

# Guidelines for risk-based fish inspection

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PAPER

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## Acronyms

AOAC	Association of Official Analytical Chemists
ASP	Amnesic shellfish poisoning
AZP	Azaspiracid
CAC	Codex Alimentarius Commission
CCRF	FAO Code of Conduct for Responsible Fisheries
CEN	European Committee for Standardisation
CODEX	Codex Alimentarius
DA	Domoic acid
DAP	Defect Action Plan
DDT	Dichloro-diphenyl-trichloroethane
DSP	Diarrhoetic shellfish poisoning
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FBT	Fish-borne trematodes
FDA	Food and Drug Administration (United States)
FIFO	First-in first-out
FIM	FAO Risk-based Food Inspection Manual
GAP	Good Aquaculture Practice
GHP	Good Hygienic Practice
GMP	Good Manufacturing Practice
H&G	Headed and gutted
HACCP	Hazard Analysis Critical Control Point
ISO	International Standards Organisation
JEFCA	Joint Expert Committee of Food Additives
LMG	Leucomalachite green
MID	Minimum infective dose
MPN	Most probable number
MRL	Maximum residue level
NSP	Neurotoxic shellfish poisoning
OA	Okadaic acid
PCB	Polychlorinated biphenyl
POP	Persistent organic pollutants
PSP	Paralytic shellfish poisoning
RFU	Responsible Fish Utilization

RTE	Ready to eat
SFP	Strengthening Fisheries Products
SPS	Sanitary and Phytosanitary
SSOP	Standard Sanitation Operating Procedures
STX	Saxitoxin
TCDD	Tetrachlorodibenzo-p-dioxin
TMA-N	Trimethylamine–nitrogen
TTX	Tetrodotoxin
TVB-N	Total volatile basic nitrogen
WHO	World Health Organization
WTO	World Trade Organization



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# **1. Introduction to the guidelines**

## **Background**

Fish and fishery products are nutritious and healthy and are an important source of food and livelihood for many millions of people worldwide. However, if such products are not handled and processed correctly the consumer may be at risk. The key food safety concerns in this context are food-borne illness as a result of contamination by pathogenic bacteria and viruses, and the presence of biogenic amines such as histamine and biotoxins. For example, in China, nearly 300 000 people contracted hepatitis A in 1988 after eating contaminated clams that had been harvested from an area polluted with sewage. This is the largest recorded incident of food poisoning to have occurred in the world (Huss et al., 2003). In 1997 several hundred cases of gastroenteritis occurred in several European countries associated with consumption of oysters. In 1999, nearly 200 people in Spain contracted hepatitis A after eating frozen clams from Peru (Seafood Plus/Eurofish, 2004).

Certain fish and shellfish can also contain high levels of industrial pollutants such as heavy metals and polychlorinated biphenyls (PCBs). Unapproved preservatives, veterinary drug residues and the use of agricultural pesticides to control insect infestation in some products are also of concern. According to Huss *et al.* (2004), the main causes of rejection or detention by fish inspection authorities of fish and fishery products imported into the European Union (EU) between 1999 and 2002 were the presence of chemical and drug residues, microbial contaminants, histamine and parasites.

The consequences of food-borne illness are felt at all levels: the well-being of the consumer is impaired; the business that supplied the product may be prosecuted and suffer financially from negative publicity; the reputation of the industry at large and international trade may be tarnished.

Since the 1980s the fish inspection systems of many developing countries have evolved to be based more on the food chain and on prevention of problems. This has often been a result of efforts to upgrade inspection systems and the activities of the private sector to meet the food safety requirements of major fish importing developed countries and the World Trade Organization Sanitary and Phytosanitary (WTO SPS) Agreement. The latter promotes the use of fair food safety control measures and a “risk assessment” approach to national food safety measures that is based on international standards, guidelines and other recommendations adopted by international organizations, such as those of the Codex Alimentarius. Policy guidance in relation to the importance of fish as food is also provided by the FAO Code of Conduct for Responsible Fisheries (CCRF) (FAO, 1995) which states that “*the harvesting, handling, processing and distribution of fish and fishery products should be carried out in a manner which will maintain the nutritional value, quality and safety of the products, reduce waste and minimize negative impacts on the environment*”.

Ababouch *et al* (2005) have amply demonstrated that there is still a high level of rejections from developing country products entering the major markets for fish products. Huss *et al.* (2004) had previously pointed out the need for further improvement of sanitary conditions throughout the fish food chain in many developing countries. Sanitary conditions in aquaculture can be improved by the implementation of Good Aquaculture Practices (GAP), and national food control systems are a key area where improvement is also needed Molins (2006).

### ***Scope of the guidelines***

The fisheries sector is in a constant state of flux, and changes occur in terms of knowledge and understanding of food safety issues as well as legislation and control approaches. Priorities, concerns, technology, research and equipment are constantly evolving and changing. As a consequence these guidelines are not designed to be definitive but to include sources of further information that the reader can consult, some of which will capture the important changes that are taking place within the sector.

Whilst these guidelines provide technical information to support fish inspection systems it must be recognized that, in reality, fish inspectors in many countries are faced with a range of constraints that go beyond the scope of this guide. For example, the financial resources required to implement an inspection system and to carry out food safety research and surveillance are often lacking, as are food safety analysis facilities and skills, as well as training support. Despite clear food safety concerns, in some countries fish and fishery products may be seen at the policy level as a low priority or risk, and as a consequence resources are diverted to the control of other foodstuffs. Furthermore, the fish inspection service itself may be understaffed, or the staff may not have the knowledge and skills required to carry out their duties effectively. Legislation may be lacking, as may adequate data on food-borne illness risk factors associated with fish products that can be used to inform the development of a risk-based inspection plan. The absence of monitoring programmes within inspection systems, for example to detect contaminants in the food supply chain, contributes to the lack of understanding of food safety issues and effective control of hazards. Controlling the safety of imports and exports may also be hampered by illegal and informal trade across border points where inspection facilities are lacking. Difficulties may also arise due to the different legislative requirements of different export markets.

In addition, the small-scale or artisanal sector presents a challenge in terms of adapting modern food safety approaches such as Hazard Analysis Critical Control Point (HACCP) systems and traceability to suit the needs and capabilities of what is often a large, unregulated informal fish processing and distribution sector. This sector, however, provides a livelihood for many poor and vulnerable people who may lack basic education skills and access to the information, services and inputs required to facilitate the production of safe fish and fishery products and to meet national legislative requirements.

### ***Objectives***

Fish inspection is concerned with ensuring that the consumer has access to safe and nutritious fish and fish products, whether the fish is from domestic sources of supply, imported or to be exported to consumers in another country. The main objectives of fish inspection are:

- to establish whether fish and fish products are being handled and produced hygienically;
- to establish whether fish and fish products are, or will be following further processing, safe to eat;
- to identify foreseeable incidents of food poisoning or injury as a consequence of consumption of fish and fish products.

According to Huss *et al.* (2003), food control includes all activities carried out to ensure the quality and safety of food. Every stage from initial production to processing, storage, marketing and consumption must be included in a food quality and safety (fish inspection) programme. The overall goal is to provide a systematic approach to all control and inspection

activities through a managed programme based on proper scientific principles and appropriate risk assessment, leading to careful targeting of inspection and control resources. Box 1.1 provides an overview of key elements of a modern preventive risk-based inspection system.

**Box 1.1. Fish safety and the food chain approach (Ababouch *et al.*, 2005).**

In fisheries, there are five broadly defined needs on which a strategy in support of a food chain approach to food safety should be based:

1. Fish safety and quality from a food chain perspective should incorporate the three fundamental components of **risk analysis** – *assessment, management and communication*.
2. Tracing techniques (*traceability*) from the primary producer (including animal feed and therapeutics used in aquaculture), through post-harvest treatment, processing and distribution to the consumer must be improved.
3. **Harmonization** of fish quality and safety standards is necessary, implying increased development and wider use of internationally agreed, scientifically based standards.
4. **Equivalence** in food safety systems – achieving similar levels of protection against fish-borne hazards and quality defects whatever means of control are used – must be further developed.
5. An increased emphasis is needed on “**risk avoidance or prevention at source**” within the whole food chain – *from farm or sea to table*.

The responsibility for the supply of fish that is safe, healthy and nutritious should be shared along the entire chain from primary production to consumption. Development and implementation of Good Aquaculture Practices (GAP), Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP) and Hazard Analysis Critical Control Point (HACCP) principles are required in all the food chain step(s). Government institutions should develop an enabling policy and a regulatory environment, organize the control services, train personnel, upgrade the control facilities and laboratories and develop national surveillance programmes for relevant hazards. The support institutions (academia, trade associations, private sector, etc.) should also train personnel involved in the food chain, conduct research on quality, safety and risk assessments and provide technical support to stakeholders. Finally, consumers and consumer advocacy groups have a counterbalancing role to ensure that safety and quality are not undermined by political considerations when drafting legislation or implementing safety and quality policies. They also have a major role in educating and informing the consumer about the major safety and quality issues.

The broad objectives of these guidelines are:

- to assist FAO developing country member states to strengthen, develop and apply risk-based and preventive fish inspection systems that will promote the right of all consumers to safe and nutritious fish and fishery products;
- to help both the public and private sector to move away from an end product testing-based inspection approach to a food chain risk-based preventive approach;
- to promote the harmonization of fish inspection systems nationally and internationally;
- to inform the development of fish inspection regulatory frameworks;
- to support implementation of key policy guidance such as the WTO SPS Agreement, Codex Alimentarius and the FAO CCRF–Responsible Fish Utilization (RFU) initiative.

### ***Target audience***

The guidelines are designed for use by public, private, civil society and academic organizations concerned with the food safety of fish and fisheries products that are working towards the introduction or development of risk-based preventive approaches. Typical users include fish inspectors, the staff of fisheries departments, environmental health departments, competent authorities and local authorities, and fisheries sector extension workers. Private sector operators such as fishers, aquaculturists, processors and traders, who are ultimately responsible for the production and marketing of safe products, could use these guidelines to raise their awareness of risk-based systems, their obligations and those of the fish inspector.

### ***Contents and use of the guidelines***

The guidelines are designed to complement the FAO risk-based food inspection manual published elsewhere, and consist of five main sections and annexes. Following this introduction Section 2 highlights important characteristics of fish as food, and food safety hazards, before discussing the risk-based approach to fish inspection. Section 3 describes elements of the fish inspection process. Section 4 highlights the knowledge and understanding required by fish inspectors in order to carry out their duties, and Section 5 provides sources of further information on the topics covered in these guidelines. Key references that provide more information on the topics covered in these guidelines and that are recommended further reading are listed at the end of the final chapter.

The modern day preventive fish inspection service oversees the safety of fish imports, fish exports and the supply of fish to the domestic consumer, and fish inspectors are authorized by law to implement fish quality and safety rules and legislation. Their responsibilities often include those listed below.

- Assessing the risks associated with different fish and fishery products.
- Inspecting facilities and health and hygiene practices associated with fish production, processing and marketing (e.g. fishing vessels, landing sites, vehicles, premises, aquaculture establishments, ice plants, cold stores, markets).
- Approving the operation of production and processing sites, activities and premises.
- Advising the private sector on best practice and corrective action when standards do not meet those required.
- Monitoring the implementation of corrective action.
- Developing codes of practice for the private sector to help uptake and application of best practice and compliance with food safety law.
- Designing and running training courses on best practice and new legislation.
- Monitoring health and hygiene conditions, including sampling and analysis of products, water and samples that demonstrate the hygiene of handling and processing facilities.
- Issuing licences and certificates to businesses showing compliance with food safety law.
- Ensuring that non-compliant products are rapidly withdrawn from the food chain and disposed of accordingly.

These guidelines will assist fish inspectors to carry out these responsibilities and are designed to be used in conjunction with the generic food inspection procedures described in the FAO *Risk-based Food Inspection Manual* (FIM). It should also be noted that there are other recent manuals, including Goulding and do Porto (2005), which can also contribute to equipping fish inspectors to undertake their work.

### ***References and recommended further reading***

**CAC.** 2005. *Code of practice for fish and fishery products*. CAC/RCP 52-2003 Rev. 2-2005. Codex Alimentarius Commission. Rome, Food and Agriculture Organization/World Health Organization. Draft; 98 pp.

**FDA.** 2001. *Fish and fisheries products hazards and controls guide*, 3rd edition. Washington, DC, United States Food & Drug Administration, Center for Food Safety & Applied Nutrition (available at: <http://www.cfsan.fda.gov/~comm/haccp4.html>).

**Huss, H.H., Ababouch, L. & Gram, L.** 2003. *Assessment and management of seafood safety and quality*. FAO Fisheries Technical Paper No. 444. Rome, FAO. 230 pp. (available at: <ftp://ftp.fao.org/docrep/fao/006/y4743e/y4743e00.pdf>).

**Goulding, I & do Porto, O.** 2005. *Strengthening fishery products health conditions in ACP/OCT countries. Manual/handbook for the execution of sanitary inspection of fish as raw material and fish-products as food for human consumption*. (available at: <http://www.sfp-acp.eu/EN/B15-Handbook.htm>)

## **2. Food safety and fish and fisheries products**

It is fundamental for fish inspectors to understand the food safety hazards associated with fish and fish products. Hazards can occur at different stages of the fish food chain and vary according to the species or type of fish or shellfish, the aquatic environment from which the animal came, and post-harvest handling and processing procedures. Without a knowledge of food safety hazards it will be impossible to develop and implement an effective preventive risk-based inspection system and for inspectors to carry out their roles and responsibilities properly.

This section of the guidelines complements the FAO risk-based food inspection manual's chapter on general inspection procedures by providing an introduction to fish as a food, important food safety hazards, how these arise and how they can be controlled. In doing so it draws attention to fish safety in the context of:

- cross-contamination;
- food from unsafe sources;
- inadequate cooking;
- improper holding temperatures;
- contaminated equipment;
- poor personal hygiene;
- food handlers' health status;
- water quality;
- presence of pests.

Various important generic control approaches are introduced, such as Good Hygienic Practice (GHP), Standard Sanitation Operating Procedures (SSOP), Good Aquaculture Practice (GAP), Hazard Analysis Critical Control Point (HACCP) and traceability, as well as specific technical approaches used to control particular food safety hazards.

Understanding the hazards associated with fish and fish products is a prerequisite to understanding the level of food safety risk associated with different activities and the stages in the fish food chain and its products. These aspects are discussed in Section 3 of the guidelines, which focuses on risk assessment and typical preventive fish inspection activities and issues.

Much of the information presented here has been summarized from FDA (2001), Huss *et al.* (2004) and CAC (2005), which should be consulted for further details.

### ***Fish as food***

Fish and the fish trade are important sources of both direct and indirect food security, employment and income. On a global scale, capture fisheries and aquaculture supplied approximately 101 million tonnes of fish for human consumption in 2002, the equivalent of 16.2 kg (live weight equivalent) per capita. While supplies from capture fisheries remained relatively stable between 1999 and 2002, production from aquaculture grew (FAO, 2004).

Fish has long been an important source of food and there are many thousands of different species of fish and shellfish found in seas, rivers and lakes, as well as farmed fish, that are consumed as food.

In general terms, fish and shellfish provide an important source of easily digested protein for many millions of people and for some are the main or only sources of affordable animal protein. Fish and shellfish are important because they contain essential amino acids and some fish species are good sources of polyunsaturated fatty acids, particularly omega 3, which is known to reduce the risk of cardiovascular disease and to help brain and nervous system development in the young. Fish is also an important source of vitamins A, B12, D and E and trace elements such as iodine and selenium. The fat content of fish and shellfish varies and can be as low as 0.1 percent or as high as 14.4 percent depending on species and the time of year or life cycle stage. Protein content similarly varies from 13 to 25 percent, and water content from 68 to 84 percent.

A nation's fisheries sector may supply fish for domestic consumption or export and many countries also import fish to satisfy local demand. Fish is the most important foreign exchange earner among all agriculture products traded by developing countries (Josupeit, 2003). The international trade in fish and fish products is predicted to grow with an expanding world economy, liberalization of food trade, growing consumer demand, developments in food science and technology, and improvements in transport and communication. The overall value of fish exports worldwide was US\$63 billion in 2003. Developing countries accounted for 48 percent of this (Kurien, 2005). The majority of exports are imported by developed countries, especially Japan, the EU and the United States, and in terms of international trade, the differences between importing countries' regulations, standards, the organization and function of inspection services, and the modus operandi of such services are among the most important practical difficulties of compliance faced by developing countries (Ababouch *et al.*, 2005).

It is estimated that there are about 38 million full-time and part-time workers employed in primary production in fisheries (fishing and aquaculture) globally, and 87 percent of these are in Asia (FAO, 2004). According to McGoodwin (2001) there are also estimated to be some 20 million people involved in small-scale processing, marketing and trading. If the fishers, the secondary workers and ancillary workers, and their families, are taken into account it is estimated that some 200 million people are supported by small-scale fisheries worldwide, of which at least 100 million depend on the post-harvest sector (McGoodwin, 2001). These include fishers, fish farmers, processors, traders and their staff and workers, such as transporters, fish carriers and porters, who are involved in handling and distributing fish and fishery products.

However, a key feature of raw fish and shellfish is that it is highly perishable and once harvested and dead will rapidly spoil and become inedible due to:

- autolysis caused by enzymes naturally occurring in the fish and shellfish, which leads to a breakdown of muscle and other tissues, producing "off" odours;
- the growth and action of bacteria present on and in fish, leading to muscle and tissue breakdown and "off" odours;
- rancidity of oils and fats.

As the chemical composition of fish flesh varies from species to species, and even within species according to season, maturity, fishing ground, feed, etc. the onset, importance and severity of these post-mortem changes will vary.

Fresh fish and shellfish after capture or harvesting are typically marketed in live form, or more commonly undergo some form of preparation, preservation and processing. The combination of a large variety of different species of fish and shellfish and a variety of different processing and preservation methods, which are often dependent on the prevailing climate, the available resources and different consumer preferences, has meant that there is an incredible variety of different fish and fish products marketed throughout the world. These include products that are consumed raw without cooking, such as sushi, ceviche and fresh live bivalve molluscs such as oysters. Products that are cooked before consumption include fresh fish, which may have been chilled using ice, frozen fish and shellfish, smoked fish, salted fish and dried fish. Fish and shellfish are also canned and processed into value-added products, some of which are ready to eat (RTE).

### ***Food-borne illness risk factors***

As with any food, fish and shellfish can pose food safety risks to the consumer, unless adequate controls are in place. Importantly, processing and preservation can be used to control some of the food-borne illness risk factors discussed in this section. Processing and preservation are also carried out to maintain product quality, create usable and desirable products, fully utilize the raw material and add value.

The fish inspector must be able to understand the food safety hazards associated with the particular fish and fish products they are working with and how these hazards are controlled. Once this understanding is in place the inspector will be better able to carry out both their advisory and their enforcement roles effectively. The information in this section will also contribute to the risk analysis process.

Important food safety hazards associated with fish and fish products are typically described as biological, chemical or physical agents in, or a condition of, fish and fish products, with the potential to cause adverse health effects in consumers that include:

- food poisoning, e.g. from pathogenic bacteria, viruses, natural toxins;
- chronic illness, e.g. from pesticides, other chemicals, heavy metals, parasites;
- cuts to mouth and internal injury, e.g. caused by glass, metal;
- choking e.g. caused by swallowing a foreign body.

Typically, fish and shellfish pose a health risk and become hazardous to the consumer because of contamination from the environment in which they grow and live, their inherent chemical composition, cross-contamination during handling and processing, inadequate processing, and poor storage, distribution and marketing practices. Box 2.1. presents an overview of the hazards associated with bivalve molluscs to illustrate some of the key issues that are discussed further later in this section.

### **Box 2.1. Food safety and bivalve molluscs.**

Bivalve mollusc species such as oysters, mussels, manilla and hard-shell clams can survive for extended periods out of water and can be traded for human consumption as live animals. Other species such as cockles can be traded live if carefully handled, but are usually processed.

There are five different types of important hazard that arise from the growing environment of bivalve molluscs:

- enteric bacterial pathogens
- enteric viral pathogens
- naturally occurring bacterial pathogens
- biotoxins
- chemical contaminants.

The main hazard identified in the production of bivalve molluscs is microbiological contamination of the waters in which they grow, especially when the bivalve molluscs are intended to be eaten raw. Because molluscs are filter feeders they concentrate contaminants to a much higher concentration than in the surrounding seawater. Contamination with bacteria and viruses in the growing area is therefore critical for the end product specification and determines the requirements for further processing. Gastroenteritis and other serious diseases such as hepatitis can occur as a result of agricultural run-off and/or sewage contamination containing enteric bacterial and/or viral pathogens (e.g. norovirus, hepatitis viruses) or from naturally occurring bacterial pathogens (e.g. *Vibrio* spp.).

Another hazard is represented by biotoxins. Biotoxins produced by some algae can cause various forms of serious poisoning, such as diarrhoeic shellfish poisoning (DSP), paralytic shellfish poisoning (PSP), neurotoxic shellfish poisoning (NSP), amnesic shellfish poisoning (ASP) and azaspiracid poisoning (AZP). Chemical substances, such as heavy metals, pesticides, organochlorides and petrochemical substances, may also constitute a hazard in certain areas.

To control such hazards, identification and monitoring of growing areas is very important for the safety of bivalve mollusc products. The identification, classification and monitoring of these waters is a responsibility for competent authorities in cooperation with fishers and primary producers. Measurement of faecal coliforms/*E. coli* or total coliforms may be used as an indicator of the possibility of faecal contamination. If biotoxins are found in the flesh of bivalve molluscs in hazardous amounts the growing area must be closed for harvesting bivalve molluscs until toxicological investigation has ensured that the bivalve mollusc meat is free from hazardous amounts of biotoxins. Harmful chemical substances should not be present in such amounts that the calculated dietary intake exceeds the permissible daily intake.

Bivalve molluscs from waters subject to microbiological contamination, as determined by the authority having jurisdiction, can be made safe by re-laying in a suitable area or using a prolonged depuration process to reduce the level of bacteria and viruses, or by processing to reduce or limit the density of target organisms. Depuration is a short-term process that is commonly used to reduce low levels of bacterial contamination, but long-term re-laying is required if there is a greater risk of contamination.

Especially when the bivalve molluscs need to undergo re-laying or depuration to be eaten raw, excessive shock and stress to the bivalve molluscs must be avoided. This is important

because these molluscs should be able to regain their function during depuration, re-laying or conditioning.

Summarized from: *Proposed Codex Alimentarius Commission Draft Code of Practice for Fish and Fishery Products*. Report of the 28<sup>th</sup> Session of the Codex Committee on Fish and Fish Products, Beijing, China 18–22 September 2006.

The Annexes of this document introduce some of the main biological, chemical and physical food safety hazards associated with fish and shellfish and how these are controlled. Further information can be found in Huss *et al.* (2003) and FDA (2001).

#### ***Water and its use in the “fish as food” chain***

Water is used at all stages of the fish distribution chain – to wash fish and equipment, to make ice, to glaze frozen products and in brines for salting. Consequently water is important but is also a potential source of contamination, especially microbiological contamination, and therefore must be potable, i.e. of a standard intended for human consumption.

For example, various references are made in the Codex to the use of ice for chilling fish and fish products, and general guidance is given as follows: “the water used for the manufacture of ice shall be of potable quality or shall be clean seawater. Standards for potable water shall not be less than those contained in the latest edition of the WHO *International Guidelines for Drinking Water Quality*.” Clean seawater is seawater that meets the same microbiological standards as potable water and is free from objectionable substances. Box 2.2. provides a summary of a GHP/GMP control procedure for water quality that could be adapted and used at the primary production, processing or marketing stages and also applied in ice production.

**Box 2.2. Water quality control (Huss *et al.*, 2003).**

Goal: Water that comes into contact with food or food contact surfaces or is used in the manufacturing of ice is from a safe and sanitary source or is treated to make it safe.

Criteria: Water that comes in contact with fish products must pass potability standards, for example to *E. coli*, enterococci, coliform 0/100 ml aerobic plate count (22 °C) 102 cfu/ml (guide level), residual free chlorine 0.2–0.5 mg/l in water distribution system, max 10 mg chlorine/l in water.

Monitoring: When a public water supply is used, the official records from the water works suffice. Water from own water supply: check for residual chlorine; daily check for microbiological contamination; a water sampling schedule must be worked out. Sampling must follow standard microbiological procedures. Responsible person is the quality assurance manager.

Corrective action: Actions to be taken when criteria are exceeded must be outlined, e.g. adjusting water treatment, cessation of production if water is contaminated, search for source of contamination.

Records: Records of all sampling, testing and actions must be kept for two years. Daily hygiene record form (chlorine).

Verification: Once every year, water samples are tested by a certified laboratory.

Microbial safety of water can be controlled by chlorination using sodium or sometimes calcium hypochlorite. The presence of free chlorine (hypochlorite ion) for an adequate contact time will kill pathogenic bacteria and their spores. A test for free chlorine can be used as a routine indicator of the microbial safety of water. Periodic microbial tests can be performed as confirmation of safety.

***The evolution of process-based fish inspection***

Standards and legislative requirements governing the quality of marketed fish and fish products have been in existence for many years. For example the Fishmongers of London are known to have been an organized community by AD 1272, when Wardens of the Mystery of Fishmongers were empowered by the king to oversee the selling of fish and to ensure that only “sound” fish were offered for sale.

In many countries concern regarding the safety of fish and fish products has been an aspect of fish quality control or fish quality assurance systems that aimed to ensure that the consumer received fish and fishery products of the correct quality, which were not adulterated, contained the right ingredients and were labelled correctly. These systems historically relied on the inspection and surveillance of the final products, which can be difficult to manage, costly to implement and cannot be relied upon to prevent food safety risks from occurring. This approach has now given way to a preventive “food chain” approach and Ababouch *et al.* (2005) state that as early as 1980 there was an international drive towards reforming fish inspection systems to move away from end-product sampling and inspection towards preventive process-focused Hazard Analysis Critical Control Point (HACCP)-based safety

and quality systems. (See Annex 2 for an overview of HACCP.) A further integral aspect of these systems is traceability (Box 2.3).

### **Box 2.3. Traceability.**

An important aspect of quality and safety assurance is to be able to trace products, ingredients, suppliers, retailers, processing operations or storage procedures through the food production chain. This is especially relevant when failures occur (Huss *et al.*, 2003). The European Committee for Standardisation (CEN) defines traceability as the “ability to trace the history, application or location of what is under consideration”. Traceability is an important aspect of HACCP and is an important approach to controlling the risk of biotoxins and pathogenic bacteria in live bivalve molluscs. For some fish processors and traders, applying a traceability system can be a legal requirement under food law. The entire reason for the existence of a traceability system comes into play when a food safety problem is identified and there is a need to withdraw or recall products from the market (Goulding & do Porto, 2005).

For example if a particular batch of smoked fish has caused an outbreak of listeriosis, authorities will want to trace the product in question to the producer to establish recall procedures. Similarly, the producer will want to determine if contamination with *L. monocytogenes* occurred as a result of their activities, e.g. due to temperature abuse, or whether the problem occurred during distribution or during storage at the retailer. One may regard an epidemiological investigation as part of a traceability study, e.g. determining the sources of an agent involved in an outbreak of food-borne disease. Traceability is also important for tracing fish from tropical reef waters (potentially containing marine toxins) or tracing fish from waters polluted with, for example, heavy metals. It is also used to monitor the time–temperature of products, e.g. fresh fish during distribution, as freshness is – for all species – almost exclusively a function of time and temperature (Huss *et al.*, 2003).

Traceability begins by capturing data on a catch or a harvested batch of fish or shellfish on a particular day, including the date and the fishing vessel details. For farmed fish it can be the farm, pond and day of harvest. Minimum data requirements are: name of supplier (fishing vessel or fish farm), date and time of receipt, divisions of/additions to the batch, name of consignee and date and time of despatch. Traceability systems cover not only the fish but also other raw materials that may be used in the preparation of products, such as the feed used in aquaculture. Traceability systems have been traditionally paper based, but increasingly involve information technology including bar-coding of final products.

As with HACCP, implementing and monitoring a traceability system in a situation where fish are caught by a large number of small-scale fishers, who may not be literate, poses many challenges.

Process-based quality assurance systems are now reflected in the food law and supporting rules and regulations of many countries that promote the control or prevention of food safety hazards occurring in the pre-harvest environment of the fish or shellfish, and through the stages of fishing, landing, handling, processing, packaging, storage, transport and marketing. The duties of the fish inspector will involve checking that GHP and, where appropriate, HACCP are applied and that regulatory standards are being met throughout the chain. This will normally involve site visits and audits and may necessitate taking samples and the organization and interpretation of the results of different tests at different stages of the “fish

as food” chain, according to recognized standards. How often various types of activity are undertaken will be determined by the food safety risks and the history of compliance of operators at a particular site.

The organization of the current fish inspection system in Kenya, which is influenced by EU Food Law, is not untypical of that of many countries and is summarized in Box 2.4.

**Box 2.4. Fish inspection in Kenya.**

The Ministry of Livestock and Fisheries, through its Fisheries Department, is in charge of auditing Kenyan fisheries and the safety and quality of Kenyan fish and fisheries products. The department operates under the Fish Quality Act, Cap. 378 of the Laws of Kenya and the Fisheries (Safety of Fish, Fishery Products and Fish Feed) Regulations, 2006. The department’s primary goal is to ensure compliance with national regulations that are fully equivalent to international regulations – notably those of the EU – and to certify the safety and quality of Kenyan fish exports. The safety and quality of the local fish supply is under the jurisdiction of the Ministry of Health, and local district and municipal councils.

The central government provides guidelines and regulations as well as training and infrastructure (e.g. landing sites) to the fisheries sector. The Fisheries Department’s 33 Inspectors and 20 Fisheries Assistants inspect fish and fish handling methods at the production, transport and factory levels. This includes the inspection of fishing vessels, landing sites and processing establishments, checking compliance with Hazard Analysis and Critical Control Point (HACCP) plans along the chain, monitoring the quality of fishing waters and certifying fish for export. The department takes samples for verification and has them examined for pesticide residues, microbial parameters, heavy metal contaminants and chemical freshness indicators.

The department is recognized by importers such as the EU, and its fish quality assurance programme has received equivalence to that of the EU. On a regional level, the Fisheries Department has collaborated with counterparts in Uganda and Tanzania since 1997 in the development of various East African Community fisheries standards with support from the Lake Victoria Regional Environmental Programme.

To a certain extent the evolution of the preventive food chain approach has been driven by the supply of fish for export, which has facilitated the upgrading of the associated production and supply system. There is now scope for attention to be paid to food safety and the supply of fish to the domestic market, where the conditions of facilities and products are vastly different from those involved in the export trade.

Summarized from: Molins, R. & Gitonga, N. 2006. *Assessment of capacity building needs of the food control system Republic of Kenya*. Project FNOP/INT/103/NOR B2 Objective 1: “Improved Food Safety and Quality at the National Level and along the Food Chain”. Rome, FAO.

***Risk-based fish inspection***

The management and control of the safety of fish and fishery products is carried out by several groups of people. It involves experts assessing the risk who provide the epidemiological, microbiological and technological data about the pathogenic agent, the food, the host, etc. It involves risk managers who at government level have to decide what level of

risk society will tolerate, and risk managers in both industry and government (e.g. fish inspectors) that have to implement procedures to control the risk (Huss *et al.*, 2003).

Due to the nature of these different food safety hazards and the different types of fish and fishery products, particularly the processing methods employed, certain fish and fishery products pose a greater risk, where risk is the severity of the food safety hazard e.g. the effect it can have on the consumer and the number of consumers affected, and the probability or likelihood that the hazard will occur.

Classification of risk is integral to the fish inspector's work. It can only be undertaken with a detailed knowledge of the hazards and associated health risks associated with the particular species and products for which the inspector is responsible. Box 2.5. outlines the risk analysis approach.

**Box 2.5. Risk analysis (Huss *et al.*, 2003).**

The term “risk analysis” encompasses the process underlying development of food safety standards (FAO/WHO, 1997). It consists of three separate but integrated parts, namely risk assessment, risk management and risk communication. The risk analysis process must be open and at every step all stakeholders should be allowed to participate and comment. It has been seen as important that there is a separation between risk management and the risk assessment (FAO/WHO, 1995). The risk assessment is a science-based evaluation, whereas risk management (at government level) also involves a range of societal issues.

The objective of the rules that govern international trade with food, the WTO/SPS1 Agreement, is to permit countries to set certain safety measures for their populations and to ask that imported foods give the same level of public health protection. To justify and compare the levels of public health protection and food safety measures, risks must be analysed using the risk assessment techniques described by the Codex (CAC, 1999).

Analysis of risk includes the following steps:

- identification of a food safety problem;
- assessment of the risk;
- establishment of a public health goal, e.g. expressed as a food safety objective;
- implementation of risk management decisions, e.g. GHP, HACCP, fish inspection procedures;
- establishment of performance criteria;
- establishment of process and product criteria;
- establishment of acceptance criteria;
- communication of risk.

***Fish and fishery product profiles and food safety risk***

The design and implementation of a fish inspection plan will reflect an assessment of the food safety risks at different stages, or associated with different activities, of the “fish as food” chain. This will mean that the resources available for inspection will be focused where they can have the most effect in terms of food safety and public health. The plan needs to be responsive to new food safety problems that may be identified by epidemiological data,

changes in processing methods or technologies, and in the characteristics of the human population.

The analysis of food safety hazards associated with fish and fishery products and the identification of critical control points (CCP) is discussed in detail in FDA (2001), Huss *et al.*, (2004) and CAC (2005). However, in general, high-risk products are those that are consumed raw without cooking, e.g. live bivalve molluscs. This is because such products do not undergo a processing step that would eradicate biological hazards. Bivalve molluscs are filter feeders, which means that they can concentrate material from the aquatic environment, including pathogenic bacteria, viruses and potentially toxic phytoplankton. In contrast, products that are cooked thoroughly before final consumption are seen as being of lower risk, as such products have a heat control step that will eradicate most biological food safety hazards, except biotoxins that are heat stable. Table 1 introduces different fish and fishery product types and indicates the potential level of associated food safety risk. The definition of the level of risk used is:

- **High:** *Significant potential to put at risk vulnerable groups (the elderly, infants, immunosuppressed people) or large numbers of consumers;*
- **Medium:** *Reduced potential to put vulnerable groups at risk, where the distribution may be limited or where the product is to be cooked before consumption;*
- **Low:** *Only a minimal potential to harm consumers.*

Judgements regarding risk are best made using scientific information on the severity and frequency of the hazard. Information on the extent and nature of the public health problems caused by the hazard and that obtained by sampling and testing of fish and fishery products entering the market can help inspectors to understand the risks posed by different products and practices. At the level of the fish processing establishment, the assessment of risk should also take into account the compliance record of the individual establishment. The following is adapted from Huss *et al.* (2004), to whom high-risk fish and fishery products are those that are associated with four or more of the following characteristics:

- do not involve any terminal heat treatment, except for raw fish, which is cooked thoroughly immediately before consumption;
- are associated with food-borne illness outbreaks or with serious food-borne illness, e.g. molluscan shellfish, products associated with histamine formation, biotoxins and botulism;
- production or processing does not include a CCP for at least one hazard, e.g. accumulation of biological hazards and presence of biotoxins;
- are subject to harmful contamination or recontamination, e.g. RTE products contaminated with pathogens due to poor GHP, raw fish, and processed products with unapproved chemical preservatives and pesticides;
- are subject to abusive handling, e.g. time–temperature abuse;
- growth or accumulation of hazards have been allowed to occur.

Inspectors may wish to use or adapt this list of criteria to help identify the levels of risk associated with products that are within their authority and guide the prioritization of primary production, processing and marketing facilities for inspection, taking into consideration

available resources. Table 2 provides a matrix to assist in this process, based on that used by Huss *et al.* (2003).

**Table 1. Product profiles and level of risk.**

Level of risk	Product
<p style="text-align: center;"><b>HIGH</b></p>  <p style="text-align: center;"><b>LOW</b></p>	Molluscs including fresh and frozen mussels, clams, oysters in shell or shucked. Often eaten with no additional cooking.
	Lightly preserved fish products (e.g. NaCl < 6% (w/w) in water phase, pH > 5). Includes salted, marinated, cold smoked and gravadlax fish. Eaten without cooking.
	Histamine and biotoxin producing species – fresh or frozen, eaten raw
	Heat-processed (pasteurized, cooked, hot smoked) fish products and crustaceans (including pre-cooked, breaded fillets, shrimp). Some products eaten without additional cooking.
	Heat processed (sterilized, packed in sealed containers). Often eaten with no additional cooking.
	Semi-preserved fish [e.g. NaCl > 6% (w/w) in water phase, pH < 5, preservatives (sorbate, benzoate, NO <sub>2</sub> ) may be added]. This group includes salted and/or marinated fish and caviar. Eaten without cooking.
	Dried, dry salted and smoked dried fish produced and stored without the use of unapproved chemicals. Usually eaten after cooking.
	Non-histamine producing fresh and frozen fish and crustaceans from marine sources eaten after cooking.

*Adapted from:* Huss, H.H. 1992. Development and use of the HACCP concept in fish processing. In H.H. Huss *et al.*, *Quality assurance in the fish industry*. Elsevier Science Publishers BV and Goulding, I. & do Porto, O. 2005. *Manual/handbook for the execution of sanitary inspection of fish as raw material and fish-products as food for human consumption. strengthening fishery products and health conditions in ACP/OCT countries.*

**Table 2. Risk Level Matrix for Fish and Fishery Products**

Fish/fishery product	Characteristics that increase risk				Events that are reasonably likely to occur and that will increase risk			Risk level
	No terminal heat application	Bad safety record	No CCP identified for a hazard	Harmful recontamination or contamination	Abusive handling – time-temp	Growth or accumulation of hazard		
Molluscan shellfish live and eaten raw	X	X	X	X	X	X	HIGH	
Fermented < 8% NaCl	X	X		X		X	HIGH	
Semi-preserved > 6%, pH < 5	X				X	X	MEDIUM	
Frozen freshwater fin fish					X	X	LOW	

An assessment of hazards and risk will determine the type of inspection or monitoring required, where it should be focused in terms of the activity as well as geographically, and the frequency with which it should be carried out.

For example risk categorization can be used to establish a number of operational parameters applied by the inspector:

- requirements for the design and layout of the establishment;
- frequency of formal approval required;
- frequency of interim and spot check inspections;
- certification required.

### **3. Fishery establishments and technical inspection guidance**

This section is designed to complement the standard food inspection procedures described in the chapters on general inspection approaches for primary production facilities and for food processing facilities in the FAO risk-based food inspection manual. It provides an overview of different primary production, processing and marketing facilities associated with fish and fishery products. This includes suggested generic checklists to guide inspection that can be adapted to suit different situations and locations. Additional checklists are provided in Annex 3. This section concludes with an example of how establishment type and product profile can be combined to guide the targeting of inspection resources.

### ***Fisheries hygiene inspection***

The implementation of fish inspection procedures or a fish inspection plan will reflect an assessment of the food safety risks at different stages, or associated with different activities, of the “fish as food” chain. Such an assessment determines the type of inspection or monitoring required, where it should be focused in terms of activities as well as geographically, and the frequency with which it should be carried out. A fish inspection plan ultimately includes staff work plans. However, in general terms fish hygiene inspection aims to:

- establish whether fish and fish products are being handled and produced hygienically;
- establish whether fish and fish products are or will be, having regard to further processing, safe to eat;
- identify foreseeable incidents of food poisoning or injury as a consequence of consumption of fish and fish products.

With this in mind, the main objectives of a fish hygiene inspection are listed below.

- To determine the scope of the primary and processing activities and of the relevant food safety legislation that applies to the operations taking place on board vessels, at landing sites, cold stores, ice plants, during transportation, and at processing facilities and markets.
- To gather and record information from observations and from discussions with fish handlers and proprietors.
- To identify potential hazards and their risks to public health.
- To assess the effectiveness of management controls to achieve safe fish and fish products.
- To identify contraventions of food safety legislation.
- To investigate and apply appropriate enforcement action (proportionate to risk) to secure compliance with food safety legal requirements.
- To provide advice and information to fish industry workers and management.
- To recommend practical good hygiene practices, in accordance with industry guidelines and sector-specific codes of practice.
- To continue to facilitate improvements in hygiene standards for fish and fish products.

Issues associated with the inspection of primary production, processing establishments and activities and fish markets are now described, followed by an overview of the parameters that are associated with monitoring hygiene conditions and the safety of fish and fish products. More information, including other checklists, can be found in Huss *et al.*, (2004), Goulding and do Porto (2005) and CAC (2005).

### ***Primary production***

Fish are caught by a wide range of different fishing methods in the open ocean, nearshore waters, estuaries, rivers, lakes and dams. They may be stored on board fishing vessels for several days before being landed. They may be iced or frozen at sea. Fish may also be landed within only a few hours of capture, which is typical of small-scale inshore and inland fisheries. In this case handling and processing can begin immediately the net or fishing gear is hauled from the water. Fish may be landed at large well-designed and serviced ports and harbours where ice, potable water and good marketing and transport facilities are available, or landed in remote, poorly serviced, small fish landings where the only option might be to supply the local market and process any excess supply to preserve it using rudimentary methods that rely on climatic conditions and locally available resources.

Aquaculture is increasingly used to produce fish and shellfish for human consumption. It relies on a supply of clean water free of chemical and biological hazards, and some systems require the use of supplementary feeds and veterinary drugs, which are also an issue of focus for the fish inspector.

Applying a risk-based preventive approach to fish inspection means the fish inspector has a responsibility to monitor and inspect facilities and activities associated with fish capture, harvesting and landing and ensure that standards are being met and risks of food-borne illness minimized. These activities are sometimes referred to as “upstream” activities as they occur at the beginning of the “fish as food” chain. They include small-scale or artisanal activities as well as more industrial or capital-intensive activities and facilities. Wholesale fish markets, cold stores, ice plants and onward transportation are also often a feature of large fish landings where processing activities may also be undertaken. More attention is given to these activities and associated equipment and infrastructure in the following sections on processing and markets. Some of the important primary production activities and facilities that should be considered within a fish inspection system therefore include:

- fishing methods;
- small fishing vessels;
- large fishing vessels (including freezers and factory vessels);
- aquaculture establishments e.g. fish and shellfish farms;
- fish landings/ports/harbours;
- transport vehicles and vessels e.g. boats.

While fishing gear, e.g. nets and traps, and harvesting methods tend to have more of an influence on the quality of fish, some fishing methods such as the use of poison to stun or kill fish do pose a potential food safety risk.

Handling begins as soon as the fish are hauled on board the fishing vessel. Such vessels include different types of canoe, which may be powered by paddles, or outboard or inboard engines, and are used by fishermen on inland waterways such lakes and rivers as well as inshore waters. Larger, often more mechanized, vessels are designed to operate particular types of fishing gear and include trawlers, purse seiners, long liners, pole and line vessels as well as factory ships. These larger vessels contain storage facilities for fish as well as ice. Processing activities may also be carried out on board in designated areas by the fishermen while the vessels are at sea, which may be for days, weeks or months in the case of factory ships.

Aquaculture is becoming more and more important as a source of fish and shellfish supply. It is practised in and uses inland waterways such as lakes and rivers, for example floating cage culture, or in artificial ponds. Small-scale pond culture is practised by households in many countries as a subsistence activity. It is also carried out in estuaries and in inshore marine waters to produce both fish and shellfish. Extensive systems of production rely more on the availability of natural food and low stocking densities of fish, whereas intensive systems involve the use of supplementary purpose-made food and high stocking densities. The latter may be practised in purpose-built ponds or tanks as well as using cages, and, owing to the nature of production, is more likely to involve the use of veterinary drugs. Both extensive and intensive aquaculture is practised for commercial purposes to supply fish and shellfish to the domestic or export market either directly as fresh products or for further processing. More commercialized aquaculture operations will have facilities in which food is stored and where harvested fish are graded, weighed, packed and stored before onward distribution. Shellfish farms may also have onshore grading facilities, holding tanks, and depuration systems in the case of molluscan shellfish.

Fishers normally bring their catch back to shore and discharge it at landing centres, harbours or ports. The type of landing facility is often determined by the type of fishing vessel, number of vessels, location and level of investment. Landing centres should be designed to facilitate good handling and hygiene practices. Fish are usually sold at point of landing and so market facilities may also be present, as well as storage facilities. Services such as fuel supply, engine maintenance, water supply, ice making facilities and loading areas for transport may also be available.

Once landed by fishing vessels or harvested from ponds or cages, fish and shellfish are usually transported from the landing facilities to either markets or processing facilities. Transportation may be by mechanized vehicle, boat, motorcycle or bicycle. Some vehicles are specifically designed to carry live fish and shellfish; some may have refrigerated systems to keep the product chilled. Pick-ups and other open-backed vehicles are often used to transport fish. Motorized boats are also used to collect and transport fish from remote landings. Motorcycles and bicycles are used by traders in some areas to sell fish door to door.

The prevention of food-borne illness risk factors associated with primary production usually relies on the good design of facilities and equipment and the application of GHP and, in the case of aquaculture, Good Aquaculture Practice (GAP), which is summarized in the Annexes.

The generic checklist in Box 3.1 draws attention to key aspects of primary production facilities and activities and is designed to be adapted to suit different facilities and locations. It has been influenced by the work of the SFP, EU support for the development of a fish inspection system in Cambodia and the Government of Uganda's *Manual of standard operating procedures for fish inspection and quality assurance*. Further information can be found in Huss *et al.* (2003) and CAC (2005). Further checklists to guide the inspection and/or design of aquaculture facilities and small-scale fishing boats are given in the Annexes. These also provide examples of the format of inspection checklists and how the level of compliance with checklist issues can be recorded so that corrective action, if required, can be easily identified.

**Box 3.1. Primary production: Checklist for requirements of the landing site layout including jetty design and construction.**

- The design and size of landing site or vessel should provide adequate working space to allow hygienic performance of all operations including unloading, handling, marketing, processing, storage and transport and to facilitate the maintenance of quality of fish and fish products.
- The layout of landing site or vessel protects against the accumulation of dirt and water.
- The layout of landing site or vessel permits adequate cleaning and disinfection.
- Landing site fenced with lockable system to keep out animals, rodents and other pests.
- Landing site or vessel maintained in good repair and condition.
- Floor allows easy drainage of water.
- Sufficient lighting whenever necessary.

**Box 3.2. Primary production: Checklist for equipment and contact surfaces.**

- Equipment, containers and utensils that come into contact with fish at sea and on the shore are easy to clean and disinfect and are kept clean.
- Design of equipment, containers and utensils that come into contact with fish prevent build up of dirt, and facilitate GHP and good icing practice.

**Box 3.3. Primary production: Checklist for hygiene control programme.**

- Personnel assigned to do cleaning work.
- Facilities and equipment at sea and on shore are cleaned and disinfected at least immediately after using.
- Decks not contaminated with fuel, bilge water or other contaminants.

**Box 3.4. Primary production: Checklist for provisions related to the hygienic handling of fish products.**

- Parts of the premises at the landing site that are set aside for the storage of fishery products are kept clean, maintained in good repair and condition, and free from fuel or bilge water contamination.
- Fishery products are protected from contamination and from effects of weather conditions (sun, rain) as soon as possible after unloading from fishing vessels.
- Good icing practice used on board fishing vessels and on shore after landing.
- Fishery products chilled or re-iced as soon as possible after unloading from fishing vessels and time–temperature conditions facilitate maintenance of quality.
- Live fish and shellfish properly transported and handled.

**Box 3.5. Primary production: Checklist for supply of water and ice.**

- Available potable water in sufficient volume and with sufficient pressure.
- Use of potable water or clean seawater whenever fish are handled at sea or on shore.
- Ice produced from potable water.
- Ice stored in clean and well maintained containers designated for this purpose.
- Sufficient ice available for use before and after landing.
- Safety of ice monitored.

**Box 3.6. Primary production: Checklist for waste management.**

- Containers available for solid waste.
- Adequate drainage system: the discharge does not contaminate the water intake system

**Box 3.7. Primary production: Checklist for personal hygiene and health.**

- Facilities available for hand washing in sufficient numbers.
- Signs reading “no smoking, spitting, eating or drinking” at landing site.
- Adequate number of flush lavatories/toilets connected to an effective drainage system for large fishing vessels and landing facilities.

**Box 3.8. Primary production: Checklist for requirements before, during and after landing.**

- Unloading equipment easy to clean, and kept in a good state of repair and cleanliness.
- Precautions observed to avoid contamination of fish during and after landing.
- No delays in unloading.
- The equipment used does not cause any damage to the fish.
- Vehicle exhaust fumes do not contaminate the fish during unloading and while on the landing site.
- If live fish are transported in cages or in semi-submerged vessels in rivers there is a risk of contamination from chemicals, effluent and other pollutants.

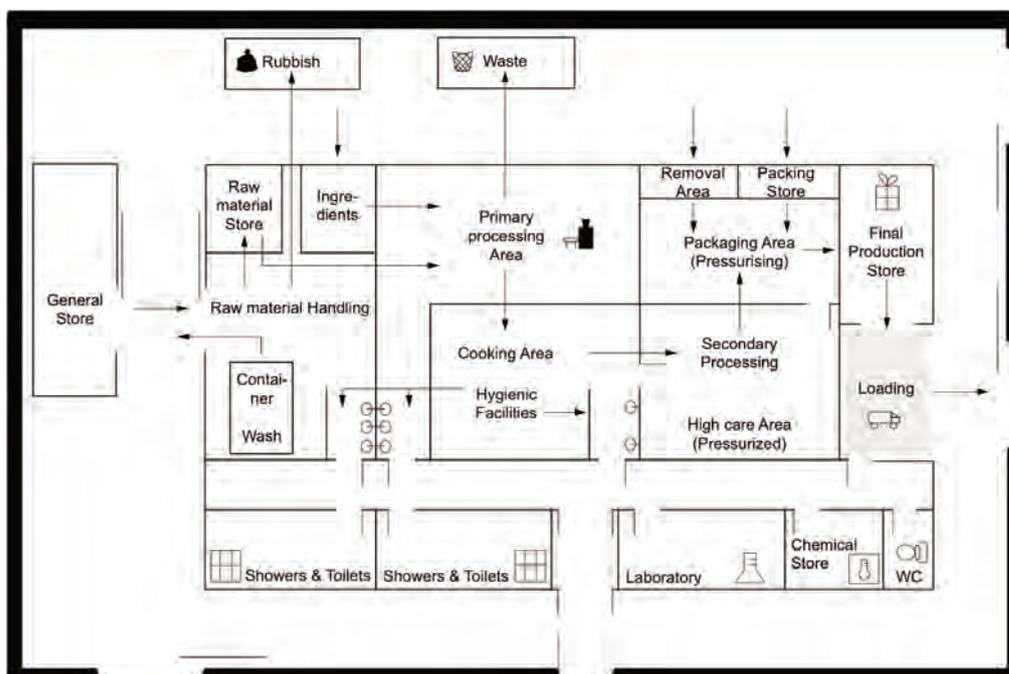
***Processing facilities and activities***

Fish and shellfish may be sold directly at point of landing or harvest for final consumption as fresh produce. They may alternatively be processed using a variety of different methods that may be applied at different stages of the food chain. For example some fish may be eviscerated and iced at point of landing for transport to another processing facility, where it may be filleted, packaged, frozen and stored ready for distribution to the domestic or export market. Such processing operations will often require high capital investment and implement sophisticated GHP programmes as well as HACCP to control food safety risks.

Particularly in small-scale artisanal fisheries, fish may be processed at the point of landing by simple low-cost techniques that rely on climatic conditions and available resources, e.g. salting and drying or smoke drying. These products are often stored without sophisticated packaging and storage facilities and are destined for domestic and regional markets. Such products are often an important source of cheap protein for consumers. Food safety concerns associated with such products include the potential use of chemicals such as agricultural pesticides to control insect infestation during processing and storage.

The fish inspector may therefore encounter a variety of different types of processing operation with different degrees of sophistication and involving stakeholders with differing levels of food safety knowledge and understanding. Figure 1 provides a basic GMP layout for a typical fresh fish or shellfish processing factory.

**Figure 1. Model layout of basic fresh fish processing establishment.**



Source: Huss *et al.* (2004)

Applying a risk-based preventive approach to fish inspection means that the fish inspector has a responsibility to approve, monitor and inspect processing facilities and activities and to ensure that standards are being met and risks of food-borne illness minimized. The following are examples of some of the different types of processing facility or activity that should be considered within a fish inspection system:

- fresh and frozen fish and shellfish processing plants;
- canneries;
- ice plants;
- cold stores;
- traditional processing activities e.g. salting, drying, fermenting, smoking, frying.

If not sold into the fresh fish distribution chain, fish and shellfish are processed into a variety of different fresh, chilled, frozen and value-added products for domestic and export markets. This is done by fish processors working in facilities and with equipment designed for the purpose. Such processing facilities may be small scale, specializing in only a few products and employing only a few staff, or can be large-scale labour intensive operations producing a variety of different products and relying on a range of different raw materials. Smokeries are an example of how fresh fish processing facilities are combined with specific equipment and processes to smoke the fish hot or cold, and then pack and store the final product.

Certain types of fish and shellfish such as tuna, sardines, mackerel, salmon and crab are canned in specialized processing plants. These plants include fresh fish handling and preparation facilities as well as equipment for heat treating the product. Canned products are stored to await onward distribution.

Good quality ice, used effectively, will enhance the distribution and marketing of fresh fish. Two common types of ice production facility are block ice producing plants and flake ice producing plants. Block ice is made in different sizes and shapes and a single block can weigh from 12 to 150 kg. It is popular in many tropical countries as it melts slowly and can be easily transported. To be used effectively, block ice must be crushed or broken into small pieces, ideally using specific crushing equipment. Block ice plants take up a lot of space and tend to produce ice slowly (12 to 24 hrs), but are easy to operate and maintain. Flake ice is produced by spraying water on to the surface of a refrigerated drum. The frozen ice sheet is then scraped off to form dry, sub-cooled flakes. Flake ice can be produced quickly but it melts quickly in the tropics. A key issue regarding ice is that it must be produced using potable water and once produced should be handled in such a way that it will not contaminate the fish or shellfish.

In some locations and in processing facilities, frozen fish and fish products and sometimes iced fish are stored for periods of time in cold stores. These are often found in strategic locations such as fish landings and in urban centres and are used to balance out fluctuations in supply and demand. Designated fish processing facilities may include cold storage.

In some locations processing is carried out using traditional methods, sometimes involving the use of basic low-cost equipment and facilities. Typical processes are salting and drying, hot smoking, boiling, fermentation and frying in oil. These methods are often used primarily as a means of preserving products so that they can be easily stored and marketed without the need for sophisticated equipment and facilities.

The following generic checklist draws attention to key aspects of processing facilities and activities. It has been influenced by the work of the SFP, EU support for the development of a fish inspection system in Cambodia and the Government of Uganda's *Manual of standard operating procedures for fish inspection and quality assurance*. For more detailed understanding of GHP and GMP in terms of processing facilities see Huss *et al.* (2004).

**Box 3.9. Fish processing facilities: Inspection checklist for external environment.**

- No source of potential contamination close to the processing plant.
- The boundary of the premises is clearly demarcated.
- The ground surrounding the processing facilities is kept clean.

**Box 3.10. Fish processing facilities: Inspection checklist for layout, design and construction of premises.**

- Sufficient area/space to carry out the work under sanitary and hygienic conditions.
- Facility layout designed to minimize cross-contamination.
- Clean areas are separated from dirty areas.
- Convenient for cleaning and maintenance.
- Provide suitable temperature-controlled handling and storage conditions of sufficient capacity to maintain fishery products at appropriate temperatures.
- Infrastructure in the areas where fish is received, handled, processed and stored includes chill rooms, ice rooms and cold stores.

#### Floors

- Made of materials that are easy to clean and disinfect.
- Constructed in such a way that water drains easily (waterproof, smooth, flat but with sufficient slope).
- Grooved junctions between floor and walls.
- Maintained properly.

#### Walls

- Smooth, easy to clean and disinfect surfaces.
- Durable and waterproof surfaces.
- Use of non-toxic light-coloured paint.
- Surfaces maintained properly.

#### Ceilings

- Tight, smooth and easy to clean.
- Maintained properly.

#### Windows

- Constructed in such a way that they are easy to clean.
- Windowsills made with a slope.
- Windows that can be opened to outside environment fitted with an insect-proof, removable screen.

#### Doors

- Made of durable materials.
- Easy to clean.
- Well closing and waterproof.
- Door ribs constructed with a slope.
- Maintained properly.

#### Lighting

- Sufficient lighting in the area where fish is handled.
- Lights protected to prevent possible contamination of food by broken glass.
- Lights are easy to clean.
- Lights are maintained properly.

#### Ventilation

- Adequate ventilation inside processing areas (no condensation is visible on walls and ceilings).
- No bad odour in processing areas.
- Good extraction of moisture facilitated.

#### Cold storage compartments

- Equipped with an easy to check temperature-recording device (automatic recording thermometer).
- Thermometer-sensor installed in proper place.
- Adequate cleaning and storage methods.
- Capacity sufficient to keep fish at appropriate temperature (at or below -18 °C).

#### Storage facilities

- Raw materials, finished products, and non-food items (e.g. packing materials, chemicals) stored in separate rooms.
- Proper methods of storage (FIFO, enough space, pallets, clean and tidy storage areas, etc.).

### **Box 3.11. Fish processing facilities: Inspection checklist for contact surfaces and equipment requirements.**

#### Contact surfaces

- Constructed of light-coloured, smooth, non-absorbent and non-toxic materials for easy cleaning and disinfection.
- In sound condition, durable and easy to maintain.
- Structures and joints of smooth construction and tight for easy cleaning.

#### Containers

- Containers protect fish from contamination.
- Containers allow for easy drainage of water.

#### Equipment and utensils

- Designed in such a way as to prevent contamination of the products.
- Designed for easy cleaning and to prevent accumulation of dirt.
- Installed so that it can be accessed from all sides for cleaning and servicing (properly sealed to the floor if permanently sited).
- Kept in good order, repair and condition so as to minimize any risk of contamination.

#### Facilities for live fish

- Enable good survival rates.
- Water of appropriate quality available in proper quantity.

#### Specific requirements for canning plants

- Retorting equipment approved and calibrated.
- Thermal process verification provided.
- Double seam control performed.

#### Specific requirements for smoking facilities

- Separated smoking area.
- Adequate ventilation.

#### Specific requirements for fish salting facilities

- Salting area separated from other sections or lines.
- Salting bins or piles to avoid inconvenient drainage.

#### Freezing and cold storage

- Sufficient capacity of freezing equipment to lower temperature rapidly to achieve a core temperature of not more than -18 °C.
- Cold store refrigeration capacity sufficient to keep fish temperature at or below -18 °C (-9 °C if in brine).

- Cold stores equipped with a temperature recording device that is easy to consult.
- Thermal sensitive part of the thermometer placed in the warmest area of the cold store.
- Ready-to-eat products that are not yet tightly packaged should not be frozen with other types of product.
- Proper glazing methods.

**Box 3.12. Fish processing facilities: Inspection checklist for transportation.**

- Vehicles used for transporting processed products designed and constructed from suitable corrosion-resistant materials with smooth and non-absorbent surfaces.
- Appropriate equipment available for cleaning and disinfecting vehicles.
- Cleaning and disinfection carried out in a separate but approved structure.
- Vehicles kept clean and maintained in good repair and condition to protect products from contamination.
- Refrigerated transport maintained at suitable temperatures.
- Live fish transported by suitable means at temperature appropriate for species.

**Box 3.13. Fish processing facilities: Inspection checklist for GMP and GHP.**

Handling fresh fish

- Products that are not immediately processed are iced or refrigerated.
- Iced products are re-iced regularly.
- Pre-packed products are iced or refrigerated.
- Gutting and heading performed hygienically.
- Gutted or headed fish are immediately washed with potable water.
- Filleting and cutting is carried out in a different place from where fish is gutted and headed.
- No delays in processing fillets or steaks.
- Fillets and steaks are rapidly refrigerated.
- Viscera and other undesirable parts of the fish are quickly separated from the product.

Parasites

- Fish are checked visually for parasites.
- Fish or fish parts that are heavily infested are removed from distribution.
- Control of parasites is carried out according to Decision 93/140/EEC.
- Fish to be consumed raw or cold smoked ( $T < 60\text{ }^{\circ}\text{C}$ ) is subject to a freezing treatment ( $T < -20\text{ }^{\circ}\text{C}$ ) for at least 24 hours.
- The processor must verify that this freezing treatment is applied.
- Declaration visible that identifies products that have been frozen because of parasites or from which the parasites have been removed.

Thawing and thawed products

- Thawing is carried out hygienically.
- No risk of contamination during thawing.
- Melting water is drained properly.
- Temperature of the frozen products is appropriate.
- Thawed products destined to be sold are well labelled.

#### Other treatments

- Pathogens control by authorized treatments (for cooked shrimp or bivalves). Effective control of critical parameters.
- Approved thermal treatments, documented/validated.
- Critical parameters controlled (pH, Aw, etc.).
- Records available for at least the product validity.
- No unauthorized chemicals used to control quality of products before, during or after processing.

#### Canned products

- Retorting parameters validated and controlled.
- Cans or pouches cooled under controlled conditions.
- Incubation tests (37–35 °C) for each lot.
- Regular microbiological verification tests.
- Double seam verification.
- Can or pouch integrity controls.
- Adapted lots unification (equivalent conditions) under Directive 89/396.

#### Salted fish production

- Controlled salt quality, properly stored.
- Salt not recycled, used only once.
- Salting bins or tanks washed and disinfected before use.

#### Smoked fish

- Smoke-producing materials properly stored separately from products.
- Smoke not toxic or dangerous.
- Wood used to produce smoke not painted, glued or otherwise treated.
- Smoked product quickly cooled to packing temperature, before packing.
- Proper storage facility.

#### Cooked crustaceans and molluscs

- Cooking followed by efficient cooling down to melting ice temperature.
- Only potable or clean seawater used for cooling.
- Shelling operations done hygienically.
- Cooked products to be frozen are quickly frozen (or chilled).
- Cooked products properly treated in clean controlled areas.
- Microbiological verification tests done regularly.

#### Minced fish

- Free of offal raw material.
- Mechanical processing done with no delay after filleting.
- Headed and gutted fish washed before flesh extraction.
- Extraction machines washed at least every 2 hours.
- Extracted flesh immediately frozen or treated.

**Box 3.14. Fish processing facilities: Inspection checklist for traceability and product recall system.**

- Origin and specifications of raw material supplied.
- Composition, packaging, distribution, validity, storage conditions notified.
- Lot identification code providing suitable traceability.

**Box 3.15. Fish processing facilities: Inspection checklist for supply of water, ice and steam.**

- Water available as necessary, distribution diagram available.
- Automatic treatment system adapted and operational.
- Monitoring of residual chlorine content, if added.
- Surveillance of contamination indicators in place. Sampling plan adequate and systematically followed.

Water

- Adequate supply of potable water with sufficient pressure and volume.
- Clear distinctions between potable and non-potable water pipes.
- Water quality monitored regularly.

Ice

- Ice is produced from potable water/clean water.
- Ice stored in clean and well maintained containers designated for this purpose.
- Safety of ice monitored.

Steam

- Steam in contact with fish and shellfish made from potable water.
- Steam available at sufficient pressure.

**Box 3.16. Fish processing facilities: Inspection checklist for staff facilities.**

- Adequate changing facilities with separate changing rooms for men and women in different processing areas.
- Sufficient flush toilets that are connected to an effective drainage system.
- Lavatories located away from production, packing and storage areas.
- Adequate number of washbasins for cleaning hands provided with running water and non-hand-operated water taps, and materials for cleaning hands and for hygienic drying.
- Staff facilities properly maintained and kept clean.

**Box 3.17. Fish processing facilities: Inspection checklist for hygiene control programme.**

- Appropriate cleaning and disinfection plan implemented by trained workers.
- Persons who use physical, chemical and biological means for cleaning and disinfection properly trained.

**Box 3.18. Fish processing facilities: Inspection checklist for waste management.**

- Offal and other waste regularly removed from production areas, so that no accumulation occurs.
- Sufficient closable containers for offal and other waste, clearly identified and made of easy to clean and impervious materials with suitable structure.
- Adequate provision made for the storage and disposal of food waste and waste materials.
- Waste stores designed and managed in such a way as to enable easy cleaning, and to prevent ingress of animals and other pests.
- Drainage channels designed to ensure that waste does not flow from a contaminated area towards or into a clean area.
- All waste eliminated in a hygienic and environmentally friendly way, and not constituting a direct or indirect source of contamination.

**Box 3.19. Fish processing facilities: Inspection checklist for pest control systems.**

- Good hygienic practices employed throughout to avoid pest infestation.
- Pest control programme available that prevents access, eliminates harbourage and infestation, and establishes monitoring, detection and eradication systems.
- Physical, chemical and biological agents for pest control are properly applied by qualified personnel.
- Rodenticides, insecticides, disinfectants and any other toxic substances stored in premises or cupboards that can be locked.
- Toxic products cannot contaminate the fish products.

**Box 3.20. Fish processing facilities: Inspection checklist for raw materials and semi-processed products.**

- Procedures available that prevent acceptance of raw materials and ingredients that would make the final product unfit for human consumption.
- The cold chain continuously maintained during processing and transport.
- Use of good icing practice.
- Melt water does not remain in contact with the products when containers are used for the dispatch or storage of unpackaged prepared fresh fishery products stored in ice.

**Box 3.21. Fish processing facilities: Inspection checklist for personal hygiene and health.**

- Persons working in a fish handling area maintain a high degree of personal hygiene.
- All people entering the area where fish is handled are provided with suitable, clean and protective clothing (uniform, aprons, rubber boots, gloves, hairnet).
- Protective clothing cleaned by the company.
- Medical examination periodically carried out on workers handling fish.
- Workers who could contaminate the products excluded from handling fish and fishery products.
- Workers handling fish wash and disinfect their hands each time before resuming work.
- Workers keep their fingernails short, clean and unvarnished.
- Any wounds covered with waterproof bandages.

- Smoking, spitting and eating are prohibited in production, packaging and storage areas, and workers follow these rules.
- Workers trained in and follow the hygiene instructions.
- First aid assistance or first aid cabinet available.
- Medical personnel available when factory is working.

**Box 3.22. Fish processing facilities: Inspection checklist for wrapping and packaging of foodstuffs.**

- Suitable material used for wrapping and packaging of food products.
- Materials used for wrapping and packaging stored and managed in a hygienic way.
- Wrapping and packaging operations carried out in such a way that the product is not contaminated.
- Re-used wrapping and packaging materials for food are easy to clean, and if required easy to disinfect.

**Box 3.23. Fish processing facilities: Inspection checklist for training.**

- All personnel including temporary workers are appropriately trained before starting work.
- Workers supervised throughout by trained and experienced staff.

Examples of checklists to guide the inspection of transport and traceability systems are provided in the Annexes.

In addition to general GMP and GHP aspects of processing, inspectors may be required to verify that HACCP systems are in place and to carry out HACCP audits (Huss *et al.*, 2003). For this a detailed understanding of the relevant food safety hazards is required, many of which are summarized in Section 2, and further information can be found in FDA (2001) and CAC (2005). Generic procedures, which are not specific to the fisheries sector, can be used to audit a HACCP system and these are described in Huss *et al.* (2004) and Goulding and do Porto (2005).

### **Markets**

Fish markets are found at landing sites and in ports, towns, villages and urban centres. They can range from the sophisticated to the basic and may involve the wholesale or retail sale of fresh and/or processed fish and shellfish products. Markets may also provide storage facilities for chilled, frozen, dried, smoked and live products as well as ice-making facilities. Key stakeholders in terms of food safety are the traders and their staff, those responsible for moving products within the market and to and from stores and transport vehicles, and local authorities who may manage the market and have responsibility for inspection duties.

Applying a risk-based preventive approach to fish inspection means that the fish inspector has a responsibility to monitor and inspect market facilities and activities associated with the trade in fish and fishery products. Ensuring that fish and fish products are safe for the consumer relies on a combination of good market design, the availability of appropriate services such as potable water and electricity, the application of GHP and the knowledge and understanding of key stakeholders.

With reference to retail marketing, CAC (2005) recommends that fish, shellfish and their products should be received, handled, stored and displayed to consumers in a manner that minimizes potential food safety hazards and defects and maintains essential quality. Consistent with the HACCP and Defect Action Plan (DAP) approaches to food safety and quality, products should be purchased from known or approved sources under the control of competent health authorities that can verify HACCP controls. Retail operators should develop and use written purchase specifications designed to ensure food safety and desired quality levels. Retail operators should be responsible for maintaining the quality and safety of products.

The following generic checklist for assessing market facilities and activities is based on information from the Fish Inspectors of Billingsgate Fish Market in London and is designed to promote the safety and quality of fish and shellfish products.

**Box 3.24. Assessing fish market facilities and activities: Reception and landing areas.**

- Reception area is structurally sound and well maintained.
- Reception area is adequately drained.
- Drains are effectively trapped to prevent access by pests.
- Notices prohibiting unauthorized entry to be prominently displayed. Notices required stating: “Smoking, Spitting, Eating, Drinking forbidden in this area”.
- Delivery vehicles are hygienically maintained.
- Fish arrives on ice at the correct temperature.
- Fish is unloaded into covered reception area.
- Delivery vehicles do not pollute internal working areas.
- Fish not in direct contact with the floor.
- Reception and surrounding area free from litter, waste, vegetation and improperly stored equipment.
- Delivery containers are protected from animals, birds or other risk of cross-contamination.
- Delivery temperature is monitored and recorded.
- Fork-lift trucks and any other trucks used indoors must not be diesel powered.
- Fish is adequately re-iced as necessary.
- Fish is properly labelled.
- Fish is properly graded.

**Box 3.25. Assessing fish market facilities and activities: Chill storage.**

- Accurate, correctly located measurement devices are available and checked regularly.
- Chill store air temperature is in the range 0–4 °C.
- Storage facilities clean.
- Storage facilities in good repair.
- Facilities constructed of impervious and non-corrodible material.
- Facilities effectively used to prevent risk of contamination.
- Fish not stored on the floor.
- No use of wood in the facility.
- Protected from vermin.
- Floor and wall junction is coved.
- Floor is impervious and non-slip.
- Adequate drainage.
- Free from objectionable odours and moulds.
- Regularly defrosted.
- Fish adequately iced.
- Area adequately lit.
- Light fixtures are clean, in good repair, adequately protected.
- Chill door has secondary curtains.
- Doors capable of being opened from the inside.
- Air temperature monitored and recorded.
- Product temperatures monitored and recorded.

**Box 3.26. Assessing fish market facilities and activities: Frozen storage.**

- Facilities clean.
- Facilities in good repair.
- Free from objectionable odours and moulds.
- Products are adequately wrapped.
- Products are stored off the floor and away from walls to allow air circulation around product.
- Products stored safely.
- Doors are vermin proofed.
- Walls and ceilings constructed of impervious and non-corrodible material.
- Floor is impervious and non-slip.
- Adequately lit.
- Light fixtures are clean, in good repair, adequately protected.
- Accurate temperature devices are correctly installed.
- Temperatures are automatically recorded and measured.
- Product records include the shelf-life of the products.
- All stock is properly labelled and date coded.
- Store is capable of being opened from the inside.
- Store has secondary curtain or air curtain fitted.
- Emergency alarm system is fitted for staff safety.
- Store has a temperature-related alarm.

**Box 3.27. Assessing fish market facilities and activities: Design of premises.**

- Wiring, pipes, hangers, ducts, etc. not allowed to clutter areas.
- Adequate natural and mechanical ventilation.
- All water is of potable quality.
- Floors non-slip and adequately drained.
- Drains are properly trapped.
- Floor/wall junction is properly coved.
- Floors, walls and ceilings are in good repair.
- Floors, walls and ceilings are impervious.
- Floors, walls and ceilings are readily cleaned.
- All areas are adequately lit.
- All light fixtures are clean, protected and in good repair.
- Lighting, heating and ventilation systems must not affect the temperature of the fish.
- All doors are self-closing and fitted with vision panels.
- All doors protected with kick panels.
- All windows are clean.
- All opening windows are fitted with fly screens.
- Any pillars are adequately protected.
- Walls are light coloured.
- Facilities comply with Health and Safety requirements.
- Toilets do not open directly into workrooms.

**Box 3.28. Assessing fish market facilities and activities: Hygiene and cleaning.**

- Floors, walls and ceilings are clean.
- Personnel are trained and display awareness of hygiene procedures.
- Cleaning schedules are in place.
- All chemicals used for cleaning and disinfection are approved by the competent authority.
- All chemicals are properly labelled and stored.
- Cleaning methods do not contaminate product.
- Cleaning materials do not contaminate product.
- Adequate numbers of fly protectors are present and properly maintained.
- Cleaning equipment is in good condition, clean and regularly cleaned.
- All staff maintain a high standard of personal hygiene.
- Staff wear clean protective clothing including headgear.
- Accommodation provided for outdoor clothing.
- Waterproof clothing is cleaned at the end of each day.
- Cuts and abrasions are covered with suitably coloured waterproof dressing.
- Smoking, eating, drinking and spitting are not allowed in work areas.
- Waste is collected and disposed of in a hygienic manner.
- All waste receptacles are lidded and properly sited.
- Waste receptacles are regularly cleaned and disinfected.
- Product flow is conducive to good hygiene.
- First aid materials are readily accessible.
- Staff are not permitted to wear jewellery.

- Premises are free from pests.
  - Premises have an adequate number of wash-hand basins.
  - Wash-hand basins are non-hand operable, have a supply of hot and cold water, soap and drying facilities.
  - Wash-hand basins are clean and used solely for washing hands.
  - Notices are displayed adjacent to the wash hand basins reminding staff to wash their hands.
- Premises have an adequate number of clean toilets.

**Box 3.29. Assessing fish market facilities and activities: Product.**

- Products are properly graded for size and fitness.
- Products are properly labelled:
  - Fish labelling requirements
  - Allergens
  - Lot marking
  - Eco labelling.
- Products are kept at the correct temperature:
  - Fresh fish 0–4 °C
  - Frozen fish -18 °C
  - Smoked fish < 8 °C
  - Vacuum packed < 4 °C
  - MAP < 2 °C.
- Processed products below specified temperatures.
- Products comply with minimum landing sizes.
- Full traceability.

***Prioritization for inspection based on establishment type and product profile***

A fish inspection plan may need to consider a wide range of different types of primary production, processing and marketing facilities as well as a range of different fresh, frozen, cooked and value-added fish and shellfish products. A simple matrix, as shown in Table 3, demonstrates how different types of establishment can be prioritized to guide the targeting of inspection resources. This builds on the product profiles described in the previous section. Compliance refers to the level at which the establishment has complied with inspection requirements such as GHP.

**Table 3. Prioritizing establishments.**

<b>Establishment type</b>	<b>Compliance</b>	<b>Product</b>	<b>Priority</b>
Fish landing	High	Fresh fish for processing and direct consumption after cooking	Low
Aquaculture producer	Low	Molluscan shellfish for consumption raw	High
Processing plant	High	Frozen fish fillets	Low
Retail fish market	Low	Variety of fresh and processed products some of which are consumed without further processing	High

The scenario presented in Table 3 indicates that the inspection system would be best focused on the aquaculture producer and retail fish market with the aim of improving the compliance of these establishments. However, even when compliance has been improved, these types of establishment may remain high priority due to the nature of the products handled.

## **4. Monitoring the safety of fish and fishery products**

This section of the guidelines provides information to support the application of the chapter on enforcement and compliance in the FAO risk-based food inspection manual. It describes the relevance of monitoring, specific tests for fish and fisheries products and the importance of standards and codes of practice.

Monitoring programmes complement the inspection of primary production, processing and market facilities. They can focus on detecting the presence and levels of toxic algae and biotoxins, pathogenic bacteria, viruses and chemical contaminants in the aquatic environment. For example, a monitoring programme may be designed and implemented to assess the quality of water in areas used for shellfish production. A key feature of a monitoring programme is an action plan that would be implemented to ensure a rapid response to any risks identified. For example, the response to a risk posed by toxic algae found in water may be to close the fishing or harvesting area affected (Huss et al., 2003).

Fish inspectors are therefore involved in sampling and arranging the performance of various different tests as part of the monitoring process. These help to predict the likelihood of food-borne illness risk factors occurring, and to determine whether food safety controls such as GHP and GAP are being applied correctly. For example, the water used in aquaculture may be tested for chemical hazards, or the harvested product may be assayed for veterinary drug residues. Routine tests that inspectors may be required to perform and/or organize as part of their duties include those listed below.

- Organoleptic or sensory tests on fish to assess quality or fitness for human consumption.
- Parasite checks on fish.
- Total volatile basic nitrogen (TVB-N) assays on samples of fish to assess freshness.
- Trimethylamine–nitrogen (TMA-N) tests on fish to assess freshness.
- Assessment of environmental contamination, e.g. the presence of and maximum residue levels (MRL) for pesticides, dioxins, heavy metals or PCBs.
- Microbiological tests on fish, water, ice and swabs from equipment/facilities to test for pathogens. Tests include those for *E. coli*, total coliforms, faecal coliforms, *Salmonella* spp., *Staphylococcus aureus*, *Listeria monocytogenes*, and *Vibrio parahaemolyticus* (bivalve molluscs for live consumption), and total plate counts.
- Checks for toxic fish species.
- Tests for marine biogenic amines and biotoxins, e.g. histamine, PSP.
- Assays for veterinary drugs and chemical residues in harvested farmed fish and shrimp.

Some tests will require the collection of samples for further analysis for which sampling guidelines will be required, and internationally recognized ISO and AOAC standard analysis procedures exist for many tests. Some tests require specialist laboratory facilities. European Union Food Safety Law requires that such laboratories are certified to ISO 17025 standard. The results of the analyses are compared with required standards, which are discussed later in this section. Box 4.1 summarizes the EU approach to monitoring aquaculture products for veterinary drugs and substances, including the action to be taken should products fail to comply with legislative standards.

**Box 4.1. Residue monitoring requirements for aquaculture products.**

Council Directive 96/23/EC of 29 April 1996 on *measures to monitor certain substances and residues thereof in live animals and animal products* defines measures to monitor certain substances and residues in live animals and animal products. It requires monitoring programmes to be put in place for “aquaculture animals”, e.g. farmed fish, but not for fish from capture fisheries. The residue monitoring programme is designed to check that the controls that prevent contamination of aquaculture animals are functioning.

Inspectors should be aware of the problem areas and take them into account in the design of the plan. One example is the use of unauthorized substances in the treatment of shrimp diseases. Another is pesticide runoff in freshwater bodies used for aquaculture. Typical monitoring parameters for farmed fin fish are shown in the table below, where Group A substances are those having an anabolic effect and unauthorized substances and Group B are veterinary drugs and contaminants, including unlicensed substances which could be used for veterinary purposes

**Table 4. Typical monitoring parameters for farmed fish.**

Group	Group of substances	Compounds to be analysed	Substrate	MRL/ action level	No. of samples
A1	Stilbenes	Diethylstilboestrol	Muscle	Not set	50
A6	Annex IV of 2377/90	Chloramphenicol	Muscle	Not set	50
A6	Annex IV of 2377/90	Malachite green	Liver		
B1	Antimicrobial substances	Any active agent	Liver	Not set	100
B1		Tetracyclines	Muscle	100µg/kg	100
B1		Sulphonamides	Muscle	100µg/kg	100
B1		Quinolones	Muscle	Various	100
B3	Organochlorine compounds	PCBs	Muscle	Not set	100
B3	Chemical elements	Heavy metals	Muscle	Various	100
B3	Mycotoxins	Aflatoxins B1,B2/G1/G2/M	Feed	Not set	100

Whilst the number of samples has been indicated in Table 4, the sampling schedule should be risk based, and relate to the possible practices encountered in the industry. The following gives more insight into how to determine the number of samples to take and is from (Goulding & do Porto, 2005).

## AQUACULTURE PRODUCTS –SAMPLING REQUIREMENTS FOR RESIDUE MONITORING

### 1. Finfish farming products

A sample is one or more fish, according to the size of the fish in question and of the requirements of the analytical method.

Member States must respect the minimum sampling levels and frequencies given below, depending on the production of farmed fish (expressed in tonnes).

The minimum number of samples to be collected each year must be at least 1 per 100 tonnes of annual production.

The compounds sought and the samples selected for analysis should be selected according to the likely use of these substances.

The following breakdown must be respected:

Group A: one third of the total samples:

all the samples must be taken at farm level, on fish at all stages of farming (1), including fish which is ready to be placed on the market for consumption.

Group B: two thirds of the total samples:

the sampling should be carried out:

- (a) preferably at the farm, on fish ready to be placed on the market for consumption;
- (b) either at the processing plant, or at wholesale level, on fresh fish, on condition that tracing-back to the farm of origin, in the event of positive results, can be done.

In all cases, samples taken at farm level should be taken from a minimum of 10 % of registered sites of production.

### 2. Other aquaculture products

When Member States have reason to believe that veterinary medicine or chemicals are being applied to the other aquaculture products, or when environmental contamination is suspected, then these species must be included in the sampling plan in proportion to their production as additional samples to those taken for finfish farming products.

- (1) For sea-farming, in which sampling conditions may be especially difficult, samples may be taken from feed in place of samples from fish.

#### **Box 4.1., cont. Residue monitoring requirements for aquaculture products.**

If residue levels exceed the action level the following action is recommended.

- Where a consignment of fish is not compliant, its source should be traced, in particular its geographical origin.
- Investigations should be undertaken to determine the extent of the contamination, in terms of the geographical area, other batches of fish produced, other fish species affected, etc.
- Where the problem is identified as being due to contamination within the food chain, the competent authority must act to ensure that the cause is eliminated.

- On the basis of the results of the investigation, the competent authority may consider that no further action is required. However, if further action is required, the following steps may be taken:

Capture fisheries:

- destruction of any fishery products within the distribution chain;
- a ban on fishing within a geographically defined area (region) may be issued.

Aquaculture species:

- destruction of aquaculture fish products;
- a ban on production and marketing of certain fishery products;
- a ban on use of certain production systems/feeding stuffs.

In the case of fish originating from a geographical area (region) or production system subject to a national ban, the operators may be allowed to produce and market fishery products providing that they can provide documentary evidence that maximum levels have been complied with for each consignment.

Continuous monitoring should be carried out in order to verify whether and when a (partial) lifting of the ban on fishing or production will be possible.

As well as laboratory analysis, rapid test kits are available to detect and measure some food safety hazards such as histamine.

Official standards are used to guide many aspects of fish production, marketing and inspection. These standards set out the requirements for compliance. They include standards that describe the production and marketing of safe fish and shellfish, the assessment of the quality of important inputs such as water in aquaculture production and water used for washing fish and making ice, and the requirements regarding the presence of food-borne illness risk factors. Standards can include food safety hazard control procedures, so that if the product is produced to that particular standard the risk to the consumer from that product will be minimized.

Some standards are associated with monitoring and testing and will refer to the presence or levels of pathogenic bacteria in fish or water, the level of chlorine in water used in fish processing plants, the levels of chemical residues such as pesticides, biotoxins, toxic metals, PCBs, spoilage indicators such as total volatile bases (TVB-N) and trimethylamine–nitrogen (TMA-N), the sensory quality of fish and shellfish, as well as the sampling and analysis procedures for different hazards. Box 4.2 contains an extract from a Codex standard for bivalve molluscs.

#### **Box 4.2. Examples of standards for live bivalve molluscs.**

Live bivalve molluscs shall not contain numbers of faecal coliforms or *E. coli* bacteria in excess of testing regime standards as follows.

- Live bivalve molluscs shall not exceed the maximum permissible level of the designated micro-organism when tested in accordance with a most probable number (MPN) method specified in ISO 16649-3 or equivalent. In an analysis involving five (5) samples, none may contain more than 700 *E. coli*, and not more than one (1) of the five (5) samples may contain between 230 and 700 *E. coli*. *Escherichia coli*/g  $n = 5$   $c = 1$   $m = 2.3$   $M = 7$ , where  $n$  = the number of sample units,  $c$  = the number of sample units that may exceed the limit  $m$ , and  $M$  is the limit that no sample unit may exceed. Live bivalve molluscs must not contain more than 330 faecal coliforms. In an analysis involving five (5) samples, none may contain more than 330 faecal coliforms; if two (2) or more of the five (5) contain between 230 and 330 faecal coliforms, the five samples must be analysed for *E. coli*. In that analysis, no sample may contain more than 330 *E. coli*, and not more than one (1) of the five (5) samples may contain between 230 and 330 *E. coli* faecal coliforms/g:  $n = 5$   $c = 2$   $m = 2.3$   $M = 3.3$ ; *Escherichia coli*/g  $n = 5$   $c = 1$   $m = 2.3$   $M = 3.3$ .
- Live bivalve molluscs must not contain *Salmonella* in 25 g flesh or *Vibrio parahaemolyticus* at 100 MPN/g flesh.
- In the edible parts of live bivalve molluscs (the whole part or any part intended to be eaten separately) the total content of biotoxins from the saxitoxin (STX) group must not exceed 0.8 mg of saxitoxin (2HCl) equivalent per kg of mollusc flesh.
- In the edible parts of live bivalve mollusc (the whole part or any part intended to be eaten separately), the total content of biotoxins from the okadaic acid (OA) group must not exceed 0.16 mg of okadaic equivalent per kg of mollusc flesh.
- In the edible parts of bivalve molluscs (the whole part or any part intended to be eaten separately) the total content of biotoxins from the domoic acid (DA) group must not exceed 20 mg of domoic acid per kg of mollusc flesh.
- In the edible parts of bivalve molluscs (the whole or any part intended to be eaten separately) the total content of biotoxins from the brevetoxin group must not exceed 20 mouse units or equivalent.
- In the edible parts of bivalve molluscs (the whole or any part intended to be eaten separately) the total content of biotoxins from the azaspiracid (AZP) group must not exceed 0.16 mg per kg.

Summarized from: *Code of practice for fish and fishery products*<sup>1</sup>

Codes of practice assist the implementation of standards and fish inspection procedures. They are designed for use by the private sector to help compliance with legislation and best practice; they can also be developed to guide the work of the inspection staff. The Codex Alimentarius has produced a variety of standards and codes of practice that promote the production of safe fish and shellfish products. These include the following, for which full references are given in the further information section.

- *Code of practice for fish and fishery products.*

<sup>1</sup> Codex Alimentarius Commission. 2003. *Code of practice for fish and fishery products*. CAC/RCP 52-2003 (available at: [http://www.codexalimentarius.net/download/standards/10273/CXP\\_052e.pdf](http://www.codexalimentarius.net/download/standards/10273/CXP_052e.pdf)).

- *Codex general standard for the labelling of prepackaged foods* (Codex Stan 1-1985, Rev. 1, 1991).
- *Codex Alimentarius maximum residue limits for veterinary drugs in foods.*
- *Recommended methods of analysis and sampling.*
- *Code of practice for source directed measures to reduce contamination of food with chemicals.*
- *Code of hygienic practice for the transport of food in bulk and semi-packed food.*
- *Draft FAO/WHO guide on the use of chlorination in fish processing.*
- *Principles for the establishment and application of microbiological criteria for foods* (CAC/GL 21-1997).
- *Recommended international code of practice – General principles of food hygiene* (CAC/RCP 1 – 1969, Rev 4-2003) and other relevant Codex texts such as *Codes of hygienic practice* and *Codes of practice.*
- *Codex general guidelines on sampling* (CAC/GL 50-2004).
- *General standard for food additives* (CODEX STAN 192-1995).

These standards and codes are models that can be used to guide the development of national standards and codes of practice. A number of other useful standards, codes of practice and guidelines are available from the Codex Alimentarius.

## **5. Knowledge and skill requirements for fish inspectors**

This section of the guidelines also complements the chapter on enforcement and compliance in the FAO risk-based food inspection manual, which includes an overview of the general food inspection knowledge and skills that fish inspectors require in order to carry out their roles and responsibilities effectively.

The modern-day preventive fish inspection service oversees the safety of fish imports, fish exports and the supply of fish to the domestic consumer. Fish inspectors are authorized by law to implement rules and legislation relating to fish quality and safety. A fish inspector's role is often a combination of extension and law enforcement. This requires knowledge of food safety policy and law and the regulatory framework as it applies to fish and fishery products. In many countries specific legislation has been developed to support fish inspection. A fish inspector's duties may also include running training courses, developing codes of practice and advising the private sector. A fish inspector's responsibilities include those listed below.

- Assessing the risks associated with different fish and fishery products.
- Inspecting facilities and health and hygiene practices associated with fish production, processing and marketing (e.g. fishing vessels, landing sites, vehicles, premises, aquaculture establishments, ice plants, cold stores, markets).
- Approving the operation of production and processing sites, activities and premises.
- Advising the private sector on best practice and on corrective action when standards do not meet those required.
- Monitoring the implementation of corrective action.
- Development of codes of practice for the private sector to encourage uptake and application of best practice and compliance with food safety law.
- Designing and running training courses on best practice and new legislation.
- Monitoring health and hygiene conditions, including sampling and analysis of products, water and other samples indicating the level of hygiene of handling and processing facilities.
- Issuing licences and certificates to businesses showing compliance with food safety law.
- Ensuring that non-compliant products are rapidly withdrawn from the food chain and disposed of accordingly.

A key requirement for fish inspectors is that they have a thorough understanding of the product and the processes used to produce and market fish and shellfish. This is essential if food-borne illness risk factors are to be understood and identified, as well as for accurate and effective decision-making with regard to inspection procedures. Key knowledge requirements and skills, some of which have been discussed in these guidelines, are:

- public health, food microbiology, science and technology, and engineering;
- fish biology, taxonomy, identification and composition;
- fish quality changes and freshness evaluation;
- fish production, including aquaculture, processing and distribution;
- food-borne illness risk factors associated with fish and fish products;
- specific fish inspection procedures, standards and codes of practice;
- risk assessment;
- quality assurance programmes in the fisheries sector such as GHP, GMP, HACCP and CCPs for fish and fishery products.

## **6. Annexes**

## Annex 1. Sources of further information

### Useful websites

Organisation	Address	Information
Codex – standards	<a href="http://www.codexalimentarius.net">www.codexalimentarius.net</a>	All standards, codes of practice, guidelines, MRLs
Codex General Standard for Food Additives (GSFA)	<a href="http://www.codexalimentarius.net/gsaonline">http://www.codexalimentarius.net/gsaonline</a>	Food additives
AOAC Marine and Freshwater Toxins	<a href="http://www.aoac.org/marine_toxins/task_force.htm">http://www.aoac.org/marine_toxins/task_force.htm</a>	Biotoxins
Global Fora of Food Safety Regulators	<a href="http://www.foodsafetyforum.org">www.foodsafetyforum.org</a>	FAO/WHO general food safety issues
European Food Safety Authority	<a href="http://efsa.eu.int">efsa.eu.int</a>	Independent scientific and technical advice to underpin policymaking and legislation in the area of food safety
EU	<a href="http://europa.eu.int/pol/food/index_en.htm">http://europa.eu.int/pol/food/index_en.htm</a> <a href="http://europa.eu.int/scadplus/leg/en/s84000.htm">http://europa.eu.int/scadplus/leg/en/s84000.htm</a>	Food safety and access to EU regulations
International Association of Fish Inspectors	<a href="http://www.iafi.net/">http://www.iafi.net/</a>	Network for fish inspectors
International Portal on Food Safety, Animal and Plant Health	<a href="http://www.ipfsaph.org">www.ipfsaph.org</a>	Multi-agency website dedicated to food safety
FAO Fisheries Department	<a href="http://www.fao.org/fi/default.asp">http://www.fao.org/fi/default.asp</a>	Information on world trade in fish and fish products
Food and Drug Administration (USA)	<a href="http://www.fda.gov">http://www.fda.gov</a> <a href="http://www.cfsan.fda.gov/seafood1.html">http://www.cfsan.fda.gov/seafood1.html</a>	Global information regarding specific hazards in fishery products and their controls

Seafood Plus	<a href="http://www.seafoodplus.org">www.seafoodplus.org</a>	EU research project promoting fish food safety and quality
Globefish	<a href="http://www.globefish.org">http://www.globefish.org</a>	Information on international fish trade and marketing
Traceability of Fish Products EU Project web site	<a href="http://www.tracefish.org/">http://www.tracefish.org/</a>	Traceability
World Health Organization (WHO)	<a href="http://www.who.int">www.who.int</a>	
World Trade Organization (WTO)	<a href="http://www.wto.org">www.wto.org</a>	SPS & TBT trade agreements
FDA Center for Food Safety & Applied Nutrition – Seafood	<a href="http://vm.cfsan.fda.gov/seafood1.html">http://vm.cfsan.fda.gov/seafood1.html</a>	Fish and fishery products hazards and control; HACCP
SeafoodNIC Home Page HACCP Plans	<a href="http://www-seafood.ucdavis.edu/hacp/Plans.htm">http://www-seafood.ucdavis.edu/hacp/Plans.htm</a>	HACCP plans
Seafood NIC Home Page – Compendium of Fish and Fishery Products Processing Methods, Hazards and Controls	<a href="http://seafood.ucdavis.edu/haccp/compendium/compend.htm">http://seafood.ucdavis.edu/haccp/compendium/compend.htm</a>	Fishery products, food safety hazards and their control
Seafood NIC Home Page –	<a href="http://www-seafood.ucdavis.edu/">http://www-seafood.ucdavis.edu/</a>	Fish and fishery products
HACCP Manual – Food Safety Canada	<a href="http://www.haccp-seafood.com/">http://www.haccp-seafood.com/</a>	HACCP

## Useful documents

Document	Information
<b>Ababouch, L., Gandini, G. &amp; Ryder, J.</b> 2005. <i>Causes of detentions and rejections in international fish trade</i> . FAO Fisheries Technical Paper 473. Rome, FAO.	Examples of food safety issues. Overview of rules and regulations related to imports and fish food safety and quality of EU, US, Japan, Canada
<b>CAC.</b> 2003. <i>Recommended international code of practice general principles of food hygiene</i> . CAC/RCP 1-1969 Rev 4-2003. Codex Stan 1-1985. Rev 1-1991. Codex Alimentarius Commission. Rome, Food and Agriculture Organization/World Health Organization. 31 pp.	GHP
<b>CAC.</b> 2005. <i>Code of practice for fish and fishery products</i> . CAC/RCP 52-2003 Rev. 2-2005. Codex Alimentarius Commission. Rome, Food and Agriculture Organization/World Health Organization. Draft. 98 pp.	Fish and fishery products hazards and control; HACCP; GHP
<b>CAC.</b> 2005. <i>Codex general standard for the labeling of prepackaged foods</i> . Codex Stan 1-1985. Rev. 1-1991. Codex Alimentarius Commission. Rome, Food and Agriculture Organization/World Health Organization. 7 pp.	Labelling requirements
<b>Clucas, I.J. &amp; Ward, A.R., eds.</b> 1996. <i>Post-harvest fisheries development: a guide to handling, preservation, processing and quality</i> . Chatham, UK, Natural Resources Institute. 443 pp.	Fish handling and processing
<b>Department of Fisheries Resources.</b> 2006. <i>Manual of standard operating procedures for fish inspection and quality assurance</i> . Republic of Uganda, Ministry of Agriculture Animal Industry and Fisheries.	Fish inspection procedures and guidance
<b>Derrick, S. &amp; Dillon, M.</b> 2004. <b>Guide to traceability</b> . Eurofish, SIPPO, Humber Institute of Food and Fisheries.	Traceability
<b>Espejo-Hermes, J.</b> 1998. <i>Fish processing technology in the tropics</i> . Quezon City, Philippines, Taid Publications. 336pp.	Fish processing
<b>Espejo-Hermes, J.M.</b> 2004. <i>Quality assurance of aquaculture products: milkfish and tilapia</i> . Philippines, Tawid publications.	Hazards, HACCP, GHP and aquaculture
<b>Kurien, J., ed.</b> 2005. <i>Responsible fish trade and food security</i> . FAO Fisheries Technical Paper No. 456. Rome, Food and Agriculture Organization. 102pp.	Contribution of fish to food security and trade issues
<b>FAO.</b> .... <i>Responsible use of antibiotics in aquaculture</i> . Fisheries Technical Paper 469. Rome, Food and Agriculture Organization.	Antibiotic use in aquaculture
<b>FAO.</b> 1995. <i>Code of conduct for responsible fisheries</i> . Rome, Food and Agriculture Organization. 41 pp.	Policy guidance

<p><b>FAO.</b> 1998. <i>Responsible fish utilization</i>. Technical guidelines for responsible fisheries No 7. Rome, Food and Agriculture Organization. 33 p.</p>	<p>Policy guidance</p>
<p><b>FAO.</b> 2004. <i>State of the world fisheries and aquaculture</i>. <a href="http://www.fao.org/sof/sofia/index_en.htm">http://www.fao.org/sof/sofia/index_en.htm</a></p>	<p>Overview of current situation of important aspects of fisheries sector</p>
<p><b>FAO.</b> 2005. <i>Increasing the contribution of small-scale fisheries to poverty alleviation and food security</i>. Technical guidelines for responsible fisheries No. 10. Rome, Food and Agriculture Organization. 79 pp.</p>	<p>Policy guidance</p>
<p><b>FAO/WHO</b> (2006) <i>Risk assessment of cholerae Vibrio cholerae 01 and 0139 in warm water shrimp in international trade: interpretative summary and technical report</i>. Microbiological Risk Assessment Series 9. <a href="ftp://ftp.fao.org/docrep/fao/008/a0252e/a0252e00.pdf">ftp://ftp.fao.org/docrep/fao/008/a0252e/a0252e00.pdf</a> <a href="ftp://ftp.fao.org/docrep/fao/009/a0253e/a0253e00.pdf">ftp://ftp.fao.org/docrep/fao/009/a0253e/a0253e00.pdf</a></p>	
<p><b>FAO/WHO</b> (2005) <i>Risk assessment of Vibrio vulnificus in raw oysters: interpretative summary and technical report</i>. Microbiological Risk Assessment Series 8. <a href="ftp://ftp.fao.org/docrep/fao/008/a0252e/a0252e00.pdf">ftp://ftp.fao.org/docrep/fao/008/a0252e/a0252e00.pdf</a></p>	
<p><b>FAO/WHO.</b> 2003. <i>Food hygiene. Basic texts</i>, 3rd edition. Joint FAO/WHO Food Standards Programme. Rome, Food and Agriculture Organization. 77 p.</p>	<p>GHP</p>
<p><b>FDA.</b> 2001. <i>Fish and fisheries products hazards and controls guide</i>, 3rd edition. Washington, DC, US Food &amp; Drug Administration, Center for Food Safety &amp; Applied Nutrition. <a href="http://www.cfsan.fda.gov/~comm/haccp4.html">http://www.cfsan.fda.gov/~comm/haccp4.html</a></p>	<p>Detailed information on different food safety hazards associated with fish and fishery products</p>
<p><b>Food Safety Authority of Ireland.</b> 2000. <i>Code of practice on the risk categorization of businesses to determine the priorities for inspection</i>. Code of practice no.1/2000, Food Safety Authority of Ireland. <a href="http://www.fsai.ie/publications/codes/COP_risk_categorisation.pdf">http://www.fsai.ie/publications/codes/COP_risk_categorisation.pdf</a></p>	<p>Assessing the level of food safety risk of different types of food business</p>
<p><b>Goulding, I. &amp; do Porto, O.</b> 2005. <i>Manual/handbook for the execution of sanitary inspection of fish as raw material and fish-products as food for human consumption. Strengthening fishery products health conditions in ACP/OCT countries</i>. <a href="http://www.sfp-acp.eu/EN/B15-Handbook.htm">http://www.sfp-acp.eu/EN/B15-Handbook.htm</a></p>	<p>General overview of fish inspection system in line with EU requirements: hazards, hygiene controls, standards, traceability, inspection implementation and procedures, model certificates, forms and inspection checklists.</p>
<p><b>Graham, J., Johnston, W.A. &amp; Nicholson, F.J.</b> 1992. <i>Ice in fisheries</i>. FAO Fisheries Technical Paper No. 331. Rome, Food and Agriculture Organization. 75pp.</p>	<p>Icing best practice</p>

<b>Hobbs, G.</b> 1982. Changes in fish after catching. In A. Aitken, I.M. Mackie, J.H. Merritt & M.L. Windsor, eds. <i>Fish handling and processing</i> . Torry Research Station. Edinburgh, UK, HMSO.	Fish composition and quality
<b>Huss, H.H.</b> 1988. <i>Fresh fish: quality and quality changes. A training manual prepared for the FAO/DANIDA training programme on fish technology and quality control</i> . FAO Fisheries Series No. 29. Rome, Food and Agriculture Organization. 132 pp.	Fish quality
<b>Huss, H.H.</b> 1993. <i>Assurance of seafood quality</i> . FAO Fisheries Technical Paper No. 334. Rome, Food and Agriculture Organization. 169 pp.	Hazards, control and HACCP
<b>Huss, H.H.</b> 1995. Quality and quality changes in fresh fish. FAO Fisheries Technical Paper. No 348. Rome, Food and Agriculture Organization. 195 p.	Fish quality
<b>Huss, H.H., Ababouch, L. &amp; Gram, L.</b> 2003. <i>Assessment and management of seafood safety and quality</i> . FAO Fisheries Technical Paper No. 444. Rome, Food and Agriculture Organization. 230 pp. <a href="ftp://ftp.fao.org/docrep/fao/006/y4743e/y4743e00.pdf">ftp://ftp.fao.org/docrep/fao/006/y4743e/y4743e00.pdf</a>	Comprehensive understanding of all aspects of fish food safety
<b>Huss, H.H., Dillon, M. &amp; Derrick, S.</b> 2005. <i>A guide to seafood hygiene management. Accessing the European and American market</i> . Eurofish, Humber Institute of Food and Fisheries, Swiss Import Promotion Programme (SIPPO). 76 pp.	GHP/SSOP
<b>Johnson, S.E. &amp; Clucas, I.J.</b> 1996. <i>Maintaining fish quality: an illustrated guide</i> . Chatham, UK, Natural Resources Institute.	Extension guide
<b>Wheaton, F.W. &amp; Lawson, T.B.</b> 1985. <i>Processing aquatic food products</i> . New York, John Wiley and Sons 518 pp.	Fish processing

## Annex 2. Food safety hazards and fish and fishery products

Food safety hazards associated with fish and fishery products can be categorized as biological, chemical or physical. The following provides an overview of some of the important hazards that fish inspectors should be aware of and understand.

### **Biological hazards**

There are several important types of biological hazard associated with fish and fishery products. These are:

- pathogenic bacteria;
- viruses;
- parasites;
- biotoxins and biogenic amines (e.g. histamine).

### **Pathogenic bacteria**

Pathogenic bacteria are bacteria that may cause illness in humans or other animals. They are not the same as the bacteria that cause spoilage and are found in:

- the aquatic environment;
- the general environment;
- humans and animals.

Pathogenic bacteria found in the aquatic and general environments can be present on fish after capture. Pathogenic bacteria carried by humans and animals can be found in the aquatic environment and can contaminate fish and shellfish after capture due to poor handling and hygiene practices.

Pathogenic bacteria cause food poisoning either through the release of toxins or as a result of bacterial infection. Food poisoning by toxin-producing pathogens is characterized by a rapid onset of illness as the toxins are already formed by the bacteria in the food before consumption. Typical symptoms of this type of food poisoning are nausea and vomiting. The ingestion of pathogenic bacteria themselves is not a prerequisite for this type of poisoning: it is the toxin produced by the bacteria that causes illness.

Poisoning by bacterial infection occurs when a contaminated product is eaten and viable bacteria continue to grow within the host's body to produce typical symptoms such as fever and diarrhoea. The number of viable bacterial cells necessary to cause disease (the minimum infective dose, MID) varies considerably between bacterial species. The MID is known to be high for pathogenic *Vibrio* spp. and low for some *Salmonella* and *Shigella* species.

The following are important **pathogenic bacteria indigenous to the aquatic environment** that can be naturally present on fish and shellfish and pose a potential food safety hazard.

*Clostridium botulinum* non-proteolytic types B, E and F are found naturally in the aquatic environment and can produce toxins that are stable in a salty and acidic environment and that cause botulism in humans and other animals. Poor handling and hygiene practices will lead to a risk of contamination and therefore growth of bacteria and the toxin.

Various types of fishery product, but not raw fish cooked immediately before consumption, have been implicated in outbreaks of botulism. Symptoms of botulism vary from mild illness to serious disease, which can be fatal. Typical indicators of poisoning include visual impairment, loss of mouth and throat function, lack of muscle coordination and respiratory impairment.

Pathogenic strains of *Vibrio* spp. are found in marine and estuarine environments and consequently can be found in wild-caught and farmed fish and shellfish harvested from these environments. The pathogenic strains of this bacteria are particularly prevalent in warm tropical waters and can be found in temperate zones during summer months. Choleraenic *Vibrio cholerae* (serotypes 01 and 0139) prefer a low salinity environment and hence is common in estuaries and freshwater. Poor handling and hygiene practices, the use of contaminated water during processing and cross-contamination can increase the risk of this hazard in fish and fish products. FAO/WHO (2006) provides further details in relation to warm water shrimp aquaculture. Consumption of contaminated raw products, such as molluscs, causes severe diarrhoea leading to rapid dehydration in the infected person. Certain strains of *Vibrio parahaemolyticus* are pathogenic, are naturally occurring and commonly found in seafood products, especially bivalve molluscs such as oysters, mussels and clams. It can also be found in crustaceans and finfish, and products such as ceviche and sushi. The consumption of contaminated raw or undercooked products causes diarrhoea, nausea, vomiting, headache, fever and chills. *Vibrio vulnificus* is found especially in warm or estuarine waters. The consumption of raw infected shellfish such as oysters leads to food poisoning with typical symptoms of fever, chills and nausea. This organism also causes primary septicaemia and wound infections. FAO/WHO (2005) provides further information.

*Plesiomonas shigelloides* is found in both warm freshwater and marine environments. It can survive freezing. Poor handling and hygiene practices and cross-contamination can lead to outbreaks of poisoning, particularly through the consumption of raw shellfish, which accumulate the bacteria from the aquatic environment. Typical symptoms of illness are diarrhoea, fever and chills.

*Aeromonas* spp. are found in freshwater, estuarine and marine environments. The bacteria can grow in both contaminated vacuum and modified atmosphere packed fish products and can also grow at chill temperatures. Consumption of raw, undercooked or contaminated ready to eat products will lead to diarrhoea, abdominal pain, headache and fever.

The following are important **pathogenic bacteria indigenous to the general environment** that are associated with food-borne illness from fish and fishery products:

*Listeria monocytogenes* is found in the soil, decaying vegetation and vegetables as well as in the intestinal tracts of humans and other animals, and is passed on to fish and fish products through poor handling and hygiene practices, including cross-contamination. Symptoms of poisoning are typically fever, chills, headache, back ache, abdominal pain and diarrhoea. It may take up to 3 weeks for a person to become ill after infection. It can cause serious illness in pregnant women, newborn babies, older adults, and people with weakened immune systems.

*Clostridium botulinum* proteolytic types A and B are widely distributed in soil and plants. They are also found in the intestinal tracts of animals and fish. These bacteria grow only in situations where there is little or no oxygen; i.e. they prefer anaerobic conditions. The

bacteria produce a toxin that causes illness, and are a particular problem in improperly canned fish and vacuum-packed products. The toxin affects the nervous system, causing double vision, drooping eyelids, difficulty in speaking and swallowing and difficulty breathing. The toxin can be fatal if those infected are not treated.

Type A *Clostridium perfringens* is found in the soil, and types B, C, D and E are found in the intestinal tracts of animals and humans as well as in sewage. The bacteria grow only in situations where there is little or no oxygen and produce a toxin that causes diarrhoea and abdominal pain.

*Bacillus* spp. are found in the natural environment in the soil, on vegetation and in natural waters and the spores are resistant to drying. The bacterium produces a toxin that causes abdominal pain, diarrhoea and/or vomiting as a result of the consumption of contaminated raw or undercooked fish and fishery products. *Bacillus cereus* is associated with food poisoning outbreaks.

**Other pathogenic bacteria are found on the outer (skin) and inner surfaces (intestinal tract) of infected humans and other animals.** Contamination of fish products is almost always due to poor hygiene (poor personal hygiene, poor processing hygiene or poor water quality) (Huss et al., 2003).

These pathogens may also be present in the aquatic environment as a result of contamination with sewage. They can therefore also occur naturally in fish, although usually at low levels. The highest concentrations are usually found in molluscs and in the intestines of their predators.

Important pathogenic bacteria from human and other animal sources that are associated with fish and fishery products are described below.

*Salmonella* spp., of which there are over 2300 types, are mainly found in the intestinal tracts and faeces of animals and in the eggs of birds. Poor handling and hygiene practices lead to contamination of fish and fish products. For example, cooked products may be contaminated following processing by the uncooked raw material or by employees, and in the absence of competing microflora, it may constitute a high risk product if the bacterium is allowed to grow, e.g. following temperature abuse (Huss et al., 2003). The consumption of infected raw or undercooked fish and shellfish will result in stomach pain, diarrhoea, nausea, chills, fever and headache.

There are over 30 types of *Shigella* spp. This bacterium is found in the human intestinal tract and is usually passed on to fish and fish products as a result of poor personal hygiene practices. Consumption of raw or undercooked products can lead to diarrhoea containing blood and mucus, fever, abdominal pain, chills and vomiting.

*Escherichia coli* is found in the intestinal tracts of animals and humans and in unchlorinated water. Some strains of the bacterium can cause human illness. Cross-contamination, poor handling and hygiene practices and contact with contaminated water lead to the presence of the bacterium in fish and shellfish. The bacteria can also accumulate in molluscan shellfish such as oysters. Food poisoning occurs as a result of eating raw or undercooked products or cooked products that have been cross-contaminated. Symptoms are typically diarrhoea, abdominal pain and nausea.

*Campylobacter jejuni* and other mesophilic campylobacters are found in the intestinal tracts of animals and birds as well as in untreated water and sewage. The bacteria are typically passed on to fish by cross-contamination and contaminated water. Poisoning can result from the consumption of raw or undercooked fish and shellfish. Symptoms of poisoning are fever, headache, muscle pain, diarrhoea, abdominal pain and nausea.

*Staphylococcus aureus* is found on human skin, in the nose, throat, and in infected cuts. Poor personal hygiene practices lead to bacteria being passed on to fish and fish products. The bacteria grow rapidly at warm temperatures and produce a toxin that causes severe nausea, abdominal cramps, vomiting and diarrhoea if fish and fish products are consumed raw or undercooked, or if cooked products are cross-contaminated. The bacteria may also produce heat-resistant toxins.

### Control of pathogenic bacteria

The mere presence (in low numbers) of pathogens from the aquatic and general environment is of no safety concern, not even in ready-to-eat (RTE) products.

In contrast, the presence of pathogens from animal/human reservoirs is a serious safety concern for products to be eaten without (further) cooking. Growth of pathogens is likewise a serious safety concern for most RTE products, e.g. the growth of *L. monocytogenes* in lightly preserved fish products and the growth of *C. botulinum* in some types of fermented seafood. For raw fish products to be eaten raw the safety concern is limited. Growth of these pathogens is only possible at elevated temperatures (> 5 °C), and under these conditions spoilage will proceed very rapidly and the fish will probably be rejected due to off-odours and off-flavours long before it becomes toxic or infective organisms reach high numbers (Huss et al., 2003).

Control of pathogenic bacteria as a food safety hazard in fish and fishery products is achieved by applying Good Hygienic Practices (GHP), also known as Standard Sanitation Operating Procedures (SSOP) in conjunction with specific handling and processing controls. The generic fish inspection checklists provided in section 3 are based on GHP and GMP; the latter refers to the layout and design of fishing boats, processing establishments and markets, etc. Box A.1 provides an overview of GHP and also HACCP, which will be used in the control of product-specific hazards.

#### **Box A.1. Good Hygienic Practices (GHP) and HACCP.**

**GHP** refers to all practices relating to the conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain. GHP are similar to SSOPs and are also known as “prerequisite programmes” that aim to ensure the safety of water and ice, the cleanliness of food contact surfaces, the prevention of cross-contamination, good standards of personal hygiene and the prevention of problems as a result of employee health issues. They also aim to ensure the safe storage and use of toxic compounds, good pest control practice and waste management, proper storage and transportation of fish and fish products and raw materials, traceability and recall procedures and proper training.

GHP and prerequisite programmes need to be in place before a **HACCP** system is developed. HACCP is a generic food safety management tool that helps to ensure that foods such as fish

and fishery products are safe and will not cause adverse health effects in the consumer. It is now internationally recognized and is promoted by the FAO/WHO *Codex Alimentarius*. The use of HACCP in the fisheries sector is a legislative requirement in many countries.

**HACCP** helps food producers and processors concentrate on preventing or eliminating known food hazards. Anticipation of hazards (biological, chemical and physical) and the identification of control points at which these hazards are prevented or eliminated are key elements of HACCP. The application of HACCP and the development of a HACCP plan is based on seven stages or principles: hazard analysis, identification of critical control points (CCP), setting CCP limits, monitoring, corrective action, verification and record keeping.

Important guidelines are the CODEX *Guidelines for HACCP application*, published in 1997 as *Food hygiene basic texts*, integrating the Recommended International Code of Practices, General Principles of Food Hygiene and the 12 step HACCP system application scheme, as well as the Principles for the Establishment and Application of Microbiological Criteria for Foods. CAC (2005) provides useful guidance on HACCP to control specific hazards in fish and fishery products.

In some countries the reality is that existing facilities and locations may not have been designed with modern GHP in mind, and hence the proper application of these principles may be difficult. Furthermore, those working within the “fish as food” chain may not have knowledge of GHP, the resources to invest in training or the equipment and clothing required. For example, small-scale fish landings may lack potable water for cleaning and for maintenance of personal hygiene, and ice may not be available. In such situations the food safety system should be encouraged to evolve over time so that facilities and locations are designed and serviced and human capacity developed to enable the appropriate standards to be reached.

Spoilage changes and the growth of pathogens take place under certain optimal conditions, and altering these conditions by processing will prevent or reduce the rate at which bacteria multiply. Table 5 provides guidance on the optimum growth parameters for various pathogenic bacteria. Processing controls are based on the following:

- physical separation of bacteria and enzymes from fish flesh e.g. by washing the fish and shellfish and removal of stomach and other organs;
- temperature control (chilling, freezing or heat processing to kill bacteria and enzymes);
- removal of water (drying);
- addition of salt;
- control of pH (marinades);
- reducing the contact that fish fats and oils have with oxygen in the air e.g. by using appropriate packaging.

**Table 5. Growth limiting factors of pathogenic bacteria (Huss et al., 2003).**

Pathogenic bacteria	Temperature (°C)		pH	Aw	NaCl (%)
	minimum	optimum	minimum	minimum	maximum
<i>Clostridium botulinum</i> proteolytic, types A, B, F	10	35–40	4.6	0.94	10
non-proteolytic, types B, E, F	3.3	25–28	5.0	0.97	3–5
<i>Vibrio</i> spp. <i>V. cholerae</i>	10	37	5.0	0.97	8
<i>V. parahaemolyticus</i>	5	37	4.8	0.93	8–10
<i>V. vulnificus</i>	8	37	5.0	0.96	5
<i>Plesiomonas shigelloides</i>	8	37	4.0		4–5
motile <i>Aeromonas</i> spp.	0–4	28–35	4.0	0.97	4–5
<i>Listeria monocytogenes</i>	0–2	30–37	4.6	0.92	10
<i>Bacillus cereus</i>	4 <sup>1</sup>	30–40	5.0	0.93	10
<i>Clostridium perfringens</i>	12	43–47	5.5	0.93	10
<i>Salmonella</i> spp.	5 <sup>2</sup>	35–43	3.8	0.94	6
<i>Shigella</i> spp.	6	35–40	4.9	0.96	5
<i>Escherichia coli</i>	7	35–40	4.4	0.95	8
<i>Yersinia enterocolitica</i>	-1.3	25–37	4.2	0.96	7
<i>Campylobacter</i> spp.	30	42	4.9	0.99	1.5
<i>Staphylococcus aureus</i>	7	37	4	0.83	20–25 <sup>3</sup>
toxin production	10	40–45	4.5	0.87	10–15 <sup>3</sup>

1. Most strains of *B. cereus* are mesophilic, with minimum temperature of approximately 8–10 °C; however, psychrotrophic variants have been isolated

2. Some authors report growth at temperatures as low as 2 °C (D'Aoust, 2000)

3. Different maximum limits are reported in the literature

Low temperatures, such as those associated with chilling, will prevent the growth of most pathogenic bacteria. An adequate heating process (including cooking) prior to consumption will kill bacteria and destroy toxins and eliminate the risk of potential adverse health effects. However, the toxins and spores of some pathogens such as *Clostridium botulinum* are relatively more heat resistant and require specific processing controls. Creating very acidic conditions in fish and fishery products by lowering the pH of marinades will also prevent the growth of pathogens. Removing water by drying or salting will also create unfavourable conditions for bacterial growth. Certain pathogens require oxygen in order to grow, while others require an environment with little or no oxygen. Therefore controlling access to oxygen by appropriate use of packaging can also affect the growth of pathogens.

## **Viruses**

Viruses do not need food, water or air to survive and do not cause spoilage of fish and fishery products. Certain viruses (enteric) survive in human intestines, water or food for months and can enter the aquatic environment through sewage. The following are the main food safety hazard viruses associated with fish and fishery products:

- hepatitis A
- Norwalk virus
- Snow Mountain agent
- calicivirus
- astrovirus

Fish and shellfish can pick up viruses from the aquatic environment or be contaminated following harvesting as a result of poor personnel hygiene during handling and processing. High-risk products are those that are harvested from sewage contaminated inshore waters and consumed raw or undercooked, such as bivalve molluscs.

For *hepatitis A* symptoms of illness are fever, malaise, nausea, abdominal discomfort and jaundice. *Norwalk virus*, *Snow Mountain agent*, *calicivirus* and *astrovirus* cause gastroenteritis with symptoms such as nausea, vomiting, diarrhoea, abdominal cramps and fever.

### Control of viruses

Seafood-borne viruses are difficult to detect, requiring relatively sophisticated molecular methods to identify their presence. The risk of viral illness, however, can be minimized by controlling sewage contamination of growing and harvesting areas, pre-harvest monitoring of shellfish and growing waters and the application of GHP to prevent cross-contamination and to ensure good sanitation and employee hygiene. Proper cooking (thermal processing at 85–90 °C for 1.5 minutes) will destroy viruses in shellfish. Depuration or relaying can be used but require long periods of time for the shellfish to purge themselves clean of viral contamination, compared with the time required to purge away pathogenic bacteria (Huss et al., 2003).

## **Parasites**

There are many different parasites, known as helminths or parasitic worms, found in fish and shellfish, and more than 50 species are known to cause disease in humans. Food-borne illness arises from the consumption of raw, minimally processed or inadequately cooked fish and fish products that contain the infectious stage of the parasite.

There are three distinct types of parasite: *nematodes*, *cestodes* and *trematodes*. They have complicated life cycles and pass through a number of intermediate hosts.

Many species of *nematode* are known to occur worldwide and some species of fish act as secondary hosts. Among the nematodes of most concern related to food safety are *Gnathostoma* spp., *Capillaria* spp., *Pseudoteranova* spp. and *Anisakis* spp., which can be found in the liver, belly cavity and flesh of fish. Nematodes of the *Gnathostoma* spp. are common in Asia, Africa and Latin America. Once inside the human host the parasites often migrate to the skin, causing creeping eruption, and can migrate to the eye or other internal organs causing serious illness.

*Capillaria* spp. are a public health problem in many countries including Thailand. The infection causes severe diarrhoea and sometimes death due to loss of body fluids. *Angiostrongylus* spp. are common nematodes in Southeast Asia. The worms of some species can migrate to the tissues surrounding the brain, causing meningitis, or remain in the abdomen where they cause a severe intestinal upset.

*Cestodes* are tapeworms, and the species of most concern associated with the consumption of fish is *Dibothriocephalus latus/Diphyllobothrium latum*. This parasite occurs worldwide and both fresh and marine fish act as intermediate hosts. Symptoms include abdominal distension, flatulence, abdominal cramps and diarrhoea.

Fish-borne *trematode* (flatworm) infection (see Box A.2) is a major public health problem that occurs endemically in about 20 countries around the world. It is a common problem in Asia. The most important species, with respect to the number of people infected, belong to the genera *Clonorchis* and *Ophisthorchis* (liver flukes), *Paragonimus* (lung flukes), and to a lesser extent *Heterophyes* and *Echinochasmus* (intestinal flukes). *Clonorchis sinensis* is reported to have infected 20 million people in Asia alone. Endemic areas in Asia include Korea, China, Taiwan and Vietnam. More than 80 species of freshwater fish can carry this parasite.

**Table 6. Important parasites that cause food-borne illness.**

Parasite	Location	Aquatic product
<b><u>Nematodes (roundworms)</u></b>		
<i>Anisakis simplex</i>	North Atlantic	Herring
<i>Pseudoterranova dicepiens</i>	North Atlantic	Cod
<i>Gnathostoma</i> spp.	Asia	Freshwater fish, frogs
<i>Capillaria</i> spp.	Asia	Freshwater fish
<i>Angiostrongylus</i> spp.	Asia, South America, Africa	Freshwater prawns, snails, fish
<i>Eustrongylides</i> spp.	USA	Freshwater, brackish water, marine fish
<b><u>Cestodes (tapeworms)</u></b>		
<i>Diphyllobothrium latum</i>	Northern hemisphere	Freshwater fish
<b><u>Trematodes (flukes)</u></b>		
<i>Clonorchis</i> spp.	Asia	Freshwater fish, snails
<i>Opisthorchis</i> spp.	Asia, Eastern Europe	Freshwater fish
<i>Heterophyes</i> spp.	Worldwide	Freshwater fish, brackish water fish, snails
<i>Paragonimus</i> spp.	Worldwide	Fish, freshwater crabs, snails
<i>Echinostoma</i> spp.	Asia	Freshwater fish, clams, snails
<i>Metagonimus yokagawai</i>	Asia, Egypt	

From: Huss *et al.* (2004), Espejo-Hermes (2004)

The most important hosts of these trematodes are humans and other mammals. Freshwater fish are the second intermediate host in the life cycles of *Clonorchis* spp. and *Opisthorchis* spp., and freshwater crustaceans for *Paragonimus* spp. *Clonorchis sinensis* infection in humans causes inflammation of the biliary ducts, abdominal pain, nausea, diarrhoea and eosinophilia. Longstanding infections can result in a variety of other illnesses. *Heterophyes* spp. cause diarrhoea and abdominal pain. In some cases the immature stages of the parasite can migrate to and damage the heart or the brain. *Opisthorchis* spp. infection can result in symptoms of malnutrition and various illnesses. *Paragonimus* spp. cause, among other symptoms, diarrhoea, abdominal pain, fever, cough and lung abnormalities, including tuberculosis-like symptoms.

**Box A.2. Trematode infection - a major public health problem.**

Fish-borne trematode (FBT) infections are a major public health problem that has largely gone unrecognized by the health sector and the fish inspection services in recent years. All parasites of concern are transmitted to humans by eating raw or uncooked fish products. Transmission of fish-borne trematodes is associated with behavioural patterns determined by socio-economic and cultural conditions in endemic areas. Consumption of trematode-infected fish and shellfish occurs most often around lakes, streams and ponds. Korean men eat raw fish while drinking sake at social gatherings, thus acquiring clonorchiasis. In South China people like to eat congee (rice gruel) with slices of raw fish. In Hong Kong freshwater fish is imported from the mainland and is therefore expensive, resulting in the more affluent groups acquiring clonorchiasis and possibility cholangiocarcinoma. Paragonimiasis is acquired by eating wine-soaked "drunken" crabs in parts of China, and in Thailand and the Philippines crab juice is used for medicinal purposes as well as in food preparation. Opisthorchiasis is acquired in Thailand by eating raw fish salads or low-salt fermented fish. Echinostome infections are obtained from eating snails and raw fish in Northern Luzon in the Philippines, and in Korea. Eating habits are deeply rooted in a culture and are resistant to change. In some cultures raw animals and plants are eaten for medicinal as well as nutritional purposes. Raw crayfish is used to treat measles but transmits paragonimiasis. In the Cameroon, raw crab is thought to increase fertility and in Ecuador macerated crab supernatant is given to sick children. Raw foods are often eaten out of necessity because of the lack of cooking fuel. The use of human and animal faeces ("night soil") for fertilizer and indiscriminate defecation contaminate the environment and water bodies. In some areas toilets are built over fishponds, thereby perpetuating the infectious cycle in rural aquaculture. The relative contributions of farmed fish and wild-caught fish to the burden of these diseases are yet unclear. In countries such as China and Vietnam, aquaculture fish in small traditional ponds are heavily infected with *C. sisensis* and play an important role in the spread of the parasite.

Although there are effective drugs for treatment of most fish-borne trematode diseases, it is more important to prevent infection. Control of trematode infections is difficult and the measures that have been employed have not been successful. The parasites involved in FBT infections have complex life cycles involving one or two intermediate hosts. Effective control strategies are therefore difficult to implement.

The WHO Technical Report on trematode infections (WHO, 1995) details the basic strategies for the control of FBT infections. Many sectors are important, and collaboration between all of them is necessary, i.e. public health, agriculture, aquaculture, the food industry, food control and education. Methods for controlling FBT in freshwater fish have shown promising results in countries such as Korea and Thailand. These involve case detection and treatment, health education, improved sanitation, legislation on food safety measures and management of human faeces. Application of preventive approaches based on HACCP (Hazard Analysis and Critical Control Points) could also contribute to providing a high degree of food safety. Control of snail populations could also be envisaged, together with the promotion of infestation-resistant fish species for aquaculture purpose in endemic areas.

So far limited studies have been conducted on the control of trematodes using different preservative processes.

*Summarized from Huss et al. (2003)*

### Control of parasites

Parasite infections of fish can be eradicated by freezing and proper cooking. Freezing at -20 °C or below for 7 days or at -35 °C for 15 hours are recommended processing parameters to control nematode infestation, and for heat treatment a minimum of 15 seconds at 63 °C is recommended to inactivate parasites (FDA, 2001). Processes such as brining or pickling may reduce a parasite hazard if the products are kept in the brine for a sufficient time but this process may not eliminate the hazard completely. Parasites can also be physically removed from fish fillets. This process is known as “candling”: the fillets are placed on a translucent table below which is a strong light. The light shining up through the table and fillets shows up the location of parasites in the fish flesh, which are then removed by hand. Trimming areas of flesh from a fillet can also physically remove infected flesh. Whilst physically removing the visible parasite cysts will reduce the hazard, it may not eliminate it completely.

### **Natural toxins or biotoxins**

Natural toxins, usually produced by marine algae (plankton), can be found in fish and shellfish and can cause food-borne illnesses. Filter-feeding animals such as bivalve molluscs can rapidly accumulate such toxins. Problems are often associated with blooms of toxic algae on which the animals feed. In finfish, toxins are usually found in certain organs and may be present in the fish only at certain times of year. In some fish, the toxins are present in the blood.

One of the problems with all these toxins is that they are relatively heat-stable and can survive a cooking process. Furthermore, it can be difficult to tell a toxic from a non-toxic animal or product. According to Huss *et al.* (2004) many countries rely on biotoxin monitoring programmes to protect public health, and close harvesting areas when toxic algal blooms or toxic shellfish are detected. In non-industrialized countries, particularly in rural areas, monitoring for harmful algal blooms does not occur routinely and deaths commonly occur due to “red tide toxins”. The following is an overview of the main naturally occurring toxins in fish and shellfish that are potential food safety hazards.

Toxins associated with phytoplankton are known as *phycotoxins*. These toxins have been responsible for incidents of wide-scale death of sea life and are increasingly responsible for human intoxication. There are a number of different shellfish poisoning syndromes associated with toxic marine algae, and these include:

- paralytic shellfish poisoning (PSP), caused by saxitoxin;
- diarrhoetic shellfish poisoning (DSP), caused by okadaic acid, dinophysis toxin;
- neurotoxic shellfish poisoning (NSP), caused by brevetoxins;
- amnesic shellfish poisoning (ASP), caused by domoic acid;
- azaspiracid shellfish poisoning (AZP), caused by azaspiracids.

Eating raw infected molluscan shellfish is the most likely source of food-borne illness from these toxins. Although the toxins are relatively heat stable, the industrial canning process can be effective if the level of toxin is already low (Huss *et al.*, 2003). Severe cases of PSP can cause death due to respiratory paralysis. DSP causes diarrhoea, NSP results in nausea and ASP can cause brain damage. Health standards can be used to determine whether a product is safe or not. Tests can be performed to determine maximum residue levels (MRLs) of the different toxins and these can be compared with public health standards to determine the safety of the product.

*Ciguatoxin* can be found in over 400 species of mainly carnivorous tropical and subtropical reef fish. The heat stable toxin is produced by dinoflagellate marine algae. Symptoms of toxin poisoning include headache, nausea, diarrhoea, vomiting and tingling sensations. There is still much to be learnt about *ciguatoxin* and a key control measure is to avoid marketing fish that have a known consistent record of toxicity.

There are about 80 species of puffer fish, blowfish or fugu found in the Pacific, Atlantic and Indian Oceans belonging to the family Tetradontidea (“puffer fishes”). These fish may accumulate a toxin known as *tetrodotoxin*, which is responsible for several poisonings every year, some of which result in death. Symptoms of poisoning are numbness and tingling of the mouth, weakness, paralysis, decreased blood pressure, and a quickened and weakened pulse. The toxin has also been found in goby, blue-ringed octopus, various gastropods, newts and horseshoe crabs, as described in Box A.3. (Huss et al., 2003).

**Box A.3. Tetrodotoxin and the horseshoe crab.**

At certain seasons of the year in Thailand, the horseshoe crab *Carcinoscorpius rotundicauda* may be toxic to humans, and fatal poisoning occasionally occur. Tetrodotoxin (TTX) and its derivatives are major toxins in the toxic eggs of the horseshoe crab. An epidemic of poisoning caused by eating toxic eggs of the horseshoe crab affected 71 people in Chon Buri, which is located on the eastern coast of Thailand. Patients generally presented with neurological symptoms such as paraesthesia, vertigo, weakness, respiratory paralysis and altered consciousness with unreactive dilated pupils, in addition to gastrointestinal symptoms such as nausea and vomiting. Nineteen patients required artificial ventilation and there were two deaths. This is the first large outbreak of tetrodotoxin poisoning recognized in Thailand.

From: **Kanchanapongkul, J. & Krittayapoositpot, P.** 1995. An epidemic of tetrodotoxin poisoning following ingestion of the horseshoe crab *Carcinoscorpius rotundicauda*. *Southeast Asian J Trop Med Public Health.*, 26(2): 364–367.

Tetrodotoxin is generally found in the fish liver, roe/eggs and guts, skin, and less frequently in the muscle tissue. The mechanism of toxin production is still not clear; however, there are indications that symbiotic bacteria may be involved in the process of toxin production and that the toxin is transmitted through the food chain to the food fish or shellfish. The most obvious control is not to eat potentially toxic species. In the United States puffer fish may not be imported except under strict certification requirements and specific authorization from the FDA.

*Gempylotoxin* is a natural toxin found in the oil, flesh and bones of specific species of finfish such as Gemplids or pelagic mackerels (e.g. escolar; oilfish, castor oil fish or purgative fish; snek). Symptoms of poisoning include diarrhoea, generally without pain or cramping. Control involves avoiding the consumption of specific fish species.

The biogenic amine *histamine* causes a food-borne illness also known as *scombroid poisoning* throughout the world. This is perhaps the most common form of toxicity caused by the ingestion of improperly chilled fish, many of which are scombroid species such as tuna, mackerel, and bonito, as well as *Clupeidae*, which include sardines. However, reliable statistics on its incidence do not exist because the poisoning incidents are often unreported

due to the mild nature of the illness, lack of adequate systems for reporting food-borne diseases, or misclassification of the diagnosis by medical personnel who misdiagnose histamine poisoning as a food allergy (Huss et al., 2003).

Histamine formation is attributed mainly to the action of *Enterobacteriaceae*, which can produce high levels of histamine and other biogenic amines in fish muscle when products are not immediately chilled after catching. Fish may contain toxic levels of histamine without exhibiting any of the usual sensory parameters characteristic of spoilage. Histamine poisoning is rarely fatal, but symptoms include a metallic or peppery taste in the mouth, nausea, vomiting, abdominal cramps, diarrhoea, swelling and flushing of the face, headache, dizziness, heart palpitations, hives, rapid and weak pulse, thirst and difficulty swallowing.

#### Control of natural toxins

Examples of controls related to each toxin type have been mentioned, but the main food safety concern with many natural toxins in fish and shellfish is that they are heat stable. For toxins that result from fish or shellfish feeding on particular food items control should be centred on harvesting fish from safe areas where the food source is known to be safe. Otherwise, control involves avoiding the consumption of high-risk fish species.

The toxins are not inactivated by normal heat processing but by rapid refrigeration or chilling in ice after catching. According to the FDA (2001):

- Fish should be placed in ice or in refrigerated seawater, in chilled sea water or brine at 4.5 °C or less within 12 hours of death, or placed in refrigerated seawater, chilled sea water or brine at 10 °C or less within 9 hours of death.
- Fish exposed to air or water temperatures above 28 °C, or large tuna (above 20 lbs) that are eviscerated before on-board chilling, should be placed in ice (including packing the belly cavity of large tuna with ice) or in refrigerated seawater or brine at 4.5 °C or less within 6 hours of death.
- Large tuna (above 20 lbs) that are not eviscerated before on-board chilling should be chilled to an internal temperature of 10 °C or less within 6 hours of death.

Following GHP on board, at landing and during processing is also an important control strategy to prevent contamination or recontamination of the fish by bacteria capable of amino acid decarboxylation.

Because of the recurrence of histamine poisoning in many parts of the world and the importance of international trade in the fish species concerned, many countries have enacted maximum limits or guidelines on histamine levels in traded fish. Thus, the United States FDA guidelines established for tuna, mahi-mahi and related fish specify 50 mg/100 g (500 ppm) as the toxicity level, and 5 mg/100g (50 ppm) as the defect action level because histamine is not uniformly distributed in a decomposed fish. Therefore, if 5 mg/100g is found in one section, there is a possibility that other units may exceed 50 mg/100g (FDA, 2001). The European Union (Goulding and do Porto, 2005) requires that nine samples must be taken from each batch of fish species of the following families: Scombridae, Clupeidae, Engraulidae and Coryphaenidae. These samples must fulfil the following requirements:

- the mean value must not exceed 10 mg/100g (100 ppm);
- two samples may have a value of more than 10 mg/100g (100 ppm) but less than 20 mg/100g (200 ppm);

- no sample may have a value exceeding 20 mg/100g (200 ppm).

However, fish belonging to these families that have undergone enzyme ripening treatment in brine may have higher histamine levels, but not more than twice the above values; for example, in preserved anchovies histamine levels can be as high as 200 and 400 ppm instead of 100 and 200 ppm.

### ***Chemical hazards***

Another important food safety hazard associated with fish and shellfish is chemical contamination as a result of:

- environmental chemical contaminants found in the aquatic environment such as agricultural pesticides, heavy metals and industrial pollutants;
- improper use of veterinary drugs such as antibiotics and growth hormones used in aquaculture;
- use of unapproved food additives, flavourings and enzymes, or unregulated use of approved additives;
- accidental contamination from oil, cleaning, pest control and other chemicals.

According to Huss *et al.* (2004) long-term low level exposure to some chemical contaminants may be associated with serious diseases such as neurological damage, birth defects and cancer.

### **Environmental chemical contaminants**

Problems related to chemical contamination of the environment are nearly all caused by humans. The ocean dumping of hundreds of millions of tonnes of material from industrial processing, sludge from sewage treatment plants, agricultural drainage and raw untreated sewage from large urban populations contribute to the contamination of coastal marine environments and freshwater environments. From the aquatic environment various chemicals find their way into fish and other aquatic organisms. Of greatest concern from a food safety point of view are fish and shellfish harvested from coastal and estuarine areas and from freshwater contaminated or polluted aquatic environments, rather than fish harvested from the open seas.

High levels of certain chemicals such as heavy metals may be found in predatory species at the top of the food chain as a result of biomagnification. Alternatively, chemicals may bioaccumulate in body tissues due to repeated ingestion of these substances over a long period of time. In the latter case, a large (older) fish will have a higher content of the chemical concerned than a small (younger) fish of the same species. The presence of chemical contaminants in seafood is therefore highly dependent on geographical location, species and fish size, feeding patterns, solubility of chemicals and their persistence in the environment (Huss *et al.*, 2003).

There are a large number of different *agricultural pesticides* used in farming and by public health authorities. These chemicals find their way into the aquatic environment and are picked up and accumulated in fish living in such contaminated environments. Agricultural pesticides, unapproved for use on foodstuffs, are also used in some countries to control insect infestation and prevent post-harvest losses of fish and fishery products. These chemicals are normally applied during processing to prevent blow fly (*Diphthera* spp.) infestation and then,

once dried, during storage to prevent attack from beetles (*Dermestes* spp., *Necorbia* spp.) and mites.

While some metals are required as essential nutrients for fish and shellfish, including copper, selenium, iron and zinc, over-accumulation can occur from the aquatic environment, which can pose a food safety concern. *Heavy metals* or chemicals of particular concern include arsenic, cadmium, chromium, lead, methyl mercury, nickel and selenium. *Heavy metals* tend not to be easily excreted and can accumulate in fish and subsequently the consumer, with associated toxic effects over time caused by regular intake. This means that long-lived predators such as tuna, sharks, swordfish and groupers are susceptible to high levels of accumulation, particularly in the viscera.

Long-term exposure to cadmium can cause kidney dysfunction, chromium can affect the liver and kidneys, and lead can cause disorders of the nervous system. Because of the effect some heavy metals can have on the development of the nervous system, food safety advice should be particularly aimed at certain consumer groups such as pregnant mothers and mothers of young children.

Important industrial pollutants of food safety concern are *dioxins*, including 2, 3, 7, 8 tetrachlorodibenzo-p-dioxin (TCDD) and polychlorinated biphenyls (PCBs). *Dioxins* are persistent organic pollutants (POPs) formed as a result of combustion processes and find their way into the aquatic environment as a result of pollution and poor waste disposal practices. Dioxins appear in the natural environment as variants of a common chemical structure known as congeners and tend to accumulate in the fat of fish. High levels of dioxin intake in humans are linked with reproductive and developmental problems, heart disease, diabetes and cancer. Chloracne is a severe skin disease caused by exposure to dioxins.

#### Control of hazards from environmental contaminants

Better control of industrial and domestic waste disposal and better practice in the use of agricultural chemicals to reduce the levels of potentially harmful chemicals in the aquatic environment are important public as well as private sector control strategies.

Hazard control also centres on ensuring that fish and shellfish are harvested from safe areas that are known to not pose a risk in terms of levels of potentially hazardous chemicals. Environmental monitoring by government agencies and the closure of harvesting areas is therefore an important control strategy. Testing samples of fish and shellfish for environmental contaminants to determine MRLs is an element of monitoring, and MRLs have been established for many of the chemicals discussed.

Risk management must also take into account that many of these contaminants are cumulative and that consumer exposure is related to consumption rate. In addition, certain contaminants such as heavy metals may be present in higher quantities in certain organs or parts of fish and shellfish. For example the liver, pancreas and roe of crustaceans such as crab and lobster may contain significant levels of cadmium.

#### **Veterinary drugs**

Various veterinary drugs and chemicals are used in finfish and shellfish aquaculture to prevent or treat disease, control parasites, aid reproductive processes, tranquilize fish, and as growth promoters. These drugs and chemicals are often incorporated into feeds. Food-borne illness arises when unapproved chemicals are used or approved chemicals are used in an

unregulated way and residues above the MRL remain in the marketed fish. Some unapproved chemicals used in aquaculture are potentially carcinogenic, can cause allergic reactions and may lead to antibiotic resistance in humans (Huss et al., 2003). Unapproved chemicals that are sometimes used in aquaculture are nitrofurans, chloramphenicol, malachite green and leucomalachite green (LMG), chloroform, chlorpromazine, colchicines, dapsone, dimetridazole, metronidazole and ronidazole.

Another concern regarding aquaculture is the potential food safety risk caused by supplementary feeding, as described in Box A.4.

#### **Box A.4. Food-borne disease risk and aquaculture feed.**

Supplementary feeding of fish is used in intensive aquaculture production systems. Feeds are either commercially manufactured and meet specific dietary requirements of the species being cultured or are made from a combination of appropriate locally available raw materials such as small dried fish, vegetable matter, rice bran and other by-products from agricultural and food processing activities.

Feeds, if not manufactured using good quality raw materials and stored correctly, may result in the farmed fish or shellfish posing a food safety hazard. For example chemical contamination (pesticides, heavy metals, dioxins) of fish or fish meal used in feed manufacture lead to these chemicals being accumulated in the farmed product. Chemical contamination of feeds can also occur during feed processing and storage. The unregulated use of feed ingredients such as preservatives and dyes may also pose a food safety risk, as will the unregulated use of veterinary drugs, which are often combined with feeds to make administering the chemicals to the fish easier. Feeds can also spoil and develop mycotoxins.

Aquaculture feeds must be manufactured or made and stored in such a way that they do not result in farmed fish or shellfish posing a food safety hazard. Feed manufacturers are encouraged to apply HACCP and prerequisite programmes such as GHP in order to control the safety of the feeds produced.

#### Control of veterinary drugs

Some countries have monitoring programmes that aim to detect the presence of unapproved chemicals in aquaculture products. However, the application of Good Aquaculture Practices (GAP) is an important preventive approach to control the misuse and use of unapproved chemicals. A GAP system that can be developed into a code of practice can be used to promote best practice with regard to:

- use of chemicals, especially the use of antibiotics;
- buildings, including location;
- equipment;
- water quality;
- waste disposal;
- record keeping.

Aquaculture products can be audited and then certified if they meet the required standards. Box A.5 provides guidance, adapted from FDA (2001), on preventive measures for the control of aquaculture drugs.

#### **Box A.5. Guidance for control of veterinary drug residues in farmed fish/shellfish.**

- On-farm visits to review drug usage before receipt of the product, coupled with a supplier's certificate that any drugs/chemicals were used in conformance with the application requirements,
- Receipt of supplier's certification of proper drug usage, coupled with appropriate verification.
- Review of drug usage records at receipt of the product, coupled with a supplier's certificate that any drugs were used in conformance with the application requirements.
- Drug residue testing.
- Receipt of evidence (e.g. third party certificate) that the producer operates under a third party audited Quality Assurance Programme for aquaculture drug use (e.g. GAP).
- Preventive measures for the control of aquaculture drugs used during the holding of live fish can include controlled application of animal drugs in a manner consistent with:
  - established withdrawal times;
  - labelled instructions for use;
  - extra-label use of approved drugs, under a veterinarian's supervision in accordance with FDA regulations and guidelines;
  - conditions specified in the FDA "low regulatory priority aquaculture drug" list;
  - conditions of a drug/chemical application.

#### **Food additives**

Various chemicals known as additives can be used to extend the shelf life or to preserve products, reduce the risk of or eliminate pathogenic bacteria, improve the colour, enhance flavour, enhance texture, improve water retention properties and improve the nutritional value of fish and fishery products. However, the misuse of approved food additives or the use of unapproved additives does occur, and this poses a potential food safety hazard. In some countries safety concerns relate to the use of formalin as a means of preserving fresh fish quality and borax in processed products.

#### Control of food additives

The Codex Alimentarius Commission provides guidance on the chemical additives that are permitted for use in fish and fishery products, as does the Joint FAO/WHO Expert Committee on Food Additives (JEFCA).

#### **Other chemical contaminants**

Various chemicals are used during fishing, at landing sites and during processing. These include fuel for fishing boats and cleaning agents for fish processing premises. If these chemicals are not handled properly, or fish are not handled according to GHP, there is a risk of chemical contamination of the fish.

#### Control of contamination by other chemicals

Applying GHP reduces the risk of contamination of fish and fishery products by chemicals such as fuel, disinfectants and detergents.

#### ***Physical hazards***

A physical food safety hazard is posed by the contamination of fish or fishery products with objects or material that can cause adverse health effects such as choking, cuts to the mouth,

throat or stomach and damage to teeth. Typical physical hazards associated with fish and fishery products include glass, metal, wood, bones, stones, shell, plastic and fish hooks. Some of these may be found in the fish itself after harvesting, such as fish hooks; other hazards may come from people handling the fish, from buildings in which fish are processed and stored and from processing equipment and packaging materials.

#### Control of physical hazards

The application of GHP will reduce the risk of contamination of fish and fishery products by physical hazards. In some processing establishments equipment such as metal detectors is used to screen products for physical contaminants.

### Annex 3. Additional guidance checklists for fish inspectors.

#### *Checklist to assess/verify/audit aquaculture systems conditions and controls*

<b>Name of the establishment:</b>	<b>Certification number:</b>		
<b>Responsible official</b>	<b>Responsible quality manager:</b>		
<b>Purpose of assessment/audit:</b>	<b>Reference documents:</b>		
<b>Inspectors/auditors</b>	<b>Resulting documents:</b> - C.A.Rs (F05 Re) - Conclusions to Co. file		
<b>Minimum prerequisite plans to be in place, monitored and properly registered (*)</b>			
<b>Prerequisite plan</b>	<b>Y</b>	<b>N</b>	<b>Comments</b>
A) Veterinary drug withdrawal periods control (2377/90/CE)			
B) Monitoring of residues for vet drugs and pesticides (96/23/CE)			
C) Personnel hygiene and health control			
D) Quality of water and ice management			
E) Pest control			
F) Cleaning and disinfection			
G) Quality of feed supplies control			
H) Waste and debris management/elimination			
I) Trematode control (for freshwater farms)			
J) Identification of lots and withdrawal plans			

(\*) All the plans are requested by the regulation. No file can be considered in their absence.

<b>Site, general conditions and hygiene conditions</b>	<b>Severity of defects</b>				
<b>Particular elements to be evaluated</b>	<b>Min</b>	<b>Ma</b>	<b>Ser</b>	<b>Cri</b>	<b>Obs.</b>
<b><u>1. Site location and selection</u></b> <ul style="list-style-type: none"> <li>- Is the site sensitive to environment interferences (flooding, dangerous activities around, etc.)?</li> <li>- Are dangerous chemicals used in the vicinity?</li> <li>- Are dangerous pollutants present?</li> </ul>					
<b><u>2. Pond conditioning, fertilizers and feed</u></b> <ul style="list-style-type: none"> <li>- Were the ponds properly conditioned?</li> <li>- Only safe fertilizers used?</li> <li>- Feed stock properly rotated?</li> <li>- Feed ingredients approved by the CA?</li> <li>- Feeds clearly labelled &amp; composition declared?</li> <li>- Feeds not containing prohibited substances?</li> </ul>					
<b><u>3. Veterinary medicines and withdrawal periods</u></b> <ul style="list-style-type: none"> <li>- Only authorized drugs applied?</li> <li>- Indications, doses and administration records, vet signed ?</li> <li>- Fish treated kept separated?</li> <li>- Withdrawal periods respected?</li> <li>- Residues verified under limits?</li> </ul>					



- Critical deficiency (Cr): Any condition or malpractice observed in the establishment that can lead to the fish becoming unsafe or unwholesome.
- Serious deficiency (Se): Any condition or malpractice observed in the establishment that can preclude proper implementation of hygienic practices or obtaining an appropriate level of hygiene, and thus lead to the production of a contaminated or spoiled fish product, but with no safety implications.
- Major deficiency (Ma): Any condition or malpractice observed in the establishment that precludes general hygiene and leads to the spoilage of the product.
- Minor deficiency (Mi): Any observed condition or malpractice, which does not conform to the sanitary requirements, but is neither major nor serious nor critical.

**Checklist for the assessment of small-scale boats using ice**

Assessment of small-scale boats using ice on board		F12-OAB-G1
Reason for the inspection		
Boat Register:	Owner:	
Date	Name of inspector	

Sanitary conditions related to construction and hygienic operation			
Elements to verify	yes	no	comments
1.1 Protection of products (from sun & other) 1.2 Fish boxes adapted (insulated, easy to clean) clean, in good condition with drainage. 1.3 Space for the ice sufficient/separated 1.4 Separated box for bait			
2.1 Fishing gear easy to clean 2.2 Well maintained			
3. Fish landing 3.1 Rapid and hygienic 3.2 Allowing drainage of melted water			
4. Hygiene maintenance 4.1 Boat cleaning after landing 4.2 Fish boxes cleaned after each use 4.3 Fish boxes used for landing clean			
5. Oil and fuel kept separated			
6. Crew health and hygiene monitored 6.1 Medical checks practised 6.2 Adequate personal hygiene			
7. Ice hygiene 7.1 Ice originated in an approved establishment 7.2 The quantity utilized sufficient for the journey 7.3 Ice handled hygienically			
Summary of defects found and correctives actions requested			
Defects	Correction Date limit	Corrected	commentaries

Observations
Conclusions:

Inspector's signature

Fisher's signature

**Road transport vehicle assessment checklist**

ASSESSMENT OF ROAD TRANSPORT VEHICLES		F13- MT
Reason for inspection		
Vehicle:	Stowing:	
Vehicle registration: Authorisation	Refrigeration:: Owner:	
Date	Name of inspector	

Sanitary conditions related to the construction and hygienic operation			
Elements to verify	yes	no	comments
1. Fish container, box or closed lorry 1.1 Easy to clean 1.2 Hygienic and adapted to the purpose 1.3 Clean & well maintained, with drainage 1.4 Space for the ice sufficient			
2. For refrigerated trucks 2.1 Temperature under regime below -18 °C 2.2 Recorded and readable temperature (from outside)			
3. Loading/unloading 3.1 Quick and hygienic 3.2 Fish contained in cases of proper material			
4. Hygiene control 4.1 Cleaning of lorry after and before use 4.2 Vehicle periodically subject to general cleaning			
5. Oil & fuel kept separated			
6. Health & hygiene of crew monitored 6.1 Medical checks up to date 6.2 General hygiene adequate			
7. Temperature under control 7.1 Lorry 7.2 Product			
Summary of defects found and correctives actions requested			
Defects	Correction Date, limit	Corrected	Commentaries
Observations			
Conclusion: authorized/non-authorized			

Signature of Inspector

Responsible person signature

**Form for assessment of traceability conditions**

TRACEABILITY VERIFICATION			
Company	Product nature		
Lot/s code	Packing		
Criteria	Satisfactory	Not satisfactory	Comments
Supplier/origin clearly identified			
Receiving raw material identified by code no.			
Lots separated during transport			
Lots identified during process			
The codes include all essential information			
Separation and/or addition of lots recorded			
Label codes permit trace back of the product			
Recall plan formalized and operational			
All the data on suppliers and clients available			
Product distribution plans (if applicable)			
Recall plan verification recorded			
Conclusions:			
Unsatisfactory aspects	Correction requested	Date, Limit	Done or not

Observations

Conclusion: compliant/non compliant

Inspector's signature

Company responsible person signature

All the checklists in the annexes are adapted from Goulding and do Porto (2005).

## FAO TECHNICAL PAPERS

### FAO FOOD AND NUTRITION PAPERS

1/1	Review of food consumption surveys 1977 – Vol. 1. Europe, North America, Oceania, 1977 (E)	14/17	Unacceptable visible can defects – a pictorial manual, 1998 (E F S)
1/2	Review of food consumption surveys 1977 – Vol. 2. Africa, Latin America, Near East, Far East, 1979 (E)	15	Carbohydrates in human nutrition, 1980 (E F S)
2	Report of the joint FAO/WHO/UNEP conference on mycotoxins, 1977 (E F S)	16	Analysis of food consumption survey data for developing countries, 1980 (E F S)
3	Report of a joint FAO/WHO expert consultation on dietary fats and oils in human nutrition, 1977 (E F S)	17	JECFA specifications for identity and purity of sweetening agents, emulsifying agents, flavouring agents and other food additives, 1980 (E F)
4	JECFA specifications for identity and purity of thickening agents, anticaking agents, antimicrobials, antioxidants and emulsifiers, 1978 (E)	18	Bibliography of food consumption surveys, 1981 (E)
5	JECFA – guide to specifications, 1978 (E F)	18 Rev. 1	Bibliography of food consumption surveys, 1984 (E)
5 Rev. 1	JECFA – guide to specifications, 1983 (E F)	18 Rev. 2	Bibliography of food consumption surveys, 1987 (E)
5 Rev. 2	JECFA – guide to specifications, 1991 (E)	18 Rev. 3	Bibliography of food consumption surveys, 1990 (E)
6	The feeding of workers in developing countries, 1976 (E S)	19	JECFA specifications for identity and purity of carrier solvents, emulsifiers and stabilizers, enzyme preparations, flavouring agents, food colours, sweetening agents and other food additives, 1981 (E F)
7	JECFA specifications for identity and purity of food colours, enzyme preparations and other food additives, 1978 (E F)	20	Legumes in human nutrition, 1982 (E F S)
8	Women in food production, food handling and nutrition, 1979 (E F S)	21	Mycotoxin surveillance – a guideline, 1982 (E)
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10	Prevention of mycotoxins, 1979 (E F S)	23	Management of group feeding programmes, 1982 (E F P S)
11	The economic value of breast-feeding, 1979 (E F)	23 Rev. 1	Food and nutrition in the management of group feeding programmes, 1993 (E F S)
12	JECFA specifications for identity and purity of food colours, flavouring agents and other food additives, 1979 (E F)	24	Evaluation of nutrition interventions, 1982 (E)
13	Perspective on mycotoxins, 1979 (E F S)	25	JECFA specifications for identity and purity of buffering agents, salts; emulsifiers, thickening agents, stabilizers; flavouring agents, food colours, sweetening agents and miscellaneous food additives, 1982 (E F)
14	<i>Manuals of food quality control:</i>	26	Food composition tables for the Near East, 1983 (E)
14/1	Food control laboratory, 1979 (Ar E)	27	Review of food consumption surveys 1981, 1983 (E)
14/1 Rev.1	The food control laboratory, 1986 (E)	28	JECFA specifications for identity and purity of buffering agents, salts, emulsifiers, stabilizers, thickening agents, extraction solvents, flavouring agents, sweetening agents and miscellaneous food additives, 1983 (E F)
14/2	Additives, contaminants, techniques, 1980 (E)	29	Post-harvest losses in quality of food grains, 1983 (E F)
14/3	Commodities, 1979 (E)	30	FAO/WHO food additives data system, 1984 (E)
14/4	Microbiological analysis, 1979 (E F S)	30 Rev. 1	FAO/WHO food additives data system, 1985 (E)
14/5	Food inspection, 1981 (Ar E) (Rev. 1984, E S)	31/1	JECFA specifications for identity and purity of food colours, 1984 (E F)
14/6	Food for export, 1979 (E S)	31/2	JECFA specifications for identity and purity of food additives, 1984 (E F)
14/6 Rev.1	Food for export, 1990 (E S)	32	Residues of veterinary drugs in foods, 1985 (E/F/S)
14/7	Food analysis: general techniques, additives, contaminants and composition, 1986 (C E)	33	Nutritional implications of food aid: an annotated bibliography, 1985 (E)
14/8	Food analysis: quality, adulteration and tests of identity, 1986 (E)	34	JECFA specifications for identity and purity of certain food additives, 1986 (E F)
14/9	Introduction to food sampling, 1988 (Ar C E F S)	35	Review of food consumption surveys 1985, 1986 (E)
14/10	Training in mycotoxins analysis, 1990 (E S)	36	Guidelines for can manufacturers and food canners, 1986 (E)
14/11	Management of food control programmes, 1991 (E)	37	JECFA specifications for identity and purity of certain food additives, 1986 (E F)
14/12	Quality assurance in the food control microbiological laboratory, 1992 (E F S)		
14/13	Pesticide residue analysis in the food control laboratory, 1993 (E F)		
14/14	Quality assurance in the food control chemical laboratory, 1993 (E)		
14/15	Imported food inspection, 1993 (E F)		
14/16	Radionuclides in food, 1994 (E)		

38	JECFA specifications for identity and purity of certain food additives, 1988 (E)	47/1	Utilization of tropical foods: cereals, 1989 (E F S)
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40	Directory of food and nutrition institutions in the Near East, 1987 (E)	47/3	Utilization of tropical foods: trees, 1989 (E F S)
41	Residues of some veterinary drugs in animals and foods, 1988 (E)	47/4	Utilization of tropical foods: tropical beans, 1989 (E F S)
41/2	Residues of some veterinary drugs in animals and foods. Thirty-fourth meeting of the joint FAO/WHO Expert Committee on Food Additives, 1990 (E)	47/5	Utilization of tropical foods: tropical oil seeds, 1989 (E F S)
41/3	Residues of some veterinary drugs in animals and foods. Thirty-sixth meeting of the joint FAO/WHO Expert Committee on Food Additives, 1991 (E)	47/6	Utilization of tropical foods: sugars, spices and stimulants, 1989 (E F S)
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41/5	Residues of some veterinary drugs in animals and foods. Fortieth meeting of the Joint FAO/WHO Expert Committee on Food Additives, 1993 (E)	47/8	Utilization of tropical foods: animal products, 1990 (E F S)
41/6	Residues of some veterinary drugs in animals and foods. Forty-second meeting of the Joint FAO/WHO Expert Committee on Food Additives, 1994 (E)	48	Number not assigned
41/7	Residues of some veterinary drugs in animals and foods. Forty-third meeting of the Joint FAO/WHO Expert Committee on Food Additives, 1994 (E)	49	JECFA specifications for identity and purity of certain food additives, 1990 (E)
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41/9	Residues of some veterinary drugs in animals and foods. Forty-seventh meeting of the Joint FAO/WHO Expert Committee on Food Additives, 1997 (E)	51	Protein quality evaluation. Report of the Joint FAO/WHO Expert Consultation, 1991 (E F)
41/10	Residues of some veterinary drugs in animals and foods. Forty-eighth meeting of the Joint FAO/WHO Expert Committee on Food Additives, 1998 (E)	52/1	Compendium of food additive specifications – Vol. 1, 1993 (E)
41/11	Residues of some veterinary drugs in animals and foods. Fiftieth meeting of the Joint FAO/WHO Expert Committee on Food Additives, 1999 (E)	52/2	Compendium of food additive specifications – Vol. 2, 1993 (E)
41/12	Residues of some veterinary drugs in animals and foods. Fifty-second meeting of the Joint FAO/WHO Expert Committee on Food Additives, 2000 (E)	52 Add. 1	Compendium of food additive specifications – Addendum 1, 1992 (E)
41/13	Residues of some veterinary drugs in animals and foods. Fifty-fourth meeting of the Joint FAO/WHO Expert Committee on Food Additives, 2000 (E)	52 Add. 2	Compendium of food additive specifications – Addendum 2, 1993 (E)
41/14	Residues of some veterinary drugs in animals and foods. Fifty-eighth meeting of the Joint FAO/WHO Expert Committee on Food Additives, 2002 (E)	52 Add. 3	Compendium of food additive specifications – Addendum 3, 1995 (E)
41/15	Residues of some veterinary drugs in animals and foods. Sixtieth meeting of the Joint FAO/WHO Expert Committee on Food Additives, 2003 (E)	52 Add. 4	Compendium of food additive specifications – Addendum 4, 1996 (E)
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- 71 Joint FAO/WHO Expert Consultation on Risk Assessment of Microbiological Hazards in Foods, 2004 (E F S)
- 72 Joint FAO/WHO Expert Consultation on Risk Assessment of Microbiological Hazards in Foods – Risk characterization of *Salmonella* spp. in eggs and broiler chickens and *Listeria monocytogenes* in ready-to-eat foods, 2001 (E F S)
- 73 Manual on the application of the HACCP system in mycotoxin prevention and control, 2001 (E F S)
- 74 Safety evaluation of certain mycotoxins in food, 2001 (E)
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- 79 Safety assessment of foods derived from genetically modified animals, including fish, 2004 (E)
- 80 Marine biotoxins, 2004 (E)
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- 87 Food safety risk analysis – A guide for national food safety authorities, 2006 (E F S)
- 88 Enhancing developing country participation in FAO/WHO scientific advice activities, 2006 (E F S)
- 89 Risk-based food inspection manual, 2008 (E S)
- 90 Guidelines for risk-based fish inspection, 2009 (E)

Availability: January 2009

Ar – Arabic	Multil – Multilingual
C – Chinese	* Out of print
E – English	** In preparation
F – French	
P – Portuguese	
S – Spanish	

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Fish and fishery products are nutritious and healthy and are an important source of food and livelihood for many millions of people worldwide. However, if such products are not handled and processed correctly the consumer may be at risk. Fish inspection is concerned with ensuring that the consumer has access to safe and nutritious fish and fish products, whether the fish is from domestic sources of supply, imported or to be exported to consumers in another country. The present guidelines are designed to complement the *FAO Risk-based food inspection manual*, and consist of five main sections: 1) introduction, 2) important characteristics of fish as food, food safety hazards, and the risk-based approach to fish inspection, 3) key elements of the fish inspection process, 4) the knowledge and understanding required by fish inspectors in order to carry out their duties, and 5) sources of further information on the topics covered in these guidelines. Key references that provide more information on the topics covered in these guidelines and that are recommended further reading are listed at the end of the final chapter. These guidelines will assist fish inspectors to carry out these responsibilities and are designed to be used in conjunction with the generic food inspection procedures described in the *FAO Food and nutrition paper 89 Risk-based food inspection manual*.

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