Manual of Fish Health Practices:
Supplement to the Fish Health Management Plan

HSWRI
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1 Introduction

The intent of this document is to set expectations for the basic components of a Fish Health Management Plan and to provide guidance for fish culturists in how they might meet the basic requirements through the recognized practices that follow.

Hence the function of the following document is two-fold:

1) It acts as a guide to culturists to identify management practices or methods that address the basic requirements and objectives of the Fish Health Management Plan.
2) Regulators will use this document as a guide in assessing site specific Fish Health Management Plans to ensure they meet with the basic requirements outlined in the Guidelines.

However, it must be acknowledged that the practices outlined in this document may not accommodate the variation in species, environments, infrastructure and goals of all culture facilities. It must also be recognized that this document does not represent the "minimum or best" practices nor does it represent the "only" way that the basic requirements can be met. There are fish health practices used that are not described in this document but still address or exceed the objectives and basic requirements.

The recognized practices will be regularly reviewed and up-dated to consider advances in fish health management techniques and changes in disease risks facing fish cultured in the United States.

- The practices described in this document do not supersede any legislated requirements.

- Fish culturists must follow required government regulations, license requirements and laws, including those covering occupational safety and waste management.

2 Net Pen Sites

2.1 Biosecurity

Biosecurity includes three components:

- Keeping fish healthy, as per section 2.2.
- Keeping pathogens out, as per section 2.5.
- Keeping disease from spreading within the site, as per section 2.6.

2.2 Keeping Fish Healthy

2.2.1 Single Year Class Sites

2.2.1.1 Fish Groups and Segregation

Fish populations are grouped in a manner that avoids cross-contamination with disease causing agents.

- Single-year classes for sites and fallowing of holding units are encouraged.
- Management operations account for differences in disease or infection status of year-classes and be performed to reduce the risk of cross contamination.
- Whenever physically possible, new arrivals of fish are held separately from existing stocks regardless of their source or disease history. Where possible a physical separation of holding units, different equipment, and designated personnel.
- The separation period for new arrivals extends to cover the incubation period of diseases of particular concern for the specific fish transfer.
- The mortality rate of new arrivals is evaluated at least bi-weekly for this period of isolation. Samples of sick and dead fish are checked weekly and on a daily basis in the presence of elevated mortality rates or signs of disease.

2.2.2 Suitable Rearing Environment

Fish held at culture facilities are provided with adequate physical space, water temperature within the normal range for the species held, and adequate water quality (oxygenation, waste product levels).

- HSWRI ensures that fish get sufficient quality and quantity of food.
- HSWRI includes a routine health-monitoring program as part of their routine. Refer to section 2.7 (Monitoring Fish Health).
- Materials used in the construction and maintenance of fish holding facilities are not harmful to fish.
- Fish are regularly observed to ensure:
    - Feed is being consumed.
    - Deaths disease and abnormal behavior are observed and appropriately treated.
    - Housing is safe and secure.
    - Animals are safe from predation and vandalism.

2.2.3 Normal Fish Behavior

Refer to section 2.23 of the Fish Health Management Plan.

2.2.4 Predators

Management methods are designed to reduce the attraction of predators to culture facilities and prevent predators attacking fish and avoiding stress that could result in an increased risk of disease.

- Fish food and dead fish are properly stored.
- Dead fish are managed in a manner that does not attract predators or scavenging animals to the facility.
- Vegetation or structures that provide cover for predators are removed from around holding units where possible.
- Predator exclusion methods are used.

- Regular facility inspections include checks for signs of predator attacks.

- Predator netting or similar devices are checked for signs of being breached and are repaired as soon as possible upon detection.

- Routine examination of dead and live fish pays attention to signs of predator attack.

- Measures taken to protect fish from predators occurs in a manner that considers predator welfare and does not endanger the predator population.

2.2.5 Feed and Nutrition

- HSWRI ensures that fish get sufficient quality and quantity of food.

- Feed is properly stored according to manufacturers' instructions and in a manner that prevents its exposure to pests, vandals, and extremes of heat, light and humidity.

2.3 Fish Handling Technique

2.3.1 Common Fish Handling Techniques

- Netting and other materials used in the construction of holding units or equipment used to handle fish present a smooth surface to limit injuries to fish.

- Fish are adequately supported when out of water and are not to be held solely by the tail if expected to survive post-handling.

- After a handling episode, fish are examined for signs of poor handling such as skin injury and scale loss. If such signs are noted, affected groups are observed for increased rates of mortality or illness in the subsequent weeks.

- Methods used to mark fish (fin clipping, coded wire tags, other external tags, etc) are done in a manner that causes minimum damage to the fish and are done under appropriate levels of sedation or anesthesia.

- Marking does not affect the long-term survival or productivity of the marked fish unless it is done as part of an approved research protocol.

2.3.2 Harvesting

Refer to section 2.3.2 of the Fish Health Management Plan.

2.4 Monitoring Water Quality

Water quality management requires the consideration of fish density, feeding rate, volume, and source supply.

- HSWRI maintains a system to monitor the functioning of the equipment used to treat water and/or appropriate alarms in place to indicate when the water provided is inadequate.

- HSWRI ensures tanks are cleaned regularly and water exchange is sufficient to remove metabolic wastes and maintain oxygen.

A routine water-quality monitoring program is necessary in all fish culture facilities. The critical variables to be monitored include parameters such as dissolved oxygen, dissolved gas content, pH, temperature, salinity, flow, sediment levels, plankton analysis and turbidity. Specific variables to be measured will depend on the nature of the water source and fish reared at a particular facility.

- A water quality monitoring program is designed to consider natural spatial and temporal variation in water quality and provide an overview of the variation of water quality within a culture facility.

- Samples are taken frequently enough to differentiate normal variation from declining water quality variations.

- Where possible, HSWRI selects and maintains, or manages water sources that have the lowest likelihood of being contaminated with disease causing agents. In fresh water settings, use of a fish free water source is preferential.

- When transporting fish, fish health staff members monitor water quality in transport vessels and have the capacity to supplement oxygen or aerate holding waters. Feed is withheld from fish prior to shipping to reduce fecal and other contamination of transport water.

2.4.1 Contingency Plans

Refer to section 2.4.1 of the Fish Health Management Plan.

- HSWRI has contingency plans in place to remedy adverse water quality or quantity situations and include:

- Ability to alter water flows by supplementing holding units with extra water or increased water exchange or ability to alter water conditions (e.g. supplemental oxygen).

- In the event of life threatening poor water quality events the fish are taken off feed in order to decrease oxygen demand and stress.

- Access to equipment or supplies to move fish if necessary.

2.5 Keeping Pathogens Out

2.5.1 Personnel movement

Refer to section 2.5.1 of the Fish Health Management Plan.

Refer to sections 2.5.2 (Visitors) and 2.5.3 (Equipment).

2.5.2 Visitors

- HSWRI has a plan for managing visitors to a facility in a manner that prevents the introduction and movement of infectious agents or parasites. This includes policies regarding allowing visitors that have been to other fish culture facilities on the same day on site, the movement of equipment between sites, the need for clean footwear and clothing, and management of vessels or vehicles bringing the visitors to the site.

- Visitors are informed of precautions to take to avoid introducing or moving infectious agents or parasites between holding units and to/from other sites. These may include avoiding visiting more than one site per day; not handling water, equipment, fish or feed; the use of foot dips; and the use of hand washing facilities.

2.5.3 Equipment

Refer to section 2.5.3 of the Fish Health Management Plan.

- HSWRI has a system for the use and disinfection of equipment, footwear, clothing (including dive gear) and vehicles/vessels to prevent the spread of infectious agents or parasites within and between facilities.

- Holding units are properly cleaned and disinfected between fish groups housed in the unit. Methods can include fallowing, ultraviolet light, drying and chemical disinfection.

- Disinfectants are regularly replaced to ensure effective concentrations.

2.5.4 Equipment movement

- HSWRI has enough equipment on site to preclude or reduce the need to share equipment between facilities. Equipment does not move between watersheds or areas established for fish disease management. If equipment must be shared, it is properly cleaned and disinfected before being moved.

- The movement of equipment or nets and wastes from the cleaning operations does not facilitate the spread of infectious agents.

2.5.5 Diver Disinfection and Movement

- HSWRI supplies the disinfection protocol and, if required, related equipment to allow divers to work in a manner that promotes hygiene and prevents the transfer of pathogens by vessels and shared equipment between facilities.

- Whenever possible, the healthiest and youngest fish groups are dived first.

2.5.6 Suppliers

Refer to section 2.5.6 of the Fish Health Management Plan.

2.5.7 Moving Fish Between Sites

Refer to section 2.5.7 of the Fish Health Management Plan.

Refer to section 2.4 (Monitoring Water Quality).

- In consultation with the FHS, the diagnostic and treatment history of any fish being moved is reviewed prior to transport. This includes mortality, diagnostic and treatment records and examination of a representative sample of dead fish and moribund fish within 10 days of transportation. Consideration is given to any differences in the pattern of disease recipient area and the location which fish are being transferred.

- All fish movements must be conducted in accordance with the rules and regulations associated with the state and federal authorities.

2.6 Minimizing Disease within the site

2.6.1 Hygiene and Disinfection – Personnel

Refer to sections 2.5.2 (Visitors) and 2.5.3 (Equipment).

2.6.2 Hygiene and Disinfection - Equipment

Refer to section 2.5.3 (Equipment).

2.6.3 Mort Collection

- Disposal of mortalities must adhere to relevant waste management regulations.

- Dead fish are removed from a holding unit on a regular basis. The frequency of removal will be determined by the mortality rate, the size of the facility, the population size and worker safety considerations.

- During a disease outbreak or elevations in mortality rates, the schedule for removal of dead fish from holding units is reviewed. Refer to section 2.9.2.5 of the Fish Health Management Plan. The advantages of more frequent removal are balanced with increase stress to surviving fish; however, operators are encouraged to remove fish as frequently as possible.

If divers and dive collection rings are used to retrieve dead fish from depths, multiple dive rings are available to allow a prolonged dip or spray disinfection and the rotation of rings between and during holding unit dives.

- The containers used to store dead fish prevent the spread of potentially infected or contaminated material and are secure from scavengers. Containers have secure lids to minimize the risks of leakage and access to scavengers.

- Dead fish are handled in a manner to minimize the spread of infectious agents.

2.7 Monitoring Fish Health

Refer to section 2.7 of the Fish Health Management Plan.

Fish and fish behavior are observed daily to examine for signs of illness.

- Samples of freshly dead fish are examined if available at a facility as a minimum on a twice-monthly basis. The numbers of fish to be sampled, frequency of sampling and agents to be examined for will vary with the size of the facility and past medical history. Sample protocols can be developed in consultation with fish health staff and qualified fish health professionals.

- The planned release of enhanced, cultured fish to the wild must not result in undue harm to wild fish or public health. This judgment is based upon a review of the disease and mortality records, recommendations by a qualified fish health professional, the results of any recommended pre-release disease screening and guidance from regulatory agencies.

- Modifying factors such as the biological/ecological constraints to release for a specific group of fish, the known disease status of wild stocks likely to encounter the released fish and likely progression of the disease or infection of concern is also be considered.

When determining if there are changes in fish health, fish health staff:

- Review recent patterns of death and morbidity.
- Conduct an on-site visit to:
    - Observe fish behavior.
    - Review of general hygiene, management and other possible fish health risks.
- Conduct gross post-mortem examination to describe the presence and type of pathological processes.
- Conduct sampling and/or additional testing of fish as required. Samples are taken in a manner that represents the population held at the facility.
- Contact information for fish health expertise is readily available for all staff in the event of an occurrence of disease.
- If experiencing increased mortality rates monitoring efforts are increased and additional sampling to determine cause of event may be required.
- If fish are affected by a disease, groups of fish in contact with affected groups or otherwise linked to affected groups are monitored for changes in mortality rates or morbidity. Additional sampling occurs as advised by the FHS.

2.7.1 Mort Dives

Refer to section 2.7.1 of the Fish Health Management Plan.

- Culturists have an agreed system for classifying categories of disease in dead fish and they track these results over time.

2.7.2 Common Fish Health Procedures

2.7.2.1 Anesthetizing fish

Refer to section 2.7.2.1 of the Fish Health Management Plan.

- Anesthetic protocols address the following key components during various husbandry or stock management events.
    - Legal, labeled prescription anesthetic products are used in cultured fish. When other products are used operators must assess in consultation with a veterinarian.
    - Operators ensure that known concentrations of anesthetic are used in holding units.
    - Waterproof gloves and protective clothing (including splash glasses) are worn.
    - Adequate oxygen is be maintained during anesthesia to ensure appropriate water quality, waste dispersal and minimal fish stress during procedure and recovery.
    - Anesthetic baths need to be renewed during procedures based fish biomass, time and the water quality parameters.
    - Fish are continuously observed during anesthesia and recovery periods for the appropriate depth of anesthesia for the procedures being performed.
    - Fluids containing an anesthetic product are disposed of in a manner that meets manufacturer recommendations and existing regulations.

2.7.2.2 Vaccinating Fish

Vaccines are used to facilitate a protective immune response and are used under the conditions recommended by the manufacturer or under veterinary advice. At this time HSWRI does not routinely vaccinate fish, however, research is evolving and the need for vaccination may develop in the future.

- Water temperature and salinity, fish size, handling stressors and fish health history are considered when designing a vaccination program.
- The vaccine is properly stored, prepared and handled to avoid degradation of the product prior to use.
- Vaccination programs are designed to minimize fish stress. Anesthesia is used when injectable vaccines are used.
- Water quality is maintained when bath vaccines are used.

- Vaccination equipment does not promote the spread of infectious agents or parasites.

- Careful cleaning and disinfection of vaccination equipment on site and when moved between sites is conducted Refer to section 2.5.3 (Equipment)

- The handling of fish at sea sites must follow requirements of escape prevention regulations.

2.7.2.3 Euthanasia

Fish killed as part of disease surveys or other management plans or due to illness are euthanized in a humane manner. Severance of the spinal cord behind the head or, for larger fish, a sharp blow to the head when the fish is restrained out of water, or overdoses of anesthetics are considered humane. Stunning of fish must result in immediate loss of consciousness that lasts until death. Fish are not to be stunned unless they can be killed without delay. If fish are killed without stunning, the method used must result in a rapid and irreversible loss of consciousness.

2.8 Fish Health Records

Refer to section 2.8 of the Fish Health Management Plan.

- Operators keep a chronological record of observations or other information that indicates illness in a fish population including:

    - Increased morbidity levels.

    - Daily feed consumption, growth rate, and feeding behavior.

    - Disease findings or reports of carcass quality made at slaughter.

    - External lesions on live fish including signs of ecto-parasites.

2.9 Fish Disease Outbreaks

2.9.1 First steps

Refer to section 2.9.1 of the Fish Health Management Plan.

2.9.2 Infectious Disease Emergencies

Refer to section 2.9.2 of the Fish Health Management Plan.

2.9.2.1 Isolation/Quarantine

Refer to section 2.9.2.1 of the Fish Health Management Plan.

The following are definitions for **Isolation** and **Quarantine** established by HSWRI

Isolation: Separation for the period of communicability of infected animals in a manner that prevents or limits the transmission of an infectious agent to susceptible individuals.

Quarantine: Quarantine means maintaining a group of aquatic animals in isolation with no direct or indirect contact with other aquatic animals, in order to undergo observation for a specified length of time and, if appropriate, testing and treatment, including proper treatment of the effluent waters.

2.9.2.2 Stop Fish Movement and/or Handling

Refer to section 2.9.2.2 of the Fish Health Management Plan.

- Halt the release of enhanced fish to the wild and conduct an assessment of the risks to wild fish or the well being of affected fish by a qualified fish health professional. **If** there is an increased risk of impact and/or spread of the disease agent, movement of fish ceases.

- Do not send fish to slaughter before consultation with the FHS or depending on the nature of the outbreak, the state fish pathologist.

2.9.2.3 Disinfection and Hygiene

Refer to sections 2.5.2 (Visitors) and 2.5.3 (Equipment).

2.9.2.4 Suppliers

Refer to section 2.9.2.4 of the Fish Health Management Plan.

2.9.2.5 Mortality Dives

Refer to section 2.9.2.5 of the Fish Health Management Plan.

2.9.2.6 Determining the Cause of an Outbreak (Outbreak Investigations)

Once an outbreak is recognized, all fish on site and potentially fish off site that are epidemiologically linked to affected fish are subject to an intensified monitoring and sampling program. The exact nature of the program is designed in consultation with a veterinarian and designated fish health staff. The following is considered:

- Fish health staff is responsible for investigation and management of all unusual mortality events. This includes as a minimum, the FHS.
- All facilities have a list of the designated fish health staff with pertinent contact information so they can contact them immediately upon the suspicion that an outbreak is occurring.
- Review fish health records and other sources of information the management history of the affected fish and their unaffected cohorts on site in order to help identify possible causes/sources of the outbreak. Document these findings including:
    - Management history including species, age, year-class, source, vaccination, movements, and treatments.
    - Past diagnostic results from screening, routine disease monitoring or previous disease events.
    - Results of any in-house diagnostic work done on the affected groups of fish.
    - Water quality and feed history.
    - Mortality rates for several weeks preceding the outbreak.
- Examination of a representative proportion of sick and dead fish from holding units affected during the outbreak as well as fish in adjacent units and, if possible, epidemiological linked holding units on and off site.

2.9.2.7 Dealing With Large Scale Mortality Events

- HSWRI has plans in place that anticipate an increased need for disinfection, disposal or other issues associated with large scale losses, whether these are due to infectious disease, environmental, disease or management problems.

2.9.2.8 Reporting to authorities

Refer to section 2.9.2.8 of the Fish Health Management Plan.

2.9.2.9 Communicating with Other Operators

- HSWRI will notify other facilities or companies epidemiologically linked to the affected fish and/or in neighboring culture facilities if a disease of significance is detected and there is a risk of exposure from disease causing agents affecting fish involved in the outbreak.[2]

2.10 Fish Escape

- Facilities must have an approved escape management plan in accordance with existing regulations.

[2] A significant disease includes one with the potential for large-scale impacts on cultured and wild fish including exotic diseases and those causing high mortality rates.

2.11 Releases

2.11.1 Risk Assessment

- Fish are not be released to the wild until a health assessment can be conducted by the state pathologist. This health assessment should be made as soon as possible if the fish:
    - are known to be infected/infested/contaminated with disease agents for which there is a reasonable likelihood that a negative population health effect could result in wild aquatic organisms because of exposure to the agent(s),
    - have been treated with a drug or chemical, are still within the drug withdrawal period and are likely to enter the human food chain before the withdrawal period is over,
    - are involved in a disease outbreak, and/or
    - are affected by an unknown cause of death or illness.
- Fish are not be released until actions arising from the risk assessment are acted upon.

2.12 Handling Drugs and Chemicals

Refer to section 2.12 of the Fish Health Management Plan.

2.12.1 Medicated Feed Storage and Inventory

Refer to section 2.12.1 of the Fish Health Management Plan.

2.12.2 Handling and Administering Medicated Feed.

Refer to section 2.12.2 of the Fish Health Management Plan.

2.12.3 Treatment Records

Refer to section 2.12.3 of the Fish Health Management Plan.

2.12.4 Treatment Records for Harvest

Refer to section 2.12.4 of the Fish Health Management Plan.

2.12.5 Enhanced Fish

Refer to section 2.12.5 of the Fish Health Management Plan.

2.12.6 Chemicals and Biologicals

2.12.6.1 Disinfectants

Refer to section 2.12.6.1 of the Fish Health Management Plan.

2.12.6.2 Chemicals

Refer to section 2.12.6.2 of the Fish Health Management Plan.

2.12.6.3 Biologicals

Refer to section 2.12.6.3 of the Fish Health Management Plan.

3 Hatchery Sites

3.1 Biosecurity

Biosecurity includes three components:

- Keeping fish healthy, as per section 3.2.
- Keeping pathogens out, as per section 3.5.
- Minimizing disease within the site, as per section 3.6.

3.2 Keeping Fish Healthy

3.2.1 Separation of Year Classes

3.2.1.1 Fish Groups and Segregation

Fish populations are grouped in a manner that avoids cross-contamination with disease causing agents.

- If a facility has multiple age-classes, facility design and management strives to cause a functional separation of year classes by keeping them in different holding units, where possible. Management operations account for differences in disease or infection status of age-classes and be performed to reduce the risk of cross contamination.

- Whenever physically possible, new arrivals of fish are held separately from existing stocks regardless of their source or disease history. Where possible a physical separation of holding units, different equipment, and designated personnel.

- The separation period for new arrivals extends to cover the incubation period of diseases of particular concern for the specific fish transfer.

- The mortality rate of new arrivals is evaluated at least bi-weekly for this period of isolation. Samples of sick and dead fish are checked weekly in the absence of signs of illness and on a daily basis in the presence of elevated mortality rates or signs of disease.

- When fish are moved between or are imported from another country or state, restrictions imposed by the Federal and or State governments must be followed.

3.2.2 Suitable Rearing Environment

Fish held at culture facilities are provided with adequate physical space, water temperature within the normal range for the species held, and adequate water quality (oxygenation, waste product levels).

- HSWRI ensures that fish get sufficient quality and quantity of food.
- HSWRI includes routine health-monitoring program. Refer to section 3.7 (Monitoring Fish Health).
- Materials used in the construction and maintenance of fish holding facilities are not harmful to fish.
- Fish are regularly observed to ensure:
    - Feed is being consumed.
    - Deaths disease and abnormal behavior are observed and appropriately treated.
    - Housing is safe and secure.
    - Animals are safe from predation and vandalism.
- Redundant and/or back up systems in the event of failure in the fresh water supply must be in place and ready for operation.

3.2.3 Normal Fish Behavior

Refer to section 3.2.3 of the Fish Health Management Plan.

3.2.4 Predators

Management methods are designed to reduce the attraction of predators to culture facilities and prevent predators attacking fish and avoiding stress that could result in an increased risk of disease.

- Fish food and dead fish are properly stored.
- Dead fish are disposed of in a manner that does not attract predators or scavenging animals to the facility.
- Vegetation or structures that provide cover for predators are removed from around holding units where possible.
- Predator exclusion methods are used.
- Regular facility inspections include checks for signs of predator attacks.
- Predator netting or similar devices are checked for signs of being breached and are repaired as soon as possible after detection.
- Routine examination of dead and live fish pays attention to signs of predator attack.
- Measures taken to protect fish from predators occurs in a manner that considers predator welfare and does not endanger the predator population.

3.2.5 Feed and Nutrition

- Operators ensure that fish get sufficient quality and quantity of food.
- Feed is properly stored according to manufacturers' instructions and in a manner that prevents its exposure to pests, vandals and extremes of heat, light and humidity.

3.3 Fish Handling Techniques

3.3.1 Common Fish Handling Techniques

- Netting and other materials used in the construction of holding units or equipment used to handle fish present a smooth surface to limit injuries to fish.
- Fish are adequately supported when out of water and are not be held only by the tail if expected to survive post-handling.
- After a handling episode, fish are examined for signs of poor handling such as skin injury and scale loss. If such signs are noted, affected groups are observed for increased rates of mortality or illness in the subsequent weeks.

3.3.2 Marking Fish

- Methods used to mark fish (fin clipping, coded wire tags, other external tags, etc) are done in a manner that causes minimum damage to the fish and are done under appropriate levels of sedation or anesthesia. Refer to section 3.7.2.4 (Anesthetizing Fish).
- Marking does not affect the long-term survival or productivity of the marked fish unless it is done as part of an approved research protocol.

3.3.3 Fish Transports

Refer to section 2.5.7 of the Fish Health Management Plan.

Refer to section 3.4.3 (Monitoring Water Quality).

- In consultation with the FHS, the diagnostic and treatment history of any fish being moved is reviewed prior to transport. This includes mortality, diagnostic and treatment records and examination of a representative sample of dead fish and moribund fish within 10 days of transportation. Consideration is given to any differences in the pattern of disease recipient area and the location which fish are being transferred

- All fish movements must be conducted in accordance with the rules and regulations associated with the Federal or State authorities.

- Fish held under quarantine for any reasons are not moved.

- HSWRI avoids transporting fish exhibiting signs of illness.

3.3.3.1 Transport Care and Considerations

- Refer to section 3.4.3 (Monitoring Water Quality). Fish are transported in a manner that avoids associated stressors

- Transportation of fish is done with due care in order to not compromise the water quality to a point that is detrimental to fish. Fish being transported and their transport water are periodically examined during transit to ensure proper water quality and to inspect fish for deaths or signs of distress.

- Transportation vehicles/vessels are properly insulated, ventilated and aerated to prevent temperature fluctuations and oxygen depletion during transportation.

- Feed is withheld from fish prior to shipping to reduce fecal and other contamination of transport water.

- Fish are handled in a manner that minimizes skin damage or other trauma and leaves fish out of the water for as little time as possible.

- When fish are handled out of water, anything they contact is kept wet to minimize abrasions and loss of mucous. Dip net loads do not contain excessive numbers of fish, pipes used to move fish are smooth inside with no sharp bends, excessive water flow or inadequate water flow and vessels or vehicles may use internal baffles to reduce shifting of water in large transport containers.

- Contingency plans are in place to support fish in suitable conditions in transport vessels or vehicles if the transportation is delayed.

- Transportation vehicles and vessels are managed in a manner that discourages or precludes the inadvertent transfer of disease causing agents.

- **When zones are established for fish health reasons, for example transplant zones or disease control zones;** efforts are made to reduce vessel/vehicle movement between zones. If vessels/vehicles move between zones, transport operators are to consult with a qualified fish health professional to plan actions to reduce pathogen or parasite translocation such as cleaning and disinfecting of vessels/vehicles. Fish holding containers on transport units are cleaned to remove organic waste between use within the same watershed or zone.

- Vessels/vehicles/containers used to transport dead fish are not to be used to move live fish if possible. If this should be done, proper cleaning and disinfection are conducted.

- HSWRI makes all attempts to not use water from a site that contains fish infected with a waterborne pathogen. If these waters must be used, they are disposed of in a manner to minimize exposure of existing stock on site to pathogens. Water with fish usually released to the holding units with the fish; this is not very realistic.

3.4 Monitoring Water Quality

Water quality management requires the consideration of fish density, feeding rate, volume, and source supply.

- HSWRI maintains a system to monitor the functioning of the equipment used to treat water and/or appropriate alarms in place to indicate when the water provided is inadequate.

- HSWRI ensures tanks are cleaned regularly and water exchange is sufficient to remove metabolic wastes and maintain oxygen.

A routine water-quality monitoring program is necessary in all fish culture facilities. The critical variables to be monitored include parameters such as dissolved oxygen, dissolved gas content, pH, temperature, salinity, flow, sediment levels and turbidity. Specific variables to be measured will depend on the nature of the water source and fish reared at a particular facility.

- A water quality monitoring program is designed to consider natural spatial and temporal variation in water quality and provide an overview of the variation of water quality within a culture facility.

- Samples are taken frequently enough to differentiate normal variation from declining water quality variations.

- Where possible, operators select and maintain, or manage water sources that have the lowest likelihood of being contaminated with disease causing agents. In fresh water settings, use of a fish free water source is preferential.

- When transporting fish operators monitor water quality in transport vessels and have the capacity to supplement oxygen or aerate holding waters. Feed is withheld from fish prior to shipping to reduce fecal and other contamination of transport water.

3.4.1 Contingency Plans

Refer to section 3.4.1 of the Fish Health Management Plan.

- HSWRI has contingency plans in place to remedy adverse water quality or quantity situations and include:

- Ability to alter water flows by supplementing holding units with extra water or increased water exchange or ability to alter water conditions (e.g. supplemental oxygen).

- Access to equipment or supplies to move fish if necessary.

3.5 Keeping Pathogens Out

3.5.1 Personnel movement

Refer to section 3.5.1 of the Fish Health Management Plan.

Refer to sections 3.5.2 (Visitors) and 3.5.3 (Equipment).

3.5.2 Visitors

- Facility operators have a plan for managing visitors to a facility in a manner that prevents the introduction and movement of infectious agents or parasites. This includes policies regarding allowing visitors that have been to other fish culture facilities on the same day on site, the movement of equipment between sites, the need for clean footwear and clothing, and management of vessels or vehicles bringing the visitors to the site.

- Visitors are informed of precautions to take to avoid introducing or moving infectious agents or parasites between holding units and to/from other site. These may include avoiding visiting more than one site per day; not handling water, equipment, fish or feed; the use of foot dips; and the use of hand washing facilities.

3.5.3 Equipment

Refer to section 3.5.3 of the Fish Health Management Plan.

- HSWRI has a system for the use and disinfection of equipment, footwear, clothing (including dive gear) and vehicles/vessels to prevent the spread of infectious agents or parasites within and between facilities.

- Holding units are properly cleaned and disinfected between fish groups housed in the unit. Methods can include fallowing, ultraviolet light, drying and chemical disinfection.

- Disinfectants are regularly replaced to ensure effective concentrations.

3.5.4 Equipment movement

- Operators have enough equipment on site to preclude or reduce the need to share equipment between facilities. Equipment is not moved between watersheds or areas established for fish disease management. If equipment must be shared, it is properly cleaned and disinfected before being moved.

- The movement of equipment or nets and wastes from the cleaning operations does not facilitate the spread of infectious agents.

3.5.5 Suppliers

Refer to section 3.5.5 of the Fish Health Management Plan.

3.5.6 Moving Fish Between Sites

Refer to section 3.5.6 of the Fish Health Management Plan.

Refer to section 3.3.3 (Fish Transports).

3.6 Minimizing Disease Within the Site

3.6.1 Hygiene and disinfection – personnel

Refer to sections 3.5.2 (Visitors) and 3.5.3 (Equipment).

3.6.2 Hygiene and Disinfection - Equipment

Refer to section 3.5.3 (Equipment).

3.6.3 Mort Collection

- Disposal of mortalities must adhere to relevant waste management regulations.

- Dead fish are removed from a holding unit on a regular basis. The frequency of removal will be determined by the mortality rate, the size of the facility, the population size and worker safety considerations.

- During a disease outbreak or elevations in mortality rates, the schedule for removal of dead fish from holding units is reviewed.. The advantages of more frequent removal are balanced with increase stress to surviving fish; however, operators are encouraged to remove fish as frequently as possible

- The containers used to store dead fish prevent the spread of potentially infected or contaminated material and are secure from scavengers. Containers have secure lids to minimize the risks of leakage and access to scavengers.

- Dead fish are handled in a manner to minimize the spread of infectious agents.

3.7 Monitoring Fish Health

Refer to section 3.7 of the Fish Health Management Plan.

Fish and fish behavior are observed daily to examine for signs of illness.

- External examination of live fish will be performed in conjunction with weight sampling. Examination can include but is not limited to skin and gill scrapes. The numbers of fish to be sampled, frequency of sampling and agents to be examined for will vary with the size of the facility and past medical history. Sample protocols are developed in consultation with fish health staff and the FHS. Complete examination of freshly dead fish will be performed as needed.

- The planned release of cultured fish to the wild does not result in undue harm to wild fish or public health. This judgment is based upon a review of the disease and mortality records, recommendations by the state fish pathologist and the FHS, the results of any recommended pre-release disease screening and guidance from regulatory agencies.

- Modifying factors such as the biological/ecological constraints to release for a specific group of fish, the known disease status of wild stocks likely to encounter the released fish and likely progression of the disease or infection of concern is also considered.

When determining if there are changes in fish health, fish health staff:

- Review of recent patterns of death and morbidity.

- Conduct an on-site visit to:

    - Observe fish behavior.

    - Review of general hygiene, management and other possible fish health risks.

- Conduct gross post-mortem examination to describe the presence and type of pathological processes.

- Conduct sampling and/or additional testing of fish as required. Samples are taken in a manner that represents the population held at the facility.

- Contact information for fish health expertise is readily available for all staff in the event of an occurrence of disease.

- If experiencing increased mortality rates monitoring efforts are increased and additional sampling to determine cause of event may be required.

- If fish are affected by a disease, groups of fish in contact with affected groups or otherwise linked to affected groups are monitored for changes in mortality rates or morbidity. Additional sampling occurs as advised by the FHS.

Broodstock are examined for disease at the time of initial quarantine.

- Facilities have a plan to manage progeny of parents infected with vertically transmitted diseases of concern.

The selection of diagnostic criteria for identifying infected or at risk progeny and a response plan is developed with a the FHS.

3.7.1 Mortality Classification

Refer to section 3.7.1 of the Fish Health Management Plan.

Culturists have an agreed system for classify categories of disease in dead fish and track these results over time.

3.7.2 Common Fish Health Procedures

3.7.2.1 Egg Disinfection

Eggs are collected and disinfected to minimize the risk of transfer of pathogens from broodstock to progeny.

- Methods used for pathogen reduction are based on vertically and horizontally transferred pathogens present or suspected in the broodstock.
- Culturists are encouraged to consult the FHS when designing their broodstock and egg handling protocols.
- Before eggs are incubated, equipment is washed, disinfected and thoroughly rinsed.
- HSWRI uses a disinfectant that is recognized for use in aquaculture and follows manufacturer's instructions.

3.7.2.2 Anesthetizing Fish

Refer to section 3.7.2.4 of the Fish Health Management Plan.

- Anesthetic protocols address the following key components during various husbandry or stock management events.
    - Legal, labeled prescription anesthetic products are used in cultured fish. When other products are used hatchery managers assess these in consultation with a veterinarian.
    - HSWRI ensures that known concentrations of anesthetic are used in holding units.
    - Waterproof gloves and protective clothing (including splash glasses) are worn.
    - Adequate oxygen is maintained during anesthesia to ensure appropriate water quality, waste dispersal and minimal fish stress during procedure and recovery.
    - Anesthetic baths need to be renewed during procedures based fish biomass, time and the water quality parameters.
    - Fluids containing an anesthetic product are disposed of in a manner that meets manufacturer recommendations or existing regulations

3.7.2.3 Vaccinating Fish

Vaccines are used to facilitate a protective immune response and are used under the conditions recommended by the manufacturer or under veterinary advice.

- Water temperature and salinity, fish size, handling stressors and fish health history are all be considered when designing a vaccination program.

- The vaccine is properly stored, prepared and handled to avoid degradation of the product prior to use.

- Vaccination programs are designed to minimize fish stress. Anesthesia is used when injectable vaccines are used.

- Water quality is maintained when bath vaccines are used.

- Vaccination equipment does not promote the spread of infectious agents or parasites.

- Careful cleaning and disinfection of vaccination equipment on site and when moved between sites is conducted Refer to section 3.5.3 (Equipment).

3.7.2.4 Euthanasia

- Fish killed as part of disease surveys or other management plans or due to illness are be euthanized in a humane manner. Severance of the spinal cord behind the head or, for larger fish, a sharp blow to the head when the fish is restrained out of water, or overdoses of anesthetics are considered humane. Stunning of fish must result in immediate loss of consciousness that lasts until death. Fish are not to be stunned unless they can be killed without delay. If fish are killed without stunning, the method used results in a rapid and irreversible loss of consciousness.

3.8 Fish Health Records

Refer to section 3.8 of the Fish Health Management Plan.

HSWRI keeps a chronological record of observations or other information that may indicate illness in a fish population including:

- Increased morbidity levels.
- Daily feed consumption, growth rate, and feeding behavior.
- Disease findings or reports of carcass quality made at slaughter.
- External lesions on live fish including signs of ecto-parasites.

3.9 Fish Disease Outbreaks

3.9.1 First steps

Refer to section 3.9.1 of the Fish Health Management Plan.

3.9.2 Infectious Disease Emergencies

Refer to section 3.9.2 of the Fish Health Management Plan.

3.9.2.1 Isolation/Quarantine

Refer to section 3.9.2.1 of the Fish Health Management Plan.

The following are definitions for **Isolation** and **Quarantine** established by the Fish Health Management Team.

Isolation: Separation for the period of communicability of infected animals in a manner that prevents or limits the transmission of an infectious agent to susceptible individuals.

Quarantine: Quarantine means maintaining a group of aquatic animals in isolation with no direct or indirect contact with other aquatic animals, in order to undergo observation for a specified length of time and, if appropriate, testing and treatment, including proper treatment of the effluent waters.

3.9.2.2 Stop Fish Movement and/or Handling

- Halt the release of enhanced fish to the wild and conduct an assessment of the risks to wild fish or the well being of affected fish by a qualified fish health professional. **If** there is an increased risk of impact and/or spread of the disease agent, movement of fish ceases.

    - Do not send fish to slaughter before consultation with a veterinarian or depending on the nature of the outbreak, the appropriate regulatory authority.

3.9.2.3 Disinfection and Hygiene

Refer to sections 3.5.2 (Visitors) and 3.5.3 (Equipment).

3.9.2.4 Suppliers

Refer to section 3.9.2.4 of the Fish Health Management Plan.

3.9.2.5 Mortality Collection

Refer to section 2.9.2.5 of the Fish Health Management Plan.

3.9.2.6 Determining the Cause of an Outbreak (Outbreak Investigations)

Once an outbreak is recognized, all fish on site and potentially fish off site that are epidemiologically linked to affected fish, are subject to an intensified monitoring and sampling program. The exact nature of the program is designed in consultation the FHS and designated fish health staff. The following are considered:

- Fish health staff are responsible for investigation and management of all unusual mortality events. This includes as a minimum, the FHS.

- All facilities have a list of the designated fish health staff with pertinent contact information so they can contact them immediately upon the suspicion that an outbreak is occurring.

- Review fish health records and other sources of information the management history of the affected fish and their unaffected cohorts on site in order to help identify possible causes/sources of the outbreak. Document these findings including:

- Management history including species, age, year-class, source, vaccination, movements, and treatments.

- Past diagnostic results from screening, routine disease monitoring or previous disease events.

- Results of any in-house diagnostic work done on the affected groups of fish.

- Water quality and feed history.

- Mortality rates for several weeks preceding the outbreak.

Examination of a representative proportion of sick and dead fish from holding units affected during the outbreak as well as fish in adjacent units and, if possible, epidemiological linked holding units on and off site.

3.9.2.7 Dealing with Large Scale Mortality Events

- Operators have plans in place that anticipate an increased need for disinfection, disposal or other issues associated with large scale losses, whether these are due to infectious disease, environmental, disease or management problems

3.9.2.8 Reporting to Authorities

Refer to section 3.9.2.8 of the Fish Health Management Plan.

3.9.2.9 Communicating with Other Operators

- HSWRI will notify other facilities or companies epidemiologically linked to the affected fish and/or in neighboring culture facilities if a disease of significance is detected and there is a risk of exposure from disease causing agents affecting fish involved in the outbreak.[2]

3.10 Fish Escape

- Facilities must have an approved escape management plan in accordance with existing regulations.

[2] A significant disease includes one with the potential for large-scale impacts on cultured and wild fish including exotic diseases and those causing high mortality rates.

3.11 Releases

3.11.1 Risk Assessment

- Fish are not to be released from a public facility to the wild without a health examination by the state fish pathologist. Examination should be performed as soon as possible when fish:
    - are known to be infected/infested/contaminated with disease agents for which there is a reasonable likelihood that a negative population health effect could result in wild aquatic organisms because of exposure to the agent(s),
    - have been treated with a drug or chemical, are still within the drug withdrawal period and are likely to enter the human food chain before the withdrawal period is over,
    - are involved in a disease outbreak, and/or
    - are affected by an unknown cause of death or illness.
- Fish are not to be released until actions arising from the risk assessment are acted upon.

3.12 Handling Drugs and Chemicals

Refer to section 3.12 of the Fish Health Management Plan.

3.12.1 Medicated Feed Storage and Inventory

Refer to section 3.12.1 of the Fish Health Management Plan.

3.12.2 Handling and Administering Medicated Feed.

Refer to section 3.12.2 of the Fish Health Management Plan.

3.12.3 Treatment Records

Refer to section 3.12.3 of the Fish Health Management Plan.

3.12.4 Chemicals and Biologicals

3.12.4.1 Disinfectants

Refer to section 3.12.5.1 of the Fish Health Management Plan.

3.12.4.2 Chemicals

Refer to section 3.12.5.2 of the Fish Health Management Plan.

3.12.4.3 Biologicals

Refer to section 3.12.5.3 of the Fish Health Management Plan..

4 Broodstock – Special Considerations

4.1 Suitable Rearing Environment

Fish held at culture facilities are provided with adequate physical space, water temperature within the normal range for the species held, and adequate water quality (oxygenation, waste product levels).

- HSWRI has a routine health-monitoring program. Refer to section 2.7 or 3.7 (Monitoring Fish Health).
- Materials used in the construction and maintenance of fish holding facilities are not harmful to fish.
- Fish are regularly observed to ensure:
    - Feed is being consumed.
    - Deaths disease and abnormal behavior are observed and appropriately treated.
    - Housing is safe and secure.
    - Animals are safe from predation and vandalism.

4.2 Feed and Nutrition

Refer to section 4.2 of the Fish Health Management Plan.

- HSWRI ensures that fish get sufficient quality and quantity of food.
- Feed is properly stored according to manufacturers' instructions and in a manner that prevents its exposure to pests, vandals and extremes of heat, light and humidity.

4.3 Biosecurity

Refer to section 4.3 of the Fish Health Management Plan.

Biosecurity includes three components:

- Keeping fish healthy, as per section 2.2 and 3.2.
- Keeping pathogens out, as per section 2.5 and 3.5.
- Keeping disease from spreading within the site, as per section 2.6 and 3.6.

Special Biosecurity considerations for broodstock include:

- Precautions to prevent the discharge of potentially infectious material into fish bearing waters during egg take.

4.4 Selection and Handling

- In settings where fish are held throughout their lifecycle, broodstock are identified early so as to allow for adequate time for modifications of nutrition, housing, disease control and handling protocols to reduce general stressors, support additional needs to minimize the risk of transfer of pathogens to subsequent generations.

- Staff handling broodstock observe proper hygienic precautions. Refer to sections 2.5.3 and 3.5.3 (Equipment) and 3.3.2 (Marking Fish). If broodstock are subjected to repeated invasive procedures, including injection, and marking it must be done in a manner to minimize stress and includes consideration of repeated anesthesia or sedation.

- Broodstock are properly sedated or anaesthetized if handled to check their readiness for gamete collection and are given adequate time between checks to recover from sedation /anesthesia and handling.

4.5 Treatments

Refer to section 4.5 of the Fish Health Management Plan.

All drug and chemical use in broodstock must consider issue of drug withdrawal periods for food safety purposes

4.6 Egg Collection

Refer to section 4.6 of the Fish Health Management Plan.

Refer to sections 3.7.2.1 (Egg Disinfection), 2.7.2.1 and 3.7.2.4 (Anesthetizing Fish), and 2.7.2.4 and 3.7.2.4 (Euthanasia).

- Egg collection procedures must include hygienic precautions to minimize pathogen transfer.

4.7 Disease screening

Refer to section 4.7 of the Fish Health Management Plan.

Broodstock are examined for disease at the time of initial quarantine.

- Particular attention is placed on diseases that can be transmitted from parent to progeny.
- Facilities have a plan to manage progeny of parents infected with vertically transmitted diseases of concern.
- The selection of diagnostic criteria for identifying infected or at risk progeny and a response plan is developed with the FHS

4.8 Egg Disinfection

Refer to section 3.7.2.1 (Egg Disinfection)

4.9 Identifying Progeny

Refer to section 4.10 of the Fish Health Management Plan.

4.10 Records

Refer to section 4.11 of the Fish Health Management Plan.

APPENDIX 2: Regulations / Policies Directly Related to Fish Health Management

A. Federal

B. Provincial