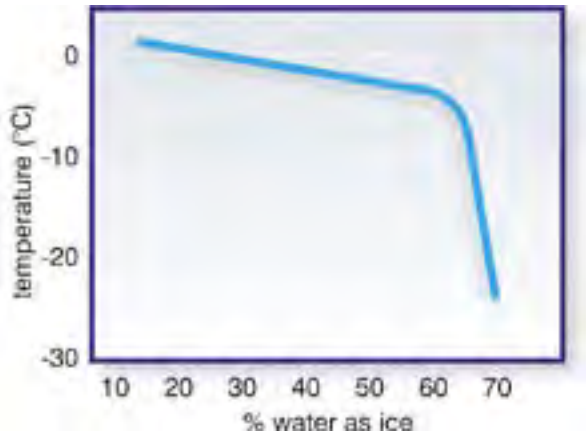


Fig. 28b Ice content of fish

On Board Freezing Procedures

Once the fish have been made ready for freezing (i.e. they have been cleaned or loined), they can be placed on trays or shelves in the blast freezer (Fig 29). Adjust the shelves to cater for the different thicknesses of fish being frozen. Fish should not be stacked on top of each other for freezing.

Another method is to hang the fish from racks so they freeze straight. To do this, each fish has a tail rope and is suspended from a meat hook (Fig 30). The rack usually has space for several rows of fish. The meat hooks slide along the rail, so the fish can be pushed along to pack them in and reduce movement. Sometimes two rails will be used – one below the other, to maximise freezing space.

The fish are blast frozen to -35ºC or lower and then stored in a separate freezer hold at -18ºC or lower. Enzyme action stops at around -18ºC. This is why AQIS stipulates -18ºC as the maximum temperature for frozen export product.

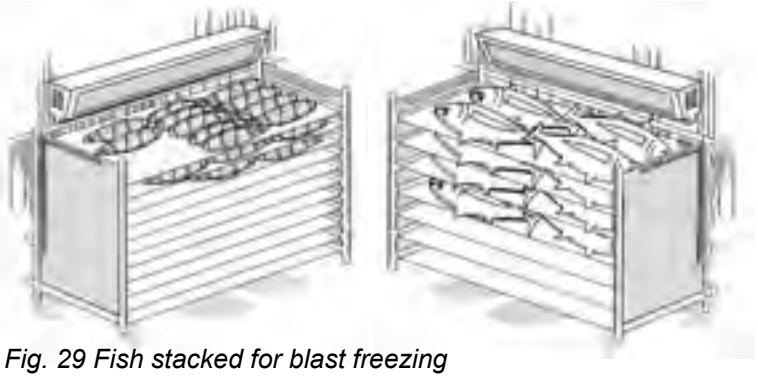


Fig. 29 Fish stacked for blast freezing

Fig. 30 Fish hung for freezing

Once the fish are frozen, they are transferred to a storage freezer, or stacked in the blast freezer. The temperature of the product should be -18ºC or lower, before being transferred from the snap room to a holding room.

In a busy period the fish may have to be transferred before the temperature has reached -18ºC. However fish should never be transferred until it is through the thermal arrest period (-4ºC) and preferably at -10ºC.

Whole fish are generally stacked in rows – alternating one head in, one out (Fig 31). Once a row is made along, or across the freezer, the next is stacked on top using the same method. It is best to stack fish of the same size together to maximise the storage space.

Loins can be stacked similarly to the whole fish, or can be packed in poly lined cartons or waxed cardboard boxes to reduce the chance of freezer burn. The cartons are then easily stacked (Fig. 32).

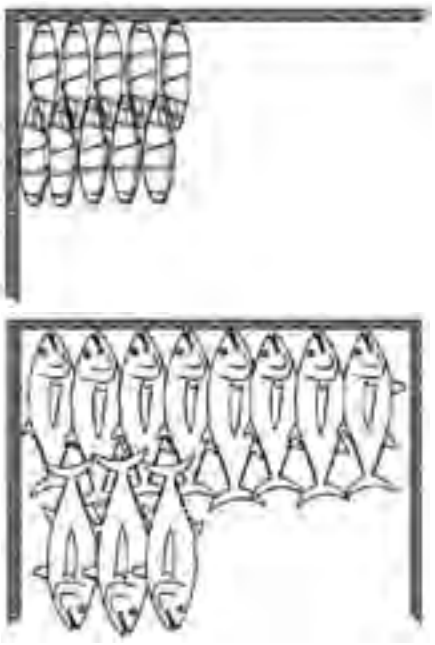


Fig. 31 Stacking whole fish

On Board Storage Procedures

Photo: Geoff Diver

A refrigerated storage hold with baffles for fresh chilled fish – layers of fish and ice built up with the baffles

When fish have been sufficiently chilled (0-3ºC core temperature), they must be removed from the chilling method and placed in the storage area of the vessel.

- Carefully transfer fish to the ship's hold. Avoid gaffing, dragging along the deck or damaging their eyes.
- The fish should remain in its original covering, i.e. cheesecloth or plastic, to minimise skin damage.
- The heaviest fish should be placed at the bottom of the hold.
- Avoid placing fish in contact with the edges of the storage area (or hold) or in contact with one another.
- There should be no heads or bodies sticking out of the ice.
- Place a layer of flake or crushed ice, approximately 10 cm thick, on the base of the storage area and follow this with one layer of fish, belly down. (Some longliners prefer to store their fish belly up: check with your buyers).
- Completely surround each fish and fill its gill and abdominal cavities with ice.
- Cover the fish with a thick layer of ice. Repeat the process with another layer of fish (ice then fish then ice etc).
- If possible have 3 layers of fish or less. Otherwise, the fish at the bottom of the hold may be damaged by the weight of the ice and fish placed on top of them.
- A dividing board, supported by aluminium sides, may be placed on top of the third layer and up to 3 layers of fish can be stored on top of that. This support around and above the bottom 3 layers protects the fish at the bottom of the storage area from damage.
- Any melt water should be pumped out of the fish hold and the top layer should get a new cap layer of ice when necessary.
- Once packed in the ice, the fish does not need to be handled again until it is off loaded at port.
- A sashimi grade tuna that has been chilled in brine and stored in ice, can be left in the ice for up to 2 weeks.

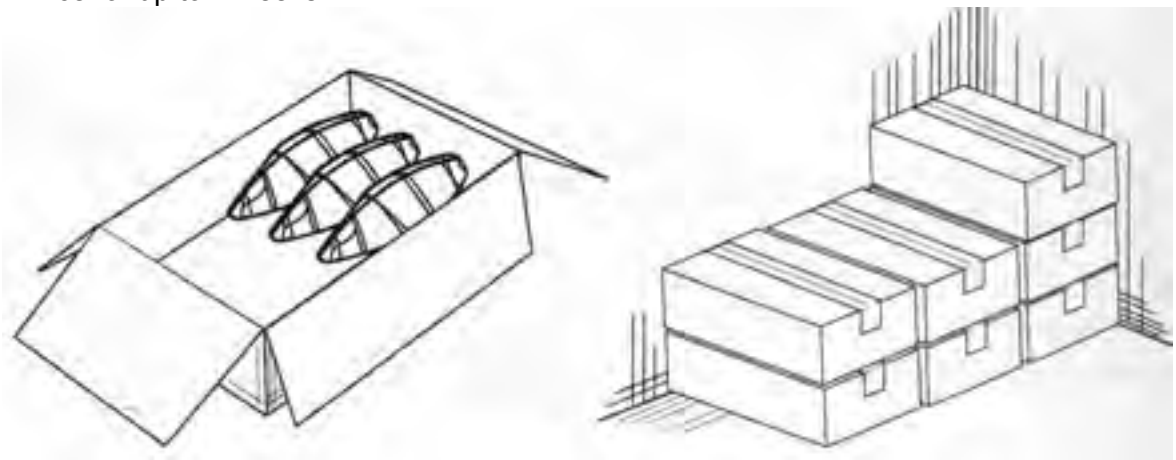


Fig. 32 Loins stacked in cartons

On Board Storage Methods

There are three main options for on board storage of the catch:

1. Icing
2. Refrigerated seawater
3. Freezing.

Ensure that the storage area being used is clean and is able to be segregated or divided to separate the oldest catch from the youngest catch. If using a storage hold you will also need to ensure that there is good chilled air circulation.

1. Icing Storage

There are 3 types of ice that can be used to store fish: fresh water (desalinated water), seawater ice, or a combination of the two.

Generally, it is not recommended to use pure seawater ice. This is because when seawater freezes the freezing temperature of the remaining water is lowered due to the increased salinity of that remaining seawater. This lower temperature can cause chill damage to the fish. The Icing method works best when only freshwater ice, or a mixture of freshwater and seawater ice, is used.

2. Storing Sashimi Grade Tuna in Refrigerated Seawater (RSW)

Sashimi grade tuna may be kept in refrigerated seawater for a number of days. However, long term immersion in water can result in leaching of colours and flavours.

Tank design is important. Without proper baffles and water circulation devices there can be hot spots in the RSW which create adverse effects, including scaling and bruising from wave action in the tank.

A RSW system should have adequate cooling capacity to ensure that storage at the desired temperatures can be obtained within given times, and that temperature fluctuations are avoided. It may be necessary to carry additional ice to maintain consistent storage temperatures for large volumes of product.

Adhering to the following procedures will help ensure protection of product and quality:

- Fill the RSW tank with fresh seawater
- Ensure the seawater is chilled **prior** to placing fish for storage.
- Remove the fish from the original chilling tank and hang them in the storage tank. Use a hoist so as to minimise the risk of damage to the fish. Keep the fish in its original covering, i.e. cheesecloth or plastic, to minimise skin damage.
- Keep the water clean to minimise the build up of bacteria and the risk of cross contamination during storage. Anti-bacterial solutions may be help protect water quality but they cannot totally clean dirty water. An in-line filtration system will help remove blood and other impurities from the water.
- Change the water in the RSW tank frequently. This is best done by having a spare RSW tank of pre-chilled water into which the fish can be transferred while the water in the other tank is being changed.

3. Ensuring Efficient Frozen Storage

To maintain frozen products in the freezer, cold air must circulate to all fish or cartons.

Air flows along the path of least resistance. Product stored in the holding room must be positioned so that air flow can cover all cartons. Cartons should be off the floor and away from walls, so air can circulate. **Products must not block fans.**

Be aware that in a partially loaded freezer some products may not receive a proper air blast.

Storage of Other Products

Avoid By-Product Contamination

All by-catch must be stored in a separate designated area, away from the tuna catch to avoid cross contamination.

Cross contamination may be caused by bacteria as well as taint or odours.

Never store other species with the tuna. This is especially true for shark because transfer of odour and flavour taint that may occur.

Follow By-Catch Storage Procedures

There are specific procedures for storage of dead by-catch. These are outlined in the **Western Tuna and Billfish Industry Code of Practice** and accompanying **Deck Manual,** and the **Protected Species Handling Manual**. These procedures must be followed at all times.

Store Waste in Separate Designated Areas

All waste matter stored on board must be kept away from fish storage areas in designated waste areas. This includes household waste. Keeping waste away from fish storage will prevent cross contamination of waste products and the catch. Green 'wheelie bins' are good storage options for waste.

Store Light Sticks Away from Fish

Light sticks contain glass. Ensure that both used and unused light sticks are stored away from fish storage areas at all times.

Store Bait in Designated Area or Container

Bait for tuna should never be stored with or near the catch. Have a designated bait storage area or bait box for all bait.

Keep Ship's Stores Away from Fish Work Areas

All stores should be securely stowed away from fish work areas. Especially pay attention to stores that may leak, seep, break or otherwise escape their containers and contaminate fish or the storage medium. Expect the unexpected!

Unloading in Port

All the good work done to produce a quality product at sea can be undone during unloading and transportation. There are two critical issues: Temperature Control and Avoiding Damage.

Temperature Control

When unloading fish in port, it is important to maintain the low temperature of the fish. This is known as 'maintaining the cold chain'. Fish must be transferred as quickly as possible from the chilled storage area on the boat to the next chilled storage area, which may be a cold store or a processing facility.

It is extremely important to minimise the time the fish is out of chilled storage. This is because any bacteria present on the fish will start to grow as soon as the fish is taken out of chilled storage. This 'temperature abuse' increases the rate of spoilage and deterioration in the product.

To help minimise the risk of temperature abuse on the catch:

- Keep refrigeration going right up to unload time.
- Do not commence unloading unless the containers for transport, forklift, refrigerated vehicle, etc are alongside the jetty.
- Make sure the transport is already pre-chilled.
- Keep fish under cover as much as possible.
- Choose the right time of day. If possible, do not unload in extreme heat.
- Have a good and fast handling system in place. Make sure everyone involved has been trained and knows what to do.
- Keep containers out of the sun wherever possible.
- Hoist the fish from the storage area and place them straight into bins with chilled water / ice.
- Do not leave fish on the deck while taking others from the storage areas.
- Monitor and record the temperatures of at least two samples of fish prior to unloading.
- Put the fish on ice or pack it for export as soon as possible.
- Work as quickly as possible.

Avoiding Damage

The following suggestions will help prevent damage or significant quality deterioration during unloading:

- Do not twist or bend the fish when removing them from ice, as this entails a risk of damaging the flesh (Miware) and damaging the fish's external appearance.
- Handle the fish gently. Do not throw them or drag them along the deck or the ground.
- If a fish is dropped, clearly label it and continue unloading so that a decision can be made on its status later on.

Remember

All the care that was taken during longlining, processing, chilling & storage can be undone if fish are dropped or left out of temperature controlled storage.

Documentation

Most vessels keep records or logs, such as engine logs and fishing logs, as well as the records required by AFMA. Some modifications to these existing records will give you and your processor key information about the catch.

Records of catch handling and distribution should be kept for at least 2 years. Check with your processor because some may require records to be kept for longer.

The temperature of chilling tanks and storage holds should be monitored and documented.

Other aspects to consider recording include the fishing area and any unusual fishing or handling occurrences that may affect fish quality. These records can be used to trace back or follow up on a particular catch or fish. They may be used for your own information or that of your processor or customers.

Photo: Geoff Diver

In general, record keeping is important because they can be used to:

- Demonstrate that fish have been handled with care and that the skipper and crew have had a professional and competent approach.
- Monitor how well equipment is working. For example, if records show chilled storage area temperatures are rising, corrective action such as adjusting the thermostat or adding more ice can be taken to protect the fish.
- Demonstrate 'due diligence'. For instance, if something were to go wrong with the fish and you are required to go to court, the records can be used to demonstrate that you did everything possible to protect the fish from contamination. This 'due diligence' documentation is likely to be a critical part of your defence in a court of law.

A number of *pro forma* record sheets are included in the Appendices. These are designed to be photocopied or modified and used in your operations.

Defining Responsibility for the Catch

Everyone on-board plays a part in the delivery of a quality product. The quality of the product is influenced at each step between hook up and delivery to the market.

The skipper and crew have responsibility for the catch from the moment the fish is hooked through its landing, cleaning, chilling and storage on-board.

The crew's responsibility does NOT end when the fish leaves the boat. The crew of the vessel have responsibility for the catch until AFTER the catch has safely reached the processing facility (ie not just delivery of fish to dockside).

Very high temperatures may be recorded in many Australian ports where tuna are unloaded. Tuna will rapidly loose their value if high quality tuna are left sitting in the sun while everyone waits for a forklift. These situations can be avoided with good organisation and communication between skipper, crew and processor. Make sure that there is not a breakdown in allocation of responsibility for tasks, especially when unloading.

Transportation

The quality of the fish catch is particularly vulnerable during the transport stage. Transporting fish is often the weak link in the fish quality chain. Risk of damage can be minimised if people plan ahead to ensure the fish are kept cold during transport. A lot of effort has gone into delivering good product from the boat, so it is important to make sure the transport stage is well organised.

There is little that can be done once the fish have left the vessel, but there are some checks a skipper or supervisor needs to make before the fish is transported:

- Check that the product is stacked efficiently and securely to minimise damage during transit.
- Ensure the transport containers or trucks are clean, pre-chilled and have their refrigeration unit running properly.
- Ensure that the transporter is aware of the temperature required to avoid spoilage of the product.
- Make sure all documentation is signed by both parties. This includes documentation on storage conditions, number of cartons, quality of product at unloading, transport agreements, etc.

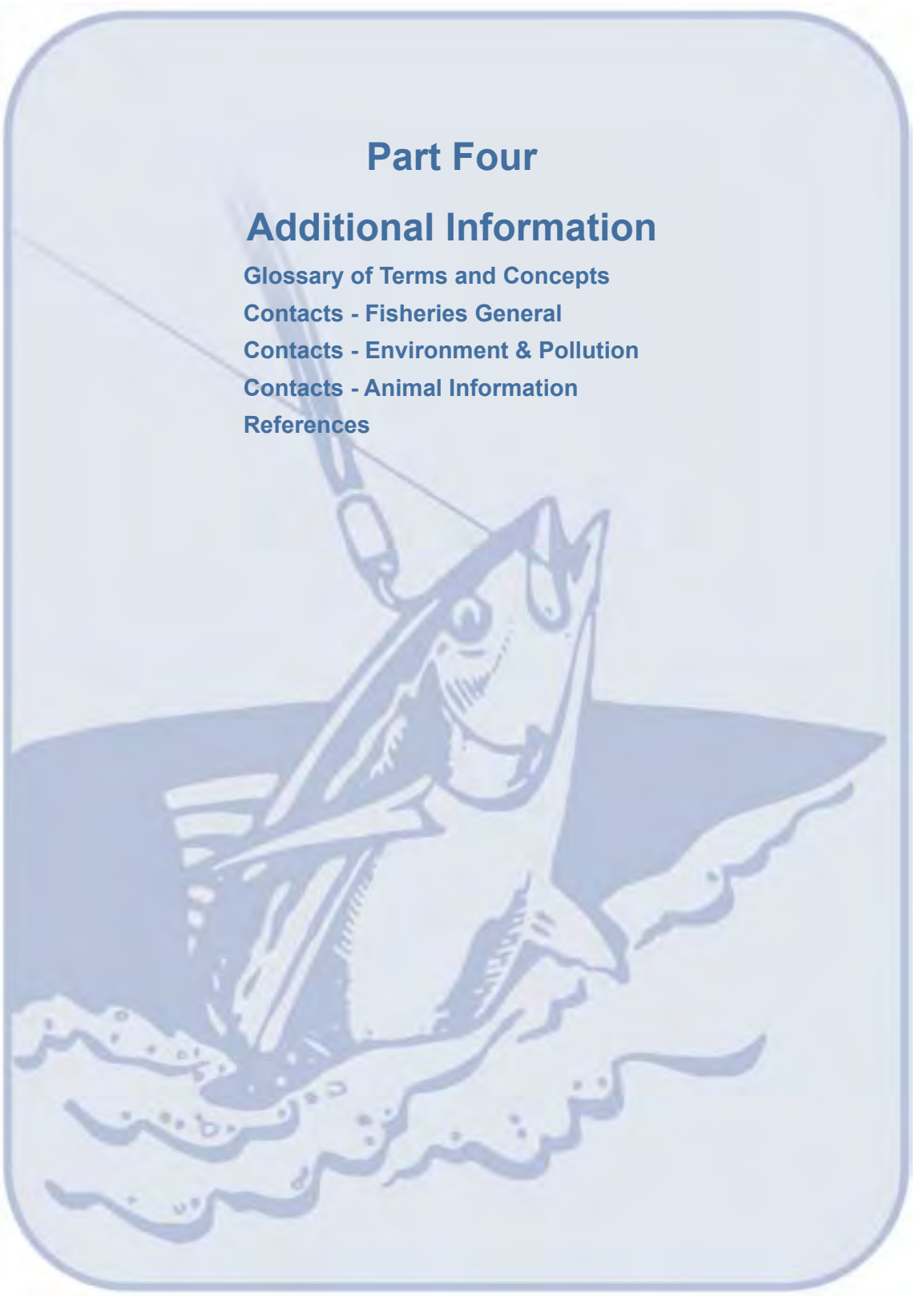
Remember

Ensure the fish cartons are stacked securely in the transport vehicle and its refrigeration system is operating properly.

Make sure all relevant documentation and agreements are in place.

Part Four

Additional Information



Glossary of Terms and Concepts

Term	Definition
Abdomen	The part of the body containing the digestive and reproductive organs.
Ambient Temperature	The surrounding temperature. The ambient temperature of seafood processing facilities is usually in the temperature danger zone for bacterial growth (5 - 60°C).
Ammonia Odour	A by-product of the enzymatic breakdown of seafood protein. Its presence indicates that the seafood is spoilt. An ammonia odour is common in spoilt shark (flake and ray) It can be controlled by sound handling practices. Although unpleasant in taste it is not a seafood safety issue.
Anaerobic Bacteria	Bacteria that are able to function in the absence of oxygen. *Clostridium botulinum* is such a bacterium and it's consumption can cause very serious food poisoning (botulism).
Anal Fin	The fin on the ventral (underneath) surface of a finfish, behind the anus.
Bacteria	Any of the numerous species of a class of microscopic single celled organisms that play significant roles in spoilage, disease, digestion, etc. They are generally very sensitive to temperature, moisture and pH levels. See also anaerobic bacteria.
Bacterial infection	Contamination by bacteria that multiply when conditions are favourable. Bacterial growth is inhibited by low temperature, dry conditions and acid, salt or sugar mediums. High temperatures and proper sanitation procedures can destroy food-poisoning bacteria
Blast freeze	To quick freeze using a method in which chilled air (at about -40°C) is blown at high velocity over the product.
Bleed	To drain the blood from a finfish. This is done by cutting an artery behind the gills while the fish is still alive. It is essential for some species (such as mackerel) or else the blood will quickly taint the flesh. When carried out correctly bleeding helps to maintain quality and extend shelf-life.
Botulism	A serious and sometimes fatal type of food poisoning. It is caused by toxin (poison) produced by the bacterium Clostridium botulinum. It is encouraged in low-acid anaerobic conditions, for example in canned or vacuum-packed products. See also Clostridium botulinum.
Brine	A solution of water and salt. Salt concentration varies depending on the brine's purpose. Brine can be used to flavour and/or preserve seafood. Brine can also be used to store seafood, for example prawns, or to cure seafood, for example when salting.
By-catch	The component of the catch excluding the targeted species.
Caudal Fin	The tail (tail fin) of a finfish.
Chill	To reduce the temperature. Unless frozen or live, seafood should optimally be chilled to and stored between -1°C and +4°C.
Chiller	A refrigerator or room for chilling and storing fresh and wet seafood to a temperature between -1°C and +4°C.
Chiller thaw	To thaw frozen items in a chiller. This is the preferred method of seafood thawing for maintaining quality and minimising bacterial spoilage.
Clostridium botulinum	A bacterium that is able to function in the absence of air. It produces toxin (poison) that can cause serious food poisoning if consumed. See also *botulism*.
Cold Chain	The series of processing, transport and display steps that take seafood from catch to cooking or consumption, during which the product must be kept cold.

Glossary of Terms and Concepts (contd)

Term	Definition
Cold Store	A room or chest designed not for freezing food, but for storing food once it has been frozen. A cold store should never be warmer than -18°C and the optimum temperature for seafood is about -25°C. The cold store should never be used to freeze seafood, as freezing will only occur slowly and may cause damage to the product.
Contamination	To pollute or to infect with undesirable material.
Cross Contaminate	To transfer bacteria from one food to another, in particular from raw to cooked food. Usually caused by poor food handling procedures that lead to careless hygiene practices.
Defrost	See ***thaw***.
Dehydrate	To lose moisture, dry out. Dehydration of seafood may not be a health hazard, but is detrimental to eating quality. It sometimes happens to frozen seafood that is not correctly covered, resulting in bleached spots and papery edges. See also freezer burn.
Denatured	When used in respect of protein, having permanently lost its true nature. This can result, for example from cooking, incorrect storage or drying.
Detergent	A chemical used to clean a surface, usually in conjunction with a physical action such as scrubbing. A detergent helps to remove dirt and soiling by chemically breaking them down.
Dorsal Fin	The unpaired fin or fins along the upper surface or the back of a finfish.
Drip Loss	The amount of fluid lost from a food item, usually expressed as a percentage of the original weight. Excessive drip loss in seafood is caused by poor storage and handling procedures.
Enzymatic Breakdown	The actions of enzymes that cause decomposition.
Enzyme	A protein that can initiate and /or speed up certain chemical reactions. Many types exist in living organisms.
Eviscerate	To remove the internal organs. Although the guts are only part of the internal organs, gutting and eviscerating are used synonymously.
Fat	A substance generally made up of a combination of glycerol and three fatty acids.
Fin Fish	A cold blooded, free swimming aquatic vertebrate, with gills and fins.
Flake Ice	Ice that is not in a cube or cup form.
Food Standards Code	Regulations for the composition, labelling and contaminants, including microbiological limits, that applies to all foods produced or imported for sale in Australia and New Zealand. See also ***FSANZ***.
Freezer	A piece of equipment (usually a room or a chest) for freezing fresh food, not for storing frozen food. A freezer should never be warmer than -18°C and the optimum temperature is about -25°C as this facilitates quick freezing. A cold store should be used to store seafood once it is frozen.
Freezer Burn	Discoloration that appears on improperly or inadequately packaged frozen food, caused by evaporation of moisture that dehydrates the surface of the product.
Fresh	Under the Food Standards Code, 'fresh' seafood is defined as seafood that has never been below the temperature of -1°C. Also used to describe the quality of seafood.
Fresh Frozen	Describes seafood that was frozen soon after capture or harvest.

Glossary of Terms and Concepts (contd)

Term	Definition
FSANZ	Food Standards Australian New Zealand. The federal statutory authority that, in partnership with State, Territory and New Zealand governments, develops food standards to cover the whole of the food supply chain - from paddock to plate - for both the food manufacturing industry and primary producers. Food Standards are published in the Food Standards Code.
Gill	To remove the gills from a finfish during processing or cleaning.
Gills	The aquatic respiratory organs found in fishes and some invertebrates such as crabs. They are usually feathery, plate-like or filamentous.
Gonads	The reproductive organs of animals.
Grading	The grouping of product according to size or weight.
Guts	The contents of the belly cavity. Technically this includes only the stomach organs, but is commonly used to cover all internal organs. Also see ***viscera***.
HACCP	Hazard Analysis and Critical Control Point. A system that identifies, evaluates and controls hazards that are significant for food safety
Histamine	An organic substance that can be released from the flesh of certain finfish. Histamine release is increased at high holding temperatures. The ingestion of finfish with a high histamine content can cause an allergic type food poisoning. Correct handling and rapid cooling as soon as the finfish is caught can prevent histamine release. Associated with species such as mackerels and tunas. Also known as scombroid poisoning.
Hygiene	The science that deals with the preservation of health. This includes conditions or practices (as of cleanliness) that are conducive to health.
Ice Slurry	A mixture of crushed ice and water, which may be salted. Ice slurry can be used to chill seafood or to store it once it is chilled.
Intestinal Tract	In crustaceans, the vein running down the back which carries the animals waste.
Lateral Line	A row of sensory organs along each side of a finfish. The darker, oily flesh is protein concentrated along this line just under the skin.
Listeria monocytogenes	A food poisoning bacterium that is killed only by high temperatures (pasteurisation levels are best) and may survive the process of smoking. It will multiply in chilled temperatures and is not killed by freezing.
Microbiological Spoilage	Spoilage of seafood by the growth and action of certain micro-organisms such as bacteria. Most micro-organisms are dormant at temperatures below 4°C, hence fresh and wet seafood should not be stored at higher temperatures. Micro-organisms are destroyed if heated above 62°C for at least 25 minutes.
Opaque	Not see-through, impenetrable to light (i.e. not translucent or transparent). Describes the flesh of cooked finfish.
Oxidation	A chemical reaction that increases the oxygen content of a compound. In seafood, the taking up of atmospheric oxygen by unsaturated fats results in rancidity. The seafood flesh will go yellow and then brown. Oxidation may not be a health hazard but it is detrimental to the eating quality of seafood.
Parasite	An organism that may populate the flesh of seafood. Some parasites are harmful to humans if consumed live. Freezing and/or cooking kills parasites in seafood.

Glossary of Terms and Concepts (contd)

Term	Definition
Pathogen	Disease causing bacteria.
pH Value	A measure of acidity and alkalinity. Seafood is generally close to neutral pH, which makes it susceptible to bacterial infection.
Potable	Used in reference to water quality, meaning 'Of safe drinking quality'.
Processing	Any series of activities involved in changing and preparing seafood for sale.
Quality	Refers to the external attributes of a seafood product that are required or stated as being necessary by a standard or customer. These may include eating quality (for example odour and texture), visual quality (for example colour) and nutritional quality (for example Omega-3 content)
Quick Freeze	To freeze food to -7˚C or colder within two hours. This is desirable in seafood because the small ice crystals that are formed cause less damage than the large crystals during slow freezing. Sometimes called snap freeze and blast freeze.
Rancid	Exhibiting a disagreeable odour and flavour indicating that the fats have badly deteriorated due to oxidation during storage. See also ***Oxidation***.
Rigor Mortis	The temporary stiffening of the body muscles following death. After rigor mortis the flesh once again becomes soft. Postponing or prolonging rigor mortis in seafood, which can be achieved by chilling it, is highly desirable. This is because significant bacterial spoilage of the flesh will occur after rigor mortis has passed.
Room Temperature	The surrounding air temperature in a room, usually somewhere between 20˚C and 25˚C.
Rotation (of stock)	Management of seafood stock so that older stock is used before new stock. Also known as FIFO (first in, first out).
Safety	The assurance that a food will not cause harm as a result of physical, chemical or biological hazards to the consumer when it is stored, prepared and/or eaten according to its intended use.
Salinity	The amount of salt present in a solution.
Salmonella	A bacterium that if eaten results in food poisoning. Common in meats, including seafood. Usually spread by improper food handling and poor hygiene standards, but can be destroyed by correct cooking.
Sanitiser	Cleaning agent that kills micro-organisms such as bacteria on a cleaned surface and so reduces their number to a safe level. Sanitisers are not good cleaners, so an area or surface must be well cleaned before it can be sanitised effectively.
Scombroid Fish Poisoning	*See **histamine**.*
Shelf Life	The expected time that seafood, if stored and handled correctly, will remain in a state fit for human consumption. The shelf life must be predicted with consideration of prior handling circumstances (for example storage temperature).
Slime	The thick transparent film that occurs naturally on the surface of the skin. After the finfish dies and spoilage sets in, the slime progressively becomes milky and opaque, then thick and yellow. Slime left on finfish is food for unwanted bacteria.
Slurry	See ***ice slurry.***

Glossary of Terms and Concepts (contd)

Term	Definition
Spoiler	A quality reducing agent such as biochemical or bacterial deterioration often facilitated by physical damage, inappropriate temperatures and/or temperature fluctuations. See also microbiological spoilage
Staphylococcus aureus ('staph')	A bacterium that produces a toxin in improperly stored food which, if consumed, can cause disease. Particularly dangerous because the toxin is not destroyed by heat.
Stress	Agitation of animals prior to slaughter. Stress can cause poor-quality flesh in seafood. Stress in live seafood held in retail premises can be minimised by using correct water quality parameters for the species and using correct handling techniques.
Temperature Danger Zone	The temperature between 5˚C and 60˚C. Most bacteria will grow rapidly within this temperature range. **Note**: Between 5˚C and 38˚C is optimum for most micro-organism growth, seafood will spoil extremely quickly in this temperature range.
Thaw	To convert from a frozen to a non-frozen (thawed or wet) state. This is the same as defrosting, except that thawing is usually used in relation to food and defrosting in relation to equipment. The three main ways to thaw food are chiller thawing, cold water thawing and microwave thawing. Chiller thawing is recommended when thawing seafood.
Translucent	Almost 'see-through', transmitting light diffusely or imperfectly. Describes the appearance of the uncooked (raw) flesh of most finfish and shellfish.
Ventral	Pertaining to the lower surface or underside of the body (or head).
Virus	Microscopic organism that multiplies only in living cells and often causes diseases. A virus of concern in seafood is Hepatitis A which is spread by poor hygiene practices.
Viscera	The internal organs including the guts. Used in reference to finfish.

Contacts

Industry Information		
Tuna West	Industry association	0418 266 065 geoff.diver@bigpond.com
Ocean Watch Australia Ltd	Protected Species Handling Manual Bycatch Solutions - (Ocean Watch Australia Ltd. FRDC)	(02) 9552 3181 www.oceanwatch.org.au
SeaNet	Sustainable fishing practices	Carl Bevilacqua (08) 9244 2933
WA Fishing Industry Council (WAFIC)	Peak Industry Body, WA	(08) 9244 2933
Seafood Training Australia	Seafood safety training throughout Australia	(02) 6281 0383 0412 430 728
Fisheries Management and Research		
AFMA	Switchboard Observers	(02) 6272 5029 (02) 6272 5648
Fisheries WA	Compliance issues, Provision of fish tags	(08) 9482 7333
CSIRO	Enquiries Provision of tags for research and reporting of tagged fish Australia wide Involvement in broadbill age and growth research	1300 363 400 (03) 6232 5359 (03) 6232 5360
Dept of Environment and Heritage	Reporting all listed species interactions. **After Freecall and email contact, you must then mail the wildlife interaction logbook sheets to: Director, Marine Species Section, Department of the Environment and Heritage, GPO Box 787, Canberra ACT 2601**	FREECALL 1800 641 806 Then, email protected.species@ea.gov.au within 3 working days,
Wildlife Australia (Australian Bird and Bat banding scheme)	Reporting of banded seabirds	(02) 6274 2407 Fax (02) 6274 2455 abbbs@ea.gov.au GPO Box 8, Canberra ACT 2601
Dept of Conservation & Land Management	Captured tagged/marked turtles (WA).	Ph (08) 9405 5100
Queensland Parks and Wildlife Service (QPWS)	Captured tagged/marked turtles nationwide.	Ph (07) 3227 7718 Fax (07) 3247 5966 col.limpus@epa.qld.gov.au Turtle Research, PO Box 155, Brisbane 4002

Contacts - Environment & Pollution

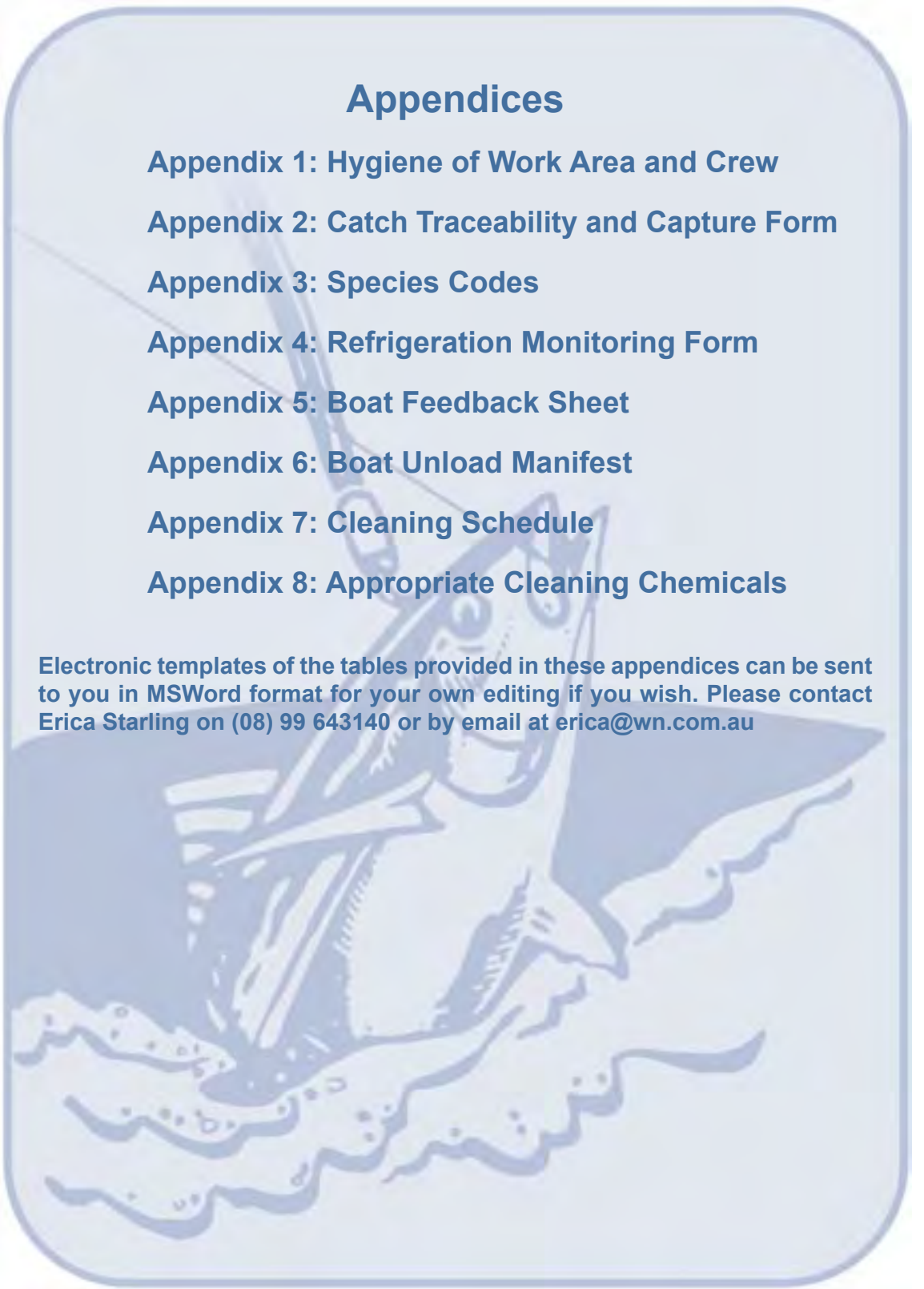
Environment and Pollution		
Rescue Co-ordination Centre Australia (RCC Australia)	Reporting of pollution at sea (beyond 3 nm.) Reporting close collisions	1800 641 792 Fax. 1800 622 153 Telex 62349 rccaus@amsa.gov.au
Australian Maritime Safety Authority (AMSA)	Queries regarding commonwealth environmental laws Determining appropriate discharges of sewage Obtaining plastic disposal placards Point of Contact (Fremantle Dept)	(02) 6279 5015 Fax (02) 6279 5966 (08) 9430 2100
Department of Planning and Infrastructure	Reporting of oil pollution at sea (inside 3 nm.)	(08) 9216 8902 0417 938 157 (after hours)

Contacts - Animal Information

Animal Identification		
Western Australian Museum Fish department (Perth)	Identification of unusual or exotic fish	(08) 9427 2700 www.museum.wa.gov.au
CSIRO	Fish taxonomy	03 6232 5351
Injured Animals		
CALM – Wildcare Helpline	First point of contact for advice on injured wildlife	(08) 9474 9055
CHELONIA Turtle Rehabilitation & Release (WA) PO Box 3266 Broome WA 6725 Australia	Care and advice of injured seabirds and turtles	(08) 9193 5409
Help for Wildlife	24 hour emergency service for all animals. Advice and list of carers - Australia wide	0417 380 687
Southern Ocean Seabirds Association (SOSA)	Care of injured seabirds and advice (Australia wide)	(02) 4271 6004

Appendices

Electronic templates of the tables provided in these appendices can be sent to you in MSWord format for your own editing if you wish. Please contact Erica Starling on (08) 99 643140 or by email at erica@wn.com.au



Appendix 1: Hygiene of Work Area and Crew

Copy and laminate this page and display on deck.

Important

Good hygiene on board a tuna boat will protect tuna from contamination and deterioration.

- **Ensure all work areas are maintained in a clean and hygienic condition:**
- **Wash all work areas and equipment thoroughly before and after each use.**
- **Sanitise.**
- **Rinse all work areas and equipment well with clean water.**

All crew must maintain excellent personal hygiene standards

- **Hands must be washed after going to the toilet, or returning to the process area after a break.**
- **When handling fish, long hair must be tied back**
- **Aprons / protective clothes kept clean to avoid contaminating the fish.**
- **Any cuts or sores must be covered when handling fish.**
- **Gloves must be clean.**
- **Smoking is not allowed anywhere near the product.**
- **Allow no food / eating during processing.**
- **Sickness / diarrhoea must be reported to the skipper, who will reallocate tasks.**
- **No dogs on board, ever**

Appendix 2: Catch Traceability and Capture Form

Vessel		**Trip No**	
Skipper		**No. Shots**	
Start date		**Unload Date**	
AFMA Log Book Pages		**Unload Port**	
Chilling Method		**Storage Method**	

Date/Shot	Tag Number	Species	Weight	Life Status	Physical Damage	Gutted by

Appendix 3: Species Codes

Common Name	Species Name	AFMA Code
Yellowfin Tuna	*Thunnus albacares*	YFT
Bigeye Tuna	*Thunnus obesus*	BET
Southern Bluefin Tuna	*Thunnus maccoyii*	SBF
Albacore	*Thunnus alalunga*	ALB
Skipjack Tuna	*Katsuwonus pelamis*	SKJ
Mahi Mahi	*Coryphaena hippurus*	DOL
Swordfish	*Xiphias gladius*	SWO
Shortbill Spearfish	*Tetrapturus angustirostris*	SSP
Sailfish	*Istiophorus platypterus*	SFA
Blue Marlin	*Makaira nigricans*	BLZ
Black Marlin	*Makaira indica*	BLM
Striped Marlin	*Tetrapturus audax*	MLS
Rudderfish	*Centrolophus niger*	CEO
Escolar	*Lepidocybium flavobrunneum*	LEC
Oilfish	*Ruvettus pretiosus*	OIL
Ray's Bream (Pomfrets)	Bramidae spp	BRA
Crocodile Shark	*Pseudocarcharias kamoharai*	PSK
Blue Shark	*Prionace glauca*	BSH
White Shark	*Charcharadon carcharias*	WSH
Shortfin Mako	*Isurus oxyrinchus*	SMA
Porbeagle	*Lamna nasus*	POR
Tiger Shark	*Galeocerdo cuvier*	TIG
Thresher Shark	*Alopias vulpinus*	ALV
Bigeye Thresher	*Alopias superciliosus*	BTH
Pelagic Thresher	*Alopias pelagicus*	PTH
Oceanic Whitetip Shark	*Carcharhinus longimanus*	OCS
Hammerhead Sharks	Sphyrnidae spp	SPL
Bronze Whaler	*Carcharhinus brachyurus*	BRO
Dusky Shark	*Carcharhinus obscurus*	DUS
Sandbar Shark	*Carcharhinus plumbeus*	CCP
Silky Shark	*Carcharhinus falciformis*	FAL
Whaler sharks	Charcharhinidae spp	CVX

Life status codes

0: **Dead and damaged**
1: **Dead and in rigor (stiff)**
2: **Dead and flexible**
3: **Alive, just**
4: **Alive and sluggish**
5: **Alive and vigorous**

Appendix 4: Refrigeration Monitoring Form

Use this form to take samples from a selected number of fish to measure chilling time and ensure that chilling and storage systems are functioning correctly.

Vessel	Skipper	Trip No	Start date	AFMA Log Book Pages	No. Shots	Chilling Method	Unload Date	Unload Port	Storage Method

Date/Shot	Tag Number	Species	Weight	Temp	Brine/RSW	Core Temp of fish & Time of capture	Core Temp & time after chilling Sample 1	Core Temp & time after chilling Sample 2	Holding room/CSW temp

Appendix 5: Boat Feedback Sheet

Vessel		**Trip No**	
Skipper		**Owner/Company**	
Unload Date		**Unload Port**	
Receival Date/Time		**Receival Port**	
Fish Receiver		**Grader**	

Unloading process: Speed, icing, covers, general:	
Fish Temps: Random samples	
Cleaning Process: Good/Poor Consistency	
Gilling/Gutting/Cutting: All removed, cutting marks	
General appearance: Firm, soft, skin condition/damage	
Other Comments on General Freshness and quality	
Signed/Date	

Appendix 6: Boat Unload Manifest

Vessel		**Trip No**	
Skipper		**Owner/Company**	

Unload Date		Transport		Refrig Temp Set	
Unload Start Time		Departure Time		Con Note No	
Unload Port		ETA		Driver's Name	
Fish Receiver		Con Note		Driver's Phone	
Destination				Drivers Signature	

Are your fish covered in:	Cheesecloth	Plastic	Nothing
Are your fish tagged:	All	Some	None
Comments			

Tub Number	**Description of Fish** (include app nos, species, state of freshness, ie first/last days)

Appendix 7: Cleaning Schedule

Task/ Area to be Cleaned	Cleaning Method	Frequency	Responsibility
Deck Area			
Carpets/ Rubber Mats / Foam Pads			
Knives, Spikes, etc			
Crew Protective Gear			
Storage Hold			
Ice Machine			
Brine Tanks			
Amenities			
Bait Store			
Galley			
Toilet Area			

Appendix 8: Appropriate Cleaning Chemicals for Fishing Vessels

The following cleaning chemical suppliers have chemicals suitable for use with seawater. The suggested chemical and usage rate are listed for each supplier. Some suppliers offer a few alternatives.

Supplier	Contact Details	Detergent	Type of Chemical	Usage Rate	Sanitiser (no rinse)	Type of Chemical	Usage Rate
Able Westchem	08 9353 1491	Mariner	Non caustic alkaline salts	20mls per 1 litre water	Q-San	Quaternary ammonium compound	4mls per 1 litre water
Chemform	08 9344 2455	Grime Buster Gold	Non caustic alkaline salts	100mls per 1 litre water	Q-San	Quaternary ammonium compound	5mls per 1 litre water
Ecolab	08 9456 6200	Atlas	Chlorinated alkali	30mls per 1 litre water	Antibac	Quaternary ammonium compound	1ml per 1 litre water
		Formula 760B	Caustic salts	25mls per 1 litre water			
Jasol Australia	08 9337 4844	All Clean	Caustic salts	25mls per 1 litre water	Kildet	Quaternary ammonium compound	2.5ml per 1 litre water
					Huwasan TR5	Hydrogen peroxide	50mls per 1 litre water
Klen International	08 9302 4000	Astrochlor	Chlorinated alkali	33mls per 1 litre water	Fresh Up	Hydrogen peroxide	1ml per 1 litre water
					Quat Klen	Quaternary ammonium compound	1ml per 1 litre water

References

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Anonymous, 'How to Preserve Freshness in Tunas, Parts 1 and 2'.

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Blanc, Michel, et al., 'On-Board Handling of Sashimi-Grade Tuna: A Practical Guide for Crew Members', South Pacific Commission, New Caledonia, 1996

Diver, Geoff, and Bevilacqua, Carl, 'Western Tuna and Billfish Fishery: Industry Code of Practice for Responsible Fishing', 2003

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Quality Fish Catchers Pty Ltd, 'Food Safety Program', Seafood Services Australia

Seafood Quality Management Initiative (SQMI), 'Handbook for On-board Handling of Demersal Gillnet and Longline Catch'

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Seafood Quality Management Initiative (SQMI), 'The Western Australian Quality Finfish Guide'

Slattery, S. 'Swordfish Handling Manual', DPI Queensland, 2004

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