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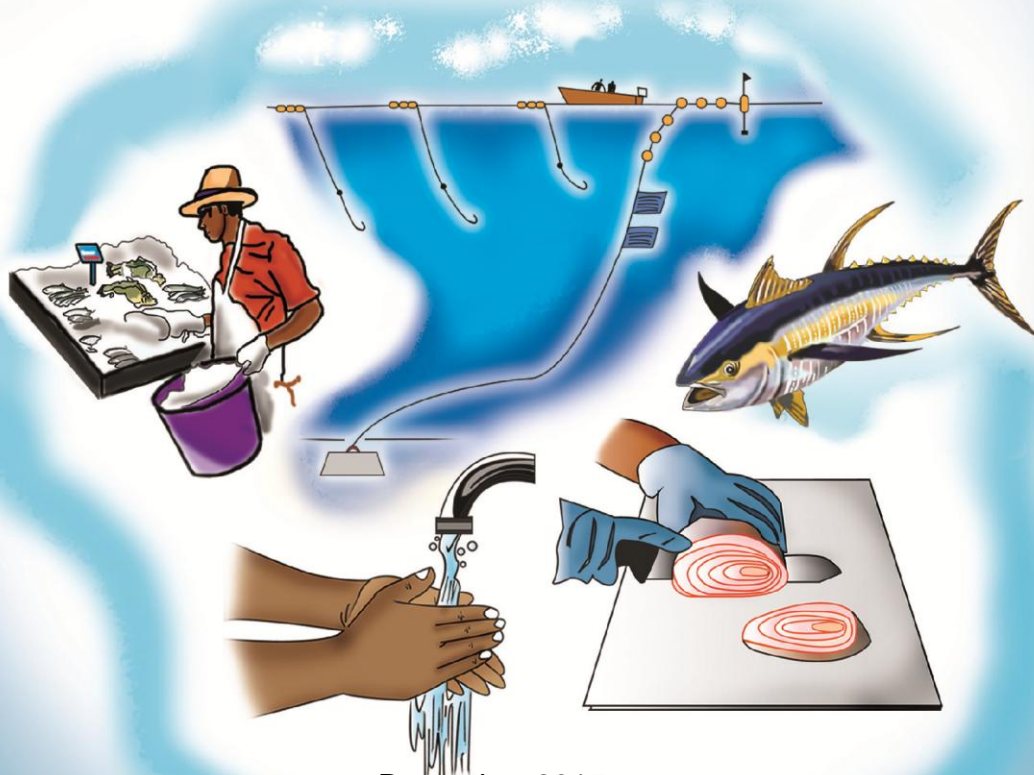
CRFM Special Publication, No. 6

**MANUAL OF BEST PRACTICES
IN FISHERIES THAT USE MOORED FISH AGGREGATING DEVICES (FADs)**

A joint activity of the CRFM Pelagic Fisheries Working Group and the
CRFM/WECAFC/JICA/Ifremer Working Group on Fisheries that use Fish
Aggregating Devices

VOLUME II

**MAINTAINING GOOD QUALITY OF FAD-CAUGHT FISH:
FROM THE POINT OF CAPTURE TO THE POINT OF SALE**



December 2015
CRFM Secretariat
Belize

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MANUAL OF BEST PRACTICES IN FISHERIES THAT USE MOORED FISH AGGREGATING DEVICES
VOLUME II – MAINTAINING GOOD QUALITY OF FAD-CAUGHT FISH: FROM THE POINT OF
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FOREWORD

It has been more than three decades since initial experimentation with the use of moored fish aggregating devices (FADs) in the Caribbean region. The main driver for development of FAD fisheries has been the need to reduce fishing costs, increase fishing efficiency, to improve fishers' livelihoods as well as national food security and to reduce fishing pressure on over-exploited coastal resources. However, the development of these fisheries in the region has been influenced by the socio-economic and bio-physical conditions of the respective countries.

This manual on Best Practices in FAD Fisheries Management is being developed as a collaborative effort among the CRFM, the Caribbean Fisheries Co-management Project (funded by the Japan International Cooperation Agency - JICA), the French Institute for Exploitation of the Sea (Ifremer) and the Western Central Atlantic Fishery Commission (WECAFC). These institutions are partners of a regional working group on FAD fisheries that was established at the 15th Session of the WECAFC and during the period 2014 to 2016 is being led by the CRFM. The impetus for development of the manual originated from the recommendations of a joint meeting of the respective institutions in December 2013, in St Vincent and the Grenadines, which were put forward to the 15th Session of the WECAFC. This task was explicitly included in the Terms of Reference of the Working Group and in June 2015 the CRFM convened a Write-Shop on FAD Fisheries Management to advance development of the manual. The manual is being published in five separate volumes addressing interests related to FAD design, construction and deployment, maintaining the quality of FAD-caught fish, fishing and business strategies for sustainable anchored FAD fisheries, safety and working conditions of FAD fishers and governance of FAD fisheries. It represents the combined technical efforts of the Working Group partners and targets a wide range of stakeholders, from FAD fishers, to other industry persons, fisheries scientists and managers. To facilitate wider distribution it is also published online (see www.crfm.int).

The experiences that inform the best practices in FAD fisheries management are drawn from a number of regional initiatives, beginning with establishment of the WECAFC Ad Hoc Working Group on the Development of Sustainable Moored Fish Aggregating Device Fishing in the Lesser Antilles in 2001, followed by the JICA-funded study on Formulation of a Master Plan on Sustainable Use of Fisheries Resources for Coastal Community Development in the Caribbean from 2009 to 2012, the project on the Moored Fish Aggregating Devices in the Lesser Antilles (MAGDELESA Project) from 2011 to 2014 (see <http://en.magdelesa.eu>) and more recently the JICA-funded Caribbean Fisheries Co-management Project being implemented from 2013 to 2018. As well, these best practices are also informed by collaborative research with the Texas A&M University and the University of Florida, Florida Sea Grant. Both the Ad Hoc Working Group and the MAGDELESA Project were led by the Ifremer and focused primarily on examining the scientific information for development of sustainable FAD fisheries, promoting sub-regional cooperation in the sustainable development and management of FAD fishing and the sharing of related information and experiences. The MAGDELESA project also focused on improving the design and construction of FADs and examining fishing strategies, gear selectivity, fish quality, safety and work conditions of FAD fishers and governance of FAD fisheries. The Master Plan Study, through one of its four pilot projects, further improved FAD fishing technology, initiated FAD data collection programmes and explored aspects of co-management of the fishery in Dominica and Saint Lucia. The pilot project also developed a draft FAD fishery Management Plan for Dominica. The current CARIFICO Project is providing additional support to Antigua and Barbuda, St Kitts and Nevis, Dominica, Saint Lucia, St Vincent and the Grenadines and Grenada to develop FAD fisheries and to address issues of governance.

ACKNOWLEDGEMENT

The production of this volume of the Manual of Best Practices in Fisheries that use Fish Aggregating Devices would not have been possible without the kind assistance and support of various agencies and experts, both regionally and internationally. We would like to thank the Pôle Agroalimentaire Régional de Martinique - *Food Technical Center*, Impact Mer Martinique, the Caribbean Fisheries Co-management (CARIFICO) Project and the Caribbean Regional Fisheries Mechanism (CRFM) for funding our participation at a Write-Shop on FAD Fisheries Management, which was convened in June 2015 in St Vincent and the Grenadines, to discuss and advance preparation of the Manual. We are also grateful to the CRFM Secretariat for organizing this Write-Shop and for facilitating the review, editing, finalization and publication of the respective outputs. We are especially grateful to Ms Pamela Gibson for assisting with technical editing and proof reading of the final document and to Ms Kemara Brackin for the design and layout of the covers of this volume of the Manual. We also wish to express our appreciation to Ms Joyce Leslie and Mr Charles Nurse for their constructive review of the document and suggestions for its improvement. This document has also benefitted from the review of the following fishers from St Vincent and the Grenadines: Mr Roderick Telemaque, Mr Donelee Providence, Mr Esworth Edwards, Mr Calvin Lampkin and Mr Winston Hazellwood, to whom we are deeply grateful. We are also grateful to the Food and Agriculture Organization of the United Nations for funding the publication and dissemination of the Manual in two languages, English and French, and in particular to the Caribbean Billfish project GCP/SLC/001/WBK for the support provided to the CRFM.

LIST OF ACRONYMS AND ABBREVIATIONS

CARIFICO	Caribbean Fisheries Co-management Project
CFTDI	Caribbean Fisheries Training and Development Institute
CRFM	Caribbean Regional Fisheries Mechanism
FAD	Fish Aggregating Device
GMP	Good Management Practices
Ifremer	French Institute for Exploitation of the Sea (L'Institut Français de Recherche pour l'Exploitation de la Mer)
JICA	Japan International Cooperation Agency
MAGDELESA	Moored fish AGgregating DEvice in the LESser Antilles
PCB	Polychlorinated biphenyls
PSE	Pale Soft Exudative
WECAFC	Western Central Atlantic Fishery Commission

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I. INTRODUCTION

Fishermen should have a proper understanding of health hazards and risk prevention methods at each stage of the supply chain from capture to delivery to the consumer. To ensure the safety and freshness of fish products, respect for hygiene rules is essential. The safety of fish and fishery products and their freshness have a major impact on the commercial value of fish landed and on the image of fishery products to, and impacts on the health of, consumers. This guide describes the good practices to be applied in order to master the key points affecting the health quality and sensory quality of fish caught in FAD fisheries.

FAD fishing trips are usually longer than near shore fishing trips. Targeted fish species in FADs are pelagic fish, such as dolphinfish, yellowfin tuna, blackfin tuna, skipjack tuna, wahoo and blue marlin, which are different from other types of fish.

Pelagic fish have three main features:

- They spoil more quickly than bottom fish because of their thin skins which break or bruise more easily. Additionally, the oils of some pelagic fish are more susceptible to deterioration (rancidity) than for bottom fish;
- Their body temperature can increase rapidly during capture and may cause high levels of acidity to develop within the fish muscle; and
- They may produce high levels of histamine (a biological toxin produced by bacteria within the fish muscle) especially for scombroid species such as tunas, mackerels and billfishes (marlins).

2. QUALITY AND HYGIENE

Quality: Fish have attributes that are specific to each species such as taste and texture which are typical for the respective species and qualities which depend on how the fish are handled by fishermen, vendors, processors and others along the value-chain. Therefore, quality includes sensory aspects as well as hygiene practices.

Hygiene is the set of measures taken to ensure the safety of food (fish) to consumers. Hygiene rules concern avoiding contamination from human activity, tools or equipment and methods of handling the fish as well as ensuring proper sanitary practices during handling, processing and storage.

After capture and death of the fish several deterioration stages occur (Table I). Autolysis (self-digestion) of the fish muscle causes bad taste, odors, and the formation of toxic compounds. The bacteria on the skin and in the intestines invade the flesh, causing deterioration and spoilage of the fish, toxins such as histamine can also develop.

Table 1: Description of deterioration factors.

Factor of deterioration⁶	Description of process
Dehydration	Fish can dry out if it is not protected or placed away from direct sunlight and wind.
Chemical and physical changes (rigor mortis)	After its death, the fish enters a state of rigor mortis (stiffness), a normal process which lasts a few hours. Flesh is then released gradually and becomes flexible. The duration of this state depends on several factors (species, fishing method and slaughter, fish size, temperature).
Enzyme activity (self digestion or autolysis)	Enzymes are naturally occurring chemicals in fish and helpful for digestion and muscle activity. After death, enzymes digest the flesh, making it soft and flabby. In addition, they transform the sugar in the muscle into lactic acid which may cause the phenomenon of burnt flesh when this acid accumulates in excess.
Bacterial spoilage (main factor of deterioration).	The flesh of a healthy living fish is sterile. Bacteria are concentrated in the mucus (skin), gills and gastrointestinal tract. After capture and death, surface bacteria and intestinal flora invade the flesh causing tissue damage or decay which result in unpleasant odors, bad taste and toxic compounds, including histamine in some species, especially in scombroids like tunas, mackerels and billfishes (marlins). Several operations conducted after capture can slow down bacterial growth (cleaning, preparation and refrigeration of fish).

Sensory evaluation

Deterioration of fish can be assessed through sensory changes perceived by different senses (smell, appearance, texture and taste). Through Sensory Evaluation of fish there is an appreciation of the level of freshness and whether the fish is suitable or not for consumption (Table 2 and Figures 1 and 2).

Table 2: Sensory detectable changes in raw fish.⁷

Attributes	Pre-Rigor (fresh)		Rigor		Autolysis (self digestion)	Putrefaction (spoiled)
Appearance	Bright with metallic lustre	→			Some loss of lustre	Colour fade or bleached
Body slime	Clear and transparent	→			Turbid opaque or milky	Thick, sticky grayish
Gill-color	Bright red or pinkish red	→			Brownish red	Brown or Grey
Gill odor	Fresh odor	→			Sour or fishy	Strong sour

⁶ Beverly, S. 2011. Fish handling techniques for a healthy and quality product. Information Fisheries Newsletter of the Secretariat of the Pacific Community (SPC), 134: 29-33.

⁷ Sakaguchi, M. (1990). Sensory and Non Sensory Methods for measuring freshness of fish. In Science of Processing Marine Food Products. Vol. 1 (1992).











Attributes	Features	SENSORY EVALUATION			
		FRESH		BAD QUALITY/SPOILED	
Skin	Pigmentation	<i>Brilliant colors Regular scale</i>		<i>Discolored / dull / grayish Detachment scales</i>	
	Mucus	<i>Transparent</i>		<i>Lumpy / yellowish</i>	
Eye	Tint	<i>Shiny black pupil Transparent cornea</i>		<i>White/grey pupil Milky cornea</i>	
	Form	<i>Convex</i>		<i>Concave</i>	
Gills	Tint	<i>Bright red No mucus</i>		<i>Yellowish Milky mucus</i>	
	Odor	<i>Neutral/ smell of seaweed</i>		<i>Foul smell</i>	
Flesh	Rigidity	<i>Firm</i>		<i>Flabby</i>	
	Color	<i>Bright Red</i>		<i>Dull red</i>	

Figure 1: Freshness referential for tunas.⁸

⁸ Dromer, C., Eugène, S., Regina, F., Reynal, L., Stephen, M., Mathieu, H., Pau, C. 2015. Study of the quality of fishery products associated with anchored FADs. MAGDELESA project. R.INT.RBE / BIODIVENV 2015-2, 123p.

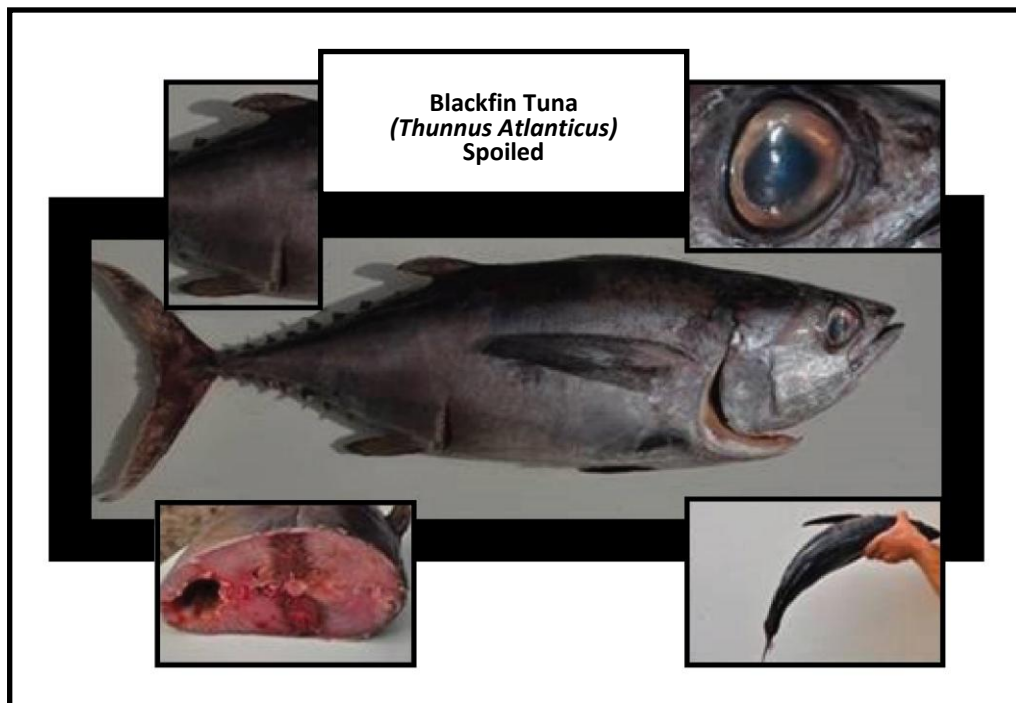
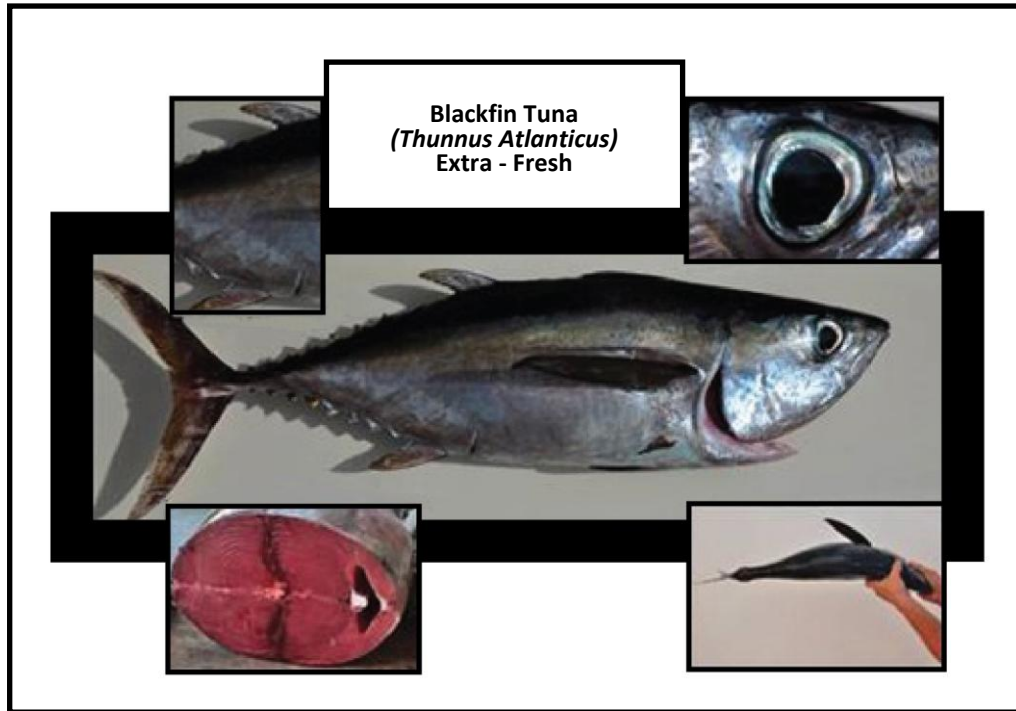


Figure 2: Freshness comparison for blackfin tuna.⁹

⁹ Dromer, C., Eugène, S., Regina, F., Reynal, L., Stephen, M., Mathieu, H., Pau, C. 2015. Study of the quality of fishery products associated with anchored FADs. MAGDELESA project. R.INT.RBE / BIODIVENV 2015-2, 123p.

3. GOOD PRACTICES

Three principles should be considered in order to maintain the quality of fish:

- The fish should be handled with care – **handle carefully**
- It must be refrigerated (chilled) quickly – **keep chilled**
- Hygienic measures should be applied – **keep clean**

3.1 Techniques on-board and at landing site

3.1.1 Before fishing trip¹⁰

- At the end of the previous fishing trip, cleaning, rinsing and disinfecting of the boat, all tools (knives, etc.) as well as the icebox should be done.
- Immediately prior to the fishing trip all tools and the icebox should be rinsed with clean water.
- Store flaked ice in the ice-box in sufficient quantity to chill the catch.

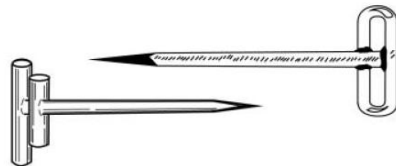
- Gaff



- Fish bat



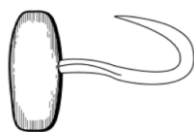
- Spike



- Stainless steel knives (1 for fishing product and 1 for bait or other use)



- Meat hook



¹⁰ All drawings are from Beverly, S., Chapman, L. and Sokimi, W. 2003. Horizontal longline fishing methods and techniques: A manual for fishermen. Secretariat of the Pacific Community (SPC). 120p.

- Clean Gloves



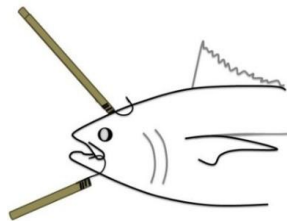
- Detergent and bleach (Keep in a secured area away from ice and fish)



3.1.2 During fishing trip

Catching and killing fish

- **Killing** of the fish must be done as quickly as possible to reduce the stress time because stress has an impact on the quality of the flesh.



Gaffing

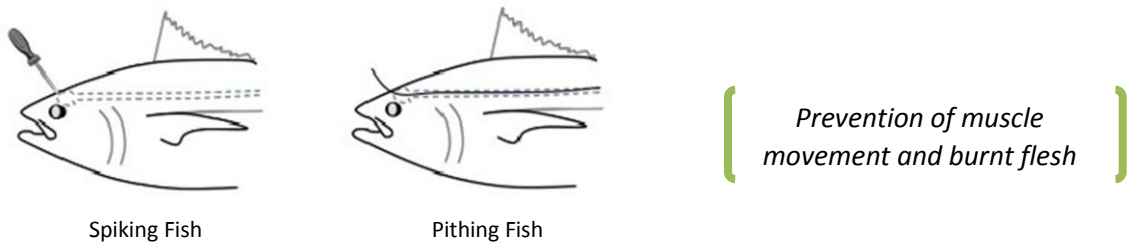
- **Gaffed fish** must be immobilized and brought alongside the boat before mounting on the vessel deck. For this, the fisherman should use one or more gaffs which must be stitched or hooked in the head of the fish (jaw or mouth), being careful not to puncture the heart.
- **Land fish** on the vessel in an area that is clean and safe (avoid bruising).

Post-harvest treatments

Post-harvest treatments aim to retain the quality of the fish by delaying degradation reactions of the flesh (Tables 1 and 2). The muscle tissue of fish is fragile and easily damaged: bruising or rough handling promotes bacterial contamination and enzyme production, thus accelerating deterioration. Observation of gaps (gaping) in the flesh is a sign of degradation. Disintegrating, flabby flesh is a sign that the fish may have been improperly treated thereby causing physical injury, such as bruising. Therefore, from the time it is captured, fish must always be handled with care by fishers until the point of landing¹¹.

¹¹ Beverly, S. 2011. Fish handling techniques for a healthy and quality product. Information Fisheries Newsletter of the Secretariat of the Pacific Community (SPC), 134: 29-33.

- **Stunning:** Once on board, the fisherman should stun the fish with a blow to the head, between the eyes, using a fish bat. This serves to avoid bruising of the skin as a result of struggling.
- **Spiking:** Prevents muscular contraction and relaxation by destroying the brain. The skull is perforated with a special tool (the spike) that punctures, at a 45° angle, the soft part of the skull behind the eyes. The fish then makes jolts.
- **Pithing:** This is a complementary practice to spiking. The Taniguichi¹² method seeks a fish of "Sashimi quality." It is done by pressing a stainless steel cable (or a monofilament) through the hole caused by the sharpened tip (spike) to the tail following the medullary canal. The result is destruction of the spinal cord.



Spiking and pithing limits the burned flesh phenomenon. This phenomenon is due to lactic acid build-up in the muscle of fish that have struggled for a long time during the capture. This results in meat that is sour to the taste and PSE (Pale Soft Exudative) meat.¹³



Figure 3: Difference between normal flesh and burned flesh (blackfin tuna).¹⁴

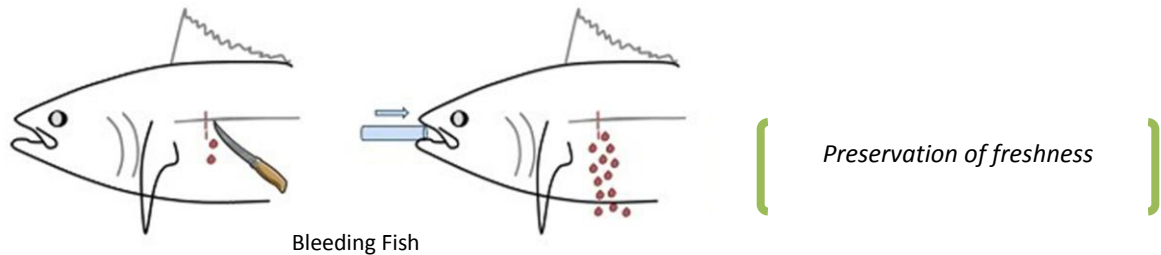
¹² Beverly, S., Chapman, L. and Sokimi, W. 2003. Horizontal longline fishing methods and techniques: A manual for fishermen. Secretariat of the Pacific Community (SPC). 120p.

¹³ Handling of Tuna (Gibson 1984 cited by Fusao Takigami in Added Value Products from Marine Tropical Fish JICA/CFTDI 2001).

¹⁴ Dromer, C., Eugène, S., Regina, F., Reynal, L., Stephen, M., Mathieu, H., Pau, C. 2015. Study of the quality of fishery products associated with anchored FADs. MAGDELESA project. R.INT.RBE / BIODIVENV 2015-2, 123p.

- **Bleeding:** Bleeding removes blood from the body of the animal, thus limiting the production of histamine (which is a cause of food poisoning in scombroid species) and retains the appearance of the flesh¹⁵.

For tuna, bleeding is performed in two stages. An incision (cut) of 2 cm depth is first made behind the pectoral fins (5cm) to sever blood vessels. Then a sea water hose is inserted in the mouth for several minutes to allow the blood to flow completely out of the body of the fish.



- **Gutting and washing the catch:** During the feeding periods, the digestive system of fish contains many bacteria and there is production of digestive enzymes. These are able to initiate self digestion that can produce an unpleasant flavor especially in the abdominal area. Effective gutting is the removal of the intestine, without puncturing of organs, all the viscera (digestive, reproductive and excretory organs) and the gills. Head and tail may be removed at this stage.

In the case of tuna, gutting is practiced as a first step, by cutting the fish 2 to 3 cm in front of the anus, then by cutting the end of the intestine. Secondly, by cutting the gill walls and cutting the attachment points of the gills to the head. The removal of internal organs is through the opening under the gill covers, done by pulling the gills. Also, the viscera and the kidneys are removed by hand through the same opening. The mass of blood present in the spine and skull base must be removed using a brush. This stage ends with a thorough rinsing of the fish by introducing a jet of sea water into the mouth.

Gutting billfish (marlin, sailfish) is a little different. It is advisable to cut the entire stomach (from the anus to the mouth) and remove all the internal organs and gills. A further step is the removal of the kidneys and the swim bladder, both located below the back bone. This is done by separating these body parts from the spine then rubbing the spine until the back bone is seen. As before, thorough rinsing is essential to remove the remaining small pieces of organs and blood.

- **Icing fish in a small scale vessel**
 - Ice must completely cover the fish for optimal cooling.
 - Use removable panels to separate:
 - Clean ice and fish storage area;
 - Tunas/Marlin and bycatch species (ocean trigger fish – “bous”); and
 - Areas where food fish and bait fish are stored.
 - Put a thick layer of ice under the fish so they do not touch the bottom of the hold or the ice-box when the ice begins to melt.
 - Store fish, on ice with ice in the belly cavity and belly down in layers separated with ice.
 - Be sure to drain water from melting ice in the hold or the cooler so that the fish do not stay in the icy water.

¹⁵ Handling of Tuna (Gibson 1984 cited by Fusao Takigami in Added Value Products from Marine Tropical Fish JICA/CFTDI 2001).

- Cut big marlin across the body in two parts, put each part in a plastic bag and store them under ice.
- If you catch a very big fish, it is better to return to the harbor or landing site quickly.
- Adapt the vessel speed to its loading in order to prevent damage and bruising of the flesh of the fish.

At the beginning of the fishing trip, all ice-bags are stored in compartments provided for this purpose (Figure 4).

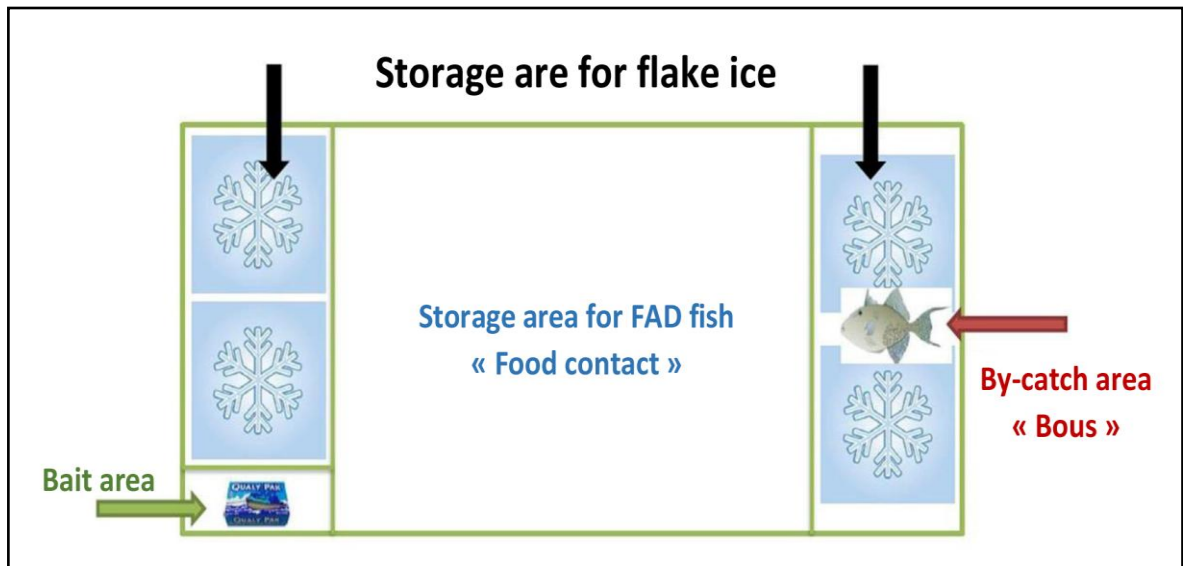


Figure 4: Example of arrangement of pelagic fish in the ice box.¹⁶

When first fishes are caught, a layer of ice is placed in the bottom of the ice-box. The fish are covered with ice progressively. The by-catch is placed separately. This arrangement helps maintain the stability of the fishing vessel. See Figure 5 below for demonstration.

¹⁶Clément Dromer, personal communication, 2015.

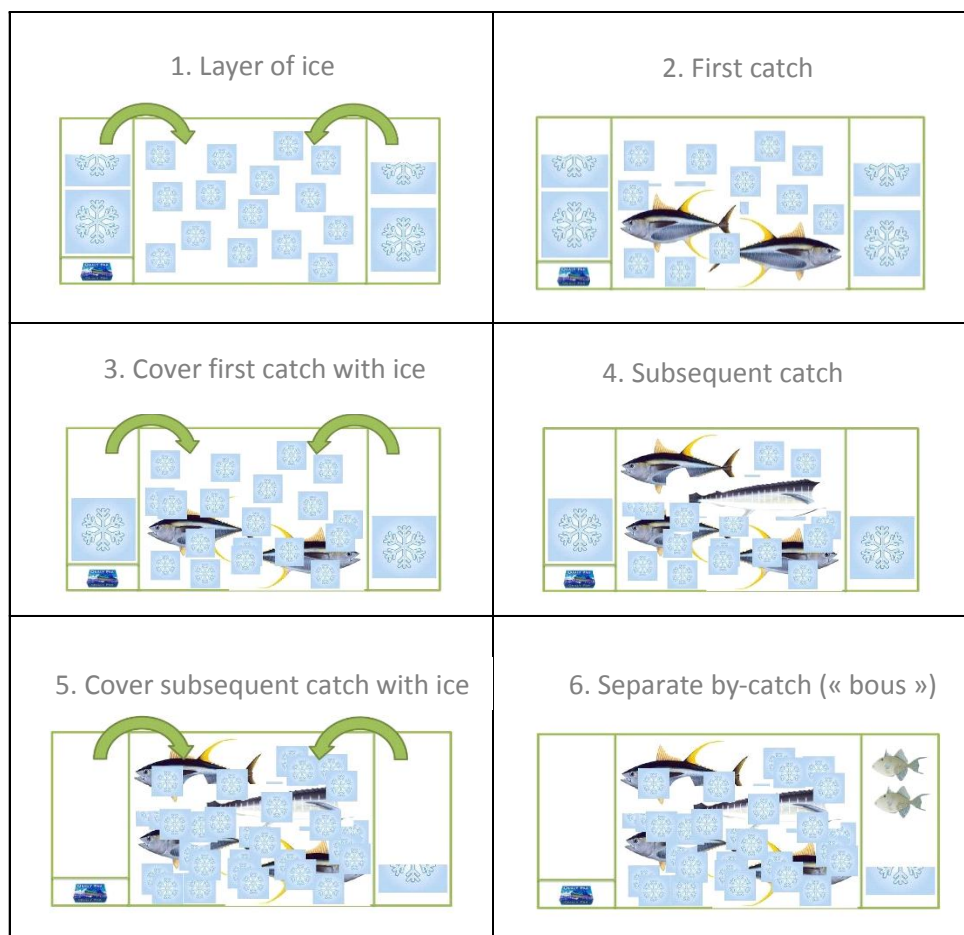


Figure 5: Example for proper icing of fish in a small vessel.¹⁷

3.1.3 Landing

Fish must be landed with care.

- **Do not** place fish directly on the ground (on the dock), as this is a source of bacterial contamination;
- Use plastic trays for medium-sized fish or trolleys for bigger fish when offloading the catch;
- Fish **must not** be washed with sea water at the dock/landing site; only potable water should be used for washing at this stage;
- Fish must not be thrown into container or boxes; this causes damage to the skin and flesh and accelerates deterioration.

Once landed, the catch must be quickly iced to a temperature between 0 and +2°C to avoid breaking the cold chain. If kept in a cold or chill room, make sure the catch is covered with flaked ice and the room temperature is between 0 and +4 degrees Celsius.

¹⁷ Clément Dromer, personal communication, 2015.

3.1.4 After fishing trip

- Remove any waste from the boat;
- Scrape the boat to remove fish blood and persistent waste;
- Clean the boat using a suitable food grade detergent; and
- Rinse and disinfect the boat, giving special attention to ice-box and tools. Use a solution of 10% bleach (1 cup of bleach and 9 cups of clean water) to disinfect.

3.2 Marketing/selling of fish

Fishery products may be sold in two ways:

- direct sales to consumers; and
- sale to an intermediary (restaurant owners, retailers/vendor).

If the fisherman must transport the fish to the dealer or retailer/vendor, he must ensure that the cold chain is maintained by using a refrigerated vehicle or cooler with ice and that the temperature is maintained as close as possible to that of melting ice. The fish should also be packaged under hygienic conditions.

3.2.1 Hygiene practices: sale of fresh fish

The Table 3 summarizes the main hygiene rules to be respected during the sale of fish.

Table 3: Key points of control during the sale of fish.

	Key points of control
Environment	Cold room Fish market Sale stall
Equipment	Worktable Cutting tools Weighing scale Ice machine
Materials	Fresh clean ice in sufficient quantities Packaging bag for sale
Techniques/methods	Cold chain Sensory evaluation Client service Cleaning and disinfection procedures Waste management Traceability
Operators	Personal Hygiene Health status Hand hygiene Training in hygiene

Environment

- The sale of fish must take place at a site that meets regulatory requirements for hygiene (usually near the landing port). See Figure 6 below.
- The site must have the following facilities and infrastructure:
 - A potable water source;
 - Walls and floors must be made of material that can be easily cleaned;
 - The stall ceiling must be placed high (more than 70 cm from the ground);
 - The sales stall must be protected from sunlight and dust;
 - The entire area be cleaned and disinfected before and after use; and
 - There must be proper waste disposal: waste must not be a source of pollution between the various stalls.

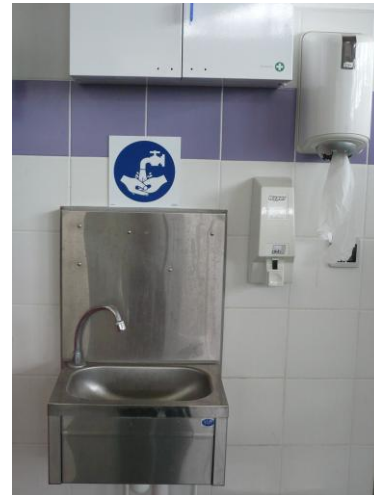


Figure 6: Facilities for processing fish & proper hand washing.¹⁸

Operator/manipulator

- The fisherman or vendor must wear **clean clothes** (at least a clean apron).
- **Hands hygiene**
 - A potable water source, preferably pedal (foot) operated, should be available at the sales space, with non-scented antiseptic soap and disposable (paper) hand towels (ideally dispensing of the hand towels should not be done manually, automation is preferred);
 - Hands must be disinfected regularly (at the start of the sale, after messy operations (scaling, gutting), before any sensitive operations (slicing, serving), after eating and after using the toilet;
 - The fisherman or vendor should have short, clean nails;
 - The fisherman or vendor should not wear jewelry on the hands or wrists; and
 - Injuries could be avoided by the use of waterproof dressing and gloves.

¹⁸ Source: PARM, Martinique, 2015

- **Health Status**
 - The fisherman's or vendor's health must be checked regularly through medical visits;
 - Persons handling fish must possess a medical certificate attesting to their suitable health condition for the handling of food.
- **Hygiene training**
 - The fisherman or vendor must be regularly informed or reminded of good hygiene practices;
 - Persons handling fish must possess a food handling certificate.



Figure 7: Fish vendor in proper attire (clean clothes).¹⁹

Equipment

- Equipment and facilities should be made of materials that can be effectively cleaned and disinfected:
 - Stall surfaces must be tiled or covered with steel, concrete or a coating that is suitable for food contact i.e. it must be smooth, durable and easy to clean and disinfect;
 - Knives with stainless steel blades and plastic handles;
 - Polyethylene cutting board;
 - Pipe borne water for rinsing fish and work surfaces;
 - Weighing scale;
 - Cold room (chill room) should be available for cold storage of fishery products and it should be equipped with storage hardware such as stainless steel shelves, hooks or pallets;
 - Ice Machine;
 - Preparation table must be so designed to hygienically remove processing waste.

¹⁹ **Source:** National Fisheries Marketing Limited, Kingstown, St. Vincent & the Grenadines, 2015.

- Small material should be stored in a clean, dry place, away from dust and in airtight plastic containers, for example.
 - Equipment must be cleaned and disinfected before and after use;
 - Facilities and equipment must be maintained in a good state of repair in order to protect them from alterations:
 - Cutting boards should be regularly planed to remove cracks, potential bacterial shelters.
 - Rusty knives should not be used.



Figure 8: Using of clean utensils (cutting board & knives) for cleaning and cutting fish.²⁰

Materials

Preservation of fish

- Fish stored in cold/chill storage must be kept in hygienic conditions and appropriate temperature between 0 and +2°C in ice;
- Fish must be kept in flaked ice for the duration of the sale;
- Ice flakes used for fish preservation must be clean and made from potable water.

Wrapping and packaging

- Bags used for the sale of fish should be suitable for food contact (indicated by a logo or on the technical packaging sheet);
- Bags should be stored in a clean, dry place specifically in airtight plastic containers;
- Old packaging boxes and supermarket bags should not be reused for packing fish.

²⁰ Source: PARM, Martinique, 2015.



Figure 9: Properly iced fish for sale

& improperly iced fish for sale.²¹

Techniques/methods

Cold Chain

- Fish should be presented for sale on a layer of ice and covered with ice (0 to +2°C);
- Flaked ice should be available in sufficient quantity to renew the ice layer (Figure 9).

Sensory Evaluation (See Section 2 on Quality and Hygiene).

Customer service

- Large pieces of fish should be pre-cut, bagged and preserved under ice;
- Slicing can be done at the customer's request;
- Customers should always be served with clean hands and utensils.

Waste Management

- Place should be furnished with garbage receptacles containing garbage bags with ties for collecting waste during operation;
- The waste of processed fish should be removed regularly and when taken to the trash can such waste should never cross products for sale;
- Clean material must be separated from dirty equipment;
- Filled garbage bags should be evacuated regularly during the sales period and if stored, must be secured from vermin; and
- Garbage receptacles must be washed and disinfected at the end of daily activity.

Cleaning disinfection

- The fisherman or vendor should have cleaning products that are suitable for use in a food environment;
- A detergent must be used to clean the equipment, utensils and work materials; and
- A disinfectant must be used to sanitize work areas and utensils/tools.

²¹ Source: National Fisheries Marketing Limited, Kingstown, St. Vincent & the Grenadines, 2015.

Traceability

- The fisherman or vendor must provide the following information at the point of sale:
 - Origin of the fish: the area where the fish was caught should be indicated on a sign near the product for sale;
 - The sale price;
- In case of sale to a professional (restaurant owner), the fisherman or vendor should issue an invoice with reference to the trade name of the product, method of production, the production area; and
- The fisherman should keep records of his catch, with information on the species caught, the corresponding weight, the area the fish was caught and other details that may be required by the national fisheries authority.

3.2.2 Hygiene practices in a processing establishment: sale of packaged fish

The shelf life of fish can be extended by vacuum packaging and modified atmosphere packaging.

- Vacuum packaging consists of placing the foodstuff in a sealed package, extracting the air contained in the package and sealing the latter. The removal of air surrounding the product reduces the amount of oxygen present in the package and thereby prevents certain bacteria (aerobic microorganisms) from growing and causing deterioration of the food.
- Modified atmosphere packaging consists of replacing the atmospheric air existing in a packaging by a specific gas mixture, thus extending the shelf life of the foodstuffs. Gases often used are nitrogen, oxygen, carbon dioxide. The mixing of the right proportions of these gases slows down the deterioration process.

These techniques extend the shelf life of foodstuff without using additives. Therefore, they add value to the products. Achieving these primary processing operations requires a specific qualification in a fishmonger's job and Good Manufacturing Practices (GMP) training.



Fish should be cut or filleted beforehand. Fish **should not** be handled or processed during rigor mortis. This is because the muscles shrink irreversibly if the fish does not remain in one piece during rigor mortis. Therefore, it is better to cut the fish when it is no longer in a state of rigor mortis (to check this, no trace remains on the flesh when it is subjected to light pressure).

Key Points (Table 4) to master the cutting and packaging should be presented in detail in another good practices guide.

Table 4: Key points of control during cutting and packaging of fresh fish.

	Key points control
Environment	Workroom at controlled temperature (room temperature +12°C) Smooth and washable floor and wall coverings Cold storage room
Equipment	Corrosion resistant and washable equipment Vacuum packaging machine, modified atmosphere packaging machine
Materials	Packaging trays
Techniques/methods	Cold chain – temperature control Cutting and packaging operations Waste management Cleaning and disinfection procedures
Processors	Fishmonger diploma Good manufacturing practices certificate (GMP) Personal hygiene Training in hygiene Hand washing

3.2.3 Advice to consumers

3.2.3.1 Composition and nutritional facts on fish

Fish flesh consists of 18 to 20 percent protein and is of the same biological value as meat, eggs and dairy products. They are essential for growth, renewal and restoration of tissues.

Unlike land animals, fish is less rich in lipids that can cause problems to health. On the contrary, its fats are beneficial to health (cardiovascular protection, fight against inflammation and depression).

A classification of fish based on the fat content of the flesh identifies two categories:

- ✓ Lean fish with lipid/fat levels below 1 percent
- ✓ Fatty fish with lipid/fat levels higher than 5 percent

Some pelagic fish belong to the category of lean fish: blackfin tuna, yellowfin tuna and blue marlin.

Consumption of fish also provides minerals including iodine, phosphorus, and vitamins A, D and B group in varying proportions depending on the species.

3.2.3.2 Hazards associated with the consumption of pelagic fish²²

The fisherman must know the dangers of fish consumption and must attract the consumer's attention to the most important hazards.

There are four main types of hazards (Tables 5 to 10):

- **Chemical**
- **Physical**
- **Biological**
- **Allergens**

²² Union of French fish trade (2010). Hygiene Good Practice Guide and HACCP implementation fish trading activities. 356p.

Chemical hazards

- Widespread environmental pollution has increasingly overshadowed the benefits of regular consumption of fish. These pollutants include heavy metals and persistent organic pollutants, e.g. dioxins and polychlorinated biphenyls (PCB).
- Bioaccumulation phenomenon results from the concentration of chemical contaminants in the flesh and organs of living organisms throughout the food chain, particularly those at the top of the food chain. Therefore, predators in the chain would have higher levels of chemical contaminants e.g. tunas and marlin.

Table 5: Potential chemical hazards in fish and their associated health risks.

	Origin	Human health impact	Preventive or remedial measures
Heavy metals (Mercury, lead, cadmium)	Environmental pollution: human and natural origins	<ul style="list-style-type: none"> - Affects nervous system - Builds up in body organs - Poisonous - Can cause cancers 	<ul style="list-style-type: none"> - No fishing in known polluted areas. - Pregnant women, breast feeding women, young children, fishermen family, persons with weak immune system, elderly persons should limit their fish intake.
Persistent organic pollutants Dioxins, furans, PCB	Industrial and agricultural activities	<ul style="list-style-type: none"> - Affects immune system - Can cause cancers 	

Biological hazards

Table 6: Health risks associated with parasitic worms in fish.

	Origin	Human health impact	Preventive or remedial measures
Parasites			
Nematodes Anisakis	Transmitted by fish, cephalopods, crustaceans, in the diets of wild fish	<ul style="list-style-type: none"> - Acute and chronic digestive disorders - Allergies can occur even if parasites are dead - Serious gastrointestinal lesions: Diarrhea, vomiting, weight loss 	Freezing fish (≥ 24 h at $\leq -20^{\circ}\text{C}$ to be eaten raw or partially cooked) Cooking (fish cooked) $60^{\circ}\text{C} - 1$ min core temperature
Cestodes			
Trematodes	Contamination endemic in some regions	Liver, lung, intestinal disorders, central nervous system diseases	Freezing ($\leq -20^{\circ}\text{C}$ for 7 days) or ($\leq -30^{\circ}\text{C}$ for 24 h)

Table 7: Health risk associated with toxin formed in some fish species.

	Origin	Human health impact	Preventive or remedial measures
Biological toxins			
Histamine (not destroyed by cooking)	Toxin produced in fish flesh after death Fish which may have high content of histamine are scombroid species (tuna, mackerel, marlin).	Allergic-type reactions such as rash, anaphylactic shock, etc.	<ul style="list-style-type: none"> - Post-Harvest treatment Bleeding Gutting - Rapid cooling of fish after capture

Table 8: Risks associated with bacterial contamination.

	Origin	Human health impact	Preventive or remedial measures
Pathogenic bacteria (disease causing)	<ul style="list-style-type: none"> - Aquatic environment - Human or earthly origin 	Various health problem caused by different type of bacteria	<ul style="list-style-type: none"> - Post-Harvest treatment - Capture: bleeding, gutting, washing, rapid cooling - Landing: Good hygiene practices - Undercooking
Spoilage bacteria	Natural environment	<ul style="list-style-type: none"> - No adverse health effect - Deterioration in fish quality 	Rapid cooling and gutting.

Physical hazards

- Any potentially harmful extraneous matter not normally found in food, e.g. glass, metal, wood, bones, stones and hard plastic.

Table 9: Potential physical hazards associated with bad handling practices.

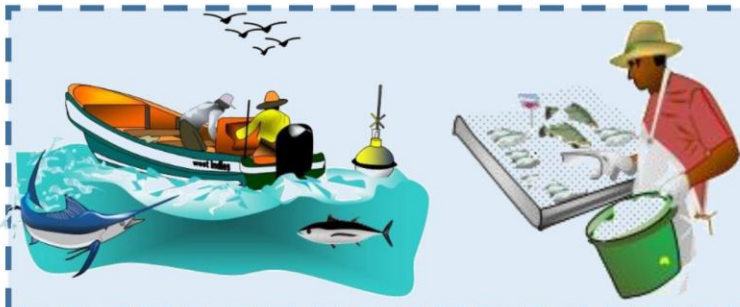
	Origin	Human health impact	Preventive or remedial measures
Cardboards, plastic residues	Various packaging	Injuries to mouth and throat	<ul style="list-style-type: none"> - Good Hygiene practices - Visual inspections
Hook	Fish		
Hair, jewels	Operators		
Metal parts	Defective tool/equipment		

Allergens

Table 10: Potential allergens associated with fish.

	Origin	Human health impact	Preventive or remedial measures
Fish flesh	Fish is a food allergen	Food allergies	Labelling
Secretion of anisakis larvae	Anisakis larvae potent allergens produced by the larvae to survive in the host	Allergic reactions of varying intensity which could range from hives to anaphylactic shock	These allergens are not destroyed by freezing and are destroyed partly by heat therefore, consumers should exercise caution.

MAINTAINING GOOD QUALITY OF FAD-CAUGHT FISH

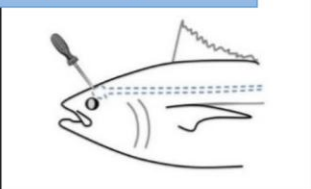


To ensure the safety and freshness of fish products, **respect for hygiene rules** is essential.
'Boat to Throat'

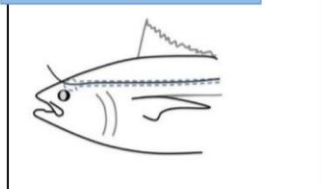
GOOD PRACTICES: The main steps to achieve the best quality...

ON BOARD

Spiking fish



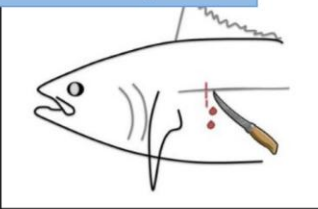
Pithing fish



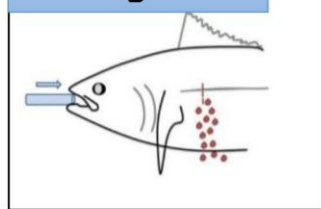
Prevention of muscle movement and **burned flesh syndrome**

Biological toxin of some pelagic fish

Bleeding



Rinsing



Prevention of **histamine** formation
Optimization of freshness
Preservation of freshness

Gutting and Washing

Slows down spoilage

Ice fish quickly after capture

- Use clean flake ice
- Cover fish entirely with ice



AT LANDING

Fish must be:

- landed **with care** (no throwing fish)
- and **quickly iced** to a temperature **between 0 and +2°C**.
If kept in a cold room, the catch is covered with flake ice



MARKETING AND SELLING

COLD CHAIN

- Fish are kept in flake ice for the duration of the sale

Between 0 and +2°C in ice

EQUIPMENT

- Cleaned and disinfected equipment and facilities

VENDOR

- Fisherman/Vendor wears clean clothes, apron, boots, hair cover
- Hands are cleaned & disinfected regularly
- Has a **Medical and food handler's certificate**

Personal hygiene



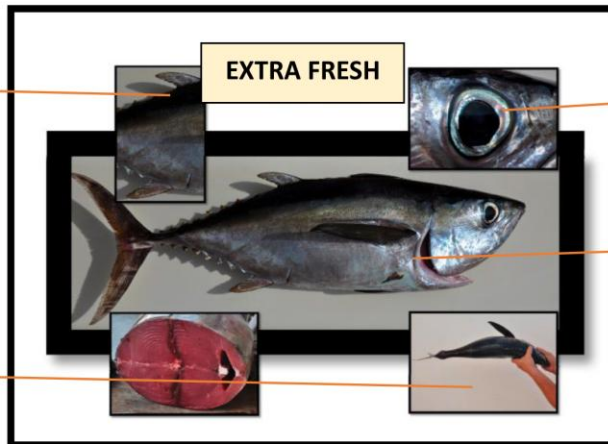
SENSORY EVALUATION

Sensory Evaluation of fish can give an appreciation of the **level of freshness** and whether or not the fish is **suitable for consumption**.



- Brilliant skin
- Regular scales
- Transparent mucus

- Firm and bright red flesh



EXTRA FRESH

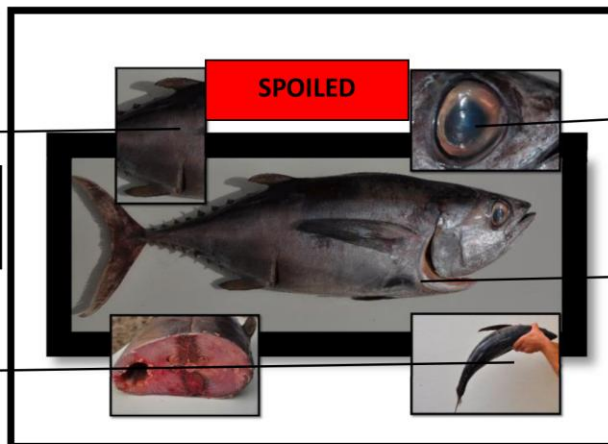
- Shiny black pupil
- Transparent cornea
- Convex form

- Bright red gills/ no mucus
- Neutral Odor /smell of seaweed



- Discolored grayish skin
- Detached scales
- Yellowish mucus

- Flabby and dull red flesh



SPOILED

- White, grey pupil
- Milky cornea
- Concave form

- Yellowish mucus
- Foul smell

The CRFM is an inter-governmental organization whose mission is to “Promote and facilitate the responsible utilization of the region’s fisheries and other aquatic resources for the economic and social benefits of the current and future population of the region”. The CRFM consists of three bodies – the Ministerial Council, the Caribbean Fisheries Forum and the CRFM Secretariat. CRFM members are Anguilla, Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago and the Turks and Caicos Islands.

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