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Viale delle Terme di Caracalla, 00153 Rome, Italy - Tel: (+39) 06 57051 - E-mail: codex@fao.org - www.codexalimentarius.org

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GUIDELINES FOR THE SAFE USE AND REUSE OF WATER IN FOOD PRODUCTION AND PROCESSING (CXG 100-2023): PROPOSED DRAFT ANNEX II ON FISH AND FISHERY PRODUCTS AND ANNEX IV ON WATER FIT-FOR-PURPOSE ASSESSMENT, SAFETY MANAGEMENT, AND TECHNOLOGIES FOR RECOVERY AND TREATMENT OF WATER FOR REUSE

(Prepared by the Electronic Working Group chaired by the EU, co-chaired by Honduras, India, Mauritania, Morocco, and the International Dairy Federation (IDF))

PROPOSED DRAFT ANNEX II ON FISH AND FISHERY PRODUCTS

1. INTRODUCTION

1. Fish and fishery products are generally regarded as safe, healthy, and nutritious foods. However, these products may be involved in infections and intoxications caused by viruses (e.g. norovirus and hepatitis A), bacteria (e.g. *Vibrio* spp. and *Salmonella* spp. and *Clostridium botulinum*), protozoans (e.g. *Giardia lamblia* and *Cryptosporidium parvum*), marine biotoxins (e.g. saxitoxin and ciguatera toxin) and helminths (e.g. *Anisakis* spp.). The causes of such hazards are diverse, ranging from naturally occurring microorganisms and parasites to contamination of primary production environments and/or poor hygiene practices during processing, storage, distribution and handling prior to consumption. Depending on the pathogen, it can remain infectious in water for a considerable period of time and affect the suitability of a site to produce or harvest fish and fishery products¹.
2. Water is a key element in the production and processing of fish and fishery products. Water of potable quality might be the safest option; however, many primary producers and food processors/handlers have challenges accessing potable water. The use of potable water is often not a feasible, practical or responsible solution, and other types of water could be also fit for some purposes, provided they do not compromise the safety of the final product for the consumer. The increasing frequency of extreme weather events (e.g. drought, flooding) have exerted greater pressure on the availability and quality of water resources.
3. Increasingly, minimizing water consumption and exploring alternative water sources (e.g. water recovered from food or a food operation that could be reused after making it fit for purpose by suitable treatments or reconditioning, if necessary) are being considered.
4. Water can contact food directly or indirectly and is used in the maintenance of hygiene and sanitation throughout the food chain.
5. An overall management strategy should be developed to prevent the use of water that is, or could be, a source of microbiological contamination of fish and fishery products, taking into account risk factors and control measures applicable at each step. The strategy should be based on a water fit-for-purpose assessment, which encompasses the entire water supply from the catchment or source to its final use.
6. A more general use of 'water fit-for-purpose' is likely to be more feasible, effective and practicable, as proposed by FAO and WHO meeting report on Safety and Quality of Water Used in Food Production and Processing. Potable water is fit for purposes for use during all stages of processing of fishery products from a microbiological safety perspective. Clean water is also defined according to the *Code of Practice for Fish and*

¹ FAO & WHO. 2023. Safety and quality of water used in the production and processing of fish and fishery products – Meeting report. Microbiological Risk Assessment Series, No. 41. Rome. <https://doi.org/10.4060/cc4356en>

Fishery Products (CXC 52-2003) as water from any source where harmful microbiological contamination, substances and/or toxic plankton are not present in such quantities that may affect the safety of fish, shellfish and their products intended for human consumption. Consequently, clean water is, considered safe for processing fishery products (e.g., clean sea water, groundwater) and can therefore be fit for purpose (FFP) for all uses of water except as an ingredient and for washing at the final stage of the preparation of filleted fishery products eaten raw. Water of other quality can become fit for purpose for specific usage following a water fit-for-purpose assessment

2. PURPOSE AND SCOPE

7. The purpose and scope of this Annex is to provide recommendations for the microbiologically safe sourcing, use and reuse of water in production and processing of fish and fishery products for human consumption by introducing the principle of 'fit for purpose' and a risk-based approach. This Annex also provides examples of Decision Trees for determining fit-for-purpose use and reuse of water for fish and fishery products focusing on fish or fishery products that could be eaten raw or undercooked.

3. USE

8. This Annex is complimentary to and should be used in conjunction with the General Section and Annex IV of these Guidelines and the following Codex Alimentarius guidance:

- *Code of Practice for Fish and Fishery Products* (CXC 52-2003),
- *General Principles of Food Hygiene*: (CXC 1-1969),
- *Principles and Guidelines for the Conduct of Microbiological Risk Management (MRM)* (CXG 63-2007),
- *Principles and Guidelines for the Conduct of Microbiological Risk Assessment* (CXG 30-1999),
- *Standard for Live and Raw Bivalve Molluscs* (CXS 292-2008),
- *Principles and Guidelines for the Establishment and Application of Microbiological Criteria Related to Foods* (CXG 21-1997),
- *Guidelines on the Application of General Principles of Food Hygiene to the Control of Foodborne Parasites* (CXG 88-2016), and
- *Guidelines on the Application of General Principles of Food Hygiene to the Control of Viruses in Food* (CXG 79-2012)

4. DEFINITIONS

9. Refer to the General Section of these *Guidelines for the Safe Use and Reuse of Water in Food Production*.

10. Refer to the *Code of Practice for Fish and Fishery Products* (CXC 52-2003) for the definitions of aquaculture, conditioning, depuration, extensive farming, fish, fish farming, glazing, growing areas, intensive farming and shellfish.

Brackish water: water occurring in a natural environment that has more salinity than freshwater but not as much as seawater. It may result from the dissolution of salt from mineral deposits, mixing of seawater with freshwater, as in estuaries, or artificial situations such as dikes or flooding of coastal marshland.

Closed aquaculture production system: any system of aquatic species production that creates a controlled interface between the farmed species and the natural environment. It includes rearing in raceways, tanks and ponds.

Open aquaculture production system: farming of any aquatic species in natural water such as oceans, bays, estuaries, coastal lagoons, lakes, or rivers.

Evisceration: The removal of viscera and other internal organs.

Fish and fishery products: Any species of fish, including crustaceans, molluscs (including bivalve molluscs, marine gastropods and cephalopods), echinoderms, tunicates, or part of them intended for human consumption.

Processing facilities: A facility (vessel or on land establishment) where harvested fish and fishery products may be depurated, processed, graded, and packed for further transportation and consumption.

Refrigerated seawater: clean seawater cooled by a suitable refrigeration system.

Reimmersion: Storing live bivalve molluscs in tanks, floats, or natural sites after harvesting from the original

production area.

Undercooked fishery products: fishery products that are neither raw nor subjected to a cooking time and temperature sufficient to ensure the destruction of non-sporing pathogenic micro-organisms.

5. WATER SOURCE

11. Water used in the production and processing of fish and fishery products can be obtained from many sources, such as:

- potable (drinking) water from a public/municipal water supply system;
- freshwater from surface sources
- freshwater from groundwater sources;
- collected rainwater;
- seawater and brackish water;
- desalinated water;
- reused water originating from agricultural activities (e.g. hydroponics);
- recycled/reused processing water within an establishment recovered from a processing step within the operation.

6. WATER USE

12. Water used in the production and processing of fish and fishery products should be subject to sanitary surveys/monitoring. It should also be subject to a water fit-for-purpose assessment covering the whole water system from the source or catchment area, treatment and storage, distribution and up to the point of use (from “source to tap”). Water use should be part of an operation’s prerequisite hygiene programme and HACCP system, when applicable.

13. Water used as an ingredient and at the final stage for the preparation of filleted fishery products eaten raw, should be of potable quality. There are many other non-food applications in vessels and processing facilities where there is no intended or expected contact of the water with food – e.g. in personal use applications and fire control systems.

14. Water use should be tailored to the particular conditions of the specific fish and fishery products processing operation to which it is applied. Consideration should be given to the potential reusable water sources of the operation, the different applications of the reused water, available recovery and treatment technologies, and the capabilities of the operator.

15. Some common examples of where water is used in production or processing are:

- for washing whole fish and rinsing the fish cavity after beheading, evisceration, skinning, and trimming;
- for depuration or conditioning;
- for reimmersion in the case of live bivalve molluscs;
- as an ingredient;
- to transport/convey fish and fishery products;
- to wash, help preserve (chill/freeze) and cook fish and fishery products;
- to clean and sanitize facilities, utensils, containers, and/or equipment;
- to make ice;
- for thawing of fish and fishery products;
- for other processing purposes such as brining, glazing of frozen fish and fishery products to maintain quality during frozen storage;
- for personal hygiene purposes; and
- for non-food contact purposes.

16. Considering the General Section and the *Code of practice for fish and fishery products* (CXC 52-2003), and recognizing the specificities of the fishery products sector, as well the diversity of water sources and uses across different countries, water can be differentiated into three categories based on the “fit for purpose” principle. The three categories can be used from a microbiological safety perspective as follows:

a) Potable water

- Water fit for purpose for all uses;
- Can be used as an ingredient in fish and fishery products and for washing at the final stage of the preparation of filleted fishery products eaten raw (e.g. ceviche, sashimi);
- Standards of potability should align with the recommendations included in the latest edition of the Guidelines for drinking-water quality, issued by the World Health Organization;
- Example: drinking water from a public/municipal water supply system; when sourced from a well, the potable quality of the water should be verified; wastewater, can seep into drinking water sources e.g. after flooding and these sources should be monitored when there is any suspicion that this may have occurred;

b) Clean water:

- Water fit for purpose for all uses except as an ingredient and for washing at the final stage of the preparation of filleted fishery products eaten raw
- Should [come] from any source where harmful microbiological contamination, substances and/or toxic plankton are not present in such quantities that may affect the safety of fish and fishery products intended for human consumption.
- Example: includes offshore sea water or deep groundwater water and artificial seawater⁴. The locations of the water sources should be assessed for appropriate proximity from higher risk factors (e.g. sea water is collected sufficiently offshore, wells that are sufficiently deep) and against any recent microbiological data relevant to the source.

c) Other ~~fit for purpose~~ resources of water

- Can be used but only after a water fit-for-purpose assessment to specify what use is suitable for and after implementing additional control measures to ensure food safety.
- Example: surface groundwater, recycled/reused processing water within an establishment recovered from a processing step within the operation, or recirculated water, etc.

17. In any processing facility, contamination of the potable water system with non-potable water from other sources should be avoided. Non-potable water systems should be identified (for example, with labels or colour codes) and should not connect with or allow reflux into potable water systems. Contamination may occur for example, due to cross connections, dead legs, backflows or back siphonage in the water plumbing systems because of improper installations, or additions/modifications to the existing plumbing.

18. Before any processing stage at a processing facility, the source of the water coming into direct or indirect contact with material or product, should be identified and assessed; where necessary, testing and treatment should be applied to ensure that the water is fit for purpose for the processing step in which it will be used.

19. Food Business Operators (FBOs) should consider the following in assessing and managing water:

- Sanitary surveys/monitoring and a water fit-for-purpose assessment may be important to determine if water is fit for purpose and the likelihood of contamination in the production and processing systems.
- Characterization of surface or groundwater safety in extraction points should be extended upstream, when possible, to include the whole water catchment area.
- A water fit-for-purpose assessment should consider the specific waterborne hazards (e.g. marine microbiological contaminants) that may impact the safety and quality of the fish and fishery product.

⁴ a synthetic mixture of dissolved mineral salts that simulates natural seawater, primarily used in marine biology, aquaculture, and laboratory research.

Depending on the fishing ground of origin, seasonal and climatic factors affecting source water quality in the immediate area should be included.

6.1 Water use for aquaculture production

20. In primary production, any source of water can be used provided that its suitability for the intended use has been assessed. The type and source of water used in aquaculture systems varies by species, geographical location, and water availability.

21. Seawater is primarily used in marine aquaculture, while inland aquaculture systems primarily use water from surface and groundwater sources, although other water sources as per Section 5 can be used in both of these production systems.

6.2 Water use onboard vessels

22. Many different types and sizes of fishing vessels are used throughout the world for catching, harvesting, and/or processing fish and fishery products. Water may be used on onboard vessels for preservation, washing, holding of live seafood, and further processing of fish and fishery products, as well as various non-food contact purposes.

23. Onboard preservation of fish and fishery products can involve chilling and/or freezing. Ice is most commonly used to chill fish and fishery products onboard vessels. Other means to chill fish and fishery products include chilled water, ice slurries and refrigerated seawater, including brine freezers. Ice may be brought on board from onshore sources and/or manufactured on board using brackish water or seawater.

24. Depending on a variety of factors (e.g. the geographical region, seasonality, proximity to marine dumping, proximity to congregation of marine life, industrial or sewage outflow (e.g. wastewater, storm water, sewer overflow), agricultural run-off and temperature), seawater can hold naturally occurring pathogenic microorganisms, such as *Vibrio* spp., that may require monitoring and control.

25. Seawater is used on fishing vessels, should be taken from offshore areas that are sufficiently distant from known pollution sources (e.g. sewage outflow) to ensure that the water is of suitable quality. Cross-contamination should be avoided between the point at which seawater is taken on board, and wastewater streams, bilge water and engine coolant outlets or other potential contaminants from the fishing vessel when stationary or moving.

6.3 Water use at land-based processing facilities

26. Water is used for a variety of applications in land-based processing facilities for fish and fishery products. Recognizing the specificities of the fishery products sector, different sources of water may be used depending on the intended purpose as illustrated in Section 5. Where seawater is extracted from coastal sources for land-based processing plants, it cannot be guaranteed to be free from pathogens from the marine microbiota or from faecal contamination. It cannot be classified as a fit-for-purpose source for processing without an adequate water fit-for-purpose assessment, the appropriate monitoring and application of control measures where necessary.

27. In any processing facility, contamination of fit-for-purpose water by non-fit-for-purpose water should be avoided.

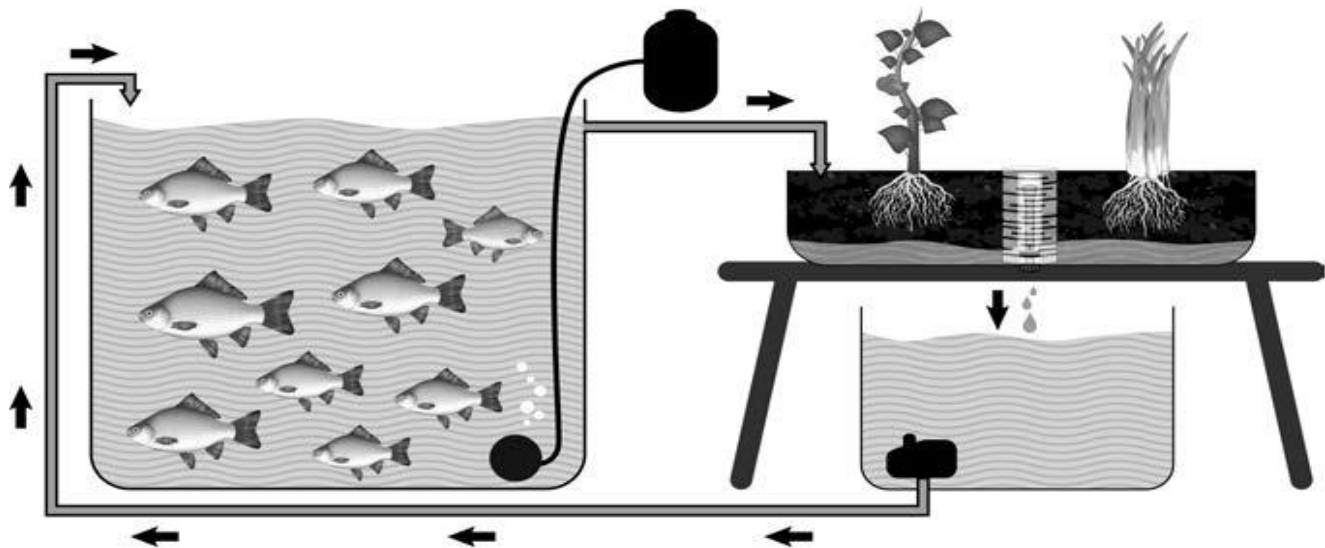
7. WATER INTENDED FOR REUSE

28. Water recovered from food, certain agricultural activities (e.g. hydroponics), processing activities (such as cooling) or treated wastewater, are good examples of water that can be reused as long as its microbiological quality is fit for purpose for its planned use. Its use could be expanded for additional applications after treatment. Any water treatment processes should be effectively monitored, controlled and recorded.

29. Examples of aquaculture systems where water can be reused include integrated multi-trophic aquaculture systems, where multiple aquatic species from different trophic levels are farmed in an integrated fashion (e.g. finfish and seaweed) and aquaponic systems⁵, which integrates aquaculture and hydroponics into a single recirculating production system (see Figure 1). The reuse of water within these (or other) aquaculture systems should be subject to a water fit-for-purpose assessment and appropriate water safety management practices.

⁵ More information on Aquaponic System could be found in FAO & WHO. 2023. Safety and quality of water used in the production and processing of fish and fishery products – Meeting report. Microbiological Risk Assessment Series, No. 41. Rome.
<https://doi.org/10.4060/cc4356en>

Figure 1. Schematic of a simple aquaponic unit⁶



30. All reuse of water in the production and processing of fish and fishery products should be part of the hygiene programme and HACCP system, when applicable.

7. WATER USE OR REUSE FIT-FOR-PURPOSE ASSESSMENT

31. Refer to section 7 of the general section and Annex IV⁷ of these Guidelines in line with the recommendations in Annex IV.

32. It is important to note that the complexity of the water fit-for-purpose assessment required will depend on the situation and level of general understanding of the risk associated with a particular scenario e.g. by just assessing the source of water and the intended use (e.g. use of potable water, use of clean water from high seas known to be free of risk of coastal or other contamination, use of deep groundwater). For other water, the water fit-for-purpose assessment should include an evaluation of the specific operation, including the type and source of water used/reused to determine which indicator(s) are appropriate to be used to monitor the water source, including reconditioned water.

33. In addition to the factors described in Annex IV of these Guidelines, fit-for-purpose assessments of water to be used/reused in the production or processing of fish and fishery products should consider process- or product-specific factors such as:

- whether the fish is dead or alive;
- whether fish products are whole or processed; and
- whether the fish or fishery product is likely to be eaten raw or undercooked.

34. General recommendations on the minimum microbiological quality for water to be fit for certain purposes include:

- Water used as an ingredient in a fish and fishery product and for washing at the final stage of the preparation of filleted fishery products eaten raw, should be potable.
- Water used in food contact applications for fish and fishery products that are potentially eaten raw or undercooked should be potable or clean water, or water demonstrated as fit for purpose through a risk assessment.

⁶ Source: FAO. 2014. Small-scale aquaponic food production. Integrated fish and plant farming. FAO Fisheries and Aquaculture Technical Paper No. 589. Rome, FAO. <https://www.fao.org/3/i4021e/i4021e.pdf>

⁷ Under development

- Any water used in direct contact with fish and fishery products during preservation or processing activities (e.g. for chilling, washing whole fish, or rinsing the fish cavity after beheading, evisceration, skinning, and trimming) should not further contaminate the product.
- Any water that can be used following the suitable outcome of a water fit-for-purpose assessment and implementation of additional control measures whenever necessary. The result of the water fit-for-purpose assessment will specify what use it is fit for.

35. Evaluating risk of microbiological hazards in water in the fit-for-purpose assessment, should include information on local hazards of public health significance (e.g. epidemiological data). Waterborne microbiological hazards and their relative risk are listed in Table 1.

36. In a fit-for-purpose assessment, the tasks in the decision processes are similar to the first steps and Principle 1 in the implementation of a HACCP system during food safety management. They include some or all of the following:

- description of the fish or fishery product;
- its intended use if known (e.g. eaten raw, cooked, ...);
- understanding the product flow from production to consumption (e.g. harvesting, processing, transport, marketing, consumer handling);
- identifying water use (e.g. washing, processing, ice, ingredient) and inputs (e.g. water source types, storage and delivery);
- identifying potential water-related hazards⁸ at each stage; and
- analysing the microbiological hazards and considering any measures in the product flow stages that may prevent, eliminate or reduce the water-related microbiological hazards introduced in the final product to acceptable levels.

37. When assessing the microbiological safety of surface or groundwater, it is important to extend the assessment upstream of extraction points, when possible. In addition, seasonal and climatic factors that may affect the microbiological quality of surface or groundwaters should also be considered.

7.1 Examples of Decision Trees

38. For practical guidance, a decision tree (DT) approach with underlying risk assessment (RA) is a useful decision support system (DSS) tool to identify whether the water is fit for purpose for use or reuse at a given step in the supply chain.

39. There is no single DT that applies/fits in all situations. The DTs below therefore should rather be considered as examples of an approach to evaluate a situation and draw attention to risk factors instead of as a tool fixed for all purposes. Competent authorities are encouraged to publish simplified national or regional decision trees to facilitate implementation by small-scale operators.

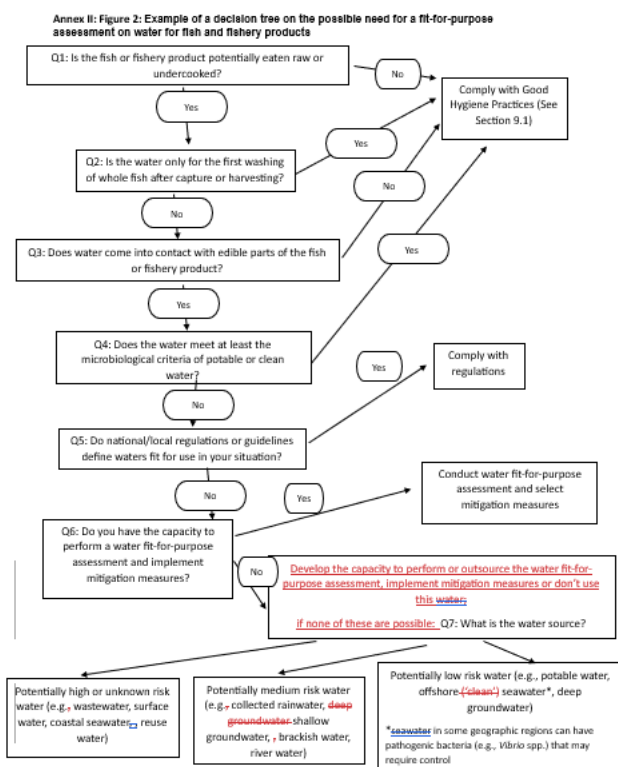
40. The DTs provide examples of how the quality of water used at each step in the process impacts final product safety, and hence whether the water available at that stage is fit for purpose or not.

41. Recommended good hygiene practices related to the appropriate use/reuse of water (see Section 9.1), historically identified using risk assessment principles, are considered sufficient to support decision making when fish and fishery products are intended to be cooked. In several cases, it will not be possible to exclude at the stage of production and processing that fish will not be consumed raw or undercooked. When not possible to guarantee that the fish will be cooked, the recommendations in these guidelines on the use of water for the production and processing of raw or possibly undercooked fish, should be applied. Figure 2 provides an example of a DT estimating associated with the use of water, particularly when a fit-for-purpose assessment on water is warranted. It also outlines potential risk characterizations for various water sources in a situation where the capacity to perform a water fit-for-purpose assessment or implement mitigation measures is lacking. Water sources considered as a potentially medium, high or unknown risk should not be used unless monitoring demonstrates compliance with the microbiological criteria of potable water, after treatment if required. Alternatively, a water fit-for-purpose

⁸ Chemical and physical hazards are out of scope, but relevant to be considered.

assessment should be outsourced or the internal capacity to conduct such assessments and implement mitigation measures should be developed.

Figure 2. Example of a decision tree to determine whether or not a fit-for-purpose assessment of the water for fish and fishery products is warranted and potential risk characterizations where the capacity to perform a water fit-for-purpose assessment or implement mitigation measures is lacking.



42. Other DTs may assist in assessing if water is fit for purpose for fish and fishery products potentially eaten raw or undercooked. In such case, the water used should represent the lowest possible risk at each stage.

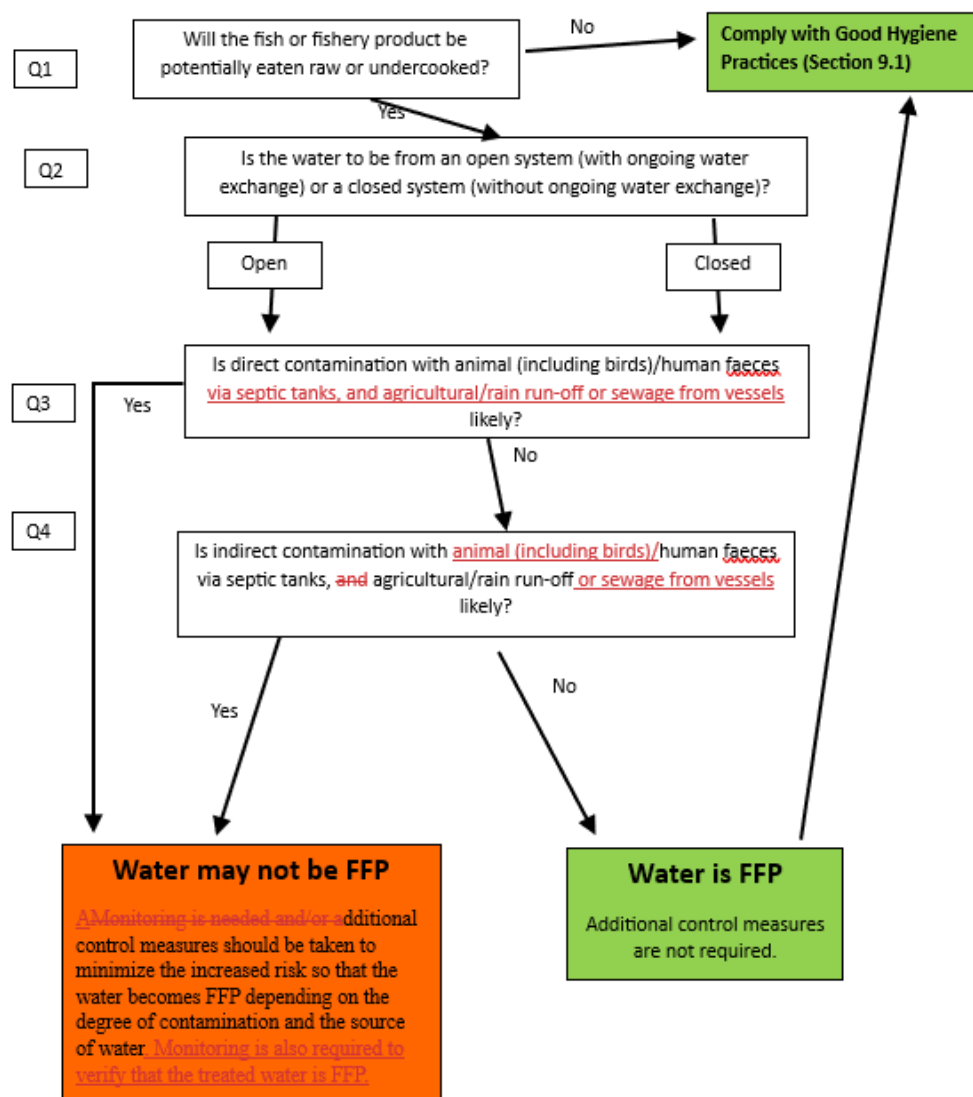
7.1.1 Example of DT to determine whether or not the water to be used in freshwater, marine or estuarine aquaculture production of fish and fishery products potentially to be eaten raw or undercooked, is fit for purpose.

43. Figure 3 provides an example DT that can be useful in determining if water systems used for the aquaculture production of fish could have been subjected to conditions/events that increase the risk of microbiological hazards such that the application of control measures to the water are necessary. Since prevention of (faecal) contamination is a good hygiene practice for any fish production, this example DT could be applied both when the fish is to be consumed cooked or uncooked.

44. When one or several possible sources of contamination (sewage nearby, faeces or surface run-off water entering the system) have been identified by the DT, the possible presence of pathogens should be considered a risk unless regular monitoring demonstrates that it is fit for purpose or control measures have been put in place and validated (the control measures can be water treatment or processing measures subsequently applied to the fish and fishery products). Any water treatment processes should be monitored, controlled and recorded. Detailed information on the possible control measures can be found in the FAO/WHO documents referred to by footnotes at different steps or in relevant national guides. For example, specific guidance to control contamination of *Vibrio* spp. in the Guidelines on the application of General Principles of Food Hygiene to the Control of *Vibrio* Species in Seafood (CXG 73-2010) should be taken into account.

45. The risk presented by water changes with the season. For example, in periods with high rainfall in a short period, the risk of surface run-off water entering the growing waters or water supply may increase. Contamination by the faeces of mammals should be avoided (e.g. restricting access to growing waters or water supplies by fencing) while contamination by bird faeces should be minimize as much as possible (e.g. by removing perches as overhanging branches).

Figure 3. Example of DT to determine whether or not the water used in freshwater, marine or estuarine aquaculture of fish and fishery products is fit for purpose.

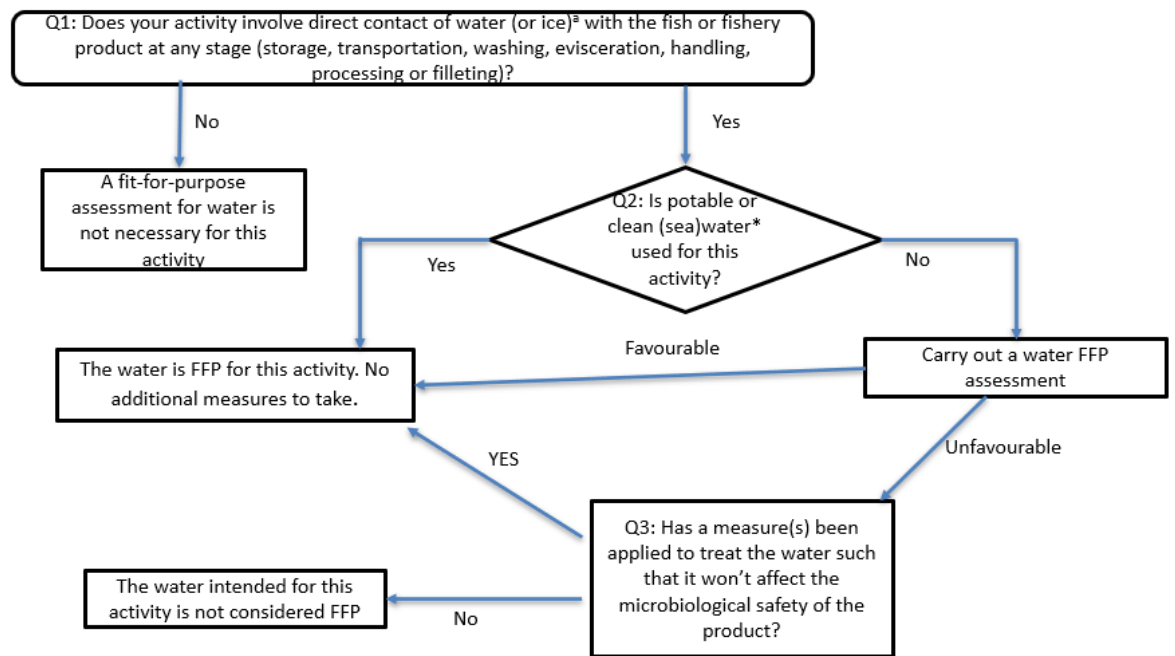


7.1.2 Example of DT to determine fit-for-purpose water used for post-harvest handling or processing of fish and fishery products, potentially eaten raw or undercooked.

46. In case of post-harvest handling and processing of fish and fishery products, the DT in Figure 4 can be used to determine if the water is fit for purpose or will require prior treatment (e.g. unacceptable levels of/ presence of pathogens) before use. Only potable or clean (sea)water would be fit for purpose for descaling, eviscerating and washing the fish cavity or use during filleting. The use of other waters would require a fit-for-purpose assessment or treatment of that water to minimize or eliminate faecal pathogens. This also applies to water used on contact surfaces (knives, cutting boards). For the (first) washing or transport (ice) of whole (non-eviscerated) fish, water can still be fit for purpose if of lower quality.

47. Consideration should be given to prevent the presence of naturally occurring marine pathogens (e.g. *Vibrio* spp.) where cross-contamination between fresh and seawater fish and fishery products may occur at this stage.

Figure 4. Example of DT to determine whether or not the water to be used for post-harvest handling and or processing of fish and fishery products, potentially eaten raw or undercooked, is fit for purpose

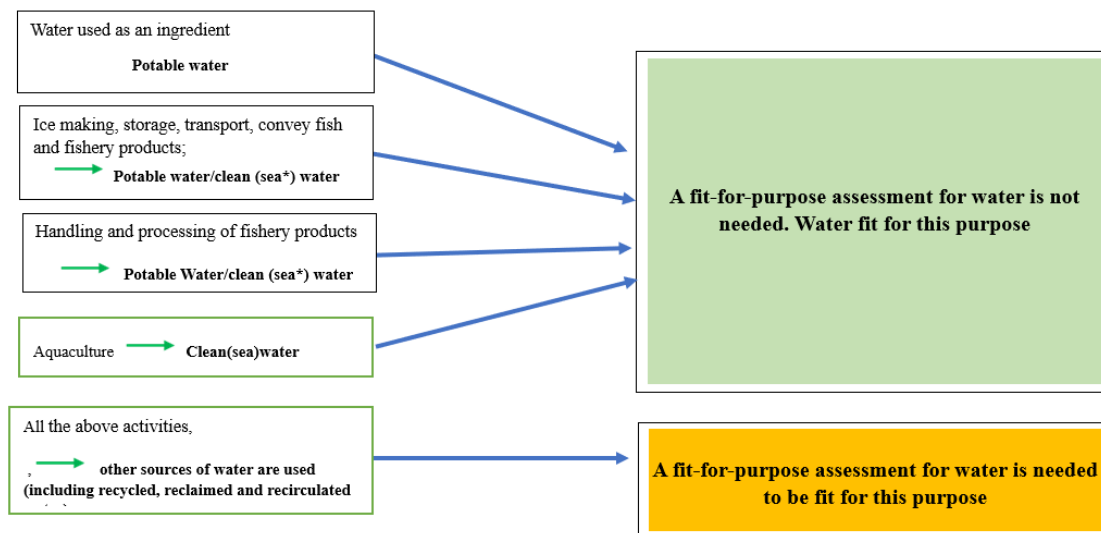


*: When seawater is used, the risk depends on the origin of seawater, e.g. the seawater from high seas has lower risk compared to seawater from coastline.
a: This also includes water used to clean all surfaces that come into direct contact with fish and fishery products.

7.1.3 Summary of examples of DTs

48. Figure 5 provides a summary of examples of water fit for purpose for use at certain steps with direct contact in fishery production and processing.

Figure 5. Summary of examples of water fit for purpose for use at certain steps with direct contact in fishery production and processing in case of fish and fishery products potentially eaten raw or undercooked



* When seawater is used, the risk depends on the origin of seawater, e.g. the seawater from high seas has lower risk compared to seawater from coastline.

8. WATER SAFETY MANAGEMENT

49. Refer to section 8 of the general section [and Annex IV^(see footnote 5)] of this Guidelines.

8.1 Good hygiene practices

50. The good hygiene practices described in this Section should be applied as prerequisite programmes to ensure the safety of any fish and fishery product by the use and reuse of water in direct and indirect contact with the product. Categorization of quality of water used at various processing steps varies and includes potable water, clean (sea)water, and other water fit for purpose for its intended use.

51. [Keeping the fish or fishery products at a low temperature (e.g. 4°C or less) is an effective measure to slow microbial growth after harvest.]

52. Whenever possible, potable water (or other water supply from any source where harmful microbiological contamination, substances and/or toxic plankton are not present in such quantities that may affect the safety of fish and fishery products) should be used for the final rinsing of fish and fishery products.

53. When seawater is used on board fishing vessels, it is fit for purpose for any washing of whole fish, preservation and other processing activities when, for example the water is collected from offshore areas that are sufficiently distant from known pollution sources (e.g. sewage outflow, ship fleets and animal congregations). The point at which offshore seawater is taken on board should be located such that contamination from wastewater streams, bilge water and engine coolant outlets, or other objectionable substances from the fishing vessel is avoided.

54. Any water used in direct contact with fish and fishery products during preservation or processing activities (e.g. for chilling, washing whole fish, or rinsing the fish cavity after beheading, evisceration, skinning, and trimming) should not further contaminate the product. It is essential that water used on fish and fishery products that may be consumed raw or undercooked is free from microbiological hazards that could pose risks to human health.

55. Where an essential onboard treatment for water used in direct contact with fish or fishery products has failed or malfunctioned, fish and fishery products should be directed to further processing (e.g. cooking) to ensure food safety.

56. Storage and transportation of live fish:

- Water should not be contaminated with either human sewage or industrial pollution; holding tanks and transportation systems should be designed and operated in a hygienic way to prevent contamination of water and equipment.
- [Water in holding and conditioning tanks should be well aerated before fish are transferred into it.]
- Where seawater is used in holding or conditioning tanks, for species prone to toxic algae contamination, the seawater shall not contain toxic algae or toxic phytoplankton in a quantity that could contaminate the contained fish and fishery products.

57. On fishing vessels, adequate facilities should be provided for the handling and washing of fish and fishery products and should have an adequate supply of cold potable water or clean (sea)water. If not gutted, the catch should be immediately frozen or stored in tanks with refrigerated seawater, in seawater chilled with ice or in boxes containing ice. Refrigerated fish should be transported in ice water

58. Processing steps that use water can be the same on board or on land and for captured or cultured fish and fishery products and may include washing and evisceration, filleting, skinning, trimming and candling, glazing and mincing.

59. Processing of fresh, frozen and minced fish:

- Washing and evisceration: an adequate supply of clean (sea)water or potable water should be available for washing of:
 - whole fish, to remove foreign debris and reduce bacterial load prior to evisceration;
 - eviscerated fish, to remove blood and remaining viscera from the belly cavity;
 - surface of fish, to remove any loose scales;
 - evisceration equipment and utensils, to minimize build-up of slime, blood and offal.
- Filleting, skinning, trimming and candling: An adequate supply of clean (sea)water or potable water should be available for washing of:

- fish prior to filleting or cutting, especially fish that have been scaled;
 - fillets after filleting, skinning or trimming to remove any signs of blood, scales or viscera;
 - filleting equipment and utensils to minimize build-up of slime and blood and offal.
60. Ice should be produced using potable water or clean water and it should be protected from contamination.
61. For operations that require steam, an adequate supply at sufficient pressure should be maintained. Steam used in direct contact with fish, fishery products or food contact surfaces should not constitute a threat to the safety or suitability of the food.
62. Washing live bivalve molluscs: Washing should be carried out using pressurized seawater fit for purpose or saltwater made from potable water. If saltwater other than seawater is used, it should be prepared from potable water and of about 3 percent of food grade salt to minimize the uptake of moisture. The salinity of the saltwater should be monitored. Reimmersion should not cause additional contamination in live bivalve molluscs.
63. Washing shucked bivalve molluscs: Pre-chilling should include the immersion of the bivalve molluscs in clean refrigerated seawater or iced seawater.
64. Fresh, refrigerated and frozen products: Transportation of fish in an ice slurry, chilled seawater or refrigerated seawater (e.g. for pelagic fish) should be considered where appropriate. Chilled seawater or refrigerated seawater should be used under approved conditions.
65. Glazing: The application of a protective layer of ice formed at the surface of a frozen product by spraying it with, or dipping it into, clean (sea)water, potable water or potable water with approved additives, as appropriate.
66. Cleaning and disinfection of equipment and facilities: A good supply of clean (sea)water or potable water at adequate pressure should be available.

8.2 Implementation of a water safety management plan based on the fit-for-purpose assessment

67. Management procedures, such as a water safety plan, should be site specific. Their elaboration and implementation should consider particular characteristics of the site and the relevant hazards/hazardous events and the outcomes of the water fit-for-purpose assessment. The management procedures should include:
- all uses of water,
 - measures to prevent contamination of water supplies,
 - measures to prevent cross-connections between a supply of water determined to be microbiologically fit for its intended use(s) and other supplies of water with lesser microbiological quality or safety,
 - any treatments, including the treatment parameters, necessary to control hazards such that the treated water is microbiologically fit for its intended use(s),
 - validation of disinfection steps of water treatments,
 - appropriate monitoring procedures and corrective actions.
68. A multi-barrier approach (e.g. protecting the water source from faecal contamination, treatment of water, and avoiding cross-contamination) is possible with regard to water safety management. The management procedures should include strict segregation measures for preventing cross-connections between supply waters of different qualities, and most importantly with wastewater systems.
69. When reusing water, the need for water treatments (e.g. biological, chemical, physical) should be considered to ensure that the water from the reuse system is fit for purpose, including conditions related to distribution, storage and intended use where relevant.
70. Revise and reinforce, as appropriate, operational monitoring, including periodic microbiological testing of water used in the production and processing of fish and fishery products to provide insight into the performance of the water safety management process. Such monitoring can enable identification of potential nonconformities and inform corrective actions, which may include additional microbiological testing of the process and/or the fish and fishery products.

8.3 Treatments for fit-for-purpose water

71. When the outcome of a water fit-for-purpose assessment or the risk characterization of a water source (see Suggested Figure 3) indicates that control of microbiological hazards is necessary for water to be fit for its

intended use, treatment options should be determined on a case-by-case basis considering the hazards that may occur through contamination (e.g. faecal pollution) as well as any naturally occurring microorganisms (e.g. pathogenic *Vibrio* spp. and *Clostridium botulinum*).

72. Treatment technologies that render water fit for purpose by eliminating or inactivating microorganisms or reducing them to acceptable levels for use/reuse water include, but are not limited to, heating (e.g. pasteurization or boiling); use of a chemical disinfectant such as chlorine, chlorine dioxide⁹, ozone; and/or physical treatments such as membrane filtration and irradiation (e.g. UV light). Guidance on resistance to chlorination by different microbiological hazards is provided in Table 1.

73. Appropriate treatment parameters should be monitored and recorded to ensure the effectiveness of any treatment technology used to control microbiological hazards in water to be used/reused in the production or processing of fish and fishery products. The efficacy of such treatments should be periodically verified through appropriate microbiological testing of the treated water.

74. For more information on water treatment technologies refer to Annex IV (see footnote 5) of this guidance.

75. If disinfection is part of the water processing facility treatment or other water treatment, the effectiveness should be validated. In this case, attention should also be paid to possible residues of disinfectants used.

8.4 Monitoring the microbiological quality of water

76. Monitoring of water is a core element of any food safety management system. It is necessary for ensuring water safety and it is important to ensure that various type of water use in the production and processing of fish remain fit for purpose. The monitoring frequency must be risk-based and should be increased following unusual events (e.g. flooding, sewage incidents, harmful algal blooms) and tapered once trends stabilize and controls are verified.

77. The microbiological quality of any water used in the production and processing of fish and fishery products should be monitored at a frequency commensurate with the level of risk identified in the water fit-for-purpose assessment. Monitoring practices should cover the whole water system, from the source or catchment area, treatment and storage, distribution and up to the point of use (from “source to tap”). Historical data and information, including seasonal and climatic factors, should be considered when determining the frequency of monitoring. Additional monitoring should be carried out following weather events that may affect water being fit for purpose (e.g. flooding).

78. No single indicator microorganism (or group of microorganisms) is suitable for monitoring the safety of water from all potential water sources and in all applications in the production and processing of fish and fishery products. The limitations of various indicator microorganisms to appropriately identify microbiological safety of water in a specific application should be understood. There is rarely a direct correlation between indicator microorganisms (e.g. coliform bacteria), and enteric pathogens (e.g. protozoans or viruses) or naturally occurring pathogenic microorganisms (e.g. *Vibrio* spp.). In addition, pathogens may be present in the absence of indicator microorganisms. Notwithstanding these issues, testing for indicator microorganisms affords a better degree of health protection than testing for pathogens alone.

79. If the water is not potable nor clean, the water fit-for-purpose assessment of the type and source of water to be used/reused/reconditioned should include an evaluation of processes and procedures specific to the operation to determine which indicator(s) are appropriate for monitoring the microbiological safety of the water. In some circumstances, monitoring certain physico-chemical parameters may be useful in assessing the microbiological safety of water. Direct monitoring for pathogens may still be required, at an appropriate frequency, where suitable indicators for particular pathogens are not available.

80. Geographical region and temperature of seawater should be considered as they may impact the level of pathogenic bacteria, viruses, and parasites, and hence the utility of indicator organisms.

81. When monitoring water quality in a harvest region or area, contamination risks from surface or groundwater from the immediate area of the catchment, as well as further upstream in the catchment area should be assessed. In addition, seasonal and climatic factors across the whole water catchment area should be considered.

82. When establishing a new monitoring programme for the microbiological safety of water, it may be appropriate to begin with frequent sampling testing to rapidly establish a baseline profile of water safety. This

⁹ Attention should be paid to the possible formation of toxic compounds when adding chemical disinfectants to seawater.

baseline can then inform the design of subsequent monitoring, which may involve reduced sampling frequency, as appropriate. The selection of an analytical method for water testing should meet the information and management needs of the monitoring program as determined by the fit-for-purpose assessment of the water system and its historical data. The selection may also consider the laboratory and human resources available, the speed of analyses required, and validation of the method for the specific type of water being analysed, among other factors.

83. Monitoring procedures should include a description of corrective actions that will be taken when testing identifies a potential problem with the microbiological quality or safety of water used/reused in the production or processing of fish and fishery products. The corrective actions can include additional microbiological testing of water (collected from various processing steps from the water supply to point of use) and/or the fish and fishery products.

Table 1. Risk Ranking on the most significant waterborne microbiological hazards of relevance to fish and fishery products and their resistance to disinfection by chlorine¹⁰

Microbiological HAZARD	RISK RANKING	RESISTANCE TO CHLORINE
Bacteria		
<i>Aeromonas hydrophila</i>	++	Moderate
<i>Bacillus cereus</i>	++	High (spores)
<i>Campylobacter jejuni/C. coli</i>	+++	Low
<i>Clostridium botulinum</i>	+++	High (spores)
<i>Escherichia coli</i> , pathogenic	+++	Low
<i>Listeria monocytogenes</i>	+++	Moderate
<i>Pseudomonas aeruginosa</i>	+	Moderate
Non-tuberculosis mycobacteria	+	High
<i>Salmonella enterica</i> , all serovars	+++	Low
<i>Salmonella</i> , typhoid	+++	Low
<i>Shigella</i> spp.	+++	Low
<i>Vibrio cholerae</i>	+++	Low
<i>Vibrio parahaemolyticus</i>	+++	Low
<i>Vibrio vulnificus</i>	+++	Low
<i>Vibrio</i> , other species	+	Low
<i>Yersinia enterocolitica</i>	++	Low
Viruses		
Enteroviruses	+++	Moderate
Hepatitis A virus (HAV)	+++	Moderate
Hepatitis E virus (HEV)	+++	Moderate
Norovirus and Sapovirus	+++	Moderate
Rotavirus	+++	Moderate
Protozoans		
<i>Acanthamoeba</i> spp.	+	High
<i>Cryptosporidium parvum</i>	++	High
<i>Cyclospora cayetanensis</i>	++	High
<i>Entamoeba histolytica</i>	+++	High
<i>Giardia lamblia</i>	+++	High
<i>Toxoplasma gondii</i>	+++	High
Helminths		
<i>Anisakis</i> spp.	+++	N.R.
<i>Dracunculus medinensis</i>	+++	Moderate
<i>Schistosoma</i> spp.	+++	Moderate
<i>Diphyllobothrium latum</i>	++	N.R.

N.R. = Not relevant.

Note: The risk ranking in the table refers to the risk for consumers of fishery products and is based on the perceived frequency and consequence of disease: (+) low risk to consumers; (++) common cause of foodborne disease, but of variable importance for fishery products; and (+++) cause of disease by fishery products and of potentially high risk to consumers. The hazards listed are assumed to represent all regions globally and include those hazards relevant to all types of water, including fresh-, brackish- and seawater. The selection of hazards when evaluating risk should be based on local circumstances, particularly where the water is used.

¹⁰ Adapted from FAO & WHO. 2023. Safety and quality of water used in the production and processing of fish and fishery products – Meeting report. Microbiological Risk Assessment Series, No. 41. Rome. <https://doi.org/10.4060/cc4356en>