NATIONAL FARM ANIMAL CARE COUNCIL
CONSEIL NATIONAL POUR LES SOINS AUX ANIMAUX D'ÉLEVAGE

CODE OF PRACTICE

FOR THE CARE AND HANDLING OF

FARMED SALMONIDS

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Canada

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Preface

The National Farm Animal Care Council (NFACC) Code development process was followed in the development of this Code of Practice. The Codes of Practice are nationally developed guidelines for the care and handling of farm animals. They serve as our national understanding of animal care requirements and recommended practices. Codes promote sound management and welfare practices for housing, care, transportation, and other animal husbandry practices.

Codes of Practice have been developed for virtually all farmed animal species in Canada. NFACC's website provides access to all currently available Codes (www.nfacc.ca).

The NFACC Code development process aims to:

- link Codes with science
- ensure transparency in the process
- include broad representation from stakeholders
- contribute to improvements in farm animal care
- identify research priorities and encourage work in these priority areas
- write clearly to ensure ease of reading, understanding and implementation
- provide a document that is useful for all stakeholders.

The Codes of Practice are the result of a rigorous Code development process, taking into account the best science available for each species, compiled through an independent peer-reviewed process, along with stakeholder input. The Code development process also takes into account the practical requirements for each species necessary to promote consistent application across Canada and ensure uptake by stakeholders resulting in beneficial animal outcomes. Given their broad use by numerous parties in Canada today, it is important for all to understand how they are intended to be interpreted.

Requirements - These refer to either a regulatory requirement or an industry-imposed expectation outlining acceptable and unacceptable practices and are fundamental obligations relating to the care of animals. Requirements represent a consensus position that these measures, at minimum, are to be implemented by all persons responsible for farm animal care. When included as part of an assessment program, those who fail to implement Requirements may be compelled by industry associations to undertake corrective measures or risk a loss of market options. Requirements also may be enforceable under federal and provincial regulation.

Recommended Practices - Code Recommended Practices may complement a Code's Requirements, promote producer education, and encourage adoption of practices for continual improvement in animal welfare outcomes. Recommended Practices are those that are generally expected to enhance animal welfare outcomes, but failure to implement them does not imply that acceptable standards of animal care are not met.

Broad representation and expertise on each Code Development Committee ensures collaborative Code development. Stakeholder commitment is key to ensure quality animal care standards are established and implemented.

This Code represents a consensus amongst diverse stakeholder groups. Consensus results in a decision that everyone agrees advances animal welfare but does not necessarily imply unanimous endorsement of every aspect of the Code. Codes play a central role in Canada's farm animal welfare system as part of a process of continual improvement. As a result, they need to be reviewed and updated regularly. Codes should be reviewed at least every five years following publication and updated at least every ten years.

A key feature of NFACC's Code development process is the Scientific Committee. It is widely accepted that animal welfare codes, guidelines, standards, or legislation should take advantage of the best available research. A Scientific Committee review of priority animal welfare issues for the species being addressed provided valuable information to the Code Development Committee in developing this Code of Practice.

The Scientific Committee report is peer reviewed and publicly available, enhancing the transparency and credibility of the Code.

The *Code of Practice for the Care and Handling of Farmed Salmonids: Review of Scientific Research on Priority Issues* developed by the farmed salmonids Scientific Committee is available on NFACC's website (www.nfacc.ca).

Introduction

As a nationally developed welfare standard for farmed salmonids, this Code of Practice is the first of its kind in Canada. The Code Development Committee developed this Code based on research, veterinary expertise, and practical experience of those responsible for the day-to-day care of fish. The Code aims to provide feasible and scientifically informed approaches to fish husbandry that will contribute to a sustainable and internationally competitive Canadian aquaculture industry. As much as possible, user-friendly tools have been included in the Code to support its use in any production context.

The public and industry alike are increasingly concerned about the welfare of farmed fish. There are both practical and moral reasons for taking fish welfare seriously. Good production and good flesh quality often follow good welfare and are all integral to the success of the farm. Most importantly, optimizing fish welfare is the ethical thing to do for the fish in our care. It is essential that staff managing farmed fish are aware of the importance of welfare as an integral part of production.

The Five Freedoms (below) provide a framework for assessing fish welfare (1). At every stage of production, the welfare of fish should be considered in terms of these freedoms:

- Freedom from Hunger and Thirst
- Freedom from Discomfort
- Freedom from Pain, Injury, or Disease
- Freedom to Express Normal Behaviour
- Freedom from Fear and Distress

This Code of Practice pertains to farmed salmonids (i.e., trout, salmon, and charr) in all stages of production, including hatchery, nursery, grow out, transportation, and slaughter. While the vast majority of the sector is in salmonid production and is therefore covered by this Code (approximately 95%), the Code Development Committee recognizes the growing diversity of farmed fish species and encourages the timely development of Codes of Practice for all farmed fish species in Canada. This Code does not apply to commercial or recreational fishing, conservation aquaculture, or wild stock enhancement.

Cleaner fish are outside of the scope of this Code of Practice (they are typically wrasse or lumpfish and are not part of the salmonid family). However, producers who rely on cleaner fish to control sea lice are strongly encouraged to adapt the farmed salmonids Code to cleaner fish management where applicable. Resources on the care of cleaner fish are available in *Appendix L – Resources for Further Information*.

All applicable provincial/territorial and federal acts and regulations continue to take precedence, and anyone establishing or assuming management of a hatchery, nursery, farm, or transport or slaughter service will need to be familiar with, and follow, existing legislation.

Glossary

Alevins: larval stage fish not yet ready for first feeding (with yolk sacs still visible and used for nutrition).

All-in/all-out: a production strategy whereby all fish are moved into and out of facilities or production phases at the same time.

Anesthesia: temporary induction of loss of sensation or awareness. Fish are generally considered to be anesthetized when they lose consciousness. (Contrast with "Sedation.")

Animal welfare: an animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear, and distress (2). Animal welfare refers to the state of an animal; the treatment that an animal receives is covered by other terms such as "animal care."

Biodensity (stocking density): the number of fish multiplied by the average fish weight per cubic meter of water (expressed in kg/m^3). (Contrast with "Biomass.")

Biofouling: the accumulation of microorganisms, algae, plants, or small aquatic animals on rearing units or the equipment within.

Biomass: the number of fish multiplied by the average fish weight. (Contrast with "Biodensity.")

Biosecurity: measures intended to reduce the risk of introducing, establishing, and spreading animal diseases.

Broodfish: adult fish of reproductive age that are used to produce eggs and sperm from which juvenile fish result.

Cervical transection: a secondary step performed on unconscious fish to ensure death by severing the spinal cord at the level of the cervical vertebrae.

Cleaner fish: species of fish, such as wrasse or lumpfish, which are stocked with farmed fish as a biological control measure for sea lice.

Cleaning: physical removal of visible wastes such as biofilm, debris, dirt, and dust, often with soap and water. (Contrast with "Disinfection.")

Condition factor: a tool for assessing the nutritional status of fish, calculated using the formula $K = 100 \times \text{Weight (g)} \times \text{Length (cm)}^{-3}$. The higher the value, the rounder the fish. A value of <0.9 is generally considered poor condition; however, thresholds vary somewhat by strain and life stage, and physical appearance is also an important indicator of poor condition.

Competent: demonstrated skill and/or knowledge in a particular topic, practice, or procedure that has been developed through training, education, experience, and/or mentorship.

Compromised animals: in the context of transport, a group of fish that has a reduced capacity to withstand transportation due to weakness, illness, injury, or other cause (3). (Contrast with "Fit animals" and "Unfit animals.")

Corrective actions: actions to eliminate the cause(s) of nonconformity or other undesirable situations and to prevent recurrence. Generally, corrective actions relate to aspects of animal care or welfare that a producer can control; the action taken needs to be directed at effectively addressing a given issue.

Crowding procedure: the process in which the area available to the fish is temporarily reduced, usually to facilitate the removal of fish from a rearing unit.

Degree days: a value used to estimate and predict the amount of time for fish development, growth, and other physiological processes. The number of degree days is calculated by multiplying the average temperature by the number of days. For example, 300 degree days may be 30 days at 10°C, 100 days at 3°C, or any other multiple that results in 300. Throughout this Code, degree days are estimated using the Celsius scale.

Depurated: a pre-slaughter process to ensure fish are free of naturally occurring compounds that can cause off flavour. Fish in recirculating aquaculture systems are generally depurated by transferring them to separate depuration tanks that are flushed with water or operated with limited water recirculation (with no biofilter) to purge these compounds.

Disease: any physiological alteration of the normal state of an animal that interrupts or disturbs its vital functions and causes a pathological change. Infectious diseases may be caused by bacteria, virus, fungus, parasites, or other pathogens.

Disinfection: the application of procedures or products intended to effectively inactivate disease-carrying microorganisms on equipment or facilities. (Contrast with "Cleaning.")

Distress: distress results when an animal's response to stimuli interferes with its well-being and comfort. This definition may differ from how "distress" is used in some animal welfare legislation.

Ectotherm: an animal that is dependent on the environment for thermoregulation. Salmonids are ectotherms. (Contrast with "Endotherm.")

Endotherm: an animal that is dependent on internally generated heat for thermoregulation. (Contrast with "Ectotherm.")

Euthanasia: inducing the humane death of one or more fish for humane reasons in a way that minimizes or eliminates distress and suffering (4).

Exsanguination: cutting of the gill arches to bleed the fish. Performed as a secondary step on unconscious fish to ensure death.

Eyed eggs: eggs that have reached the stage of development where the black spot of the eye is clearly visible (approximately 220–250 degree days after spawning).

Fallowing: the practice of leaving rearing units empty of fish for a period of time to reduce the likelihood of pathogen transmission or parasite infestation between groups (5).

Fingerling: fish that have reached the stage where the fins can be extended and scales have started developing throughout the body. In this stage, the fish are typically the size of a finger.

Fit animals: a group of fish that can withstand the stress of transportation without experiencing suffering and that are expected to arrive at their destination in good condition. (Contrast with "Compromised animals" and "Unfit animals.")

Fry: fish starting from first feeding up to 1 gram.

Grading: sorting fish by size.

Group of fish: fish in an individual rearing unit (i.e., pen, tank, pond). (Contrast with "Population of fish.")

Hatchery: a site dedicated to artificial breeding, hatching, and rearing through to the early life stages of fish development.

Loading density: in the context of transport, the number of fish multiplied by the average fish weight per cubic meter of water (expressed in kg/m^3).

Lux: a standardized unit of measurement for the intensity of light, as perceived by the human eye.

Mass depopulation: humane termination of a population or large numbers of fish, often under emergency circumstances. Depopulation may be necessitated by detection of a regulated disease, the need to alleviate suffering, or an untreatable disease affecting large numbers of fish (6).

Morbidity: the condition of being diseased.

Moribund: fish whose condition is in a state of terminal decline; in a state of dying.

Nursery: a site that raises fish starting at post hatching until transfer to grow out.

Opercular rate: the number of times the operculae (gill covers) open and close during a specified period. For example, an opercular rate of 10 per minute means that the operculae opened and closed 10 times over a period of one minute.

Parr: fish that are greater than 1 gram and up to the start of smoltification. Parr are characterized by the appearance of vertical lines on each side of their body.

Pathogen: a bacterium, virus, or other microorganism or agent that may cause disease.

Population of fish: groups of fish in many or all rearing units on a given site. (Contrast with "Group of fish.")

Pithing: physical destruction of brain tissue (also called spiking or coring).

Quarantine: maintaining aquatic animals in isolation with no direct or indirect contact with other aquatic animals in order to undergo health observation for a specified length of time and, if appropriate, testing and treatment, including water treatment (5).

Rearing system: the overall infrastructure (e.g., buildings, lighting, pumps) that supports rearing units. (Contrast with "Rearing unit.")

Rearing unit: the enclosure that is used to contain the fish (e.g., tank, pen, pond). (Contrast with "Rearing system.")

Sea lice: parasitic copepods commonly found on salmon species and a variety of other fish species in marine and brackish water.

Sedation: physiological state where fish are lightly anesthetized and show reduced activity but normal equilibrium, opercular rate, and muscle tone. (Contrast with "Anesthesia.")

Shocking eggs: the mechanical process of turning unfertilized eggs white so that they can be separated from fertilized eggs. Eggs are shocked when they reach the eyed stage.

Slaughter: humane killing of animals intended for food.

Smoltification: a series of physiological and behavioural changes some young salmonids undergo to adapt from living in freshwater to seawater (also called parr-smolt transformation).

Smolts: fully smolted juvenile fish. These fish are silver in appearance.

Special provisions: in the context of transport, measures that are intended to prevent suffering, injury or death and include, among others, slow shipping, lower density, and increased monitoring frequency.

Standard operating procedure (SOP): written step-by-step instructions describing how a particular task is to be completed. Standard operating procedures typically include specific assignment of responsibilities, workflows, desired outcomes, and contingencies.

Swim-up stage: the stage of development when an alevin exhibits deliberate swimming motion and must swim to the water surface to fill its swim bladder.

Transportation process: any stage in preparing for or transporting fish off site (i.e., loading, confinement, transporting, and unloading).

Triploid fish: fish that are sterile as a result of a procedure performed on the eggs. Triploid fish possess three sets of chromosomes instead of the normal two.

Unconsciousness (insensibility): the point at which an animal can no longer perceive and respond to its environment or stimuli (e.g., light, pain).

Unfit animals: in the context of transport, a group of fish exhibiting signs of weakness, illness, injury, or other condition that indicates that they cannot be transported without suffering (3). (Contrast with "Compromised animals" and "Fit animals.")

Veterinarian-client-patient relationship (VCPR): the basis for interaction among veterinarians, their clients, and their clients' animals. The VCPR is specifically defined in provincial veterinary acts but, generally, a VCPR has been established when the veterinarian has examined the fish or visited the site; the veterinarian has assumed responsibility for making clinical judgments related to the health of the fish; and the client has indicated a willingness to follow the veterinarian's instructions.

1 Knowledge and Skills of Hatchery, Nursery, and Farm Personnel

The people who care for fish at any life stage have an important impact on their welfare (7). Personnel who work directly with eggs and fish are often the first to identify possible concerns, and it is essential that they are competent in their assigned duties. Research in several farmed animal species shows that attitudes and beliefs about animals and the importance of routine care influence the way people interact with animals and the diligence with which they carry out their tasks (7). These factors also contribute significantly to the variation across farms in productivity and other performance metrics (7).

Eggs and young fish are at the most critical of all life stages. Not only does the care they receive in the hatchery/nursery directly impact their welfare during this stage of production, but it also has significant and lasting influence on their welfare in all subsequent life stages. Attentive and skillful husbandry during these early life stages is integral for success throughout the grow out period.

Competency of personnel involved in fish transport is covered in *Section 7 – Transportation.*

REQUIREMENTS

Personnel who care for eggs or fish must have the competence to properly carry out the practices and procedures they are responsible for.

RECOMMENDED PRACTICES

a. develop and implement a written fish welfare code of conduct outlining the company's commitment to responsible care of eggs and fish (see sample in Appendix A)
b. ensure personnel move about in rearing units and interact with fish in ways that minimize startle responses in fish
c. participate in continuing education activities related to animal care and welfare
d. document completed training and certifications (see *Appendix B – Sample Training Log*)
e. develop and implement detailed standard operating procedures (SOPs) to facilitate training and ensure consistency in the delivery of the procedures
f. routinely assess compliance to SOPs
g. update SOPs at least annually (or whenever important improvements are made to procedures) and promptly communicate changes to personnel (Appendix C provides a sample form to help track these activities)
h. identify managers or mentors that personnel can approach with questions/concerns about the care of eggs and fish.

2 Rearing Systems and Units

A variety of rearing systems and units are used in the farmed salmonid industry, ranging from ponds, sea and lake net pens, and land-based flow-through and recirculating systems. Despite this diversity, the same main factors need to be considered when designing any rearing system or unit.

2.1 Site Selection

Environmental conditions (e.g., potential for storms) are important to consider when selecting a site, as is the probability of events that may result in poor water quality (e.g., flooding, plankton blooms). Long term availability of water for land-based sites is also a critical consideration. When it exists, consulting historical data and knowledge (e.g., hydrographic, oceanographic) will help to determine whether a location is appropriate. Suitability may change over time with decreasing oxygen or increasing water temperatures, so site risks need to be continually reassessed.

REQUIREMENTS

Site selection considerations must include an assessment of water quality and environmental risks.

Where it exists, historical data (e.g., hydrographic, oceanographic) must be consulted to determine site suitability and understand seasonal changes.

Site suitability must be routinely evaluated as it may change over time. Management practices must change in relation to changes in site condition.

RECOMMENDED PRACTICES

a. locate enclosures such that damage by adverse weather or poor water quality events is minimized as best as possible
b. avoid sites that are near sources of noise pollution or vibrations that will stress or disturb fish (e.g., heavy boat traffic).

2.2 Rearing System and Unit Design

Water Quality and Water Current Speed

The amount of control over water quality parameters depends on the type of rearing system. Water supply needs to be assessed for contaminants and to ensure there is sufficient capacity. Water current speeds are particularly important in net pens, where they influence water exchange. Low current speeds can lead to low oxygen events and hypoxia in fish, especially at high biodensities and high temperatures. High current speeds may cause net pens to become deformed, reducing the pen volume and potentially leading to crowding, entanglement, and injury. High current speeds may also prevent fish from maintaining their position in the school or water column. In extreme cases, high water current speeds can lead to fish becoming exhausted. Various strategies and tools (e.g., aeration, buffers) can be used to mitigate the impacts of low or high current speeds.

Life Support Redundancy and Emergency Procedures

All rearing units benefit from having backup life support systems and emergency procedures, but these are particularly vital in systems that are reliant on electricity or where biodensities are high and water quality ranges are narrow. Life support systems need to be maintained and tested regularly, and emergency procedures should be reassessed frequently. It is necessary to know how long water quality will be maintained in the event of a power failure to evaluate the level of life support redundancy needed (e.g., what size of generator is needed and how much fuel).

Containment and Exclusion

Escaped farmed fish may experience poor welfare. Rearing units with lids or appropriate netting help prevent fish from escaping. Inlets and outlets should be designed to prevent escape of farmed fish as well as entry of wild animals, including wild fish.

Noise, Vibrations, and Electrical Current

Equipment used in aquaculture produces vibrations and ambient noise at low, sustained frequencies (e.g., aerators, pumps, harvesters, blowers). Loud, intermittent noises with high levels of vibration are disruptive to fish. The effects depend on the intensity of the noise but may include hearing impairment, behavioural changes, and death (8). Aquaculture production also involves the use of electrical equipment (e.g., electrical feeders) that may produce stray electrical currents. Electrical current is highly noxious to fish and may lead to injury or mortality.

Environmental Enrichment

Enrichments can be used to enhance the rearing environment and encourage expression of normal species-specific behaviours (9). The broad types of enrichments include social (e.g., contact with other salmonids for schooling), physical (e.g., addition of objects, substrates, or shelters), sensory (e.g., appropriate tank colour), and dietary (e.g., varied or novel feed types) (10). Use of dark backgrounds, tank floor substrate, and shelters may reduce aggression (11, 12, 13). Artificial turf mats and other substrates have been shown to increase survival rates of alevins and fry (14). Environmental or dietary changes need to be monitored to ensure that they positively enhance welfare and do not cause health or production issues.

REQUIREMENTS

Rearing units must not contain sharp protrusions or abrasive surfaces that could injure fish.

Emergency procedures relevant to the farm's location and type of rearing system must be developed and communicated to personnel.

Farms that are reliant on electricity for life support systems (e.g., water flow, provision of oxygen) must have alternative means to support these critical functions in the event of a power failure, mechanical breakdown, or other emergency.

Systems must be in place to prevent fish escape and the entry of wild animals, including wild fish.

Netting and screens must be a suitable size for the fish being held to prevent escape, entanglement, entrapment, and injury.

Netting and screens must be regularly checked for holes and maintained in good condition.

Net pens must be adequately tensioned and of a weight that prevents distortion and associated crowding, entanglement, or injury.

Flow rate must allow fish to hold their normal position and distribution in the water column and for water quality to be maintained.

RECOMMENDED PRACTICES

a. consider using environmental enrichment or other design features that allow fish to perform a range of natural behaviours (e.g., shelters, artificial substrates, dark tank backgrounds)
b. consider the following design elements when developing rearing systems and units:
   - fish welfare
   - fish behaviour
   - water treatment
   - water volume and flow
   - access to fish for monitoring
   - protection from adverse weather
   - redundancies in life support
   - feed delivery
   - minimizing sources of vibration
   - ease of mortality collection and disposal
   - reducing pathogen introduction and spread
c. design and maintain rearing systems such that noises that cause startle responses in fish are minimized
d. monitor for and eliminate stray voltage within the rearing units.

2.3 Water Quality

Water quality is fundamental to the welfare of farmed fish. Poor water quality elicits a stress response in fish (15). When the conditions become too challenging or prolonged, fish cannot maintain homeostasis and experience chronic stress, which can impair immune function, growth, and reproductive function (16). The potential for serious welfare issues related to water quality is highest in intensive recirculating aquaculture systems (RAS) where fish are raised at high densities in highly controlled environments with narrow margins for error.

Oxygen

Monitoring of oxygen is essential in all aquaculture systems. Supplemental oxygen is needed in some systems, such as RAS, to maintain adequate levels. Oxygen levels in water decrease as temperature increases, so oxygen levels should always be assessed in conjunction with temperature (15). Consumption of oxygen is also affected by body mass, growth rate, feeding rate, activity, and stress (17). An increased ventilation rate or gasping at the surface may indicate severely low levels of oxygen, whereas gas bubble disease may be seen if oxygen levels are extremely high (supersaturation) (18).

Carbon Dioxide

High levels of carbon dioxide are most likely to occur in RAS, and can result in decreased oxygen uptake, decreased growth rates, kidney damage, and cataracts (18). Signs of carbon dioxide toxicity include slowed respiration and fish laying on the bottom of the tank.

Ammonia, Nitrite, and Nitrate

Ammonia is produced by fish as well as by decomposing feed and feces. It is converted by bacteria to nitrite, then nitrate. Nitrite and unionized ammonia are toxic at high levels. Elevated levels of nitrite may impact the uptake and transport of oxygen in the blood, which will lead to reduced growth rates and poor swimming performance (15). Signs of ammonia toxicity include a lack of foraging, reduced swimming performance, increased gill ventilation, gill damage, gasping, loss of equilibrium, and osmoregulatory disturbances (15). Nitrate is relatively non-toxic but can cause problems, such as poor growth, if allowed to accumulate (18).

pH

The pH of water will vary significantly depending on its source. Agricultural runoff, storms, and other factors may cause temporary fluctuations in pH. Very low pH (below 5.0) can be lethal for salmonids (17).

Temperature

Salmonids rely on their environment and behaviour to maintain their body temperature. Optimal temperature range varies significantly with species and life stage. Temperature range may be manipulated to alter growth rates, but serious welfare issues, including mortality, can occur if this is done inappropriately (18).

Suspended Solids and Turbidity

High levels of suspended solids can have negative effects on gill health and function, compromising oxygen transfer and providing a habitat for the growth of pathogens. Increased suspended solids result in increased turbidity and biofouling and make it harder to observe fish. Variation in the formulation of commercial feeds may result in diarrhea, which contributes to turbidity (18).

Hydrogen Sulphide

Hydrogen sulphide is formed by the decomposition of organic matter in anoxic areas, like sludge or sediment buildup in tanks (18). It is highly toxic to fish even in very small quantities, with the risk of buildup being higher in seawater (18). Hydrogen sulphide interferes with respiration, so the initial sign of poisoning is an increased respiratory rate (15). Routine cleaning and sediment removal from rearing units reduce the risk of poisoning.

REQUIREMENTS

Oxygen must be monitored daily at the effluent, or the point of lowest expected oxygen, in each fish rearing unit.

Water temperature must be monitored daily in all systems.

If water temperature or oxygen levels are outside of the appropriate range and cannot be corrected, non-urgent procedures that may cause additional stress (e.g., handling) must be postponed until parameters are back within the appropriate range.

Monitoring and mitigation plans for plankton must be in place for marine systems.

If abrupt changes in water quality or behaviour suggesting poor water quality occur (e.g., fish gasping due to low oxygen levels), corrective action must be taken.

RECOMMENDED PRACTICES

a. keep water quality parameters within the following optimal ranges:
   - Oxygen: 80–100%
   - Carbon dioxide: <10 mg/L
   - Ammonia (unionized): <0.0125 mg/L
   - Nitrites: <0.2 mg/L
   - Nitrates: <100 mg/L
   - pH: 6–8.5
   - Temperature: 4–18°C

b. use automated alarm systems to monitor water quality and enable early identification and correction of issues

c. monitor and have mitigation plans in place for turbidity and total dissolved solids

d. avoid buildup of biofouling in rearing units (e.g., wash or change out nets frequently, use biofouling resistant nets, clean pond and tank surfaces frequently)
e. monitor pH closely in situations where it may drop quickly (e.g., before and during snow melt, during heavy rainfall)
f. monitor oxygen levels continuously in RAS
g. avoid abrupt changes in water quality when taking corrective action, as fish may be slow to adapt to the change
h. monitor ammonia, nitrite, and nitrate levels several times a week in RAS. Increase to daily monitoring when using medications, in the event of an increase in mortality, or when changing feeding programs
i. increase monitoring during any major system change (e.g., increase monitoring of pH and oxygen in net pens during algal blooms)
j. ensure there are no areas of very low oxygen or sludge buildup within the rearing unit
k. be aware of all other water quality parameters in a system (e.g., total gas pressure, heavy metal contaminants) and investigate if there are problems.

2.4 Lighting

Photoperiod and light intensity are key management tools in salmonid production. Artificial lighting is used to control photoperiod to induce smoltification, advance or delay the timing of spawning, manipulate sexual maturation, and promote fish growth. Various lighting regimens are used for these purposes, including extended day length, reduced day length, or continuous light (i.e., no dark period in a 24-hour cycle). Continuous lighting is also used to prevent suffocation in the early swim-up stage and to avoid maturation and associated disease vulnerability (19). However, some research has reported an association between continuous lighting and reduced bone strength, poor smolt quality, failed smolting, and failed spawning (20, 21, 22).

Light intensity can be manipulated by increasing or decreasing the number of lights on the farm, or by changing the strength and type of the lights. Light intensity is affected by the distance between the fish and the light source, the clarity of the water, and the biodensity within the rearing unit. Sudden changes in light intensity may cause a startle response, increased oxygen consumption, injuries, or suffocation (23, 24, 25). In indoor systems, various approaches can be used to ensure a slow transition of light intensity (e.g., setting lights to phase on/off slowly, removing tank lids gradually, turning lights on/off in stages, having windows or other natural sources of light). Fish also need to be gradually exposed to a change in light intensity before transfer to a new environment.

Excessive exposure to ultraviolet (UV) light from the sun may damage the eyes of fish resulting in cataracts or ulcers and may cause sunburn.

Light emitting diodes (LEDs) offer a new form of lighting technology for aquaculture (26). LED technology is fast evolving and may offer an alternative that is more in tune to environment and species sensitivities (26), but the full impact on fish welfare is not yet known.

REQUIREMENTS

Rapid changes in light intensity that will cause a startle response and associated injury, mortality, or suffocation must be avoided.

Lighting and lighting control systems must be inspected regularly and maintained in good working order.

RECOMMENDED PRACTICES

a. minimize the pre- and post-transfer changes in light intensity and regimens
b. prevent eye and skin damage from UV light by ensuring adequate enclosure depth or by using tank lids

c. monitor for any unwanted outcomes when introducing or using a continuous lighting regimen. Where necessary, provide periods of low light intensity.
d. monitor for any unwanted outcomes when introducing LED lighting into a rearing system.

2.5 Biodensity

The impact of biodensity on fish welfare is dependent on several variables, including species, life stage, water quality, feed access, and the ability to control the environment within different types of rearing units. In general, the potential for negative welfare is increased with high biodensities (27). Issues include stress and increased susceptibility to disease, unequal feed access, and reduced growth rate, feeding efficiency, and fin quality (27). However, as is illustrated in *Appendix D – Relationship between Biodensity and Welfare Outcomes*, high biodensity does not always result in negative welfare outcomes nor does low biodensity always result in positive welfare outcomes. With good water quality and attentive husbandry, healthy fish may do well at higher densities.

Maximum biodensities range between approximately 10–25 kg/m^3 in net pens (i.e., an upper limit of 2.5% fish, 97.5% water) and 20–100 kg/m^3 in land-based systems (i.e., an upper limit of 10% fish, 90% water). Semi-contained systems fall somewhere between these ranges depending on their design and the degree of control over water quality. Given the interaction of variables involved in determining an appropriate biodensity and the range of species and rearing units covered in this Code of Practice, it is not possible to provide a list of biodensity ranges that would both account for all of these factors and guarantee positive health and welfare outcomes. The overall condition and behaviour of the fish should serve as the main considerations when assessing welfare in relation to biodensity.

The number of fish in a unit should be counted when a tank or pen is first stocked. Accuracy of counts may be validated with a second method of counting or by putting a predetermined number of fish through a counter to check its accuracy. Tracking the average weight of the fish over time as well as the number of mortalities removed from rearing units is also important for ensuring the accuracy of biodensities.

REQUIREMENTS

Biodensity must be assessed at least once a month, unless conditions present a risk to fish welfare (e.g., algal blooms), in all rearing units to ensure it remains appropriate relative to fish growth and environmental conditions.

If a slower than expected growth rate and/or welfare issues (fin or skin erosion, excessive size variation, or reduced feeding response) occur, biodensity must be assessed as a potential contributing factor and corrective action must be taken.

RECOMMENDED PRACTICES

a. aim for a biodensity that produces outcomes in alignment with the green column in *Appendix E – Guidance on Welfare Indicators*
b. ensure fish counts and weights are accurate when calculating biomass. Validate weights and counts where possible
c. combine weighing and counting with other husbandry procedures to minimize the frequency of handling
d. consider the use of technologies that allow biomass to be calculated without handling fish (e.g., biomass frames, stereo camera-based systems).

3 Husbandry Practices

3.1 Husbandry Practices at Specific Life Stages and for Triploid Fish

3.1.1 Egg Management

Proper incubation and handling of eggs promotes healthy embryo development, minimizes embryo mortality and deformity, and promotes good welfare in all subsequent life stages. Eggs require careful handling and care throughout all stages of development but are particularly susceptible to damage before they reach the eyed stage.

Incubating eggs in consistent darkness or low light intensities results in better survival and larger alevins (19).

Optimal egg incubation temperatures vary somewhat amongst salmonids and stages of egg development (see Table 3.1). Temperatures that are too high or low or that fluctuate too much are associated with increased rates of jaw, fin, vertebral, and other deformities in developing fish (28).

Prompt and careful removal of dead eggs and egg surface disinfection, as appropriate, helps prevent the establishment of fungal infection and/or its spread to live eggs (19, 29).

Table 3.1 – General Guidance on Optimal Egg Incubation Temperature Ranges*

	Charr	Trout	Salmon
Green	2–4°C	4–14°C	4–8°C
From eyed stage	2–8°C	4–14°C	4–10°C

*The exact ideal temperature varies by strain of fish (e.g., for Brook trout 2–10°C is recommended for both green and eyed eggs).

REQUIREMENTS

Eggs must be incubated, cared for, and handled in ways that promote healthy embryos.

Incubators must be in good working condition to prevent injury or death of eggs and prevent eggs from falling out.

Incubators with eggs must never be handled in a manner likely to damage the eggs.

Eggs must be disinfected after fertilization.

RECOMMENDED PRACTICES

a. follow the incubator manufacturer's recommendations on stocking rates for eggs
b. minimize movement of eggs between the fertilization and the eyed stage
c. maintain the optimal incubation temperature for the type of fish and life stage (see Table 3.1)
d. protect eggs from dramatic fluctuations in water temperature (no more than +/- 1°C per hour, as a guide)
e. keep eggs under a low light intensity (e.g., <5 lux) (19, 30)
f. avoid exposing eggs to abrupt fluctuations in light intensity
g. promptly remove dead/unviable eggs at the earliest appropriate stage (ideally not before approximately 250 degree days after fertilization) (29)
h. ensure removal of dead/unviable eggs is done with minimal disturbance to live eggs

i. establish and implement site-specific protocols for keeping the surface of eggs clean and monitoring egg mortality and fungal growth
j. if shocking eggs against a hard surface, ensure sufficient water flow and have sufficient water in the container to mitigate the intensity of the shock.

3.1.2 Broodfish

Broodfish are often exposed to frequent handling as personnel select for specific traits or assess fish for maturity. These handling events likely occur during sensitive time periods of egg development and release, and therefore handling of individual fish needs to be done with care (see *Section 3.2 – Handling*).

Some broodfish are tagged for identification and sampled for genotyping. Genotype sampling is usually done by clipping a small amount of tissue from either the caudal or adipose fin or through a scale scrape. Tagging and genotype sampling may result in stress and/or pain, so these procedures must only be performed by trained individuals on anesthetized fish (see *Section 3.2.1 – Sedating and Anesthetizing Fish*).

Synchronizing maturation is done primarily to increase egg and fingerling supply throughout the year. Depending on the rearing environment and species, production of monosex fish or the use of hormones may be necessary to synchronize maturation between males and females. If photoperiod manipulation is used to alter the time of maturation, consistent and accurate changes in day length are recommended.

Eggs may be collected by hand pressure, compressed air, or saline flushing. In order to facilitate handling, broodfish that spawn more than once are sedated or anesthetized prior to gamete collection. To reduce the risk of transmission of pathogens between batches of eggs or milt, collection needs to be performed in a hygienic manner (refer to *Section 5 – Health Management*).

REQUIREMENTS

Personnel involved in spawning, tagging, and fin clipping must be competent in the technique prior to performing the procedures on broodfish.

Eggs and milt must be collected using only gentle pressure.

If spawning is terminal, broodfish must be euthanized in a humane manner prior to spawning. Refer to Section 6 – Euthanasia, Slaughter, and Mass Depopulation.

RECOMMENDED PRACTICES

a. perform tagging or marking of broodfish in a manner that will not have any long-term adverse effects on fish behaviour, health, feeding, or movement (e.g., use PIT or polymer tags and follow supplier recommendations)
b. remove no more than the necessary amount of tissue when performing a fin clip or scale scrape for genotype sampling
c. use the following techniques when inserting tags:
    - ensure fish have empty guts prior to tagging (refer to *Section 4.3.3 – Feed Withdrawal*)
    - ensure the size of the tag is appropriate for the size of fish
    - use a sharp needle for insertion of the tag
    - disinfect the needle between each fish
d. maintain accurate and complete records for all broodfish procedures to guide future collections
e. ensure any gloves worn while handling broodfish minimize slipping and prevent scale loss and damage to the mucous layer
f. use automatic lighting timers when using photoperiod manipulation to alter the time of maturation.

3.1.3 Triploid Fish

Triploids are desirable in certain production systems because they are infertile, which minimizes the impact of escapees on wild populations (31). In addition, female triploids are beneficial because they do not develop secondary sexual characteristics and associated issues (31). It is common practice in some systems to produce all female triploids. The use of either single sex populations or triploids is legally mandated in some provinces.

The procedure performed on eggs to produce triploids may be associated with high rates of mortality and deformity if not done properly (31), so careful training and technique is required. Induction of triploidy by pressure treatment is associated with lower mortality at the eyed stage or at hatching, and lower rates of deformities at hatching compared to induction of triploidy by heat treatment (30).

It is particularly important to rear triploid fish in optimal water quality and avoid conditions that may cause chronic stress (e.g., high temperature combined with low oxygen levels and/or changes in salinity) (31).

When reared together with diploids, triploids may show reduced growth rates and increased fin erosion, possibly due to the generally less aggressive demeanor often observed in triploids (31).

There is recent evidence that deformities in triploid adult Atlantic salmon can be reduced with the use of specific triploid diets, as there are different nutritional requirements between ploidies (31).

REQUIREMENTS

To reduce the rate of mortalities and deformities, personnel responsible for performing triploid production on eggs must be competent in the technique.

Producers raising triploid fish must be aware of and accommodate their specific requirements through husbandry and stress reducing strategies (e.g., adjusting feeding, oxygen, temperature, and salinity).

RECOMMENDED PRACTICES

a. improve triploid production techniques if deformity or larval mortality rates increase (31)
b. avoid using heat treatment as the technique for producing triploid fish
c. avoid rearing diploids and triploids in the same rearing unit (31)
d. frequently monitor triploid fish to ensure any issues can be addressed promptly (the window to correct issues is narrower with triploid fish)
e. ensure, as best as possible, that triploid fish are reared in units with high oxygen levels (10–50% higher than diploid units) and minimal fluctuations in water temperature
f. avoid rearing triploid fish in environments that have high water temperatures or high salinity (31).

3.2 Handling

Although handling is necessary for certain procedures that contribute to fish welfare, it is stressful for fish. Fish may be more susceptible to handling injuries depending on their life stage (e.g., first feeding, late stages of sexual maturation), health status (e.g., gill damage, concurrent disease), and environmental factors (e.g., hypoxia, extreme water temperatures).

REQUIREMENTS

Personnel must be competent in techniques used to handle fish in all life stages.

Fish must have their body supported when they are lifted and carried and must never be lifted or carried by only the fins, head, tail, or gills.

Fish must be handled in a manner that minimizes stress and the risk of injury.

Abusive handling is unacceptable. Personnel must not beat, whip, kick, sweep, or drag fish.

The time that fish are out of water must be minimized (i.e., only as long as necessary to carry out the procedure).

The number of fish in hand nets must prevent suffocation and injury.

Fish handling must be delayed or adapted if warranted due to poor health (e.g., gill disease) or poor water quality conditions (e.g., low oxygen, plankton bloom, low or high water temperature).

RECOMMENDED PRACTICES

a. develop and implement a standard operating procedure (SOP) for handling fish at each life stage
b. have sufficient personnel to perform procedures in a timely manner and any necessary tools/equipment ready before fish are handled
c. strive to return fish to the water in less than 30 seconds (32, 33)
d. whenever possible, run water over the gills when handling fish out of water
e. ensure any gloves worn while handling fish minimize slipping and prevent scale loss and damage to the mucous layer.

3.2.1 Sedating and Anesthetizing Fish

Section 3.2.1 pertains to temporarily sedating/anesthetizing fish prior to certain husbandry procedures to minimize the harms associated with their increased activity during handling. *Section 6 – Euthanasia, Slaughter, and Mass Depopulation* addresses anesthetizing fish in the context of humane killing.

Features of an appropriate sedative/anesthetic include (34):

- short induction time
- straightforward to administer to ensure correct and consistent use
- short recovery time relative to depth of sedation/anesthesia.

Table 3.2 – Stages of Sedation and Anesthesia (35)

Stage	Descriptor	Fish response	Some examples of procedures appropriate for a given stage
1	Lightly sedated	Disoriented; reduced activity; normal equilibrium, opercular rate, and muscle tone	Wet weighing
2	Light anesthesia	No activity; loss of equilibrium; decreased opercular rate and muscle tone; reactive to reflex responses (e.g., tail pinch)	Close visual inspection/health checks; external, non-invasive tags; gill or scale scrape
3	Surgical anesthesia	No coordinated activity; loss of equilibrium; shallow opercular rate; decreased heart rate and muscle tone	Invasive tags; vaccination or other injection; blood sampling; non-terminal spawning; gill biopsy; surgery; fin clip
	Unintentional overdose	Opercular and heart rates stop; no muscle tone; death imminent without life support	n/a

Table 3.3 – Stages of Recovery

Stage	Descriptor
1	Body immobilized but opercular movements just starting
2	Regular opercular movements and body movements beginning
3	Equilibrium regained and pre-anesthetic appearance

REQUIREMENTS

Procedures requiring sedation or anesthesia include injectable vaccination, a scale scrape, fin clipping, tagging, and any other procedure requiring sedation or anesthesia as directed by the farm veterinarian.

Sedatives/anesthetics must be selected and used in consultation with the farm veterinarian to ensure fish are appropriately sedated/anesthetized for the intended procedure.

Carbon dioxide must not be used to sedate/anesthetize fish.

Prompt corrective action must be taken if injuries or gasping occur or water quality visibly deteriorates (e.g., debris, stable foam, mucus) during sedation/anesthesia.

If freshwater is used during sedation/anesthesia, it must have a neutral pH or be buffered to a neutral pH.

RECOMMENDED PRACTICES

a. develop and implement, in consultation with the farm veterinarian, procedure-specific protocols for sedating/anesthetizing fish including:
   - duration of feed withdrawal
   - dosage at different life stages and water temperatures
   - behavioural responses to monitor (and frequency of monitoring)
   - water quality parameters to monitor (and frequency of monitoring and water changes)
   - criteria for discontinuing treatment (and guidance on how to do so)

b. confirm appropriate dosage (which can vary according to many factors) by first testing a recommended dose on a single fish or small group of fish
c. have a recovery section within the rearing unit or if using a separate container for recovery, ensure appropriate water quality is maintained (e.g., oxygenation, water changes)
d. consider, in consultation with the farm veterinarian, the use of recovery aids (e.g., salt) particularly if issues during recovery occur
e. revise farm protocols if an unintentional overdose occurs.

3.3 Crowding Procedure

With attentive management, stressors associated with the crowding procedure (e.g., reduced oxygen, increased swimming activity) can be minimized (27). When crowding in net pens, deep, narrow crowd nets are generally preferred (compared to shallow crowd nets) as they maintain normal light intensity, permit greater freedom of movement, and reduce the risk of injury (36). As fish are crowded, the water surface should be as calm as possible with few fish breaking the water's surface and no vigorous activity should be observed (37).

REQUIREMENTS

Crowding must be accomplished gradually (i.e., no sudden or rapid decrease in the available space) to prevent injury.

If crowding behaviour progresses from a score of 3 to 4, immediate corrective action must be taken to prevent injury. Refer to Appendix F – Assessing Fish Behaviour during the Crowding Procedure.

Crowding must be delayed or adapted if warranted due to poor health (e.g., gill disease) or poor water quality conditions (e.g., low oxygen, plankton bloom, low or high water temperature).

RECOMMENDED PRACTICES

a. develop and implement a written SOP for crowding
b. use deep, narrow crowd nets (36)
c. situate crowd pens such that fish can swim against the tide towards the inlet pipe and preferably into a shaded area (to take advantage of natural fish behaviour) (36)
d. monitor water quality throughout the crowding procedure and avoid any sudden changes in oxygen levels
e. loosen crowd nets upon seeing any increase in vigorous activity and allow the fish to calm before resuming the crowding procedure
f. monitor fish and water (e.g., for scales) after crowding and refine protocols if injuries occur or return of appetite is delayed (16).

3.4 Grading

Grading is an important part of husbandry as it prevents excessive size variation and competition and promotes uniform smoltification and fingerling size (38). However, the grading process is stressful for fish and necessitates withdrawal of feed. The health status of fish as well as water temperature and other environmental conditions need to be evaluated prior to grading.

The need for grading can be reduced by:

- using equipment that helps yield uniform fish size from first feeding (e.g., automated egg quality machines)

- having a plan for biodensities in all production stages or rearing units
- ensuring optimal feeding strategies, particularly feed distribution and ration size (refer to *Section 4 – Feeding Management*)
- employing lighting regimens that minimize the risk of fish maturation (refer to *Section 2.4 – Lighting*)

There are important welfare benefits to withdrawing feed prior to grading (e.g., reduced injury and mortality) (38). Refer to *Section 4.3.3 – Feed Withdrawal.*

REQUIREMENTS

Grading must be delayed or adapted if warranted due to poor health (e.g., gill disease) or poor water quality conditions (e.g., low oxygen, plankton bloom, low or high water temperature).

RECOMMENDED PRACTICES

a. develop and implement a written SOP for grading
b. avoid grading during periods of low- or high-water temperatures, whenever possible (39)
c. monitor water quality and temperature throughout the grading procedure
d. monitor fish and water (e.g., for scales) after grading and refine protocols if signs of injury are noted or there is a delay in return of appetite (16).

3.5 Transfer/Ponding

Optimizing pre- and post-transfer conditions increases the likelihood of successful transfer and provides fish with the best start at grow out. The correct timing for transfer is particularly important for later growth and survival. Many diseases develop in the months following transfer, and these may be directly associated with the stress fish are exposed to in the pre- and post-transfer period—research shows that repeated stress impairs fish health and coping ability (16).

Signs that fish are not thriving after transfer (whether into salt or freshwater) include: (16)

- weight loss or poor condition factor (e.g., condition factor value <0.9)
- skin darkening and scale loss
- slow or stationary swimming (especially at the surface or corners/sides of the rearing unit)
- poor or no response to feeding.

Refer to *Section 7 – Transportation* for off-site movement of fish.

REQUIREMENTS

The group of fish to be transferred to grow out must be assessed as healthy and fit for transfer.

Individual fish that are moribund, malformed, or severely injured must be removed from the group of fish to be transferred, as much as is reasonably possible, and euthanized.

Fish condition and performance must be closely monitored after transfer to confirm groups of fish are adapting to new conditions and are feeding appropriately.

RECOMMENDED PRACTICES

a. grade fish prior to transfer to minimize size variation in the group and ensure optimal feeding management after transfer (refer to *Section 3.4 – Grading*)
b. establish benchmarks for fish condition after transfer (e.g., mortality, return to appetite, failure to thrive) that, if exceeded, will trigger changes to transfer sizes/weights in future groups

c. after transfer, continue to remove fish that are moribund, malformed, severely injured, or in poor body condition as these fish are vulnerable to disease and may become a source of pathogens and parasites affecting other fish.

3.5.1 Transfer to Saltwater

Fish that are fully adapted when transferred to full strength saltwater have few osmoregulatory problems and better growth performance after transfer (40). Stage of adaptation may be assessed visually (see Table 3.4) or through laboratory testing. Tests include checking for increasing sodium, potassium, and ATPase activity in the gill tissue or assessing sodium and chloride levels in the blood after exposure to full strength saltwater for 24 hours.

In salmon production, temperature control can optimize growth rate but can raise welfare concerns around the completion of smolting and duration of the smolt window and grow out to 4 kg (18). For smolting, 10°C is safe and >15°C poses significant welfare risks if the fish are to be transferred to sea pens (18). For grow out to ≥4 kg in RAS, 14–17°C appears to be safe (18).

Table 3.4 – Visually Assessing Smoltification Stages in Salmon

Smolt Score	Fish Appearance
1	Parr marks clear, light coloured back, flanks green, belly yellow, no silvering
2	Parr marks fading, back and fins light, flanks starting to silver, belly yellow
3	Parr marks faint, back and fins darkening, flanks silver, belly whitening
4	Parr marks very faint, dark back, yellow only around fin bases and gill cover, flanks silver
5	Parr marks gone, back dark, dark margin to fin edges, flanks silver, belly white, silver dominant

Source: RSPCA Welfare Standards for Farmed Atlantic Salmon, p.33, 2018 (as amended from the scoring system of C. Findlay of the Fish Vet Group, Inverness). Used with kind permission from the RSPCA.

REQUIREMENTS

Group(s) of fish in freshwater must be adapted to saltwater before they are transferred into saltwater.

RECOMMENDED PRACTICES

a. use multiple criteria to assess smoltification status, including swimming pattern, shape, visual assessment, and laboratory tests
b. frequently monitor the degree of adaptation for several weeks prior to the anticipated transfer date so that the optimal time for transfer can be identified
c. gradually adapt fish to the photoperiod and temperatures they will experience after transfer to reduce stress and help ensure complete adaptation (16)
d. avoid high water temperatures (e.g., >15°C for Atlantic salmon) during the smoltification process (18)
e. ensure daytime light intensity at the level of the fish is greater than 10 lux during the smoltification process to avoid deformities in developing fish (19).

3.6 Equipment for Handling, Grading, and Transferring Fish

Selecting appropriate equipment can significantly reduce the occurrence and severity of injuries. Equipment design, material, maintenance, and correct use are all important factors.

Transferring fish by pumping them in pipes where they are not removed from water is less aversive and damaging (41). Fin damage is less severe when fish are moved in knotless nets (42).

REQUIREMENTS

Equipment must be free from protrusions and sharp edges and must be designed, maintained, and operated to minimize stress and the risk of injury.

Equipment used to transfer fish must be suitable for the size of fish and must be designed and maintained to prevent escapes.

The mesh size of hand or crowd nets must be suitable for the size of fish to prevent escape, entanglement, entrapment, and injury.

RECOMMENDED PRACTICES

a. ensure all manufacturer's instructions are followed
b. use equipment that permits fish to stay in water as much as possible when being moved or transferred
c. minimize the time fish are kept in pumps
d. ensure pump speed is adequate to allow proper fish orientation and transfer without injury or exhaustion
e. promptly reduce pump speed if any fish flip during pumping
f. ensure minimal bends and joints in pumps and pipes
g. use knotless or rubber nets when handling or crowding fish.

4 Feeding Management

Good feeding management, particularly ensuring intake of a nutritionally balanced diet, is essential to the growth, physiological functioning, and health of salmonids. As cold-blooded species, salmonids do not need to maintain a constant body temperature. This means that periods of feed deprivation, whether from a natural loss of appetite or management strategy, do not necessarily result in loss of body condition, especially at low temperatures, provided that fish have sufficient stored energy in the form of body fat and muscle mass (38).

4.1 Quality and Safety of Feeds

Feed for salmonids is a perishable item, especially when bags are opened, and the quality and safety will change if feed is exposed to air, adverse conditions, or prolonged storage time. Protection from pests is essential to protect the integrity of the bags. Vitamins, proteins, pigments, and lipids are particularly heat-sensitive and can be denatured by high storage temperatures (43). High moisture in feed storage areas stimulates mold growth and feed decomposition (43). The freshness of feed (time in storage) can affect the quality of feed, including its vitamin and antioxidant content.

Pellets should be hard enough to resist abrasion during handling and shipping but soft enough to ensure nutrient availability when consumed (i.e., hold together in water for 4–5 minutes and fall apart within 12–15 minutes) (44). Pelleted feeds should also be stored, handled, and delivered in ways that avoid breakage of the pellets into fines, which will not be consumed by fish and can adversely affect water quality and fish health.

REQUIREMENTS

Stored feed must be protected from direct sunlight, pests, and precipitation.

Prior to feeding, feed must be assessed visually and by smell; moldy or rancid feed must not be fed.

RECOMMENDED PRACTICES

a. store feed in areas that are temperature and humidity controlled
b. incorporate pest control and monitoring strategies in and around feed storage areas (e.g., keep the area around feed storage well-trimmed and tidy)
c. purchase feed in quantities that ensure use prior to the manufacturer's best before date
d. avoid excessive handling of feed bags and feed
e. limit stacking of bagged feed on top of each other
f. maintain a feed sampling program to verify feed quality (e.g., breakage, dust, mold, excess oil)
g. relay any concerns about feed quality to the supplier upon receipt so that prompt improvements can be made (e.g., excessive fines, incorrect or variable pellet size, deviations in fat, protein, and pigment, and floating requirements)
h. ensure all feed is properly labelled
i. store medicated feed separately and ensure it is delivered to the right group of fish
j. ensure a clean and well-maintained feed storage and delivery system.

4.2 Nutritional Needs

Salmonids require a diet high in appropriate fats and proteins. Provision of a balanced, complete diet is essential for preventing nutritional diseases in fish. Feeding a complete diet generally supplies the ingredients (protein, carbohydrates, fats, vitamins, and minerals) necessary for the optimal growth and health of the fish. Some minerals, if present in the water, can be supplied to fish by diffusion across the gill membrane rather than through feed.

Nutrient requirements vary according to water temperature as well as fish age, size, species, and activity level (44).

Feeding appropriately sized pellets promotes efficient feeding in fish. Generally, pellets that are 20–30% of the size of the fish's mouth gape are suitable (43).

REQUIREMENTS

Fish must receive feed that meets their nutrient requirements to maintain good health and meet physiological demands for their life stage.

Fish must be fed pellets that are appropriately sized for their life stage.

RECOMMENDED PRACTICES

a. develop a written feed program for each life stage in consultation with a nutritionist or other qualified specialist.

4.3 Feeding Strategies

Factors such as light, temperature, water velocity, social interactions, predators, and disturbance by humans influence feeding behaviour in salmonids. Fish may go off-feed due to:

- disease
- water quality deterioration
- poor feed quality
- perceived risk of predation
- maturation
- changes in photoperiod or temperature
- stress

Monitoring feeding response and fed amounts will help confirm feed acceptance and detect changes in appetite.

Overfeeding results in feed wastage and deterioration in water quality and can strain filtration systems in recirculating aquaculture systems or result in benthic impacts. Salmonids may also overeat to the point of permanent gastric distension and, especially in warm temperatures, metabolic stress. Underfeeding is associated with competition, aggression, and inadequate feed intake by some fish resulting in high variation in fish size and the need for more grading (45).

Strategies to ensure good feed access include:

- feeding in a consistent dispersal pattern (46)
- ensuring maximum dispersal of pellets
- preventing dominant fish from defending the feed source
- increasing the delivery rate of pellets (45)
- feeding to satiation (45)

- optimizing biodensity (densities that are too high or low are associated with reduced overall feed availability or intake, territorial behaviour, and injuries) (27)
- grading fish to reduce size variation

Feeding Schedule

Because fry and fingerlings grow rapidly, they can be at greater risk of nutritional disorders (e.g., spinal defects, eye problems, excessive size variation). To mitigate this, they are fed frequently (3 times or more per day) or even continuously (refer also to *Section 4.3.1 – Additional Strategies for First Feeding*). Closer to harvest, a feeding frequency of 1 or 2 times per day will accommodate nutritional needs.

The predictability of feed delivery can also influence welfare in some salmonids. If accustomed to a specific feeding time, short-term unpredictability in feed delivery has been associated with increased stress, aggression, and dorsal fin damage (47).

REQUIREMENTS

Appetite and feeding behaviour must be monitored daily.

Respond to changes in appetite and feeding behaviour by investigating the cause(s) and, where possible, take corrective action.

Use feeding strategies that reduce competition and minimize weight variation within a group, as assessed by body size and overall condition.

Feed must be delivered in a predictable manner, taking into consideration environmental conditions.

RECOMMENDED PRACTICES

a. consult with the farm's veterinarian on relationships between feeding management and health and regularly update the health plan to minimize dietary health and welfare issues (Refer to *Section 5 – Health Management*)
b. ensure dietary changes (to feed form, quantity, or nutritional content) are gradual
c. sample fish weights routinely and before making feed size changes.

4.3.1 Additional Strategies for First Feeding

First feeding is a critically important stage—attentive monitoring can help avoid significant health and welfare issues. Historically, first feeding was recommended when 90% of the group was at swim-up stage; however, current best practice is to initiate feeding when 40–50% of the group is at swim-up stage. Exact timing depends on many factors including the type of feeding equipment, rearing environment, temperature, species, and overall alevin management.

REQUIREMENTS

Fry must be monitored frequently every day to achieve the correct timing of first feeding.

Once feeding is initiated, fry must be monitored frequently every day to ensure successful first feeding.

Uneaten feed must be promptly removed to maintain good water quality, taking care to avoid injuring fry at this delicate life stage.

RECOMMENDED PRACTICES

a. initiate first feeding when 40–50% of the group is at the swim-up stage
b. offer feed to fry continuously or several (e.g., up to 5) times a day spaced evenly throughout the day (44).

4.3.2 Additional Strategies for Broodfish

In general, diet formulations for broodfish may contain different levels of fat and protein relative to grower diets and increased levels of certain vitamins and minerals such as ascorbic acid, vitamin E, manganese, iron, zinc, and copper. Carotenoids such as astaxanthin can also be important for producing healthy offspring (48).

Feeding strategies for broodfish differ from those of production fish, particularly as they begin to mature. Broodfish tend to be fed at a lower ration than production fish. Feeding of broodfish is typically stopped several weeks prior to final maturation in response to a lack of appetite shown by the fish; this is a behaviour shown naturally by wild salmonids as they direct stored energy reserves to gamete development and spawning.

If broodfish will be kept for repeat spawning, care should be taken to ensure the fish are encouraged back onto feed again so that they can replenish nutrient resources prior to their next spawn. Repeat spawning success is dependent on the condition of the fish.

RECOMMENDED PRACTICES

a. use a specially formulated diet, in appropriate amounts, to meet the nutritional requirements of broodfish
b. encourage repeat spawners to eat as soon as possible after spawning; frequent feedings may help to initiate their appetite again.

4.3.3 Feed Withdrawal

Salmonids are ectotherms and therefore have reduced metabolic rates relative to endotherms. These physiological differences mean that salmonids do not depend on frequent meals to stay healthy, and internal energy resources take a significantly longer time to deplete relative to endotherms. Fish, including salmonids, will naturally experience prolonged periods of no food intake in response to life stage (e.g., maturity) or environment (e.g., food scarcity).

Animals will go through three physiological states during periods of feed withdrawal. During the first two phases, the animal uses up internal stores of glycogen and fatty acids. During the third stage, the animal starts to break down protein for energy. It is during this third stage that the animal will experience health issues that, if prolonged, will eventually lead to death. Ectotherms such as salmonids can spend a long time is each phase relative to endotherms. For example, research has shown that Atlantic salmon experienced negligible impact on welfare indices and no loss of body condition after a feed withdrawal period of 4 weeks at 12°C (49). It is important to consider temperature, life stage, and body size on response to feed withdrawal. Smaller fish have higher energy demands per unit body mass and feed withdrawal may be particularly detrimental if it is too long relative to their physiological condition.

Gut evacuation rate is an important consideration during feed withdrawal and is mainly a function of temperature and body size, but temperature appears to be dominant (see Table 4.1) (38). Gut evacuation rate specifically refers to the passage of digested food through the gut; it is not a physiological response to feed withdrawal (i.e., the three phases described above). However, it provides a useful reference for integrating feed withdrawal as an important component of fish welfare practices.

There are important welfare benefits (e.g., reduced injury and mortality, reduced fouling of holding water) to withdrawing feed prior to grading, vaccination, transfer, and other husbandry practices (38). In net pens, withdrawing feed can help prevent high mortality during algal blooms, extreme temperature conditions (warm, cold, or ice cover), low oxygen events, and prior to or after a significant storm (38). During an algal bloom, the algae are typically concentrated close to the surface where the photosynthesis rate is highest (38). Salmonids normally remain in the safer, deeper water of the pen, but are attracted to the surface if feed is offered, with possible fatal consequences during these environmental conditions (38).

All feed withdrawal decisions, but especially those related to extended periods of withdrawal, should include consideration of the welfare risks and benefits as well as alternative strategies. For fish approaching market size, the most appropriate strategy in some cases may be to harvest them early as a means of avoiding a potential long-term withdrawal period.

Table 4.1 – General Guidance on Minimum Gut Evacuation Rates of Atlantic Salmon and Trout Fed a Variety of Meals and Under Optimal Environmental Conditions* (38)

Species	Body weight (g)	Temperature (°C)	Time (hours)	Degree days (°D)
Atlantic salmon	5600	4	168	28.0
	695	7.1	48	14.2
	150–200	9	30	11.3
	900–1450	13.4	24	13.4
Brown trout	90–300	5.2	42	9.1
	90–300	9.8	27	11.0
	90–300	15	15	9.4
Rainbow trout	142	10	28	11.7
	91	15	24	15.0
	140–145	18	14	10.5

* Table 4.1 provides a general guideline on gut evacuation rates; these rates may be significantly influenced by environmental conditions and feed formulation. For most procedures, feed withdrawal needs to extend beyond the time needed for gut evacuation, to ensure optimal water quality and minimal fish response. Evacuation rates generally range from about 48 hours at 5–7°C to about 15 hours at 15–18°C relatively independent of species and body size. Degree days for gut evacuation range from 9.1–15°D, the exception being 28°D.

REQUIREMENTS

Prior to routine husbandry procedures, fish must be fasted sufficiently to promote optimal water quality and minimize fish stress during procedures, taking into consideration life stage, the number and nature of procedure(s), and the environmental conditions.

Feed withdrawal periods intended to safeguard health and welfare during treatments or adverse environmental conditions must be in accordance with veterinary recommendation and outlined in the health management plan. Refer to Section 5.1 – Health Management Plans.

If fish are depurated prior to slaughter, feed withdrawal must not result in negative fish health and welfare outcomes.

If a group of fish does not have adequate fat reserves to undergo an extended period of fasting, strategies other than feed withdrawal must be taken to safeguard fish health and welfare.

When reintroducing feed, the quantity fed must match intake and minimize feed waste and associated water quality issues, and corrective action must be taken if bloat, mortality, or abnormal behaviours occur.

RECOMMENDED PRACTICES

a. use Table 4.1 as a guide for estimating gut evacuation rates
b. keep records of welfare outcomes following any feed withdrawal and use them to inform future feed withdrawal strategies
c. increase the frequency of monitoring fish after feed reintroduction.

4.4 Feeding Equipment

There are welfare advantages and disadvantages to all feed delivery systems (i.e., hand feeding, mechanical feeding devices, on-demand feeders) (45). Criteria for selecting a feeding system that promotes fish health and welfare include:

- ease of cleaning and disinfection
- ability to control the timing and amount of feed given
- dependability and ease of maintenance
- dispersal pattern of feed pellets
- potential for feed wastage and associated water quality impacts.

The safety of feeds can be affected by how often feed delivery systems are cleaned.

REQUIREMENTS

Feed equipment must be checked daily to confirm it is in good working order, and defective systems must be attended to without delay.

RECOMMENDED PRACTICES

a. select and locate feeding equipment to minimize the risk of contamination or fouling by wildlife, including birds

b. clean feeding equipment at least once per production cycle. If excess oil, dust, or breakage is detected during quality testing of feed, increase the frequency of feed equipment cleaning.

5 Health Management

5.1 Health Management Plans

Health plans contribute to fish health by outlining management and husbandry procedures that reduce disease occurrence and maintain an environment that promotes fish health. Implementing procedures that optimize fish health and minimize infectious and non-infectious diseases will have positive impacts on fish welfare and productivity (50).

Veterinarians play a key role in helping to attain the health objectives of the hatchery/nursery or farm. Having a valid, ongoing veterinarian-client-patient relationship (VCPR) helps to ensure that the veterinarian will be familiar with your management practices to prevent and respond to health issues, and it is a prerequisite for obtaining some classes of medications. The VCPR also facilitates collaborative decision-making between the producer and veterinarian.

Vaccines, which are typically administered in the hatchery phase, are an important disease prevention strategy. However, multiple factors influence vaccine efficacy and good overall health management practices are still important for vaccinated fish.

REQUIREMENTS

A written health management plan must be developed, implemented, and kept up to date.

A valid, working relationship with a veterinarian (VCPR) must be established for the prevention, diagnosis, and treatment of disease and care of fish.

RECOMMENDED PRACTICES

a. develop the health management plan in collaboration with a veterinarian
b. review the health management plan at least annually or whenever there is a disease outbreak or significant change to the technology/equipment used, rearing environment, or management practices potentially impacting fish health
c. strive to continuously improve fish health by taking the following steps in response to any disease:
   - obtain a veterinary diagnosis and provide timely treatment (where appropriate)
   - characterize the disease event by reviewing health and other records (e.g., date of onset, affected life stages and rearing units)
   - investigate the risk factors (biosecurity, nutrition, management, rearing environment)
   - develop a manageable action plan to prevent new cases
   - communicate the action plan to relevant personnel and monitor implementation
   - evaluate the effectiveness of the action plan and refine if needed.

5.2 Disease Prevention

5.2.1 Biosecurity

Biosecurity is based on the principles of keeping infectious diseases out of the aquatic environment (exclusion) and preventing disease from spreading within the hatchery/nursery or farm (management) and to other sites (containment). This can be done through traceability and the control of animals, water, equipment and conveyances, feed, people, and other materials.

Having a biosecurity protocol helps farms to take a consistent approach to reducing disease transmission. The protocol should be practical and tailored to individual farms (it may be simple or complex depending on the needs of the farm).

The biosecurity protocol should be linked to the overall health management plan and include, at a minimum:

- identification of the likely infectious disease risks for the species and region
- identification of entry and exit points and establishment of critical control points
- active control measures to prevent disease introduction and spread by movement of fish
- active control measures to prevent disease introduction and spread by people and equipment
- hygiene and sanitization protocols and standards for personnel, equipment, and conveyances
- procedures that will be followed to contain, remove, or treat wastes so they do not present a biosecurity risk.

Tools to support biosecurity planning are provided in *Appendix L – Resources for Further Information*.

REQUIREMENTS

A written biosecurity protocol must be developed, implemented, and kept up to date.

RECOMMENDED PRACTICES

a. develop biosecurity protocols in collaboration with a veterinarian or other qualified advisor
b. review the biosecurity protocol at least annually or whenever there is a disease outbreak or significant change to disease risk
c. post biosecurity signage throughout the hatchery/nursery or farm to ensure personnel and visitors are aware of, and follow, biosecurity protocols
d. source eggs and fish from suppliers that have tested for diseases or pathogens of concern and that document and report what they test
e. before placement, ensure fish are healthy and low risk for introducing a significant pathogen of concern
f. ensure workflow and handling is from the youngest to the oldest fish and from the healthiest to the least healthy fish, or dedicate staff to specific life stages/groups
g. remove mortalities daily to limit disease transmission, and ensure biosecure storage and disposal.

5.2.2 Cleaning and Disinfection

Effective strategies for cleaning and disinfecting tools, equipment, and rearing units help to minimize the spread of infectious diseases. Specific strategies will vary but generally include some combination of cleaning and disinfection, typically followed by rinsing and drying.

REQUIREMENTS

A written protocol for cleaning and disinfection must be developed and followed.

Cleaners and disinfectants must be stored and used in accordance with the manufacturer's directions to ensure efficacy and fish safety.

RECOMMENDED PRACTICES

a. select tools/equipment made of materials conducive to thorough cleaning and disinfection (mainly, non-porous) (51)
b. dedicate equipment to a specific site or fish population rather than moving it between systems, particularly for hard-to-disinfect items (e.g., dive and harvest equipment, nets or any fibrous tools/equipment) (51)
c. dispose of wastes associated with cleaning in a biosecure manner as they may contain pathogens that have the potential to spread infection if not controlled (51)
d. detach any removable equipment (from boats or tanks) so that it can be cleaned and disinfected separately (51)

e. ensure cleaned and disinfected tools/equipment are dried prior to being stored (moisture may enhance survival of any remaining pathogens) (51)
f. clean and disinfect rearing units between groups.

5.2.3 Fallowing and Quarantine

Fallowing, quarantine, and year-class separation help prevent disease transmission between groups. Quarantine of new fish is particularly important when their health status is unknown and in recirculating aquaculture systems given the difficulty in eradicating disease, once present, in these systems (remedial treatments may impact the functioning of the biofilter) (52). Fallowing procedures should be based on an evaluation of anticipated benefits, site and area level risk factors, and disease history (51).

RECOMMENDED PRACTICES

a. review the potential need for fallowing and other separation strategies with a veterinarian based on area- and site-specific factors (e.g., overall system design and management, equipment, capacity for effective disinfection, pathogens present)
b. quarantine fish of unknown health status and monitor or conduct testing prior to introducing them
c. where possible, stock fish in an all-in/all-out method (at site and area levels)
d. use single year-class stocking
e. fallow sites between production groups.

5.2.4 Pest and Predator Control

Pests and predators can introduce diseases into the rearing environment, and some predators (e.g., mink, seals) may also stress fish and cause injury. While pests and predators cannot be fully eliminated from rearing environments, several prevention and management strategies can be implemented.

Control measures vary with the type and degree of pest and predator pressure and may include physical barriers, site selection, deterrence, and secure storage of anything that may attract pests and predators (e.g., mortalities, feed). The most humane and appropriate predator control measures should always be chosen.

REQUIREMENTS

To safeguard fish health and welfare, strategies for pest and predator control must be developed and followed.

Netting and screens must be regularly checked for holes and maintained in good condition.

RECOMMENDED PRACTICES

a. continuously evaluate and refine control strategies based on humane and ethical considerations, animal welfare implications, health and safety considerations, and overall effectiveness
b. ensure predator deterrents are in place before the fish are stocked (once predators are habituated to seeing the fish as prey, they are harder to deter)
c. eliminate or reduce the number of places pests and predators can use for shelter or nesting (e.g., heavy vegetation around buildings)
d. remove and/or securely store any wastes that may attract pests and predators
e. store feed securely and promptly clean up any spilled feed
f. remove mortalities daily and ensure secure storage to avoid attracting pests and predators.

5.3 Monitoring Fish Health

Regular monitoring of fish facilitates early identification of health problems. Assessment of group behaviour is an important indicator of fish stress and health status (53). Some behaviour modifications may be associated with pathogens, parasites, or pollutants (e.g., flashing on the water surface, decreased activity, lethargy) (53). Use of cameras can assist in observing fish throughout the water column with minimal disruption (16).

Include the following in routine assessments of fish health and welfare: (16, 53)

- fish appearance (size, body condition, skin, fin, eye and gill integrity and colour)
- departure from normal schooling behaviour
- loss of equilibrium, slow swimming, or unusual vertical position
- unstructured swimming near the bottom of the rearing unit
- increased respiration or problems with buoyancy
- change in feed intake or feeding behaviour
- presence of moribund fish.

Record keeping is important for monitoring changes in fish health status. Without accurate and complete records, the incidence of disease and mortality is often underestimated.

Resources to support fish health and welfare monitoring are included in the Appendix, including:

- *Appendix E – Guidance on Welfare Indicators*
- *Appendix G – Scoring Fish Welfare Indicators*
- *Appendix H – Troubleshooting Injuries.*

REQUIREMENTS

Personnel must be knowledgeable in normal fish behaviour and signs of injury and disease.

Groups of fish must be checked daily for general health except during extreme environmental conditions where assessment may compromise their welfare.

If there is an increase in the expected daily mortality or morbidity or a significant change in health indicators (e.g., fin or skin erosion), personnel must investigate and take corrective action as outlined in the health management plan. Refer to Section 5.1 – Health Management Plans.

RECOMMENDED PRACTICES

a. educate staff on signs of disease that necessitate veterinary involvement
b. conduct regular observations, which can include testing for diseases of concern to the site and population of fish
c. establish a baseline for expected mortality and morbidity rates, feed consumption and growth rates, and acceptable water quality data; monitor for changes in trends; and investigate any deviation from expected rates (*Appendix E – Guidance on Welfare Indicators* provides a sample approach and suggested benchmarks)
d. aim to achieve health and welfare outcomes in alignment with the green column in *Appendix E – Guidance on Welfare Indicators*
e. keep complete and accurate morbidity and mortality records, including life stage and classification of cause (e.g., predation, type of disease)
f. increase the frequency of monitoring during high-risk conditions (e.g., prior to transfer from freshwater to saltwater, deliveries from a new site).

5.4 Skin and Gill Health

The skin serves as an important first barrier to infections (39). Even a small injury can be a route for infection, and larger wounds and ulcers may compromise osmoregulation (28, 39). The impacts of skin injuries depend not only on the severity and frequency of the injury, but also the potential pathogens that are present in the rearing environment (28, 39).

Risk factors for skin injuries include (39):

- rearing units whose texture or fittings cause abrasions
- low- or high-water temperatures at transfer
- use of untreated seawater in land-based smolt production
- inappropriate stocking density for the species (injuries associated with densities that are too high or low)
- injuries during lice treatment or other handling events
- water quality issues (e.g., turbidity)
- predators
- poor diet or unequal feed access.

Gill health can be impaired due to bacterial, viral, or fungal infections; parasitic infestations; or poor water quality (including zooplankton, phytoplankton, jellyfish, toxins, and debris) (39). Reduced gill function negatively impacts the fish's ability to exchange gases and excrete waste products and may make fish more susceptible to stressful events (39).

Fish with gill disease respire more rapidly and display a rapid "clamping" of the gill covers (54). Affected fish may show little interest in feed and show diminished response to other stimuli (54).

RECOMMENDED PRACTICES

a. use *Appendix H – Troubleshooting Injuries* to ensure effective actions are taken to reduce the occurrence of injuries
b. strive to maintain optimal water quality parameters at all times especially at transfer (39) (refer to *Section 2.3 – Water Quality*)
c. ensure proper techniques are always used when handling fish (refer to *Section 3.2 – Handling*)
d. ensure optimal nutrition and feed access (refer to *Section 4 – Feeding Management*).

5.5 Sea Lice

The focus of this section is on sea lice in marine water, but the same principles may apply when dealing with freshwater lice. Section 5.5 addresses overall management, prevention, and treatment of sea lice. If lice levels cannot be controlled despite management and treatment strategies, fish may need to be harvested early or euthanized. *Section 6 – Euthanasia, Slaughter, and Mass Depopulation* includes Requirements for when fish must be euthanized for humane reasons.

Lepeophtheirus salmonis is the primary concern for Canadian aquaculture, but several species from genus *Caligus* also infect farmed salmonids. The mobile adult stage of sea lice causes the most damage by grazing on skin tissue. Heavy sea lice infestation can result in skin lesions notably around the head, behind the dorsal fin, and in the perianal region, and these lesions may increase disease susceptibility (55). Jumping and rolling behaviour increases markedly during the initial stages of sea lice infection (16).

Integrated Pest Management Plans

Sea lice management requires an integrated approach that focuses on prevention and best husbandry practices to minimize the need for treatment. Good practices will also reduce the time fish spend at sea and facilitate effective treatments by ensuring that fish are able to receive in-feed treatments or tolerate the additional handling associated with baths or physical removal. An integrated pest management plan includes good husbandry practices, monitoring, record keeping, setting action levels, proper selection and use of both chemical and non-chemical controls, and resistance monitoring.

Treatment and Control Options

Chemical controls are safe and effective when used according to the manufacturer's instructions and under veterinary supervision, but consideration should be given to lice sensitivity, efficacy at different life stages, water temperature, required withdrawal times, and strategic rotational use to prevent resistance development. There may be containment requirements necessitating the use of full enclosure tarpaulins or well boats to administer bath treatments.

As lice have developed resistance to many products, non-chemical control strategies such as high-water temperatures, low salinity, physical removal (e.g., water jets, cleaner fish), and pen barriers have also been developed. Non-chemical controls that reduce or eliminate initial lice infections include deep nets, deep lights/deep feeding, skirts, and semi-closed containment systems that draw water from depth (55). As some of these methods restrict both lice and water flow, environmental conditions and oxygen levels need to be appropriate and monitored during their use. Both bath treatments and physical lice removal methods require additional handling and crowding that may result in injuries, scale loss, and gill damage (55).

Area-based management has also evolved as a best practice for sea lice control (56). The goal of area-based management for sea lice is to coordinate production practices (e.g., stocking, treating, harvesting, fallowing) between farms to ensure that sea lice are not moving amongst sites, defeating control efforts.

REQUIREMENTS

An integrated pest management plan for the control of sea lice at marine farms must be developed and implemented in consultation with the farm veterinarian.

Personnel involved in sea lice management must be knowledgeable of how to identify different species and life stages of lice, accepted counting protocols, and signs of lice infection.

Lice levels must be monitored through lice counts and records must be kept on lice numbers, seasonal trends, controls, and results.

When using bath treatments or physical methods of lice removal, treatment efficacy and fish condition must be assessed throughout so that corrective action can be taken as necessary.

If sea lice are compromising fish welfare, personnel must determine if further treatment, euthanasia, or harvest is appropriate in consultation with a veterinarian.

RECOMMENDED PRACTICES

a. include, in the integrated pest management plan, strategies and technologies that prevent lice infection and do not necessitate crowding and handling (e.g., deep lights, deep feeding, semi-closed containment systems) (55)
b. increase the frequency of lice monitoring during high-risk periods (e.g., wild fish migration)
c. test the sea lice treatment on one fish or a small group of fish prior to treating a larger number of fish
d. ensure veterinary supervision the first time any chemical or physical methods are used
e. monitor fish condition in the days following treatment and refine strategies if signs of stress are noted (e.g., delay in return of appetite, change in feeding response, slow swimming) (16)
f. participate in area-based management initiatives for sea lice control where applicable.

5.6 Additional Considerations for Maintaining Healthy Broodfish

Broodfish are typically reared over longer periods than production fish. Therefore, they may be at higher risk of exposure to pathogens. At freshwater facilities shared by other fish year-classes, biosecurity is particularly vital to prevent the introduction of pathogens to broodfish or the transfer of pathogens from the mature fish to susceptible young fry.

Saprolegnia infections are common in sexually mature salmonids, especially males, and can be serious. During handling events it is important to ensure that no wounds occur on the fish because these will be opportunistic areas for growth of fungi or bacteria. Salt baths and/or supplementation with seawater in the rearing unit can be useful for prevention and treatment (31).

Disease screening procedures may be conducted at the time of spawning to mitigate risk of transmission of pathogens to progeny. Broodstock may also transmit diseases to their progeny at the time of spawning.

REQUIREMENTS

Strict biosecurity procedures must be in place when working with broodfish to prevent transmission of pathogens amongst broodfish and their progeny.

RECOMMENDED PRACTICES

a. designate specific staff and equipment to interact only with broodfish
b. hold mature broodfish at designated facilities or in a designated area of a facility away from production or hatchery/nursery fish
c. use a separate water supply for broodfish
d. optimize nutrition and minimize stress to control infections
e. conduct disease screening at the time of spawning to minimize the risk of transmission of pathogens
f. use salt baths to prevent and treat infections as needed (e.g., fungal).

6 Euthanasia, Slaughter, and Mass Depopulation

Humane approaches to euthanasia, slaughter, and mass depopulation are important for fish welfare and expected by society and the aquaculture industry alike.

Those who are responsible for performing end of life procedures on fish should be aware that they may be at risk for traumatic stress and should take preventive measures to mitigate this risk (4, 57). Coping mechanisms can vary from person to person. Owners and managers should continue to be vigilant and impress on staff and service providers that the fish that will be killed must continue to be treated in a manner that promotes their welfare until the very end.

Mass depopulation events can have a particularly significant impact on the well-being of everyone involved, including producers, staff, families, and veterinarians. The trauma may be more significant for owners and those who have been directly involved in the day-to-day care of the fish. Where feasible, it can be beneficial to arrange for fish to be depopulated by an external service provider (a team specifically trained in slaughter, as an example). Appendix L provides further information on mental health support resources.

6.1 Planning and Protocols

Having protocols can improve confidence when euthanizing, slaughtering, or depopulating fish and helps ensure these procedures are carried out in a consistently humane manner.

On-farm protocols should include (58):

- criteria for when to euthanize
- method(s) (including an alternative method or back-up equipment)
- clear intervention and end-point criteria
- operational procedures (e.g., safety procedures for personnel, maintenance of equipment)
- roles and responsibilities
- discharge of any contaminated water
- carcass disposal and/or end use
- strategies to identify signs of traumatic stress and to support the well-being of personnel.

Fish producers care for large numbers of fish, which can make it difficult to assess and remove individual fish for euthanasia, especially in certain water conditions or where removal of individual fish may otherwise compromise the welfare of the group. However, producers should take all reasonable steps to ensure individual fish are euthanized when necessary.

REQUIREMENTS

Fish must be promptly euthanized if they have a condition that compromises their welfare and

- ***they do not have a reasonable prospect of improvement, or***
- ***are not responding to treatment(s) within an appropriate timeframe, or***
- ***treatment is not a humane option.***

A written euthanasia plan must be developed with veterinary input and implemented.

On farms that slaughter fish, a written slaughter plan must be developed with veterinary input and implemented.

A written contingency plan for mass depopulation must be developed with veterinary input.

REQUIREMENTS (continued)

Fish must be cared for and treated in a manner that promotes their welfare until euthanasia, slaughter, or depopulation.

RECOMMENDED PRACTICES

a. review and update plans at least annually or whenever there is a significant change to the technology/equipment used, rearing environment, or management practices that impact fish welfare during euthanasia, slaughter, or depopulation
b. use checklists or other documentation to track observations throughout the procedure

Recommendations specific to mass depopulation:

c. do at least one practice drill of the contingency plan well in advance of an emergency to help ensure preparedness
d. designate one person to serve as a team leader through all stages of depopulation to provide oversight, monitor fish welfare, and support staff
e. conduct a planning discussion with personnel to coordinate activities and operational procedures immediately prior to the depopulation event
f. arrange a debrief with personnel after a depopulation event and refine the contingency plan based on feedback.

6.2 Methods

Acceptable methods are those that result in rapid, irreversible unconsciousness (insensibility), followed by prompt death (4, 58, 59). For this reason, methods that affect the brain first followed quickly by cardiac and respiratory arrest are preferred (4). When insensibility is not immediate, induction of unconsciousness should be non-aversive or the least aversive possible and should not cause distress or suffering in fish (4, 6, 58).

The most humane method for the situation should always be chosen. Other important considerations when selecting a specific method include:

- the number of fish involved and their size(s) and life stage(s)
- the emotional comfort of the personnel performing the procedure and any bystanders
- the type of aquaculture system
- the availability of necessary equipment and/or anesthetic drugs
- discharge of any contaminated water
- carcass disposal and/or end use
- specific disease or pathogen present in a population (including its host and environmental survival) (if applicable)

The use of acceptable methods may not be feasible in all depopulation contexts. Selection of the most humane option may be constrained by limited carcass disposal or end-use options and/or the nature of the emergency (6). In some cases, regulatory authorities may be involved, and the decisions may ultimately reside with these authorities.

Beyond the procedure itself, it is also critically important that the necessary crowding, transfer, and/or handling be kept to a minimum and carried out in the most humane way possible to reduce distress, fear responses, and suffering (refer to *Section 3 – Husbandry Practices*) (58, 59).

REQUIREMENTS

An acceptable method of euthanasia, slaughter, and depopulation, as outlined in Appendix I, must be used.

Methods of euthanasia, slaughter, and depopulation must be quick, cause minimal stress and pain, and result in rapid loss of consciousness followed by death without the fish regaining consciousness.

- ***Ice slurry slaughter does not meet the above criteria; farms that still use this method must transition to an acceptable method (Appendix I) as soon as possible and no later than January 1, 2025. As of this date, ice slurry must only be used as a secondary step (after fish have been rendered insensible) to ensure death.***

Use of a method not listed as acceptable in Appendix I is only permitted in exceptional emergency circumstances as outlined in a contingency plan developed with veterinary input. Refer to Section 6.1 – Planning and Protocols.

When a secondary step is needed, it must be performed as soon as possible and before recovery.

Prior to euthanasia, slaughter, or depopulation, fish must be handled, crowded, and moved humanely. Refer to Section 3 – Husbandry Practices.

RECOMMENDED PRACTICES

a. ensure effectiveness by testing the method on a small group of fish (to be euthanized, slaughtered, or depopulated) prior to performing the procedure on a larger number of fish (59).

6.2.1 Training and Equipment

Persons engaged in the handling, stunning, and killing of fish play an important role in their welfare (58). The successful application of any method depends on many factors, particularly the experience, training, sensitivity, and compassion of the individual carrying out the procedure (4). Personnel who have received training have greater confidence and the skills to perform the procedure competently.

Proper storage and maintenance of equipment is essential to ensure the equipment functions effectively (60).

REQUIREMENTS

Personnel must be competent in the euthanasia, slaughter, and/or depopulation methods used.

Equipment must be used, stored, calibrated, and maintained according to the manufacturer's instructions to ensure proper functioning.

RECOMMENDED PRACTICES

a. maintain accurate records of equipment maintenance and training
b. routinely monitor personnel for proficiency during euthanasia, slaughter, and depopulation
c. routinely monitor personnel for signs of emotional distress and offer supports to ensure their ability to carry out the procedures humanely and correctly is not affected (60).

6.2.2 Confirming Death

Multiple indicators should be used to confirm death, including:

- loss of movement
- loss of reactivity to any stimulus
- flaccidity
- respiratory arrest (cessation of rhythmic opercular movement)
- loss of eye-roll (the movement of the eye when the fish is rocked from side to side)

A fish's heart can continue to contract after brain death and is not necessarily an indicator of recovery (60).

REQUIREMENTS

A repeat procedure (or alternate method) must be promptly performed if signs of recovery are noted.

Fish must be dead before disposal or processing.

RECOMMENDED PRACTICES

a. establish clear intervention points (e.g., fish are obviously recovering from unconsciousness)
b. establish clear end points (e.g., minimum time after opercular movements stop)
c. use multiple indicators to confirm death
d. record instances of return to sensibility and take steps to mitigate potential problems with the methods.

7 Transportation

Section 7 – Transportation covers the movement of fish between sites whether by road, water, or air. Moving fish underwater in net pens (to another site or for slaughter) is also considered transport. Refer to *Section 3 – Husbandry Practices* for guidance on on-site transfer of fish.

The federal requirements for animal transport off the farm or hatchery are covered under the *Health of Animals Regulations*, Part XII. They are enforced by the Canadian Food Inspection Agency (CFIA) with the assistance of other federal, provincial, and territorial authorities. Some provinces have additional regulations related to fish transportation. Those with responsibilities during any part of the transportation process (i.e., loading, confinement, transporting, or unloading) must be familiar with, and follow, all applicable animal transport requirements. The Requirements in *Section 7 – Transportation* are based on the regulatory requirements outlined in the Health of Animals Regulations. These regulations are accessible through the following link: www.laws-lois.justice.gc.ca/eng/regulations/c.r.c.,_c._296/page-16.html#h-548075 (accessed on July 9, 2021).

When moving fish or eyed eggs as cargo within aircraft, the requirements for loading density and container design and construction set out in the International Air Transport Association's *Live Animals Regulations* must be met. Consult the following website for information on the *Live Animals Regulations*: www.iata.org/en/publications/store/live-animals-regulations/ (accessed on July 9, 2021).

7.1 Training and Record Keeping

Transportation of animals is highly specialized and requires suitably trained and knowledgeable personnel. Transporters must be trained in the following areas of fish transportation: (3)

- normal fish behaviour and signs of stress in fish
- assessing fitness for transportation, including risk factors (refer to *Section 7.2.2 – Assessing Fitness for Transportation*)
- appropriate loading densities
- methods for handling, loading/unloading, confinement, and transport
- effective monitoring of fish, water quality, and equipment throughout the transportation process
- the contingency plan (refer to *Section 7.7 – Emergency Preparedness and Response*)

Transporters must also keep records related to the movement of fish prior to and during transportation intended to protect the welfare of fish in transport and those who transport fish by ensuring that important information is available and transferred to those who accept care and control of the animals further down the transport chain (61). A template record is available in Appendix J.

REQUIREMENTS

Personnel who load, confine, transport, or unload fish must have the competence to properly carry out the procedures they are responsible for (3).

Transporters must maintain accurate and complete records for each shipment (3).

RECOMMENDED PRACTICES

a. develop and implement a written fish welfare code of conduct outlining the transporter's commitment to responsible care of eggs and fish (see sample in Appendix A)
b. participate in continuing education activities related to egg and fish transport
c. document completed training and certifications (see *Appendix B – Sample Training Log*)
d. develop and implement detailed standard operating procedures (SOPs) about fish transport to facilitate training and ensure consistency

e. routinely assess compliance to SOPs
f. update SOPs at least annually (or whenever important improvements are made to procedures) and promptly communicate changes to transporters (Appendix C provides a sample form to help track these activities)
g. identify managers or mentors that personnel can approach with their questions/concerns about egg and fish transport.

7.2 Preparations for Transportation

7.2.1 Planning and Arranging Transportation

Personnel responsible for arranging transportation need to be aware of how long fish may be in transit (including intermediate stops, if applicable) and the additional services the transporter needs to provide during transit (e.g., water quality monitoring, water exchange, settling fish). When unsure, assume the longest possible journey.

Fish have a sensitive lateral line system and may exhibit motion sickness if transported in bad weather or poor road/sea conditions (39). Weather forecasts should be assessed when planning a journey to minimize exposure to poor conditions.

Planning also includes consideration of the potential need to acclimatize fish to the next production stage or receiving site (e.g., light, water temperature, and salinity changes). It is important to avoid exposing fish to sudden changes in light intensity as this may cause startle responses, increased oxygen consumption, injuries, or suffocation. To habituate fish to a change in light intensity, fish need to be gradually exposed to these lighting levels before transport. The time that fish are in transit may be part of the acclimation process for water quality parameters.

Prior feed withdrawal is essential to maintaining good water quality during transportation. *Section 4.3.3 – Feed Withdrawal* provides a table of gut evacuation rates.

REQUIREMENTS

Fish on a 24-hour light regimen must be exposed to dark periods over at least 3 days prior to loading to prevent crowding at the bottom of the container, unless transportation containers permit the entry of ambient light or are artificially lit.

Fish must be fasted for a minimum of 24 hours or 10 degree days (whichever is longer) prior to transport to achieve as much gut clearance as possible and promote optimal water quality during transportation.

At or before the time of loading, producers must communicate the fasting period to transporters to support good water quality management during transport.

Refer also to the Requirements in Section 4.3.3 – Feed Withdrawal.

RECOMMENDED PRACTICES

a. ensure receiving water temperature, oxygen and pH are as close as possible to the parameters in the shipping site (e.g., temperature difference should ideally not exceed +/-4°C, as a guide)
b. organize production flows and site selection to minimize the number and duration of transportation events
c. schedule transportation such that delays are avoided due to severe weather, road construction, ferry cancellations, as examples
d. select routes with the best possible conditions (e.g., smooth roadways, avoidance of high seas)

e. ensure the following is discussed and agreed upon with the transporter, prior to transport:
   - number, size range, and weight of fish to be transported
   - current health status of fish to be transported
   - loading densities in containers
   - equipment to monitor and maintain water quality, including at the receiving site
   - water quality parameters (e.g., temperature, oxygen, CO_2, pH)
   - frequency of monitoring water quality and fish and associated record keeping.

7.2.2 Assessing Fitness for Transportation

Fish producers care for large numbers of fish, which makes assessment of individual fish difficult. However, producers must take measures to ensure that groups of fish are assessed for fitness prior to loading. Risk factors that must be considered when evaluating a group's fitness for transport include (3, 62):

- life stage
- current condition of the fish and any recent disease or other stressor
- group mortality rate
- the expected duration of the journey and confinement in the container (including foreseeable delays)
- the foreseeable conditions during transport (e.g., sharp inclines/declines; weather, particularly in well boats); and
- the type and condition of the conveyance, container, and equipment.

REQUIREMENTS

In preparation for transport, the group of fish to be transported must be evaluated for fitness and if

- ***unfit, must only be transported with special provisions on the advice of a veterinarian to receive veterinary care***
- ***compromised, must only be transported with special provisions directly (i.e., not through an assembly/distribution centre) to the nearest suitable place where they can be humanely killed or receive care (e.g., grow out environment in the best interest of the fish).[1]***

Before and during loading, individual fish that are compromised or unfit must be removed from the population of fish to be transported as much as reasonably possible and must receive care or be euthanized.

Conditions that make a group of fish unfit or compromised are outlined in Appendix K – Transport Decision Tree.

Mortalities must be removed prior to loading.

RECOMMENDED PRACTICES

a. ensure proactive grading and culling throughout production stages to reduce the number of compromised or unfit fish at the time of transportation
b. avoid, as much as possible, any procedures that may affect fitness for transport in the weeks prior to shipping
c. increase health monitoring as transportation nears to ensure early detection of a condition that may warrant early shipping, as appropriate, before fish become compromised

[1] The "nearest suitable place" may not always be the closest geographically—it refers to the closest facility suitable for the type and condition of fish that has adequate facilities for safe unloading/holding and the competent human resources available to provide care or humanely kill fish without compromising the biosecurity in place for both the facility and the conveyance (61).

d. consult a veterinarian if in doubt about a group's fitness for transportation and when transporting compromised fish
e. outline, in the health management plan, water quality and fish health criteria for when fish may be transported to a new grow out environment or shipped early to slaughter to safeguard health and welfare (refer to *Section 5.1 – Health Management Plans*)
f. develop, in consultation with a veterinarian, standard protocols for specific conditions that would render a group of fish unfit or compromised.

7.2.3 Loading Density

Loading density in containers has a significant impact on water quality throughout the transportation process. A high density combined with a long transport duration can cause stress and mortality. At inappropriately high densities, fin erosion and scale loss may occur, and fish may be unable to maintain their normal position of being horizontal and upright in the water column. As a rule, as the transport time increases (particularly >8 hours), the loading density should be reduced (63).

REQUIREMENTS

Loading density must be determined prior to loading, taking into consideration fitness for transport, water temperature, body size/weight, life stage, weather conditions, and the duration of transport.

Loading density must minimize fin erosion and scale loss and permit fish to maintain a horizontal position.

Loading density must not exceed 150 kg/m³ (i.e., 15% fish, 85% water) (64).

RECOMMENDED PRACTICES

a. start with a low loading density (e.g., 40–50 kg/m³ depending on life stage) increasing from this amount only if good outcomes are consistently achieved and transporters are suitably experienced.

7.3 Loading and Unloading Procedures

Skilled, patient, and humane loading improves fish welfare and reduces losses associated with these processes (62). Some research has shown that while fish stress response can increase with journey duration, loading and unloading may be the more stressful part of the transportation process (62, 65). Injuries incurred during crowding, pumping, or manual loading can compromise a group's ability to handle the stress of transportation potentially making them compromised or unfit.

Eggs require careful handling and transport at all development stages but are particularly susceptible to damage before they reach the eyed stage.

REQUIREMENTS

Fish must be loaded/unloaded at a speed and in a manner that minimizes the risk of injury, enables fish to promptly revert to a normal position and distribution in the water column, and prevents crowding at the bottom of the container or rearing unit.

Eyed eggs must not be allowed to dry out and must have air space in their container.

During unloading, fish in the container must be covered with water and the last fish to be unloaded must be flushed or netted out (never swept or dragged).

Refer also to the Requirements in Section 3.2 – Handling and Section 3.6 – Equipment for Handling, Grading, and Transferring Fish.

RECOMMENDED PRACTICES

a. strive to keep the time fish are out of water to <30 seconds (32, 33)
b. complete any required documentation prior to loading fish to avoid delays in transit
c. notify any visual inspection checkpoint officers of your arrival in advance
d. minimize movement of eggs between the fertilization and the eyed stage.

7.4 Transport Containers

Proper design and operation of transport containers (e.g., wells, tanks, net pens for underwater transport) can reduce many fish stressors (63). Tank/well construction and material play a vital role in maintaining the water temperature within the desired range particularly if the water and air temperature differ significantly (63). Salmonids have been shown to prefer and behave less aggressively in rearing units with dark backgrounds (11), which may also apply to transport containers.

REQUIREMENTS

Net pens that are used to transport fish under water must be adequately tensioned and of a weight that prevents distortion and associated crowding, entanglement, or injury.

Containers must prevent fish escapes and water leakage and be free from projections or loose fittings that may injure fish.

Containers must be designed or properly insulated so that any change in water temperature is within the adaptive ability of the fish.

Containers must permit visual inspection of fish (e.g., top latch), clearly indicate the presence of eggs or fish (on at least 2 sides) and clearly indicate the upright position of the container (3).

Containers loaded with eggs or fish must never be handled in a manner likely to cause suffering, injury, or death.

Containers must be filled with water to a level that minimizes sloshing.

Containers must be cleaned and disinfected after all groups to be transported have been moved.[2]

RECOMMENDED PRACTICES

a. use containers with better insulation properties if water temperatures during transportation fluctuate more than +/ - 1.5°C per hour, as a guide
b. consider the use of horizontal baffles during transport to minimize sloshing.

7.5 Road and Water Transportation

7.5.1 Monitoring Water Quality and Fish During Transport

Water is the life support system for fish. While feed withdrawal and oxygenation both help maintain water quality, parameters can deteriorate during transport, particularly during long journeys and where there is little or no opportunity to exchange water (62). Oxygen levels have been shown to decrease significantly during the loading process, so it is important to saturate water with oxygen prior to placing a load of fish into a container (63). Oxygen levels decrease as water temperature increases, so temperature control is also vital during transport.

2 Except for one-time use containers and net pens used to transport fish.

Supersaturation of oxygen may occur during transportation if oxygen levels are too high. This situation should be avoided as much as possible because it may cause swelling in the swim bladder or respiratory acidosis from an accumulation of carbon dioxide in the blood (66).

Waste products from fish (e.g., ammonia, carbon dioxide) and suspended solids tend to increase with journey duration, and these changes are more pronounced with increased loading density (62). Ammonia toxicity is a concern, especially during long hauls (63). The accumulation of ammonia is minimized by fasting fish prior to transport (see *Section 7.2.1 – Planning and Arranging Transportation*). Elevated levels of carbon dioxide are also a concern during transport and could result in acidosis and possibly death (63). Aerators and agitators can be used to remove carbon dioxide from the water (63).

During transport, fish must be periodically monitored for any abnormal behaviour. Some examples include:

- laboured breathing or gasping
- fish crowding themselves in a small area of the container
    - crowding at the bottom of the container (a sign of insufficient oxygen)
    - crowding at the top of the container (a sign of high oxygen)
- rushing to the oxygen/aeration/degassing system
- darting and flashing.

REQUIREMENTS

Containers must only be opened as necessary to inspect fish, eggs, or water quality.

Prompt corrective action must be taken if an abrupt change in water quality occurs or fish show abnormal behaviour.

Oxygen levels must be monitored and maintained at a minimum of 80% during transport (64).

Water quality parameters during transport must be similar to the water quality parameters at the source and the destination, unless fish are acclimated before or during transport.

If a group of fish becomes compromised or unfit during transport, reasonable measures must be taken as soon as possible to prevent suffering, injury, or death (3).

Conditions that make a group of fish unfit or compromised are outlined in Appendix K – Transport Decision Tree.

RECOMMENDED PRACTICES

a. install cameras for continuous monitoring of fish
b. use sensors that continuously monitor water quality
c. ensure a visual inspection of water and fish every 1–2 hours if cameras and sensors are not in use
d. ensure lids are removed in a manner that minimizes startle responses in fish
e. have a procedure in place to maintain conditions within the container of eyed eggs if it needs to be opened (e.g., adding oxygen)
f. install temperature loggers particularly for eggs and fry (to enable monitoring without opening the container)
g. check and calibrate all monitoring equipment prior to each trip
h. use supplementary oxygen or aeration during transport
i. ensure oxygen levels remain below 120% to reduce the risk of supersaturation
j. periodically check carbon dioxide levels during transport and aim to keep them below 10 mg/L
k. avoid abrupt changes in water quality during transport.

7.5.2 Use of Additives During Transport

Excessive mucus or foaming may indicate a water quality issue (including an abrupt change in temperature), improper loading, or that fish are stressed due to some other cause. Additives such as anti-foam agents may occasionally be used to mitigate this issue, in addition to several other issues including pH stabilization and ammonia removal.

Sedation may be used to reduce the stress response during the transportation process. It may also be used to slow the metabolism of fish, thus reducing oxygen uptake and decreasing carbon dioxide and ammonia production (63). Only light sedation should ever be used during transport, to ensure that physiological functions are preserved and to prevent fish from injuring themselves upon induction or recovery (as is possible with deeper sedation or anesthesia). See Stage 1 of T*able 3.2 – Stages of Sedation and Anesthesia* for further information. Additives that alter fish actions make it difficult to assess behaviour and well-being during transport, so they need to be used with caution.

REQUIREMENTS

Additives, including sedatives, must only be used according to the manufacturer's instructions or on the advice of a veterinarian.

7.5.3 Driving and Other Journey Factors

Research has shown that driving conditions (e.g., acceleration, braking, cornering) directly impact the stress level and welfare of the animals (65). During transport, fish are at risk of physical damage through the motion of the vehicle or boat associated with driving practices and the condition of the road or sea. Weather also significantly influences the amount of physical disturbance fish experience, and boat transport in rough waters (strong breeze, wind gusts, high waves) is associated with an increased stress response and post-transportation mortality (62, 65).

Transportation in good journey conditions enables fish to better recover from the loading process—without this opportunity, fish are exposed to multiple, additive stressors (loading, transport, and unloading) that cumulatively impact their health and overall condition in the weeks following transportation (65).

REQUIREMENTS

All lids, outlets, or any other openings must be secured before departure.

Containers must be secured to the conveyance prior to departure.

On-site roads and laneways must be free of obstructions and large potholes to minimize the risk of sloshing.

Transporters must drive in a manner that minimizes the risk of sloshing, injury, and uncontrolled movement of fish.

Net pens that are used to transport fish under water must be driven at a speed that prevents distortion of the nets and swimming fatigue, which can lead to crowding, entanglement, and injury.

7.6 Transfer of Care and Post-Transportation Monitoring

Under the *Health of Animals Regulations*, the responsibility for the care of fish is transferred from the transporter to the slaughter plant or assembly/distribution centre when the consignee acknowledges receipt of required documentation and when unloading is complete.

After arrival, the duration of time before unloading will depend on water quality but should ideally permit fish to briefly settle prior to being unloaded.

The overall condition of fish, any scale loss, and the time it takes for appetite to return are important indicators of how well fish have coped with transportation procedures. Transport-associated mortality might be the result of one severe stressor or several mild stressors (63). Relevant stressors include handling, confinement, abrupt changes in water quality, and improper acclimation (63).

REQUIREMENTS

The consignee must receive documentation on the date and time of arrival, any adverse events that occurred during transport, and the fasting period.

The fasting period must be ended once the fish are acclimated unless it is necessary to continue the fasting period due to water quality issues (e.g., plankton).

Refer also to the Requirements in Section 4.3.3 – Feed Withdrawal.

RECOMMENDED PRACTICES

a. ensure information between the transporter and receiver is exchanged about the time since the last water exchange and/or water quality check
b. track the condition of fish upon arrival (e.g., scale loss) on a site-by-site basis throughout the year and refine transportation processes if a deviation from normal at any site is observed
c. track mortality associated with transportation (i.e., during transport and in the week following), including cause if known
d. investigate possible causes and introduce improvements to transportation and acclimation processes if the following occur:
    - return to expected feed intake takes more than 3 days after unloading
    - mortality during transportation or unloading >0.1%
    - mortality >1% in the group within 48 h after unloading
e. provide detailed feedback to the facility of origin and transporters about fish condition after transportation to promote continuous improvement.

7.7 Emergency Preparedness and Response

Emergencies or unforeseen issues can arise during the transportation process that impact the welfare of fish being transported (e.g., accident involving the conveyance, equipment failure). Pre-planning will assist transporters to respond in a timely and effective manner and is required under Part XII of the *Health of Animals Regulations*.

Alternative means of maintaining the life support system include:

- sufficient oxygen and backup supply lines and regulators
- connecting a system that has failed to one that is still working
- alternate routes and places along the route where fish can be unloaded
- sites along the route where backup air or oxygen or other essentials are available

A link to a sample contingency plan is given in *Appendix L – Resources for Further Information*.

REQUIREMENTS

Transporters must have a contingency plan outlining:

- ***measures to address fish that become unfit or compromised during any part of the transportation process***
- ***measures to address unforeseen delays or other emergencies during transportation that may affect fish welfare, and***
- ***emergency euthanasia or depopulation during transportation.***

The contingency plan must be communicated to relevant personnel.

Transporters must have an emergency contact list accessible in the conveyance.

Alternative means of maintaining the life support system of fish must be available and implemented in the event of a mechanical breakdown or other emergency in transport.

RECOMMENDED PRACTICES

a. update the transportation contingency plan after an emergency incident to promote continual improvement in planning and response strategies
b. have a secondary route (or alternate nearby destination) should the primary route become inaccessible
c. ensure supplementary oxygen or aeration sufficient to last 50–100% longer than the anticipated journey duration.

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Sample Fish Welfare Code of Conduct

[Your Farm/Company] Employee Code of Conduct

Our commitment to our animals

[Our company/farm] is committed to responsible farm animal care and handling. That means animals in our care deserve to be healthy, safe and well cared for.

Our commitment to our customers

Working with animals is important work that we take seriously. We are proud of the work that we do, and we strictly enforce responsible farm animal care and handling among employees and service providers at our facility.

Every person who handles or comes into contact with an animal is required to support our core objective of responsible farm animal care and handling. The demonstration of that support is through the review and signing of this Code of Conduct agreement on a **[quarterly/annual]** basis.

Our commitment to our employees

Your job is valuable and important to our animals, and our business. When you report an incident involving possible mistreatment, illness or injury involving one of our animals, we will take it seriously. We will document your concern. We will follow up to resolve the animal's situation, and/or provide additional training among employees.

Our employees' commitment to us

Every one of our employees is required to handle and treat animals with respect and in accordance with **[farm/company]** policies and rules as well as the federal, provincial and municipal regulations under which we operate.

Any employee who is responsible for, observes or receives any information that alleges an animal on our property or in our care is being mistreated, mishandled or treated or handled in a way that is contrary to our animal care policy/guidelines must report that information to **[NAME OF POINT PERSON]** immediately so that the situation can be corrected. **[PROVIDE CONTACT INFO]**.

Failure to adhere to this agreement is cause for dismissal. **[Farm/company]** reserves the right to refer animal-abusers to law enforcement for prosecution.

I ___________________________ understand and acknowledge that willful neglect, mishandling or abuse of animals by any [name of company] employee or witnessing it and not reporting it is subject to discipline including immediate termination of employment, and that offenders may also be subject to prosecution under applicable laws.

_____________________________________ _____________________________

Signature of employee Date

Print name: ____

_____________________________________ _____________________________

Signature of employer Date

Name and Title: ____

Important Note: Seek advice from your legal counsel and human resources department if appropriate to ensure any agreement meets relevant labour laws and union contracts. Used with permission from Farm & Food Care Ontario. https://www.farmfoodcareon.org/wp-content/uploads/2016/06/Animal-Care-Code-of-Conduct-2016.pdf

Sample Training Log

Date(s)	Topic(s) & Format	Employee Name and/or Signature	Name and/or Signature of Trainer

Sample Standard Operating Procedure (SOP) Review and Training Checklist

SOP Name: ____

Date of last update: _______________________________________

Key updates and reason(s) for changes:

____

____

____

Staff review/training:

<Name>: ____

Date of review/training:___________________________

<Name>: ____

Date of review/training:___________________________

<Name>: ____

Date of review/training:___________________________

SOP Name: ____

Date of last update: _______________________________________

Key updates and reason(s) for changes:

____

____

____

Staff review/training:

<Name>: ____

Date of review/training:___________________________

<Name>: ____

Date of review/training:___________________________

<Name>: ____

Date of review/training:___________________________

Relationship between Biodensity and Welfare Outcomes

The impact of biodensity on fish welfare is dependent on the interaction of several variables, including species, life stage, water quality, feed access and the ability to control the environment within different types of rearing units. In general, the potential for negative welfare is increased with high densities, but, as illustrated below, high density does not always result in negative welfare outcomes, nor does low density always result in positive welfare outcomes. The overall condition and behaviour of the fish should serve as the main considerations when assessing welfare in relation to biodensity, and the table below outlines some of the outcomes that need to be considered when selecting an appropriate density.

Welfare Indicator	Fish Type	Life Stage	Rearing Unit	Min (kg/m^3)	Max (kg/m^3)	Outcome
Mortality	Atlantic Salmon	Parr (~70g)	Indoor tanks	21	86	No difference in mortality
	Arctic Charr	Juvenile (~177g)	Tanks	30	150	No difference in mortality
	Rainbow Trout	Fingerlings (~0.21g)	Outdoor flow-through raceways*	10 kg/m^2	12.5 kg/m^2	Mortality was reduced in lower density treatments
Fin Erosion	Atlantic Salmon	Post Smolt (~494g)	Recirculating Aquaculture System	10	53	Pectoral fin damage occurring at 53 kg/m^3
	Arctic Charr	Juvenile (~177g)	Tanks	30	150	No caudal or dorsal fin damage, regardless of density
	Rainbow Trout	Juvenile (~113g)	Flow-through tanks	25	120	Fins were less eroded at the lowest density
Aggression	Atlantic Salmon	Adult (~980g)	Tanks	15	35	General rates of aggression between fish did not differ between density treatments, but during feeding, rates increased with decreasing density and levels of disturbance from personnel
	Arctic Charr	Juvenile (~0.85 g)	Tanks	8.7	44	Significantly fewer aggressive interactions at high densities (44 kg/m^3)

*The biodensities in this row are given in m^2 since the rearing unit is a raceway rather than a tank.

Relationship between Biodensity and Welfare Outcomes (continued)

Welfare Indicator	Fish Type	Life Stage	Rearing Unit	Min (kg/m^3)	Max (kg/m^3)	Outcome
Size Variability	Atlantic Salmon	Post Smolt (~494g)	Recirculating Aquaculture System	10	53	Body sizes were the same within low (9 kg/m^3) and high (53 kg/m^3) density treatments
	Arctic Charr	Juvenile (~0.85 g)	Tanks	8.7	44	Body size was more variable at low densities
	Rainbow Trout	Juvenile (~180g)	Tanks	10	80	Higher size variation at low densities, indicating the presence of possible dominance hierarchies
Growth Rate	Atlantic Salmon	Post-smolts (~494g)	Recirculating Aquaculture System	10	53	Fish stocked at 28–53 kg/m^3 weighed less after 66 days than those stocked at either 18 or 19–36 kg/m^3, and growth rate was highest at the lowest tested density (9–18 kg/m^3)
	Arctic Charr	Juvenile (~177g)	Tanks	30	150	Impaired growth rates and feeding efficiency at very high but also at very low densities, when compared with moderate densities
	Rainbow Trout	Juvenile (~43g)	Tanks	20	80	Reduced growth, lower growth rate, and lower feed intake after 60 days at high densities

Reference: Farmed Salmonids Code of Practice Scientific Committee (2020) Biodensity. In: *Code of Practice for the Care and Handling of Farmed Salmonids: Review of Scientific Research on Priority Issues*. Lacombe, AB: National Farm Animal Care Council.

Guidance on Welfare Indicators

Welfare indicators to be assessed on a rearing unit basis				
		No welfare concerns	**Some welfare concerns**	**Serious welfare concerns**
Action	Intervention	**None**	**Investigation needed**	**Immediate intervention needed**
	Management Practices	**Continue management practices**	**Evaluate management practices**	**Improve management practices**
Welfare Indicator	Feeding Response	Normal[1] feeding behaviour	Minor changes in appetite from normal[1]	Significant changes in appetite from normal[1]
	Aggression	No aggression	Minor increase in aggression from normal[1]	Significant aggression including fin picking or causing damage to other fish
	Swimming Behaviour	All fish showing normal[1] swimming patterns	Slightly abnormal swimming patterns	Major difficulty in maintaining swimming position
	Size Variation and Condition Factor	Size variation present but small individuals appear to be in good condition	Size variation present and <2% of individuals with poor condition factor (e.g., <0.9)	Size variation present and >2% of the population with poor condition factor (e.g., <0.9)
	Eye Condition	No visible issues	<2% of individuals with visible eye issues	>2% of population with one or more visible eye issues
	Skin Condition	No visible wounds	<2% of individuals with visible wounds	>2% of population with one or more visible wounds
	Fin Condition	No visible fin damage	<2% of population with ≥25% of one or more fins missing	>2% of population with ≥50% of one or more fins missing
	Water Quality	Good water quality	Slight deterioration in water quality	Major deterioration in water quality
	Growth Rate	Within expected[1] growth rate	Minor deviation from growth rate	Significant deviation from growth rate

[1] "Normal" and "expected" should be developed using historical information and species, life stage, and site-specific conditions.

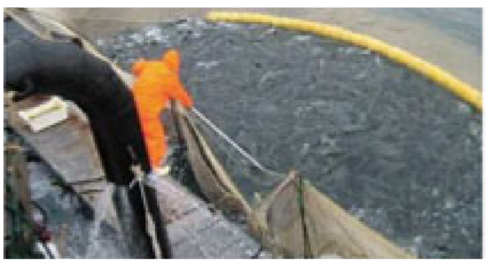
Assessing Fish Behaviour during the Crowding Procedure

1. Goal: low stress, no vigorous activity

- ✓ Fish in the sides of the crowd swimming slowly
- ✓ Normal swimming behaviour, but not all in the same direction
- ✓ No dorsal fins on surface
- ✓ No white sides on surface

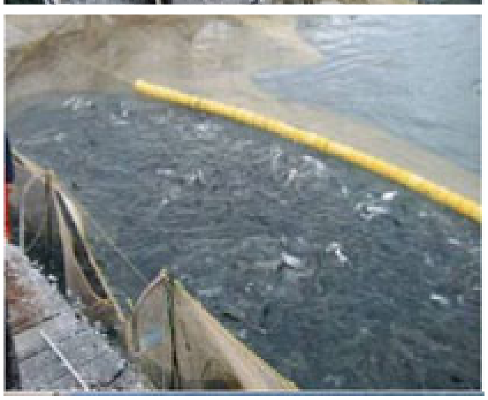
2. Acceptable: some fins on surface

- ✓ Normal swimming behaviour at suction point, low stress
- ✓ Few dorsal fins on surface
- ✓ No white sides on surface



3. Undesirable:

- Over-excited swimming behaviour (different directions)
- More than 20 dorsal fins on surface
- Some white sides constantly on surface



4. Unacceptable: overcrowding

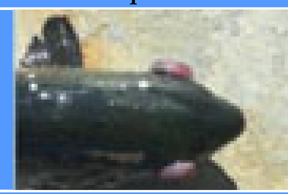
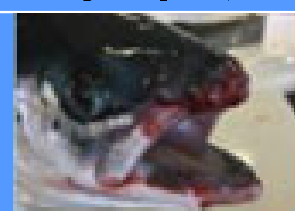
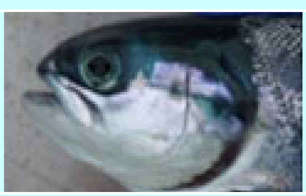
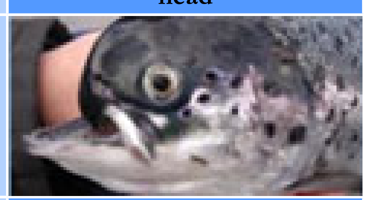
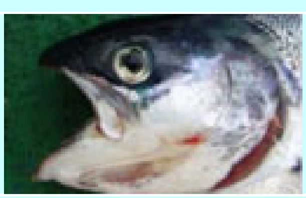
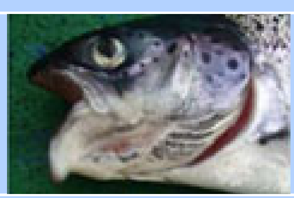
- Over-excited swimming behaviour (different directions). Some fish decreasing activity
- Pumping rate: Not possible to keep a constant rate
- Many fish stuck up against the crowd net
- Many dorsal fins on surface and numerous white sides on surface
- A few very lethargic fish

5. Unacceptable: extreme overcrowding

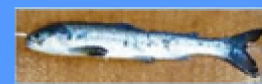
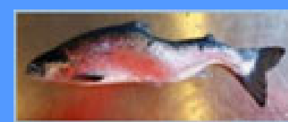
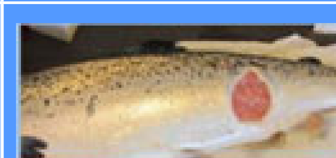
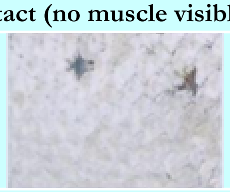
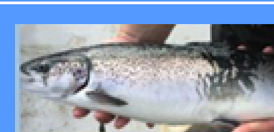
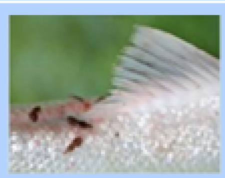
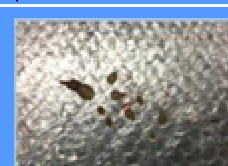
- Whole crowd boiling
- Potential for large fish kill without rapid release
- Panic in the population, the fish are exhausted
- Many fish floating on their side

Reproduced with kind permission of Alastair Smart of Smart Aqua, Aquaculture, Hazelwood Park, South Australia.

Scoring Fish Welfare Indicators

	1	2	3
Eye haemorrhage	 Minor haemorrhages	 Larger haemorrhages, or traumatic injury	 Larger haemorrhages/ traumatic injury. Eye may be ruptured
Exophthalmia	 Eye protruding a little	 Moderate eye protrusion	 Major eye protrusion
Opercular damage	 Operculum only partly covering gills	 Operculum absent on one of the gills (gill exposed)	 Both opercula absent (both gills exposed)
Snout damage	 Minor would on snout (either jaw)	 Moderate wound and broken skin on snout	 Large deep and extensive wound. Can cover the whole head
Upper jaw deformity	 Suspected malformation	 Distinct malformation	 Major malformation, jaw pointing backwards
Low jaw deformity	 Suspected malformation	 Distinct malformation	 Major malformation, jaw pointing backwards

Scoring Fish Welfare Indicators (continued)

	1	2	3
Emaciation			
	Potentially emaciated	Emaciated	Extremely emaciated
Vertebral deformity			
	Signs of deformed spine	Clearly visible spinal deformity (e.g. short tail)	Extreme deformity
Skin haemorrhages			
	Minor haemorrhaging, often on the belly of the fish	Large areas of haemorrhaging, often coupled with scale loss	Significant bleeding, often with severe scale loss, wounds and skin edema
Lesions / wounds[1]			
	One small wound (<10 pence piece)[1], subcutaneous tissue intact (no muscle visible)	Several small wounds	Large, severe wounds, muscle often exposed (≥ 10 pence piece)
Scale loss			
	Loss of individual scales	Small areas of scale loss (< 10% of the fish)	Large areas of scale loss (≥ 10% of the fish)
Sea lice infection			
	Light infection	0.05 - 0.08 pre-adult or adult lice cm $^{-2}$ of fish skin	≥0.08 pre-adult or adult lice cm^{-2} of fish skin

Source: Noble C., Gismervik K., Iversen M.H., Kolarevic J., Nilsson J., Stien L.H. & Turnbull J.F. (Eds.) (2018) Welfare Indicators for farmed Atlantic salmon: tools for assessing fish welfare. ISBN 978-82-8296-556-9. Used with permission.

[1] For pre-smolts "one small wound" should be < 1 cm. Wounds that penetrate the abdominal cavity should be scored as a 3 irrespective of size.

Troubleshooting Injuries

Injury	Risk Factor	Mitigation
Eyes		
Cataracts	Diet formulation	Use a balanced diet for each specific species
	Parasitic infections	Implement biosecurity measures to prevent pathogen entry
	High UV	Avoid using farms located in zones with high ultraviolet incidence. Cover tanks with lids. Ensure adequate enclosure depth.
	Pollutants	Use clean water free of pollutants to culture fish. Monitor water quality
Eye Injuries (general)	Pumping	Use a vacuum pump to transfer large numbers of fish
Eye protrusion (exophthalmia)	Gas super-saturation	Check aeration of water, monitor gas levels
Head		
Lower Jaw Deformity Syndrome (LJD)	Diet formulation	Ensure diets contain appropriate levels of phosphorus and vitamins A, C, D, and K
	Triploidy	Ensure a balanced diet is fed. Improve triploid production techniques
Lesions, tissue erosion and haemorrhaging around mouth	Choice of rearing system	Ensure appropriate materials are used for netting and tanks
Pug-headedness (brachygnathia)	Inappropriate egg incubation temperatures	Use optimal egg incubation temperatures for species
Early life stage jaw deformities	Inappropriate rearing temperatures	Use appropriate rearing temperatures for species
Fin		
Fin damage	Diet formulation	Select appropriate protein and lipid sources
	Underfeeding	Feed to satiation
	Choice of feed regimen	Use demand feeding systems
	Choice of rearing system	Farm fish in flow-through tanks or optimize flow dynamics in RAS tanks
		Incorporate cobble substrates into salmonid raceways during construction
		Omit baffles during raceway construction
		Limit pen submergence to periods <6 weeks
	Inappropriate rearing temperatures	Use appropriate rearing temperatures
	High stocking density	Reduce stocking densities
	Low stocking density	Increase stocking densities
	Low water current	Optimize water current
	Direct aggression	Reduce feeding aggression and competition by delivering multiple feedings and dispersing feed over wide surface area

Troubleshooting Injuries (continued)

Injury	Risk Factor	Mitigation
Skin		
Ulcers	Parasitic infections	High salinity (>12–15 ppt). Low water temperature (>10C)
		Use of antimicrobials at the correct dose
		Reduce stocking densities, disinfection of pens and equipment, restrict fish transport and control of natural host
		Implement biosecurity measures to prevent pathogen entry (disinfection, transport restrictions)
Injuries (general)	Pumping	Use vacuum pumps or turbine pumps at no more than 330 rpm
	Vaccination	Use mineral oil–based adjuvants
	Jellyfish blooms	Use jellyfish traps
Abrasion	High UV	Avoid using farms located in zones with high ultraviolet incidence. Cover tanks with lids. Ensure adequate enclosure depth.
Thinning and mucous cell opening	Therapeutic medicinal treatment	Use bath with low concentration and for the shortest time
Internal		
Intra-peritoneal adherences	Vaccination	Use mineral oil–based adjuvants

Adapted from Noble C., Cañon Jones H.A., Damsgård B., Flood M.J. Midling K.Ø., Roque A., Sæther B.-S. & Yue Cottee S. (2012) Injuries and deformities in fish: their potential impacts upon aquacultural production and welfare. In: *Welfare of Farmed Fish in Present and Future Production Systems*. Eds. H. van de Vis, A. Kiessling, G. Flik & S. Mackenzie. Netherlands: Springer, pp. 61–83.

Methods of Euthanasia, Slaughter, and Mass Depopulation

Table I.1 is based on information that was available as of the publishing of this Code of Practice. Further research under the oversight of an ethics review board may result in new, acceptable equipment and/or methods, or the elimination of some current methods. For some primary methods, a secondary step (i.e., procedure performed on unconscious fish) is required to ensure death. **Methods not listed in Table I.1 are unacceptable at any weight class.**

Use of some drugs or products may impact disposal options and/or prohibit entry of the fish into the food chain (including rendering as fish meal).

Table I.1 – Methods that are Acceptable or Unacceptable at Different Weight Classes

Primary Method	Secondary Step Required?	Fish Weight[1]		
		≤1 g	1g–500g	>500g
Maceration	No	Acceptable	Unacceptable	Unacceptable
Intentional overdose via immersion in anesthetic bath	Conditional[2]	Acceptable	Acceptable	Acceptable
Blunt force trauma to the head	Yes[3]	Unacceptable	Acceptable	Acceptable
Percussive stunning device	Conditional[4]	Unacceptable	Unacceptable[5]	Acceptable
Electrical stunning	Conditional[4]	Acceptable	Acceptable	Acceptable
Pithing	No	Unacceptable	Acceptable	Acceptable
Secondary Steps	pithing, exsanguination, decapitation, cervical transection, immersion in ice slurry			

1 Based on average weight for the specific species of salmonids.
2 Conditional: where required, as directed by a veterinarian, to ensure death.
3 Blunt force trauma does not reliably result in irreversible insensibility and a secondary step is required to ensure death.
4 Conditional: where required to ensure death in accordance with manufacturer's specifications (e.g., some percussive stunning devices stun and kill concurrently).
5 Devices can be accurately calibrated to reliably stun and kill fish at or just below 500g. Follow the manufacturer's specifications; devices must be calibrated for the size of fish on which they are being used.

The information in Table I.1 is adapted from the following references:

American Veterinary Medical Association (AVMA) (2020) *AVMA Guidelines for the Euthanasia of Animals: 2020 Edition*. Schaumburg, IL: American Veterinary Medical Association. Available at: www.avma.org/sites/default/files/2020-01/2020_Euthanasia_Final_1-15-20.pdf. Accessed: February 20, 2020.

American Veterinary Medical Association (AVMA) (2016) *AVMA Guidelines for the Humane Slaughter of Animals: 2016 Edition*. Schaumburg, IL: American Veterinary Medical Association. Available at: www.avma.org/sites/default/files/resources/Humane-Slaughter-Guidelines.pdf. Accessed: February 28, 2020.

American Veterinary Medical Association (AVMA) (2019) *AVMA Guidelines for the Depopulation of Animals: 2019 Edition*. Schaumburg, IL: American Veterinary Medical Association. Available at: www.avma.org/sites/default/files/resources/AVMA-Guidelines-for-the-Depopulation-of-Animals.pdf. Accessed: February 12, 2020.

World Organisation for Animal Health (2019) Chapter 7.3: Welfare aspects of stunning and killing of farmed fish for human consumption. In: *Aquatic Animal Health Code*. Available at: www.oie.int/fileadmin/Home/eng/Health_standards/aahc/2010/en_chapitre_welfare_stunning_killing.htm. Accessed: February 12, 2020.

World Organisation for Animal Health. (2019) Chapter 7.4: Killing of farmed fish for disease control purposes. In: Aquatic Animal Health Code. Available at: www.oie.int/fileadmin/Home/eng/Health_standards/aahc/2010/en_chapitre_killing_farm_fish.htm. Accessed: February 12, 2020.

Sample Transportation Record

An asterisk indicates the mandatory information that must be recorded for each transport in accordance with Section 154 of the *Health of Animals Regulations*. Section E (below) is required if the destination is a slaughter plant or assembly/distribution centre. This record (original or a copy) must be kept on the conveyance during the transport and updated each time fish are loaded, unloaded, and provided with rest (if required).

A. SHIPPER (ORIGIN)

* Name: ______________________________

* Business Name and Address: ______________________________

____

The shipper is the owner of the salmonids loaded in the vehicle: YES NO

* Departure Premises Location (Address, ID Number, Name, Lease Number, GPS Coordinates):

____

____

Emergency Contact Information: ______________________________

B. TRANSPORTER (Add additional sections if more than one driver or transporter)

* Name of Driver: ______________________________

* Business Name and Address: ______________________________

* Province and License Plate Number of the conveyance transporting the salmonids: ______________

* Province and License Plate Number of the trailer transporting the animals (if applicable): __________

* Vessel Registration Number of the conveyance transporting the animals (if applicable): ____________

* Conveyance last cleaned and disinfected: Date: _________ Time: _________ Place: ____________

* Container last cleaned and disinfected: Date: __________ Time: _________ Place: ____________

(Additional rows required if more than one container and date, time and place varies)

Driver has been briefed on the contingency plan: YES NO

Driver has received transport training: YES NO

Sample Transportation Record (continued)

C. LOADING OF THE CONTAINERS

Container ID	*Date Loaded	*Time Loaded	Farmed Salmonids				*Where Loaded	*Last Access to Feed
			*Species	*Age	*Ave Weight	*Number		

Attach a diagram of the conveyance and containers (provide container ID labels)

All groups of farmed salmonids have been determined to be fit for transport: YES NO

If NO, are farmed salmonids: COMPROMISED UNFIT

*Were any stops made along the way to rest the farmed salmonids? YES NO

*If YES, provide: Date: __________ Time: __________

Special provisions for the loading, confinement in the container, transport, and unloading of compromised and unfit farmed salmonids:

D. MONITORING WATER QUALITY AND FISH DURING TRANSPORT

Container ID	Date Checked	Time Checked	Oxygen Levels	Other Water Quality Notes	Fish Behaviour

Sample Transportation Record (continued)

E. RECEIVER (CONSIGNEE)

* Name: ____

* Business Name and Address: ____________________________________

Contact information in case of emergency: ____________________________

* Receiving Premises Location (Address, ID Number, Name, Lease Number, GPS Coordinates):

____

____

F. TRANSFER OF CARE

The transfer of care from the transporter to the consignee (receiver) at a slaughter plant or assembly centre occurs immediately upon acknowledgement of the shipment and the accompanying documentation by the consignee (receiver).

*Date of last access to feed: __________ *Date of arrival: __________ *Time of arrival: __________

*All animals arrived in good condition: YES NO

If NO, describe condition:

*Consignee Acknowledgment: ____________________________________

G: UNLOADING CONTAINERS (some examples of what to check)

Temperature on the conveyance: ______________________

Temperature of receiving waters: ______________________

Temperature difference: ______________________

Time needed for acclimation on truck (if applicable): ____________

Inspection of fish behaviour after unloading (e.g., normal swimming)

Other:

Transport Decision Tree

Evaluating groups of fish to determine if they are fit, compromised, or unfit for transport:

FIT ANIMALS

TRANSPORT

- Those that are expected to arrive at their final destination in good condition

COMPROMISED ANIMALS

*TRANSPORT DIRECTLY TO THE NEAREST SUITABLE PLACE**

- Exhibiting signs of infirmity, illness, injury or of a condition that indicates that the group has a reduced capacity to withstand transport

UNFIT ANIMALS

*DO NOT TRANSPORT EXCEPT FOR VETERINARY CARE ON THE ADVICE OF A VETERINARIAN**

- Unable to swim or maintain position in the school
- Moribund (dying)
- Signs of a generalized nervous system disorder (e.g., abnormal eye movements or swimming patterns)
- Laboured breathing (i.e., increased rate and range of opercular movements, gulping for air)
- Severe open wounds or severe lacerations
- Extremely thin
- Bloated with signs of discomfort or weakness
- Signs of exhaustion
- Signs of active infectious disease
- Incomplete smoltification if being moved to saltwater
- Exhibiting any other signs of infirmity, illness, injury or of a condition that indicates that the group cannot be transported without suffering

*SPECIAL PROVISIONS

FOR COMPROMISED & UNFIT GROUPS OF FISH

Measures must be taken to prevent suffering, injury or death during loading, confinement, transport and unloading. Some examples include:

- Slow shipping
- Lower density
- Increased frequency of monitoring

Resources for Further Information

PRODUCER MENTAL HEALTH SUPPORTS

- Canadian Mental Health Association www.cmha.ca
- The Do More Agriculture Foundation www.domore.ag
- Les travailleurs de rang du Québec www.santesecurite.upa.qc.ca/sante-psychologique/travailleurs-de-rang

GENERAL FISH CARE

- Merck Animal Health. Aqua Care 365 Farm Fish Behaviour Training Module. Available at: www.merck-animal-health-usa.com/aqua-care-365
- Noble C., Gismervik K., Iversen M. H., Kolarevic J., Nilsson J., Stien L. H. & Turnbull J. F. (Eds.) (2020). Welfare Indicators for farmed rainbow trout: tools for assessing fish welfare. 310 pp. Available at: www.nofima.no/wp-content/uploads/2020/05/Welfare-Indicators-for-farmed-rainbow-trout-Noble-et-al.-2020.pdf
- Noble C., Gismervik K., Iversen M. H., Kolarevic J., Nilsson J., Stien L. H. & Turnbull J. F. (Eds.) (2018). Welfare Indicators for farmed Atlantic salmon: tools for assessing fish welfare 351pp. Available at: www.researchgate.net/profile/Martin-Iversen/publication/342317515_46_Welfare_Indicators_for_farmed_Atlantic_salmon_Part_B_-Fit_for_Purpose_OWIs_for_different_production_systems/links/606b0509299bf1252e2f13fe/46-Welfare-Indicators-for-farmed-Atlantic-salmon-Part-B-Fit-for-Purpose-OWIs-for-different-production-systems.pdf

CLEANER FISH

- Noble C., Iversen M. H., Lein I., Kolarevic J. Johansen L. –H., Berge G. M., Burgerhout E., Puvanendran V., Mortensen A., Stene A. & Espmark Å. M. (2019). An introduction to Operational and Laboratory-based Welfare Indicators for lumpfish (Cyclopterus lumpus L.). 46 pp. Available at: www.ntnuopen.ntnu.no/ntnu-xmlui/handle/11250/2599803
- Noble C., Iversen M. H., Lein I., Kolarevic J., Johansen L. –H., Burgerhout E., Puvanendran V., Kousoulaki K., Aas G. H., Stene A. & Espmark Å. M. (2019). An introduction to Operational and Laboratory based Welfare Indicators for ballan wrasse (Labrus bergylta). 43 pp. Available at: www.ntnuopen.ntnu.no/ntnu-xmlui/handle/11250/2600257
- Powell A., Treasurer J.W., Pooley C. L., Keay A.J., Lloyd R., Imsland A.K, Garcia de Leaniz C. (2018) Use of lumpfish for sea-lice control in salmon farming: challenges and opportunities. *Reviews in Aquaculture*, 10:683–702. Available at: www.onlinelibrary.wiley.com/doi/epdf/10.1111/raq.12194
- Royal Society for the Prevention of Cruelty to Animals (2021) Welfare Standards for Farmed Atlantic Salmon. Available at: www.science.rspca.org.uk/sciencegroup/farmanimals/standards/salmon.

FISH HEALTH MANAGEMENT

- Danner G.R. & Merrill P. (2006) Disinfectants, Disinfections and Biosecurity in Aquaculture. In: *Aquaculture Biosecurity: Prevention, Control, and Eradication of Aquatic Animal Disease*. Eds. A.D. Scarfe, C. Lee & P.J. O'Bryen. Ames, Iowa: Blackwell Publishing, pp. 91–128.
- Government of Canada. Aquatic Animal Diseases. Available at: www.inspection.gc.ca/animal-health/aquatic-animals/diseases/eng/1299156296625/1320599059508
- Government of Canada. Aquatic Animal Biosecurity. Available at: www.inspection.gc.ca/animal-

Resources for Further Information (continued)

health/aquatic-animals/aquatic-animal-biosecurity/eng/1320594187303/1320594268146

FISH TRANSPORTATION

- Canadian Food Inspection Agency (last modified 2020-05-12) Example Contingency Plan Template. In: *Health of Animals Regulations: Part XII: Transport of Animals Regulatory Amendment Interpretive Guidance for Regulated Parties*. Available at: www.inspection.gc.ca/animal-health/humane-transport/health-of-animals-regulations-part-xii/eng/1582126008181/1582126616914#app2

Participants

Code Development Committee Members

Role	Representative	Organization
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	Arlen Taylor	Canadian Aquaculture Industry Alliance
	Amanda Borchardt DVM	Canadian Aquaculture Industry Alliance
	Wendy Vandersteen PhD	Canadian Aquaculture Industry Alliance
Veterinarian	Chris Harvey-Clark DVM	Canadian Veterinary Medical Association
Animal Welfare	Leigh Gaffney MSc (2019 – 2021)	World Animal Protection Canada
	Victoria Braithwaite DPhil (2019)*	World Animal Protection Canada
Animal Welfare Enforcement	Carolyn Sanford DVM, PhD	Prince Edward Island Department of Agriculture and Land
Provincial Government Representative with Responsibilities in Animal Welfare	Myron Roth PAg, PhD	British Columbia Ministry of Agriculture, Food and Fisheries
Retail	Alexandra Leclerc MSc	Retail Council of Canada
Federal Government	Kim Klotins DVM, DVSc	Canadian Food Inspection Agency
	Victoria Pedersen DVM	Canadian Food Inspection Agency
Researcher/Academic	Richard Moccia MSc	Scientific Committee Co-Chair
	David Scarfe DVM, PhD, MRSSAf, CertAqV	Scientific Committee Co-Chair
Technical Expert & Provincial Government Veterinarian	Roland Cusack DVM, MSc	Nova Scotia Department of Fisheries and Aquaculture

*Dr. Victoria Braithwaite was a strong supporter of this Code of Practice and the importance of fish welfare in aquaculture. This Code of Practice benefited greatly from Dr. Braithwaite's significant contributions as a committee member until her passing in 2019.

Scientific Committee Members

Name	Named By
Richard Moccia MSc (Co-Chair)	International Society for Applied Ethology (Canadian Chapter)
David Scarfe DVM, PhD, MRSSAf, CertAqV (Co-Chair)	Canadian Veterinary Medical Association
E. Don Stevens PhD	Canadian Veterinary Medical Association
James Duston PhD	Canadian Society of Animal Science
J. Michelle Lavery MSc	Scientific Committee, in accordance with its Terms of Reference

Participants are defined as per NFACC's Guiding Principles for Codes of Practice.

The expertise and contributions of all committee members were greatly appreciated. The Code Development Committee wishes to recognize David Werminski, Nigel Harrison, and Sheri Beaulieu who served at different times as Industry Liaisons. The committee also appreciates the valuable input from the public comment period and all those who provided comments and advice throughout the process.

Summary of Code Requirements

The following is a list of the Requirements within the farmed salmonids Code of Practice. Refer to the cited Code section for further context about the Requirements.

SECTION 1 Knowledge and Skills of Hatchery, Nursery, and Farm Personnel

- Personnel who care for eggs or fish must have the competence to properly carry out the practices and procedures they are responsible for.

SECTION 2 Rearing Systems and Units

2.1 Site Selection

- Site selection considerations must include an assessment of water quality and environmental risks.
- Where it exists, historical data (e.g., hydrographic, oceanographic) must be consulted to determine site suitability and understand seasonal changes.
- Site suitability must be routinely evaluated as it may change over time. Management practices must change in relation to changes in site condition.

2.2 Rearing System and Unit Design

- Rearing units must not contain sharp protrusions or abrasive surfaces that could injure fish.
- Emergency procedures relevant to the farm's location and type of rearing system must be developed and communicated to personnel.
- Farms that are reliant on electricity for life support systems (e.g., water flow, provision of oxygen) must have alternative means to support these critical functions in the event of a power failure, mechanical breakdown, or other emergency.
- Systems must be in place to prevent fish escape and the entry of wild animals, including wild fish.
- Netting and screens must be a suitable size for the fish being held to prevent escape, entanglement, entrapment, and injury.
- Netting and screens must be regularly checked for holes and maintained in good condition.
- Net pens must be adequately tensioned and of a weight that prevents distortion and associated crowding, entanglement, or injury.
- Flow rate must allow fish to hold their normal position and distribution in the water column and for water quality to be maintained.

2.3 Water Quality

- Oxygen must be monitored daily at the effluent, or the point of lowest expected oxygen, in each fish rearing unit.
- Water temperature must be monitored daily in all systems.
- If water temperature or oxygen levels are outside of the appropriate range and cannot be corrected, non-urgent procedures that may cause additional stress (e.g., handling) must be postponed until parameters are back within the appropriate range.
- Monitoring and mitigation plans for plankton must be in place for marine systems.
- If abrupt changes in water quality or behaviour suggesting poor water quality occur (e.g., fish gasping due to low oxygen levels), corrective action must be taken.

Summary of Code Requirements (continued)

2.4 Lighting

- Rapid changes in light intensity that will cause a startle response and associated injury, mortality, or suffocation must be avoided.
- Lighting and lighting control systems must be inspected regularly and maintained in good working order.

2.5 Biodensity

- Biodensity must be assessed at least once a month, unless conditions present a risk to fish welfare (e.g., algal blooms), in all rearing units to ensure it remains appropriate relative to fish growth and environmental conditions.
- If a slower than expected growth rate and/or welfare issues (fin or skin erosion, excessive size variation, or reduced feeding response) occur, biodensity must be assessed as a potential contributing factor and corrective action must be taken.

SECTION 3 Husbandry Practices

3.1.1 Egg Management

- Eggs must be incubated, cared for, and handled in ways that promote healthy embryos.
- Incubators must be in good working condition to prevent injury or death of eggs and prevent eggs from falling out.
- Incubators with eggs must never be handled in a manner likely to damage the eggs.
- Eggs must be disinfected after fertilization.

3.1.2 Broodfish

- Personnel involved in spawning, tagging, and fin clipping must be competent in the technique prior to performing the procedures on broodfish.
- Eggs and milt must be collected using only gentle pressure.
- If spawning is terminal, broodfish must be euthanized in a humane manner prior to spawning. Refer to *Section 6 – Euthanasia, Slaughter, and Mass Depopulation*.

3.1.3 Triploid Fish

- To reduce the rate of mortalities and deformities, personnel responsible for performing triploid production on eggs must be competent in the technique.
- Producers raising triploid fish must be aware of and accommodate their specific requirements through husbandry and stress reducing strategies (e.g., adjusting feeding, oxygen, temperature, and salinity).

3.2 Handling

- Personnel must be competent in techniques used to handle fish in all life stages.
- Fish must have their body supported when they are lifted and carried and must never be lifted or carried by only the fins, head, tail, or gills.
- Fish must be handled in a manner that minimizes stress and the risk of injury.
- Abusive handling is unacceptable. Personnel must not beat, whip, kick, sweep, or drag fish.
- The time that fish are out of water must be minimized (i.e., only as long as necessary to carry out the procedure).
- The number of fish in hand nets must prevent suffocation and injury.
- Fish handling must be delayed or adapted if warranted due to poor health (e.g., gill disease) or poor water quality conditions (e.g., low oxygen, plankton bloom, low or high water temperature).

Summary of Code Requirements (continued)

3.2.1 Sedating and Anesthetizing Fish

- Procedures requiring sedation or anesthesia include injectable vaccination, a scale scrape, fin clipping, tagging, and any other procedure requiring sedation or anesthesia as directed by the farm veterinarian.
- Sedatives/anesthetics must be selected and used in consultation with the farm veterinarian to ensure fish are appropriately sedated/anesthetized for the intended procedure.
- Carbon dioxide must not be used to sedate/anesthetize fish.
- Prompt corrective action must be taken if injuries or gasping occur or water quality visibly deteriorates (e.g., debris, stable foam, mucus) during sedation/anesthesia.
- If freshwater is used during sedation/anesthesia, it must have a neutral pH or be buffered to a neutral pH.

3.3 Crowding Procedures

- Crowding must be accomplished gradually (i.e., no sudden or rapid decrease in the available space) to prevent injury.
- If crowding behaviour progresses from a score of 3 to 4, immediate corrective action must be taken to prevent injury. Refer to *Appendix F – Assessing Fish Behaviour* during the Crowding Procedure.
- Crowding must be delayed or adapted if warranted due to poor health (e.g., gill disease) or poor water quality conditions (e.g., low oxygen, plankton bloom, low or high water temperature).

3.4 Grading

- Grading must be delayed or adapted if warranted due to poor health (e.g., gill disease) or poor water quality conditions (e.g., low oxygen, plankton bloom, low or high water temperature).

3.5 Transfer/Ponding

- The group of fish to be transferred to grow out must be assessed as healthy and fit for transfer.
- Individual fish that are moribund, malformed, or severely injured must be removed from the group of fish to be transferred, as much as is reasonably possible, and euthanized.
- Fish condition and performance must be closely monitored after transfer to confirm groups of fish are adapting to new conditions and are feeding appropriately.

3.5.1 Transfer to Saltwater

- Group(s) of fish in freshwater must be adapted to saltwater before they are transferred into saltwater.

3.6 Equipment for Handling, Grading, and Transferring Fish

- Equipment must be free from protrusions and sharp edges and must be designed, maintained, and operated to minimize stress and the risk of injury.
- Equipment used to transfer fish must be suitable for the size of fish and must be designed and maintained to prevent escapes.
- The mesh size of hand or crowd nets must be suitable for the size of fish to prevent escape, entanglement, entrapment, and injury.

SECTION 4 Feeding Management

4.1 Quality and Safety of Feeds

- Stored feed must be protected from direct sunlight, pests, and precipitation.
- Prior to feeding, feed must be assessed visually and by smell; moldy or rancid feed must not be fed.

Summary of Code Requirements (continued)

4.2 Nutritional Needs

- Fish must receive feed that meets their nutrient requirements to maintain good health and meet physiological demands for their life stage.
- Fish must be fed pellets that are appropriately sized for their life stage.

4.3 Feeding Strategies

- Appetite and feeding behaviour must be monitored daily.
- Respond to changes in appetite and feeding behaviour by investigating the cause(s) and, where possible, take corrective action.
- Use feeding strategies that reduce competition and minimize weight variation within a group, as assessed by body size and overall condition.
- Feed must be delivered in a predictable manner, taking into consideration environmental conditions.

4.3.1 Additional Strategies for First Feeding

- Fry must be monitored frequently every day to achieve the correct timing of first feeding.
- Once feeding is initiated, fry must be monitored frequently every day to ensure successful first feeding.
- Uneaten feed must be promptly removed to maintain good water quality, taking care to avoid injuring fry at this delicate life stage.

4.3.3 Feed Withdrawal

- Prior to routine husbandry procedures, fish must be fasted sufficiently to promote optimal water quality and minimize fish stress during procedures, taking into consideration life stage, the number and nature of procedure(s), and the environmental conditions.
- Feed withdrawal periods intended to safeguard health and welfare during treatments or adverse environmental conditions must be in accordance with veterinary recommendation and outlined in the health management plan. Refer to *Section 5.1 – Health Management Plans*.
- If fish are depurated prior to slaughter, feed withdrawal must not result in negative fish health and welfare outcomes.
- If a group of fish does not have adequate fat reserves to undergo an extended period of fasting, strategies other than feed withdrawal must be taken to safeguard fish health and welfare.
- When reintroducing feed, the quantity fed must match intake and minimize feed waste and associated water quality issues, and corrective action must be taken if bloat, mortality, or abnormal behaviours occur.

4.4 Feeding Equipment

- Feed equipment must be checked daily to confirm it is in good working order, and defective systems must be attended to without delay.

SECTION 5 Health Management

5.1 Health Management Plans

- A written health management plan must be developed, implemented, and kept up to date.
- A valid, working relationship with a veterinarian (VCPR) must be established for the prevention, diagnosis, and treatment of disease and care of fish.

5.2.1 Biosecurity

- A written biosecurity protocol must be developed, implemented, and kept up to date.

Summary of Code Requirements (continued)

5.2.2 Cleaning and Disinfection

- A written protocol for cleaning and disinfection must be developed and followed.
- Cleaners and disinfectants must be stored and used in accordance with the manufacturer's directions to ensure efficacy and fish safety.

5.2.4 Pest and Predator Control

- To safeguard fish health and welfare, strategies for pest and predator control must be developed and followed.
- Netting and screens must be regularly checked for holes and maintained in good condition.

5.3 Monitoring Fish Health

- Personnel must be knowledgeable in normal fish behaviour and signs of injury and disease.
- Groups of fish must be checked daily for general health except during extreme environmental conditions where assessment may compromise their welfare.
- If there is an increase in the expected daily mortality or morbidity or a significant change in health indicators (e.g., fin or skin erosion), personnel must investigate and take corrective action as outlined in the health management plan. Refer to *Section 5.1 – Health Management Plans*.

5.5 Sea Lice

- An integrated pest management plan for the control of sea lice at marine farms must be developed and implemented in consultation with the farm veterinarian.
- Personnel involved in sea lice management must be knowledgeable of how to identify different species and life stages of lice, accepted counting protocols, and signs of lice infection.
- Lice levels must be monitored through lice counts and records must be kept on lice numbers, seasonal trends, controls, and results.
- When using bath treatments or physical methods of lice removal, treatment efficacy and fish condition must be assessed throughout so that corrective action can be taken as necessary.
- If sea lice are compromising fish welfare, personnel must determine if further treatment, euthanasia, or harvest is appropriate in consultation with a veterinarian.

5.6 Additional Considerations for Maintaining Healthy Broodfish

- Strict biosecurity procedures must be in place when working with broodfish to prevent transmission of pathogens amongst broodfish and their progeny.

SECTION 6 Euthanasia, Slaughter, and Mass Depopulation

6.1 Planning and Protocols

- Fish must be promptly euthanized if they have a condition that compromises their welfare and
  - they do not have a reasonable prospect of improvement, or
  - are not responding to treatment(s) within an appropriate timeframe, or
  - treatment is not a humane option.
- A written euthanasia plan must be developed with veterinary input and implemented.
- On farms that slaughter fish, a written slaughter plan must be developed with veterinary input and implemented.
- A written contingency plan for mass depopulation must be developed with veterinary input.
- Fish must be cared for and treated in a manner that promotes their welfare until euthanasia, slaughter, or depopulation.

Summary of Code Requirements (continued)

6.2 Methods

- An acceptable method of euthanasia, slaughter, and depopulation, as outlined in Appendix I, must be used.
- Methods of euthanasia, slaughter, and depopulation must be quick, cause minimal stress and pain, and result in rapid loss of consciousness followed by death without the fish regaining consciousness.
  - Ice slurry slaughter does not meet the above criteria; farms that still use this method must transition to an acceptable method (Appendix I) as soon as possible and no later than January 1, 2025. As of this date, ice slurry must only be used as a secondary step (after fish have been rendered insensible) to ensure death.
- Use of a method not listed as acceptable in Appendix I is only permitted in exceptional emergency circumstances as outlined in a contingency plan developed with veterinary input. Refer to *Section 6.1 – Planning and Protocols*.
- When a secondary step is needed, it must be performed as soon as possible and before recovery.
- Prior to euthanasia, slaughter, or depopulation, fish must be handled, crowded, and moved humanely. Refer to *Section 3 – Husbandry Practices*.

6.2.1 Training and Equipment

- Personnel must be competent in the euthanasia, slaughter, and/or depopulation methods used.
- Equipment must be used, stored, calibrated, and maintained according to the manufacturer's instructions to ensure proper functioning.

6.2.2 Confirming Death

- A repeat procedure (or alternate method) must be promptly performed if signs of recovery are noted.
- Fish must be dead before disposal or processing.

SECTION 7 Transportation

7.1 Training and Record Keeping

- Personnel who load, confine, transport, or unload fish must have the competence to properly carry out the procedures they are responsible for (3).
- Transporters must maintain accurate and complete records for each shipment (3).

7.2.1 Planning and Arranging Transportation

- Fish on a 24-hour light regimen must be exposed to dark periods over at least 3 days prior to loading to prevent crowding at the bottom of the container, unless transportation containers permit the entry of ambient light or are artificially lit.
- Fish must be fasted for a minimum of 24 hours or 10 degree days (whichever is longer) prior to transport to achieve as much gut clearance as possible and promote optimal water quality during transportation.
- At or before the time of loading, producers must communicate the fasting period to transporters to support good water quality management during transport.
- Refer also to the Requirements in *Section 4.3.3 – Feed Withdrawal.*

Summary of Code Requirements (continued)

7.2.2 Assessing Fitness for Transportation

- In preparation for transport, the group of fish to be transported must be evaluated for fitness and if
  - unfit, must only be transported with special provisions on the advice of a veterinarian to receive veterinary care
  - compromised, must only be transported with special provisions directly (i.e., not through an assembly/distribution centre) to the nearest suitable place where they can be humanely killed or receive care (e.g., grow out environment in the best interest of the fish).[1]
- Before and during loading, individual fish that are compromised or unfit must be removed from the population of fish to be transported as much as reasonably possible and must receive care or be euthanized.
- Conditions that make a group of fish unfit or compromised are outlined in *Appendix K – Transport Decision Tree.*
- Mortalities must be removed prior to loading.

7.2.3 Loading Density

- Loading density must be determined prior to loading, taking into consideration fitness for transport, water temperature, body size/weight, life stage, weather conditions, and the duration of transport.
- Loading density must minimize fin erosion and scale loss and permit fish to maintain a horizontal position.
- Loading density must not exceed 150 kg/m^3 (i.e., 15% fish, 85% water) (64).

7.3 Loading and Unloading Procedures

- Fish must be loaded/unloaded at a speed and in a manner that minimizes the risk of injury, enables fish to promptly revert to a normal position and distribution in the water column, and prevents crowding at the bottom of the container or rearing unit.
- Eyed eggs must not be allowed to dry out and must have air space in their container.
- During unloading, fish in the container must be covered with water and the last fish to be unloaded must be flushed or netted out (never swept or dragged).
- Refer also to the Requirements in *Section 3.2 – Handling* and *Section 3.6 – Equipment for Handling, Grading, and Transferring Fish.*

7.4 Transport Containers

- Net pens that are used to transport fish under water must be adequately tensioned and of a weight that prevents distortion and associated crowding, entanglement, or injury.
- Containers must prevent fish escapes and water leakage and be free from projections or loose fittings that may injure fish.
- Containers must be designed or properly insulated so that any change in water temperature is within the adaptive ability of the fish.
- Containers must permit visual inspection of fish (e.g., top latch), clearly indicate the presence of eggs or fish (on at least 2 sides) and clearly indicate the upright position of the container (3).
- Containers loaded with eggs or fish must never be handled in a manner likely to cause suffering, injury, or death.
- Containers must be filled with water to a level that minimizes sloshing.
- Containers must be cleaned and disinfected after all groups to be transported have been moved.[2]

[1] The "nearest suitable place" may not always be the closest geographically—it refers to the closest facility suitable for the type and condition of fish that has adequate facilities for safe unloading/holding and the competent human resources available to provide care or humanely kill fish without compromising the biosecurity in place for both the facility and the conveyance (61).

[2] Except for one-time use containers and net pens used to transport fish.

Summary of Code Requirements (continued)

7.5.1 Monitoring Water Quality and Fish During Transport

- Containers must only be opened as necessary to inspect fish, eggs, or water quality.
- Prompt corrective action must be taken if an abrupt change in water quality occurs or fish show abnormal behaviour.
- Oxygen levels must be monitored and maintained at a minimum of 80% during transport (64).
- Water quality parameters during transport must be similar to the water quality parameters at the source and the destination, unless fish are acclimated before or during transport.
- If a group of fish becomes compromised or unfit during transport, reasonable measures must be taken as soon as possible to prevent suffering, injury, or death (3).
- Conditions that make a group of fish unfit or compromised are outlined in *Appendix K – Transport Decision Tree*.

7.5.2 Use of Additives During Transport

- Additives, including sedatives, must only be used according to the manufacturer's instructions or on the advice of a veterinarian.

7.5.3 Driving and Other Journey Factors

- All lids, outlets, or any other openings must be secured before departure.
- Containers must be secured to the conveyance prior to departure.
- On-site roads and laneways must be free of obstructions and large potholes to minimize the risk of sloshing.
- Transporters must drive in a manner that minimizes the risk of sloshing, injury, and uncontrolled movement of fish.
- Net pens that are used to transport fish under water must be driven at a speed that prevents distortion of the nets and swimming fatigue, which can lead to crowding, entanglement, and injury.

7.6 Transfer of Care and Post-Transportation Monitoring

- The consignee must receive documentation on the date and time of arrival, any adverse events that occurred during transport, and the fasting period.
- The fasting period must be ended once the fish are acclimated unless it is necessary to continue the fasting period due to water quality issues (e.g., plankton).
- Refer also to the Requirements in *Section 4.3.3 – Feed Withdrawal*.

7.7 Emergency Preparedness and Response

- Transporters must have a contingency plan outlining:
  - measures to address fish that become unfit or compromised during any part of the transportation process
  - measures to address unforeseen delays or other emergencies during transportation that may affect fish welfare, and
  - emergency euthanasia or depopulation during transportation.
- The contingency plan must be communicated to relevant personnel.
- Transporters must have an emergency contact list accessible in the conveyance.
- Alternative means of maintaining the life support system of fish must be available and implemented in the event of a mechanical breakdown or other emergency in transport.