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Fish Processing Plants

Guideline for Live Retail Fish Holding Systems

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Table of Contents

Index of Tables

Introduction

Fish can be held in holding tanks if they are going to be sold within 2-3 days. The design and operation of a live fish holding system plays an important role in maintaining fish health, preventing worker illness, and in the prevention of foodborne illness.

Proper design will facilitate cleaning and sanitizing of the equipment. In addition, the hydraulic design of the unit is important to assure an adequate quantity and quality of water for the intended purpose. Inadequate flow or "dead spots" can lead to bacteriological growth and/or oxygen deficiency and can lead to fish mortality. Minimum turbulence will permit feces and other organic matter generated by active fish to settle out without being suspended and ingested. Use of food grade materials for all construction materials and additives will prevent possible adulteration by chemicals.

Source water for marine holding tanks must meet certain standards. Water may be made from aquarium marine salts or food grade ingredients (artificial water), purchased commercially, or obtained from marine environments as long as the water can be verified to meet the standards. Depending on the species of live animals stored in the holding tank, salinity and temperature requirements may vary.

Holding tanks also have the potential to pose a serious health concern for employees. Fish are known to carry organisms that may cause infection and disease in humans. These pathogenic organisms are transmitted to humans either by direct handling of the fish or indirectly through contacting tank water.

Common microbes, that have the potential to cause serious infections and even death, include *Vibrio* spp. such as *Vibrio vulnificus*, *Salmonella* spp., and *Streptoccocus iniae*. Although all individuals are susceptible to these pathogens, workers that are immunocompromised or elderly are at higher risk. However, with properly functioning equipment, such as filters and pumps, the risk of workers or the public becoming infected with these disease decreases. Proper use of materials for construction and appropriate installation of equipment is therefore essential for public safety.

Definitions

Ammonia: Toxic byproduct of fish metabolism and dead and dead/decaying organic matter.

Defoamer: Chemicals used to reduce or eliminate foam in holding tanks.

Filter Feeders: Animals that feed by straining suspended matter in water.

Fish: In this guideline, fish refers to any of the following:

> Bivalves: Molluscs are invertebrates that have symmetrical two part shells. Examples include: scallops, oysters, clams, mussels.
>
> Crustaceans: Crustaceans are invertebrates with an external skeleton. Examples include: lobsters, crabs, shrimp, and crayfish.
>
> Finfish: free swimming aquatic vertebrates that are typically ectothermic and have scales with two paired fins. Examples include: catfish, salmon, trout.

Food premise: means any place where food intended for public consumption is sold, offered for sale, supplied, handled, prepared, packaged, displayed, served, processed, stored, transported or dispensed

Nitrifying Bacteria: Responsible for converting ammonia into nitrites and nitrites into nitrates. Nitrites are also toxic but less than ammonia, nitrates are relatively non-toxic.

pH: Measure of the acidity or alkalinity of a solution using a scale from 0 to 14.

Salinity: The concentration of salt in a solution.

Turbidity: Measure of the cloudiness of a solution due to suspended solids.

Ultra Violet (UV) Light: a white tubular appliance, which is connected to the water hose lines. The unit contains a UV bulb, which kills bacteria as they pass by.

Tank Specific Terms:

> **Backwashing**: water is run through the filter in the opposite direction from normal flow
>
> **Biofilter**: Detoxifies soluble waste products
>
> **Display Tank**: Reservoir containing water
>
> **Filtration System**: Removes particulate waste from organisms
>
> **Primed**: Pump is immersed in water
>
> **Pumping System**: Maintains water circulation to keep the water continually aerated
>
> **Temperature Control System**: Heating or Refrigeration Unit

Fish Holding System Design

Each fish holding system should have the following requirements:

1. Equipment and utensils should be constructed with materials that are durable, non-absorbent, non-toxic and easily cleanable.
2. A recirculation system should include a filtration system which includes both mechanical filters and biofiltration (Appendix I).
3. Refrigeration units that can cool water temperature to 10°C (50 °F) or lower. Low temperatures reduce the metabolic activity of organisms resulting in a smaller waste load and allows for more dissolved oxygen to be held in the system (Appendix II).
4. An adequately designed aeration system that provides a minimum of 5 milligrams/litre (mg/l) dissolved oxygen
5. Units that store bivalves require a UV disinfection unit (or equivalent water treatment device) capable of maintaining the water quality at a bacteriological count of 2 coliform/100 ml or less (Appendix III).
6. Dead-ended pipes or hoses that could fill with stagnant water should be avoided.
7. Systems should be equipped with backflow prevention devices to protect potable water supplies.

Fish Holding System Operation

1. The manual and a working set of maintenance instructions should be readily available for each retail live fish holding system. These should include frequency of flushing for mechanical/biofilters and UV light bulb change frequency and instructions.
2. Defoamers, if used should be of food grade quality.
3. Turbidity of water shall not exceed 20 NTU.
4. Product loading should not exceed the manufacturer's recommended limits. The number of kilograms (pounds) of bivalves and crustaceans should be less than the number of litres (gallons) of water in the system. No more than 6 kg of finfish should be held in 100 litres of water (50 lbs per 100 gallons). Product loading information is shown in Table 1.
5. Separate tanks for bivalves, crustaceans and finfish must be provided. **DO NOT** place bivalves into the same tanks as crustaceans and finfish. The order in separate holding tanks is important if the tanks are all connected and receiving water from the same source. Otherwise, metabolic waste products from finfish and crustaceans may be filtered in by bivalves. This creates a potential health hazard for consumers. As a result, the bivalves must be placed in the tanks receiving the cleanest water, closest to the water supply source.

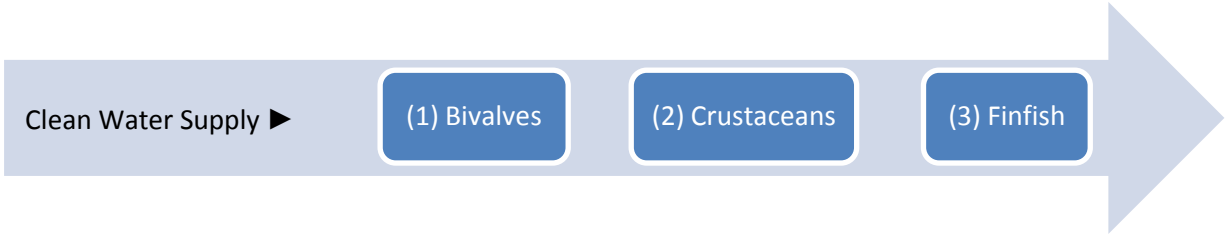

Table 1. Tank Loading Guidelines

	Recommended Loading		Recommended Temperature	
	Kilograms per 100 Litres	Pounds per 100 Gallons	°C	°F
Crustaceans	12 kg	100 lbs	4 – 10	40 – 50
Dungeness Crab	7.2 kg	60 lbs	3.3 – 5	38 – 41
Rock Crab	7.2 kg	50 lbs	4 – 13	40 – 55
Freshwater Prawns	2.5 kg	30 lbs	27 – 31	80 – 88
Shellfish	9 kg	75 lbs	4 – 10	40 – 50
Finfish	6 kg	50 lbs	9 – 11	9 – 11

Bivalves – Special Requirements

In the case of bivalves, the following requirements apply (Appendix IV):

1. Holding systems previously used for other species must be cleaned and sanitized prior to use for bivalves.
2. Prior to placement in tanks, all bivalves should be washed and culled to remove dead, broken or weak animals and culled on a daily basis, thereafter.
3. Bivalves should be held in a physically separate tank, and should not be mixed with other fish species (crustaceans, finfish). Bivalves are filter feeders that can filter in wastes from other products in the tank.
4. Bivalves that share the water system with other fish species should be placed in their own separate tank closest to the water supply source.
5. Bivalves from different suppliers, harvest areas or harvest dates should not be commingled. Vertical plastic dividers, mesh bags, etc., may be used to maintain lot identity.
6. Naturally occurring bacteria in bivalves that cause human illness, such as *Vibrio*, can multiply at warmer holding temperatures. Retail tank holding temperatures for bivalves should be kept below 10°C.

Domestic Aquaculture Products – Special Requirements

In the case of aquaculture products, the following requirements apply (Appendix IV):

1. Only artificial water (water made from marine aquarium or food grade salts) should be used for aquaculture products. For aqua-cultured bivalves, see Appendix V for additional water options.
2. Aqua-cultured species (such as tilapia and white legged shrimp) must be placed in holding tanks separate from other products due to their different salinity and temperature requirements.

Fish Water Quality and Source Requirements

1. Artificial sea water must be prepared from marine aquarium or food grade ingredients and salts with potable water from an approved source.

2. Marine water used in a retail live fish holding system may also be purchased from a commercial supplier. Commercial suppliers of marine water for food premises and for processing plants must meet several requirements and these are outlined in Appendix V. When purchasing marine water, ensure the supplier tests their water regularly to meet the same water quality requirements as your re-circulating tank, i.e. to have a bacteriological count of 2 coliform/100 ml or less with maximum turbidity of 20 NTU.
3. Marine water used for retail live fish holding systems may be drawn directly from the ocean if the site is approved and open to bivalve shellfish harvesting. To check whether the water is an open harvest area, consult the Department of Fisheries and Oceans web-site ***each time water is collected*** at http://www.pac.dfo-mpo.gc.ca/fm-gp/contamination/biotox/index-eng.html.

Fish Holding System Maintenance

Maintenance procedures (Appendix VI) should include regular water testing of holding tanks every 2 days when a system is being set up and weekly when the biofilter is mature (ammonia concentration is low). The parameters that need to be tested and their appropriate ranges are included in Table 2 below.

Table 2. Tank Water Requirements

Parameter	Range Cold Water Tanks	Range Warm Water Tanks[1]		How often to check?
Water Type (fish species)	Salt-water	Salt-water (white-leg shrimp)	Fresh-water (tilapia)	
Specific Gravity (Salinity)	1.024-1.029 (24 to29 ppt)	1.003-1.005 (3 to 5ppt)	1.000 (no salt, 0 ppt)	Daily
Temperature	<10°C	>20°C		Daily
pH	7.0-8.5	7.0-8.5		Weekly
Ammonia	<10ppm	<10ppm		Weekly
Nitrite	<2 ppm	<2ppm		Weekly
Nitrate	<100ppm	<100ppm		Weekly
Dissolved Oxygen	5mg/L	5mg/L		Weekly
Coliform Count	<2 Coliforms/100mL	<2 Coliforms/100mL		Weekly
Turbidity (max)	20 NTU	20 NTU		Weekly

[1]*Domestic aquaculture tilapia and white legged shrimp*

Most of these tests can be done onsite with a simple test kit for immediate results. Samples can also be sent to an accredited lab where accurate results will be obtained within 24-48 hours. Samples that will be sent to a lab for analysis should be collected in approved containers (contact lab) and should not be stored in direct sunlight or hot areas.

Designated employees should be responsible for maintenance.

Maintenance instructions, operating manuals and checklists should be made available (example checklists, Appendix VII).

For cleaning and servicing of the holding tank, including the filters/biofilters and UV lights, the manufacturer's recommendations in the operator manual should be followed. Basic instructions are shown below.

Weekly cleaning and servicing of the holding unit:

1. replace water every 4-7 days in the absence of a biofilter
2. check spray nozzles for clogging
3. backwash filters for 2-5 minutes to dislodge waste particles
4. remove rubber bands, paper, claws, legs and other foreign objects from intake area of pump
5. ensure the pump's impeller is primed to prevent overheating
6. refrigerator condenser should be free of dirt and debris
7. liquid refrigerant is clear without bubbles (bubbles indicate a gas leak and will result in the warming of water)
8. servicing and testing the UV disinfection system every 6-8 weeks, plus replacement of the UV bulbs every 9-10 months (spare bulbs should be readily available)

Record-Keeping

1. Maintenance and operational logs (water quality, temperature, etc.) are filled out daily, complete and should be kept for a minimum of 90 days (3 months), and
2. **Bivalve requirements:** Invoices and shellfish tags for each lot of bivalves should be kept on site for a minimum of 90 days (3 months). These should be made available for review upon request. The shellfish tags describe the processor, harvest location, harvest date and verify the shellfish has been inspected in a federally registered plant.

Workplace Safety

Injuries from Holding Tanks/Fish

Employees must work diligently and carefully when dealing with fish to ensure they don't get cuts, scratches, or puncture wounds. Furthermore, proper precautions need to be taken to ensure infectious organisms from the fish or their tank don't enter skin wounds of handlers and cause infection. Finally, although rare, humans may also experience sensitivity to fish allergens through skin contact or inhalation.

Precautionary Measures for Employees

To ensure worker safety and prevent bacterial infections, the following precautionary measures should be applied when dealing with holding tanks:

1. Do not place hands/arms directly into the holding tank if you have an open wound. Make use of protective gloves that effectively cover the wound.
2. Perform thorough hand washing both before and after handling fish and contaminated water. Avoid touching your face, nose, eyes, or mouth with contaminated gloves or unwashed hands.

3. If you are injured while handling fish or contaminated tank water immediately clean all abrasions and cuts with soap and water (avoid the use of antimicrobial soap).
4. Report accidents to the supervisor.

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Appendix I: Mechanical Filters and Biofilters

Mechanical and biofilters reduce water turbidity and must be located before the UV system.

Mechanical filters are used to physically trap waste particles in holding tanks for removal. There are 4 types of mechanical filters:

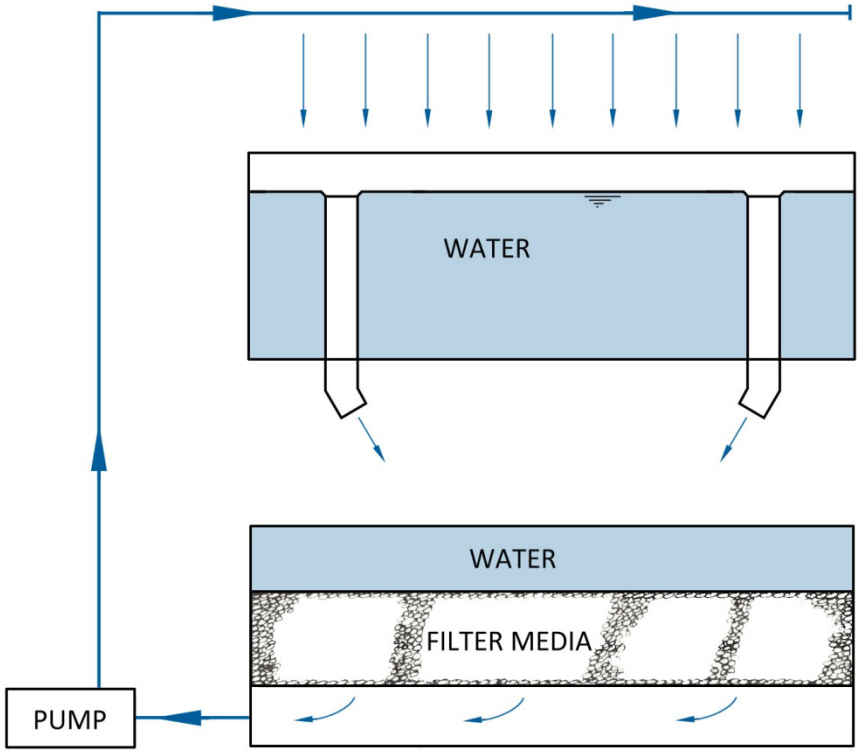
1. carbon filters
2. sand filters
3. diatomaceous earth filters
4. pre-filter pads

Biofilters are an essential component of all holding tanks that are used to detoxify soluble metabolic wastes.

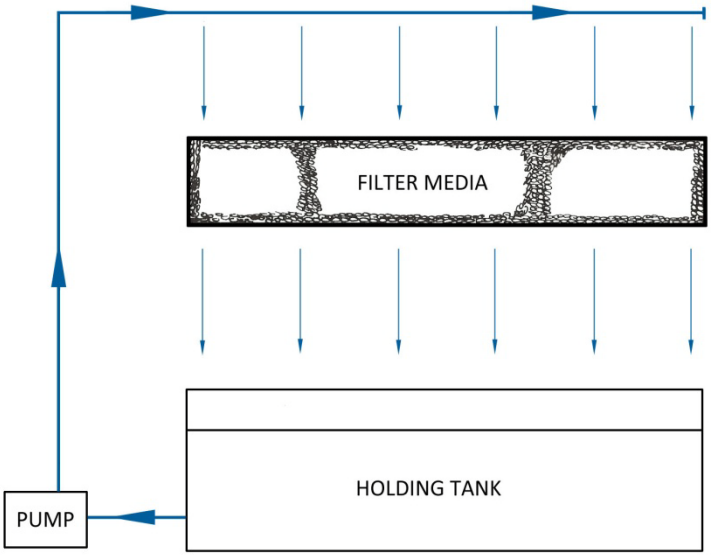
The active element of biofilters is nitrifying bacteria which break down toxic ammonia into less toxic nitrites and nitrates. Nitrifying bacteria are present on the body surfaces of organisms and therefore are automatically introduced into a holding tank when products are placed into the system. The bacteria will then grow on surfaces where nutrients (ammonia/nitrites) are present. It will take 4-6 weeks for a biological filter to become fully established and reach a balance in the system. This system balance can be observed with a low ammonia concentration in the tank.

There are 3 common types of biofilters:

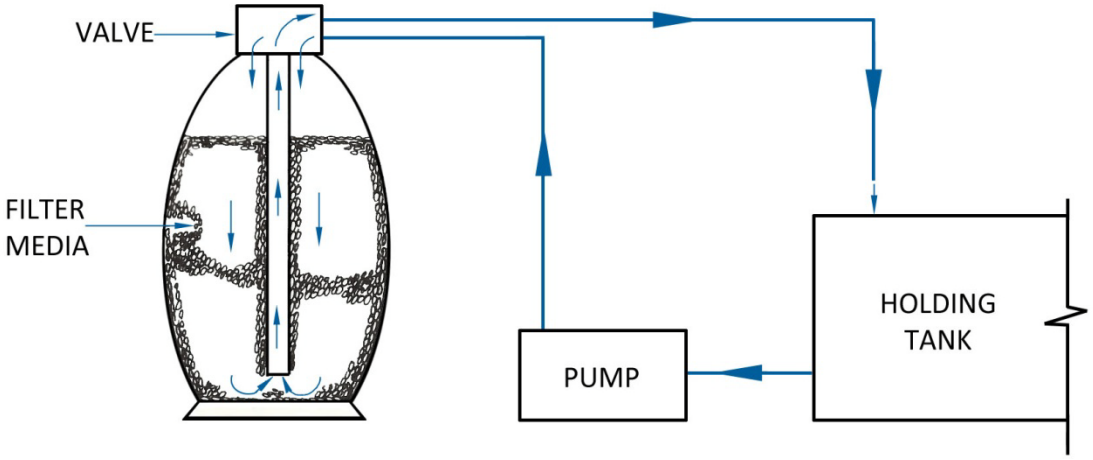
1. Submerged Filter: this filter is completely underwater and a constant flow of water is forced to pass through the filter. This filter type is most effective at removing ammonia.



2. Trickle Filter: this filter uses gravity to move the water through the filter. Water is sprayed on top of the boxed filter and gravity moves the water through the filter and out the perforated bottom of the box.



3. Pressurized filter: pressurized water is forced into a filter-filled vessel and then returned to the holding tank.



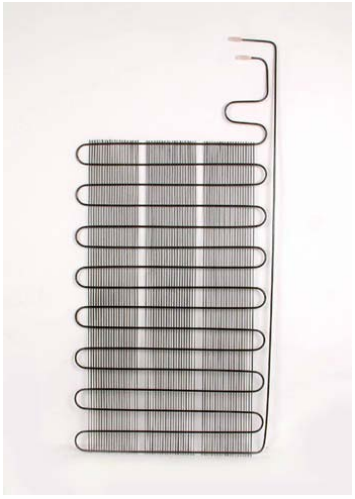
Diagrams copied/modified from: Lappin, Peter. J. (1986). Live Holding Systems: A Guide and Reference Manual.

Appendix II: Temperature Control

Fish and shellfish have an optimal temperature range in which they will remain alive and healthy. The temperature control system is responsible for maintaining that temperature range. In particular a refrigeration system is used to keep the temperature of the holding tank. Although most fish will survive in a cold holding tank (<10°C/50°F) some fish including tilapia and white legged shrimp require warm holding tanks (>20°C/68°F).

The refrigeration unit of the system should be monitored weekly. When servicing the unit, the condenser and sight glass need to be checked. The condenser converts the refrigerant gas into liquid. A sight glass is a transparent tube through which the level of liquid can be noted. The condenser should be free of dirt and dust. The sight glass should be checked to see if the liquid refrigerant is clear and contains no bubbles. The presence of bubbles is indicative of a gas leak in the system. Without proper corrective action, the gas leak will lead to the system's water becoming warmer.

Condenser



Sight glass

Appendix III: Ultraviolet (UV) Light Water Disinfection System

What a UV Light System Does

A UV-Light system functions as a disinfection unit that uses UV light, at a specific wavelength, to destroy micro-organisms. UV light is a known mutagen that targets nuclear DNA and disrupts the normal cellular processes of bacteria, viruses, and other micro-organisms. Ultimately, micro-organisms are unable to reproduce and die. The micro-organism destroying property of a UV light system is dependent on several properties:

1. length of exposure to UV
2. micro-organisms ability to withstand UV exposure
3. presence of particles that can protect microorganisms from UV (i.e. turbidity)

As a result, constant water circulation from the holding tank, through the UV unit, and back into the holding tank is important to ensure microorganisms are being targeted. Good water clarity improves disinfection; holding tanks should not be turbid as solid particles can shield microorganisms from the UV light. The UV system must be fully emerged in the water for correct disinfection, and it should be placed after the mechanical/biofilter system.

Ultraviolet (UV) Light Maintenance

The UV system needs to be regularly maintained to ensure proper disinfection is taking place. Maintenance involves both changing the UV light unit and cleaning the UV bulb. Follow the manufacturer's instructions for your system. If none are available use the guidelines in Table 3.

Table 3. Changing UV Bulbs and UV Light Units

Changing UV Bulb	Cleaning UV Light Tank
1. Unplug unit.	1. Drain tank. Do not remove bio-mix.
2. Remove protective end caps from chamber.	2. Mix ½ cup bleach with 1 gallon fresh water.
3. Disconnect bulb-pin plugs from both end of bulb.	3. Remove spray tops from riser tubes.
4. Remove "O" rings from each end and save for new bulb.	4. Pour ½ of bleach solution (from #2) down each riser tube using a funnel or container with a pour spout.
5. Remove old bulb and replace with new one.	5. Leave tank drain closed and allow solution to stand in tubes for 30 minutes.
6. Replace "O" rings and reconnect plugs and end caps.	6. Open tank drain and flush out solution by running water from hose down each riser tube.
7. Plug in unit.	7. Flush system completely.
8. Replace bulb every 9-10 months.	8. Clean UV light unit every 6-8 weeks.

Appendix IV: Bivalve & Aquaculture Operator Maintenance Guidelines

Bivalves – Regulatory Requirements

Oysters, clams and mussels in a living state should be adequately protected to remain safe, wholesome and attractive to the consumer. Federal, provincial and local health regulations usually have specific sanitary controls and record keeping requirements that are to be applied to the shellfish by all wholesalers and retailers.

In brief, these requirements usually specify that:

1. Shellfish are to be stored and handled so as not to become contaminated.
2. Storage equipment is to be properly designed, constructed, and cleaned.
3. Different lots should be stored separately.
4. Health officials should be able to trace a lot of shellfish to the original shipper and harvest area of origin.

Therefore, the maintenance guidelines should be followed to conform to federal and provincial requirements.

British Columbia Programs that Monitor Shellfish Quality and Safety

The Canadian Shellfish Sanitation Program (CSSP) classifies harvesting areas and controls the commercial and recreational harvesting and processing of shellfish for the consumer market. The CSSP is run by three (3) federal government agencies:

- Environment Canada (EC)
    - Monitors water quality in shellfish areas
- Canadian Food Inspection Agency (CFIA)
    - Monitors for marine toxins in shellfish areas
    - Registers and inspects shellfish processing plants
- Fisheries and Oceans Canada (DFO)
    - Opens and closed harvest areas
    - Prohibits shellfish harvesting when unsafe

Section 54 of the *BC Fish Inspection Regulations* requires that all commercially harvested bivalves are processed at a federally registered fish plant prior to their sale. All companies and individuals throughout the distribution system, including retailers and restaurateurs, have a responsibility to ensure that only legally processed shellfish are used in their operation. Shellfish are processed and inspected to check for toxins and check that shellfish are harvested from approved areas. Bivalve shellfish tags are required to be kept for one year by all businesses purchasing bivalve shellfish.

Bivalves shucked in BC are sold in containers that are identified with the product name, net contents of the container, registered processor distributor name, registration number of the processor, positively sealed, and best before date. It is also a requirement under the *BC Fish Inspection Regulations* that these containers are sold intact and are not displayed for bulk sales.

When packaged in retail containers, bivalves sold in the shell require an identification tag on each container that includes the following information: harvest area, best before date or date of harvest, registration number of the processor, registered processor or distributor name and address type and quantity of shellfish. This information must remain with the product as it is distributed throughout the wholesale and retail system. Tag identification is the most evident safety verification available to the retailer or restaurant operator. If a sack of shellfish is broken into smaller quantities at the distributor a new tag with the same information must be affixed to each container.

Harvesting of bivalve shellfish from closed areas is a serious contravention of Federal and Provincial regulations, and could pose a serious health risk, including death, to consumers. The potential liabilities for those selling illegally harvested bivalves, far overrides the immediate financial gains that may be had.

Bivalves –Tank Maintenance and Cleaning Requirements

1. Cull out dead, cracked and weak bivalves daily.
2. Before adding new bivalves to the retail live holding system, make sure they are cleaned thoroughly and that you cull out dead, cracked and weak bivalves.
3. If the tank is ever used for crab, lobster, etc., then it should be sanitized before bivalves can be added. Do not comingle species. To sanitize the tank, follow the instructions for cleaning the UV light (Appendix II.). At the end of the 30 minute soaking period, do not open the drain. Fill tank to normal operating level with fresh water and turn system on for 30 minutes. After 30 minutes, turn system off and thoroughly flush out tubes, bio-mix, and tank sides. Make sure all bleach smell is gone before adding the bivalves.
4. Never mix lots of bivalves, which come from different shipping containers and are marked with different shipping tags. If bivalves are added to a tank which already has the same species, then the two lots should be kept separated with a non-absorbent, easily cleaned divider or by the use of non-toxic, single use mesh bags (these requirements are designed to facilitate trace back on a food poisoning and/or food recall).

Bivalve Recommendations

- Shellfish should only be purchased from reputable distributors who are established in the seafood business. Shellstock must never be received unless accompanied with a fully completed tag or other reliable evidence that they have been processed at a federal plant.

Tag information must be retained for a minimum of 90 days (3 months)

- During transportation, storage, and display, bivalves must be protected from contamination and maintained at refrigerated temperatures. Product must be checked for identification and obvious abuses when received. Suspect product must not be accepted.
- Purchase BC shucked bivalves only in fully labelled containers.
- When *Live Holding Tanks* are used to store or display bivalves, they should be designed, constructed, and maintained such that the water quality will not cause product contamination. Use of refrigerated water, effective filters, water disinfection devices, and avoid mixing with other species of fish are all important safety controls.

Aquacultured Tilapia and White Legged Shrimp

Aquaculture products, such as tilapia and white legged shrimp, will need to be placed in tanks separate from other organisms. Both tilapia and white legged shrimp have temperature and salinity requirements that differ from other products. Specifically, tilapia has an optimal temperature range of 25-30°C (77-86°F) (and temperatures below 10°C (50°F) can be lethal. Furthermore, most species of tilapia can be grown in brackish waters, with salinity close to seawater levels. White legged shrimp also grow best in brackish high temperature waters, >20°C (68°F).

Land-grown aquaculture products are grown in filtered sterilized water in a disease free environment. For this reason, only use artificially prepared sea water. Do not dilute or substitute ocean water. Aquaculture products may not have resistance to any normally occurring fish diseases, so mixing them with other species or ocean water may cause disease in the fish.

Appendix V: Commercial Suppliers of Marine Water: Requirements

Marine water used in retail live fish holding systems must be able to meet certain chemical and microbiological requirements. The operator of a food premise may be required to provide periodic testing results from commercial suppliers to demonstrate that the water in their retail tanks meet these requirements to their local Health Authority. Similarly, commercial suppliers of marine water (to food premises), may also be required to provide periodic testing results to ensure they meet standards to their local Health Authority, and in some cases to the Canadian Food Inspection Agency. Commercial suppliers of marine water should also be able to provide a safety plan that describes where water will be collected, treatment of water (if any) and description of plans to ensure the water is free from harmful materials.

Potential hazards associated with marine water are site dependent. While naturally occurring bacteriological hazards (such as *Vibrio* spp.) and marine biotoxins from algal blooms (such as saxitoxin and paralytic shellfish poisoning) can occur at any time, other hazards from sewage, run-off, heavy metals and pollutants may be localized. These hazards may include ***Metals & Chemicals*** ammonia, arsenic, barium, cadmium, chromium, copper, iron, lead, nickel ***Persistent Organic Pollutants*** chlorophenols, chlorine-produced oxidants, phenols, styrene, tributylin ***Water Quality*** dissolved oxygen, suspended solids turbidity ***Bacteria and Viruses*** hepatitis A, norovirus, *Salmonella* (from sewage sources).

Drawing water from the marine environment also has environmental impacts, subject to oversight by different agencies. If water is drawn from an area under the purview of the Port Authority, authorization from that agency is required. Intakes should be designed to not harm fish or habitat. Authorization from the Department of Fisheries and Oceans can be sought, but is not necessary. It is recommended that businesses get a review of their proposal from an environmental consultant company if they have concerns. However, be aware that if fish or habitat is destroyed, penalties could be levied under the federal *Fisheries Act*.

The following general requirements will apply to marine water being harvested for commercial purposes that <u>does not</u> receive further treatment.

- Provide a drawing or map showing the exact site where water will be drawn. Include in the drawing any docks, sewage or storm-water outfalls or any industrial sites near the water intake.
- Water drawn from the marine environment can be a source of contamination for fish, shellfish or crustaceans stored in live tanks. Water must be drawn from appropriate locations to ensure it is not contaminated with chemicals, marine biotoxins, bacteria or viruses. In lieu of other means of verifying water quality, the classification and status of shellfish harvest areas described in the Canadian Shellfish Sanitation Program (CSSP) can be used. Marine waters without further treatment should be drawn from approved and open harvest areas as per the CSSP. Consult this web-page for detailed information Chapter 5 - wet storage.
  http://www.inspection.gc.ca/food/fish-and-seafood/manuals/canadian-shellfish-sanitation-program/eng/1351609988326/1351610579883?chap=8.
- To check whether the water is an open harvest area, consult the Department of Fisheries and Oceans(DFO) web-site ***each time water is collected*** at:
  http://www.pac.dfo-mpo.gc.ca/fm-gp/contamination/biotox/index-eng.html.

- Include in the safety plan a description of how the DFO web-site will be checked each time water is drawn. For food premises or commercial operations equipped with flow-through water systems, daily checks of the DFO web-site will be required. Marine biotoxins can develop rapidly in the event of algal blooms, and the premise must be equipped to shut off the water supply and provide an alternate water source.
- There must be a water intake shut-off valve to control water flow into the premise.
- Marine water without further treatment **must not** be taken from an area subject to contamination, i.e. sewer/storm drain outfalls, industrial areas, docks and wharves. The water intake **must not** be placed within a 300 metre radius from outfall pipes and within a 125 m radius of any docks or wharves.

The following general requirements will apply to marine water being harvested for commercial purposes that <u>does</u> receive further treatment.

- Provide a drawing or map showing the exact site where water will be drawn. Include in the drawing any sewage or storm-water outfalls or any industrial sites near the water intake.
- Provide a safety plan describing the water treatment (sand filtration, settling, UV disinfection etc.).
- Provide water testing results that verify finished water has a bacteriological count of 2 coliform/100 ml or less, and turbidity of 20 NTU or less.
- Provide evidence that water surveys from your site are not impacted by any metals, chemicals, persistent organic pollutants or other harmful substances. If no surveys have been done in your area, you may be required to provide testing results. In the absence of any other standard, water quality should meet the Canadian Drinking Water Guidelines.
- Marine waters provided to CFIA federally registered establishments will be required to comply with CSSP guidelines Chapter 5 - wet storage. http://www.inspection.gc.ca/food/fish-and-seafood/manuals/canadian-shellfish-sanitation-program/eng/1351609988326/1351610579883?chap=8.

Appendix VI: General Maintenance Guidelines

Maintenance Log

One of the melded panels on the system's base should contain a summary of maintenance instructions as well as a maintenance log. The log allows you to keep track of the frequency of critical maintenance procedures. The log should be filled out regularly.

Dividers

Removable dividers used in the tank to keep different lots of bivalves or different fish species separated should be smooth, non-absorbent, and easily cleaned and sanitized. Dividers, left in the system should be washed, rinsed, and sanitized every time the system is cleaned.

Cleaning Tank Interior

It is important that the tank interior be kept free of algae and slime build-up. To prevent this build-up, the tank interior should be wiped down with a clean rag or towel every time you clean the filter bed (at least once a week).

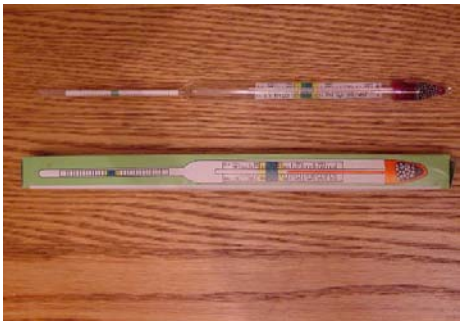
Instrumentation

It is important that the water in holding tanks mimic the natural habitat of products to prevent organism death and stress. Both simple and complex instruments are used to measure certain parameters of water to ensure it is within acceptable range.

Hydrometer: used to indirectly measure salinity. The basic principal behind a hydrometer is that that a higher concentration of dissolved salts in water results in denser water causing an object floating on top to displace less water and rise higher. A hydrometer is usually a glass tube with gradient markings. The device is then floated in the water and the level of water is measured off the gradations.

The level of salinity can be adjusted by changing the amount of salt in the solution. To lower the salinity, some of the saltwater can be replaced by freshwater. To increase the salinity, salt can be pre-dissolved and added to the holding tank.

http://www.kwaree.com/blog/wp-content/uploads/2008/02/hydrometer.JPG



http://www.reefcorner.com/images/GlassHydrometer.jpg

Thermometer: used to measure temperature. The thermometer should have a range of 0°C to 30°C (32°F-86°F). Mercury thermometers should be avoided as they may contaminate the system. Electronic digital thermometers are very accurate and robust.

pH Test Paper/ pH Liquid Kits: used to measure pH. These techniques depend on either a paper or liquid mix change in color. The color change is compared then compared to a standard chart. It is ideal to keep the pH near 7 to neutralize the toxic effects of ammonia.

Ammonia Test Kits: used to measure the ammonia levels. Tablets are added to a sample of water and the color change is matched to a standardized chart. Note: Water samples can also be sent to an accredited lab for analysis.

Table 4.Tank Maintenance Troubleshooting Tips

Problem	Potential Cause	Corrective Action
Foam	Build-up of organic products and other material in the tank water Bleeding of an aquatic animal into the water	Remove foam by scraping off surface with fine mesh screen or siphon and vacuum Look for cause Remove injured animals and check for missing body parts (i.e., fins, legs, cracked or broken shells)
Ammonia Smell - Foul Odour	Organics have built up to a level that anaerobic bacteria have started to digest the matter	Clean tank Clean filters Remove organic solvents Change the water Check the UV light
Algae	Normal when tanks are in areas of natural light	Clean algae off with a clean soft cloth Rinsing shellfish thoroughly with cold running water will remove the algae spores form their bodies Do not use chemicals to remove the algae from tanks when animals are in the tanks.
Cloudy/Yellow Hazy Water	Build-up of organic proteins (will lead to foaming)	Change the filter's activated carbon unit Check for damaged, or sick animals Check for clogged filter units or clogged air stores Install a properly designed filter system, if one is not in place
High Mortality	Animals damaged or suffering from shock during transportation or transfer to tanks Toxic substance added to tank (e.g., cleaning chemicals, insect spray, non-food grade glues, non-approved algicides	Remove animals Clean tank if necessary

Appendix VII: Live Fish Holding Tanks Checklist

Week of _____ to _____

Daily Checks

Temperature for Warm Holding Tanks: *should be greater than20°C (68°F)*

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
26.0°C							
25.0°C							
24.0°C							
23.0°C							
22.0°C							
21.0°C							
20.0°C							
19.0°C							

Temperature for Cold Holding Tanks: *should be less than 10°C (50°F)*

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
13.0°C							
12.0°C							
11.0°C							
10.0°C							
9.0°C							
8.0°C							

Specific Gravity for Cold Holding Tanks: *should be between 1.024-1.029*

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1.030							
1.029							
1.028							
1.027							
1.026							
1.025							
1.024							
1.023							

Specific Gravity for Warm Holding Tanks: *should be at 1.003 to 1.005*

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1.006							
1.005							
1.004							
1.003							
1.002							

Weekly Checks

Turbidity Level _____
Ammonia Level _____
pH Level _____

	Yes	No
Foam	☐	☐
Algae	☐	☐

Appendix VIII: Cross-Contamination and Safe Handling of Retail Seafood

Cross-Contamination

Cross-contamination is the transfer of illness-causing bacteria and viruses to cooked "ready-to-eat" seafood. These seafood include cooked crabmeat, cooked shrimp, smoked seafood, and surimi-based simulated seafood products. Cross-contamination can occur from:

- raw seafood to cooked seafood
- equipment or utensils to cooked seafood
- seafood handlers to cooked seafood
- the environment to cooked seafood

The following tips will help avoid cross-contamination:

Safe Handling of Raw Seafood and Equipment

1. Proper display or storage of seafood's is done in such a manner that raw and cooked seafood's are physically separated. This can be accomplished by separate refrigerated units and the use of barriers.
2. Place seafood in washable, non-insulated containers rather than directly on the ice. Display containers should allow liquids to drain.
3. Store cooked seafood in sanitary containers marked only for that use.
4. Clean and sanitize knives and cutting boards between processing raw and cooked products. Ideally, separate equipment and working areas would be used for raw and cooked product.
5. Empty seafood display cases daily and remove old ice. Clean and sanitize display cases and drains before adding fresh ice and restocking.
6. Handle seafood in the display case with individual utensils or single-use sanitary materials. Store utensils in a sanitizing solution or inside the refrigerated display case.
7. Place spiked price tags in garnish or ice, but not in seafood.
8. Keep the surface of the weigh scale sanitary. Protect the scale by placing seafood on single-use paper or plastic material. Clean and sanitize scale if any food comes in contact with the surface.
9. Clean up spills with single-service towels. Do not use cleaning cloths or sponges which may contain unwanted bacteria.

Seafood Handlers

1. Wear separate outerwear and gloves when handling raw and ready-to-eat fish products. Clothing can spread unwanted bacteria to seafood's. Wear clean outer garments and avoid use of aprons.
2. Wear a hair net or hat to keep hair from falling onto and contaminating seafood's. Hair contains millions of bacteria.
3. Always work with clean hands. Avoid touching your face, nose or clothing. Wash and sanitize hands between handling raw and cooked seafood's, between handling money and food, and whenever they touch anything other than seafood. Dry your hands with single-use paper towels.
4. Do not handle seafood if you have unprotected cuts and sores. Infected cuts and sores often contain illness-causing bacteria.
5. Use sanitary gloves when handling raw and cooked seafood's. Separate gloves are used for each. Wash and sanitize your gloves every time they touch anything other than seafood.
6. Sneeze and cough into a tissue and away from seafood. Never smoke, eat or drink while handling seafood.
7. Remove watches, rings, and jewellery, which may carry unwanted bacteria.
8. Inform your supervisor if you are ill.

The Environment

1. Insects and rodents carry illness-causing bacteria and must be eradicated if found in a seafood establishment.
2. Store garbage and processing wastes in sealed containers away from display areas.
3. Purchase seafood from reputable wholesalers. Confirm bivalve molluscs have been processed through a federally registered facility.