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Humane Slaughter, Euthanasia and Depopulation for Salmonid Aquaculture

Ministry of Agriculture, Food and Agribusiness

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Overview

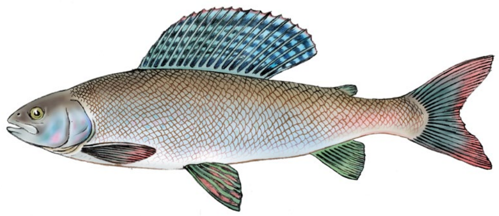
Aquaculture is one of the world's fastest-growing food production sectors. It includes the cultivation of fish, crustaceans, mollusks and aquatic plants under controlled conditions and now supplies over half of all seafood consumed globally. Demand for aquaculture production has grown rapidly since the 1990s, primarily due to population growth, rising per capita seafood consumption rates and a plateau in wild capture fisheries harvest capacity. Future increase in global seafood demand is expected to be met through a diversity of aquaculture species and production systems. It is projected that by 2030 aquaculture will supply nearly 60% of all seafood for human consumption.[1]

To meet rising global seafood demand aquaculture has developed technologies, genetics and production systems to grow seafood at scale more efficiently and sustainably. Advancements in aquaculture have included technologies and methods for humane slaughter, euthanasia and depopulation which improve fish welfare and product quality during these end-of-life procedures. Alongside aquaculture development, scientific research conducted on fish sentience has progressed and now supports teleost fish (bony fish) as sentient animals capable of experiencing negative states such as pain and suffering.[2],[3],[4]

The importance of using best available technology and humane methods for slaughter, euthanasia and depopulation is now more apparent than ever. Increasingly seafood consumers, retailers, regulators and third-party certification agencies are supporting sustainable aquaculture production which incorporates humane practices and the ethical treatment of fish into end-of-life procedures for slaughter, euthanasia and depopulation.

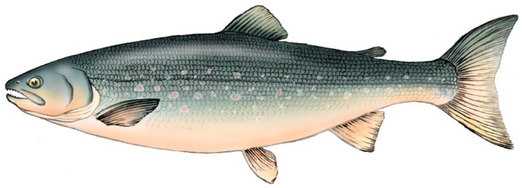
Salmonid aquaculture encompasses the cultivation of all species belonging to the Salmonidae family, including:[5]

Graylings (*Thymallus*)



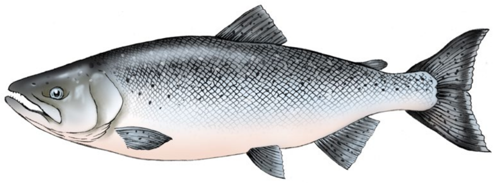
Arctic Grayling

Char (*Salvelinus*)



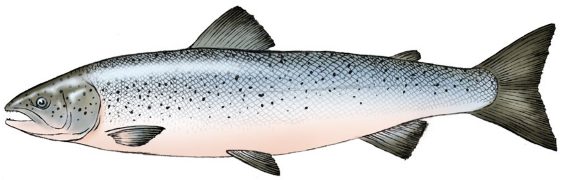
Arctic Char

Salmon (*Oncorhynchus*)



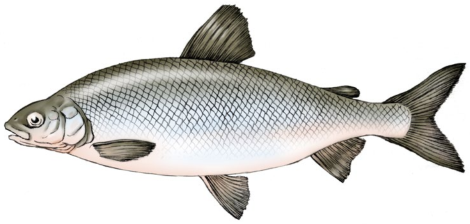
Chinook Salmon

Trout (*Salmo*)



Atlantic Salmon

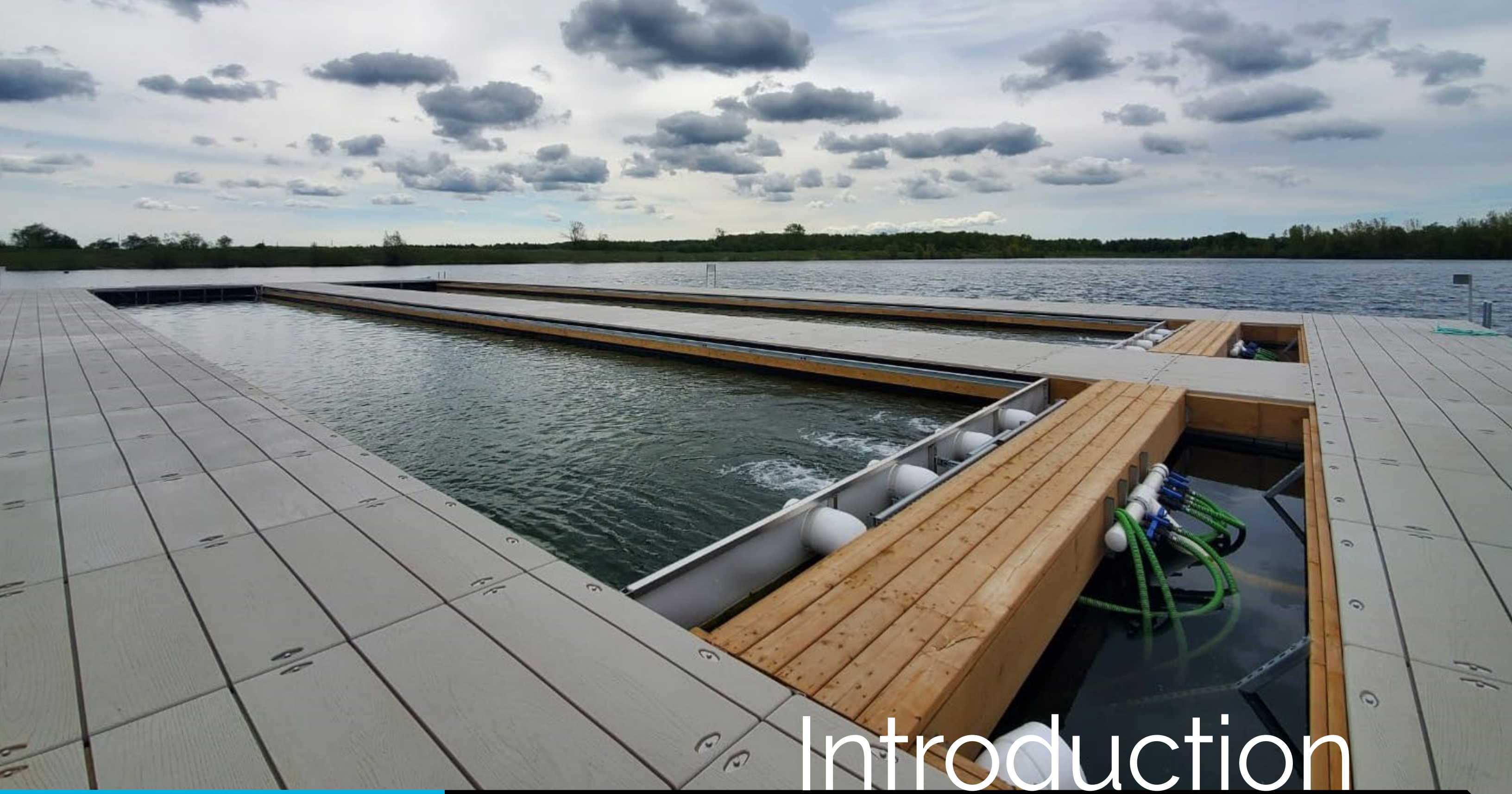
Whitefishes (*Coregonus*)



Lake Whitefish

Salmonid species make up the majority of aquaculture production in Canada and in most provinces and territories. In 2021, salmonids accounted for over 68% of Canada's national aquaculture production by volume and over 95% of Ontario's aquaculture production by volume.[6],[7]

The following document is intended to provide information on humane slaughter, euthanasia and depopulation for salmonid aquaculture. Information provided in this document is not intended for non-salmonid species or salmonids cultured for research.



Introduction

Slaughter describes the process by which healthy livestock including fish and other aquatic animals are harvested for human consumption at the end of the production cycle. It is a routine and scheduled event that involves crowding, transporting and harvesting fish for market.[8]

Euthanasia is an end-of-life procedure performed when an individual fish or larger population is experiencing a compromised state of welfare and is intended to alleviate pain and distress felt by fish.[9] Euthanasia can be necessitated by unexpected fish health or welfare concerns requiring immediate action. Euthanized fish are not used for food.

Depopulation involves the destruction of a large number of often healthy fish. It is routinely used as a stock management strategy and may be required in response to an on-farm emergency. Fish that are euthanized as part of depopulation efforts may or may not be used for food based on the health status of the fish, the method of depopulation and on-farm circumstances.

Humane slaughter, euthanasia and depopulation are multi-staged processes involving actions taken before, during and after the time of death (Figure 1). To bring about humane outcomes work is needed well in advance to plan and prepare for these end-of-life procedures.

Prior to fish losing consciousness strategies are needed to protect fish welfare during feed withdrawal, crowding, handing and transportation. At the time of death effective primary and secondary methods are necessary to ensure fish are slaughtered, euthanized and depopulated humanely. Following end-of-life procedures there are environmental management considerations for responsibly disposing of wastewater, by-products and carcasses.

Humane slaughter, euthanasia and depopulation procedures are concluded by effectively cleaning and disinfecting the aquaculture facility according to biosecurity standard operating procedures (SOPs) that have been developed in consultation with a veterinarian. Information on aquaculture biosecurity is available through the Ontario Animal Health Network's online biosecurity course.

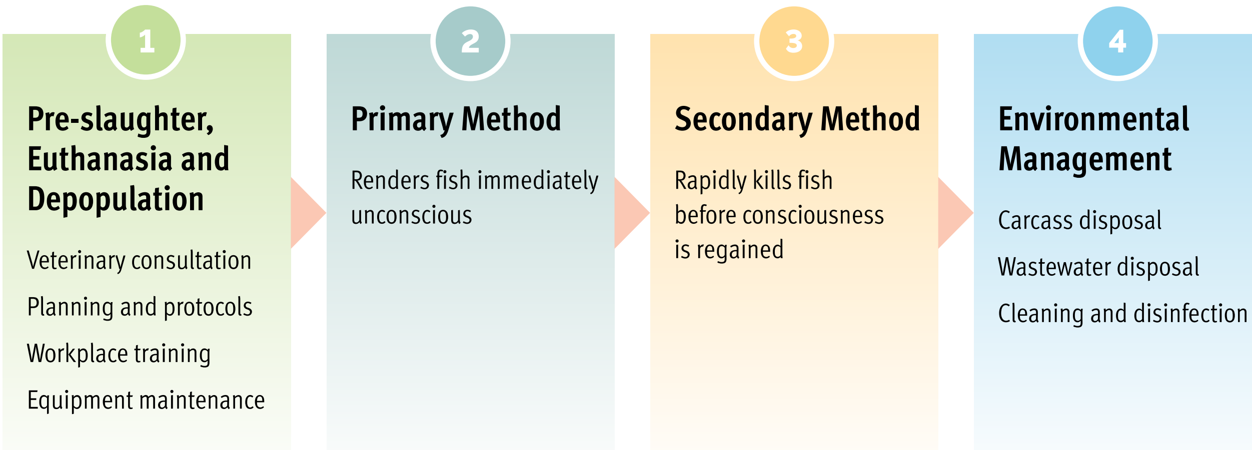


Figure 1. *The four stages of humane slaughter, euthanasia and depopulation..*

Chapter 1

Humane Slaughter

Humane slaughter is a harvest process involving pre-slaughter procedures, a primary slaughter (stun) method and secondary slaughter (kill) method (Figure 2).

Pre-slaughter: procedures are conducted to prepare fish for slaughter and transport fish from the rearing unit to the slaughter site. Pre-slaughter procedures incorporate methods to minimize fish stress during harvesting.[10]

Primary slaughter: at the slaughter site fish are first stunned, with a target to render them unconscious in less than one second.[11] This step is performed to remove fear, pain and distress felt by fish during secondary slaughter. Loss of consciousness should be verified before secondary slaughter.[8]

Secondary slaughter: Unconscious fish are quickly killed by a physical method, typically exsanguination (blood loss) before consciousness is regained. This step should be verified to confirm death.[8]

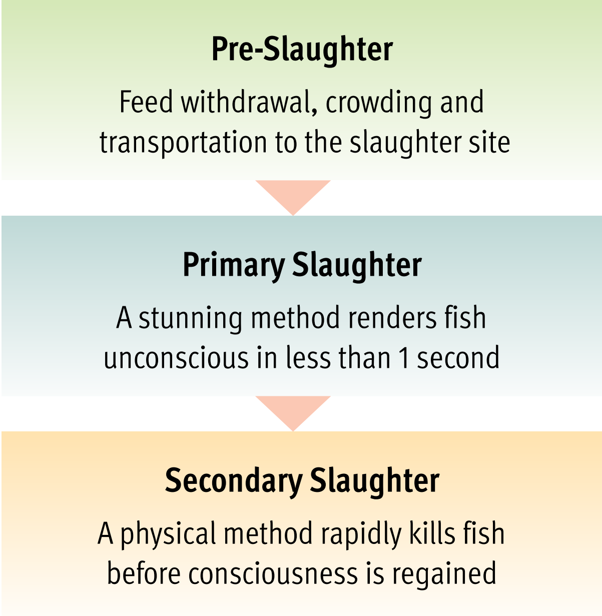


Figure 2. *Guidelines for humane slaughter.*

How Humane Slaughter Effects Product Quality

Humane slaughter methods have shown to preserve flesh quality during harvest:

- Humane slaughter methods reduce fish stress and metabolism during pre-slaughter, primary slaughter and secondary slaughter resulting in better flesh quality.[10]
- Fish stress intensifies muscle activity leading to a build-up of lactic acid in the muscle and a decrease in muscle pH which induces a softening of the raw fillet in salmonids, including rainbow trout.[8],[12],[13]
- Softer flesh is more prone to muscle gaping, downgrading and economic losses.[14]
- Consumers generally prefer flesh with a firm texture and no muscle gaping.[14]
- Humane slaughter methods delay the onset and reduce the intensity of rigor mortis in fish.[13]
- The onset and strength of rigor mortis affects muscle tissue, leading to increased gaping, flesh softening, colour change and reduced shelf-life of fillets.[13],[15]
- Filleting, eviscerating (gutting), handling or packing fish in-rigor can cause damage to flesh quality and fish should not be processed in a state of rigor mortis.[16]
- Exsanguination as a secondary slaughter method plays a role in reducing blood spots in fillets.[17]

Pre-Slaughter

The pre-slaughter stage starts on-farm days before harvesting begins with the selection of harvest ready fish and a feed withdrawal period. Only healthy fish should be selected fit for slaughter. Fish deemed unfit for slaughter because of compromised health conditions may require fish health treatments (as prescribed by a veterinarian) or euthanasia.

Once fish have completed the feed withdrawal period they are crowded and transported to the slaughter site, marking the end of the pre-slaughter stage. Proper management strategies during the pre-slaughter stage improves fish welfare and product quality by minimizing fish stress and metabolism leading up to primary slaughter.[10]

Feed Withdrawal

Prior to slaughter feed is withdrawn from fish for a duration of time suitable to clear all food contents from the fish's gut. The rate at which fish metabolize feed and the duration of time necessary for gut clearance is primarily dependent on water temperature and will require more time at a lower temperature. General guidance on minimum gut evacuation rates can be found in Table 4.1 of the National Farm Animal Care Council *Code of Practice for the Care and Handling of Farmed Salmonids*.

Feed withdrawal is carried out to reduce fish metabolism, oxygen demand, waste production and physiological stress during the slaughter process.[10] A properly executed feed withdrawal period will improve water quality during crowding and transportation, benefit hygiene during slaughter and post slaughter processing.[8]

Excessive feed withdrawal can result in the utilization of stored body fat and then functional tissue leading to poor fish welfare and a reduction in biomass at harvest. Feed withdrawal periods for salmonids should not exceed 50-degree days.[18] Degree days are assessed by multiplying the average water temperature by the number of days in the feed withdrawal period:

average water temperature x number of days = degree days

For example, at an average water temperature of 10˚C it would take 5 days to attain a feed withdrawal period of 50-degree days.[19]

Crowding

Crowding is an essential part of the pre-slaughter process and involves confining fish in a small area using a seine net (Figure 3), a screen, lowering the water level in a tank or raising a net pen. It is performed to enable access to fish for transfer to the slaughter site. If poorly managed crowding can produce a high stress response in fish and an increase in muscle activity leading to poor fish welfare and the degradation of flesh quality.[8],[13]

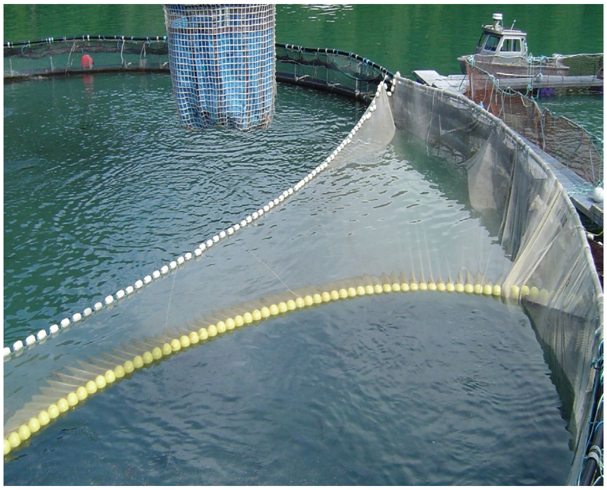


Figure 3. *Crowding Atlantic salmon using a seine net.*

Overcrowding creates conditions where fish can develop injuries, abrasions and scale loss through repeated contact with other fish and/or crowding equipment. Under extreme conditions fish can die from trauma or lack of oxygen caused by overcrowding.

Indicators of overcrowding include:

- frantic swimming behaviour in most fish
- several dorsal fins exposed out of the water
- fish are unable to maintain position in the water column
- fish are stuck against the crowding net or screen
- white bellies of fish are showing at the surface[19]

The amount of time fish spend crowded, crowding density and water quality conditions have a direct impact on fish welfare. Efforts should be made to limit the duration of time fish spend in crowding and when possible, release tension on the crowding net or screen to reduce fish density and stress.

Dissolved oxygen levels within the crowding area should be monitored and supplemental oxygen added when necessary to maintain appropriate levels for salmonids between 80%–100% oxygen saturation.[19] Avoid exposing fish to shallow water and air during crowding as this limits their ability to move and respirate. Removal from water produces an extreme physiological response in fish and all efforts should be made to limit the occurrence and duration of time fish spend out of water.[10]

Crowding presents a fish welfare challenge during pre-slaughter and requires a high degree of operator care. By minimizing the amount of time fish spend crowded and maintaining appropriate fish density and water quality conditions during crowding, producers can protect fish welfare along with product quality. Reducing fish stress during crowding has clear product quality benefits as elevated muscle activity during pre-slaughter has shown to contribute to poor texture, flesh softening and muscle gaping.[8]

Handling and Transportation

The final stage of pre-slaughter is transportation where fish are moved from the rearing unit to the slaughter site. Transportation demands will vary based on the type of production system and distance between the rearing unit and slaughter site.

On-Farm Slaughter

On-farm slaughter takes place at the aquaculture facility, close to the rearing unit and avoids the challenges of long-distance transportation. It reduces fish handling and transportation requirements which can minimize pre-slaughter fish stress.[18]

Fish can be transported over a short distance to the slaughter site using a:

- fish pump
- brail net
- dip-net
- gravity flow chute
- fish screw (Pescalator)

Off-Farm Slaughter

Off-farm slaughter takes place at a considerable distance from the rearing unit and requires live fish transportation by well-boat or truck from the aquaculture facility to the slaughter site located off-property. Large-scale net pen aquaculture often utilizes a well-boat for live fish transportation to a land-based slaughter and processing site.

Land-based aquaculture facilities use road transportation via live haul truck and trailer for off-farm slaughter.[18]

Fish welfare and water quality conditions should be continuously monitored during transportation. Shipping tanks are to be filled with the same water source that fish have been reared in and are acclimated to. Loading density within shipping tanks should be maintained below 150 kg/m^3.[9],[19]

During transportation water quality conditions within shipping tanks can deteriorate quickly and negatively impact fish welfare. Water quality parameters such as dissolved oxygen and temperature need to be continuously monitored during transportation. Continuous monitoring using digital instrumentation provides for optimal monitoring conditions and lowers the risk of a potential incident. A visual check of fish and equipment should be routinely conducted during transportation even when monitoring is continuous.

Hazards during transportation include:

- poor water quality in shipping tanks (e.g., oxygen, carbon dioxide, ammonia)
- water temperature shock — change greater than +/- 1.5˚C per hour
- equipment failure
- hazardous weather conditions and unexpected delays[19]

Equipment and supplies are required for transportation to maintain appropriate water quality conditions within shipping tanks and generally include the use of compressed oxygen, oxygen diffusers/regulators, aerators (CO_2 degassing) and insulated shipping tanks. As the duration of time fish spend in transport and fish density in shipping tanks increases so too does the likelihood of poor water quality conditions developing during transportation.

Live fish transportation both on land and in vessel (well-boat) requires conditions suitable to maintain proper fish welfare. It is not acceptable to load, transport or unload fish in a way that could cause injury, suffering or death, under the federal *Health of Animals Act* transport regulations.

Hazards during loading/unloading include:

- water temperature shock — sudden change greater than (+/- 4˚C)
- insufficient dissolved oxygen within shipping tanks (particularly during loading)
- excessive weight on fish at the bottom of a net
- prolonged fish exposure out of water
- pumping (e.g., high speed collisions, sharps/abrasions, delay in pipe)[19]

Fish can sustain injuries during crowding and loading or may have preexisting conditions which make them unfit for transportation. In these circumstances unfit fish must not be transported except to receive veterinary care upon the advice of a veterinarian.

Common signs that fish are unfit for transport include:

- injuries impeding mobility or exhibiting signs of pain and suffering
- lameness or lethargy exhibiting signs of pain and suffering
- poor physical condition (emaciated)
- severe open wounds or lacerations
- signs of illness indicating the fish cannot be transported without suffering[20]

Information to help producers identify whether livestock (including fish) are fit or unfit for transportation can be found at *Livestock and Poultry Transport in Canada*.

When fish are unfit for transportation, options include:

- on-site care and treatment
- on-site euthanasia
- transport directly to receive veterinarian care[20]

Contingency planning for emergency situations that may arise during transportation such as a equipment failure or adverse weather conditions will help producers protect fish welfare during this final stage of pre-slaughter. Contingency planning should ensure transportation vehicles are equipped with adequate supplies (e.g., O_2, fuel) to maintain appropriate fish welfare in the event of transportation delays or the necessity to return to the aquaculture facility with a full load of fish. Contingency plans should also prepare producers for in-transit humane euthanasia of all fish within the transportation vehicle if required.

Best practice transportation systems limit fish handling, minimize the duration of time fish spend in transport, optimize conditions for loading/unloading and maintain appropriate parameters within shipping tanks (e.g., water quality, water temperature, fish density).[11]

Humane Primary Slaughter Methods

Humane primary slaughter methods induce a rapid loss of consciousness and are used to remove fear, pain and distress felt by fish during secondary slaughter.[8] Percussive and electric stunning are the primary slaughter methods which provide the highest degree of fish welfare.[3] When applied correctly these stunning methods induce immediate loss of consciousness (less than 1 second) in fish.

An alternative (back-up) stunning device is required to be on-site to stun fish in the event of a mis-stun or mechanical failure.[8],[10] Mis-stunned and injured fish should not be slaughtered through automated machinery and require on-the-spot individual stunning using a handheld device.

Percussive and electric stunning methods can be imperfect but are the most humane and efficient ways to stun fish. They require appropriate operator training, adherence to training, on-going monitoring and proper working conditions to ensure sound fish welfare.

Fish welfare hazards during primary slaughter include:

- prolonged exposed out of water during de-watering and handling
- mis-stun; fish is conscious and injured
- handling and fish thrashing while conscious
- exsanguination while conscious[18]

How Humane Primary Slaughter Methods Work

Percussive stunning: a non-penetrating bolt delivers a blow to the top of the fish's head with sufficient force to cause a mechanical disruption of normal brain activity resulting in immediate loss of consciousness.[21]

Electrical stunning: fish are exposed to an electrical current with sufficient strength and frequency to induce an electrical disruption of normal brain activity producing immediate loss of consciousness.[21]

Inhumane Primary Slaughter Methods

The following methods result in poor fish welfare and are unacceptable as a primary slaughter method:

- live chilling (ice slurry)
- asphyxiation (in water or air)
- carbon dioxide saturation
- exsanguination while conscious
- decapitation
- cervical transection[3],[13],[19],[21]

How to Assess Consciousness and Confirm Death

Primary slaughter methods must be continuously monitored for effectiveness by workers who have been trained to verify the absence of consciousness, confirm death and identify other indicators of poor fish welfare.

Confirming Consciousness

The following indicators can be used to confirm consciousness:

- Opercular movement (breathing activity) and eye-rolling reflex (Figure 4) can be observed on-farm and are indicators of consciousness.[3],[11],[22]
- Eye-rolling reflex (vestibulo-ocular reflex, VOR) is the movement of the eye when a fish is tilted from side to side. [19],[22]
- When eye-rolling reflex is lost fish are unable to adjust their eye position to compensate for a change in body tilt. Eyes are fixed relative to the head.
- Fish that display opercular movement, eye-rolling reflex, coordinated behaviour (swimming, maintaining equilibrium, attempts to escape) or responsiveness to external stimuli (fin pinch) are conscious.[3],[11],[22]

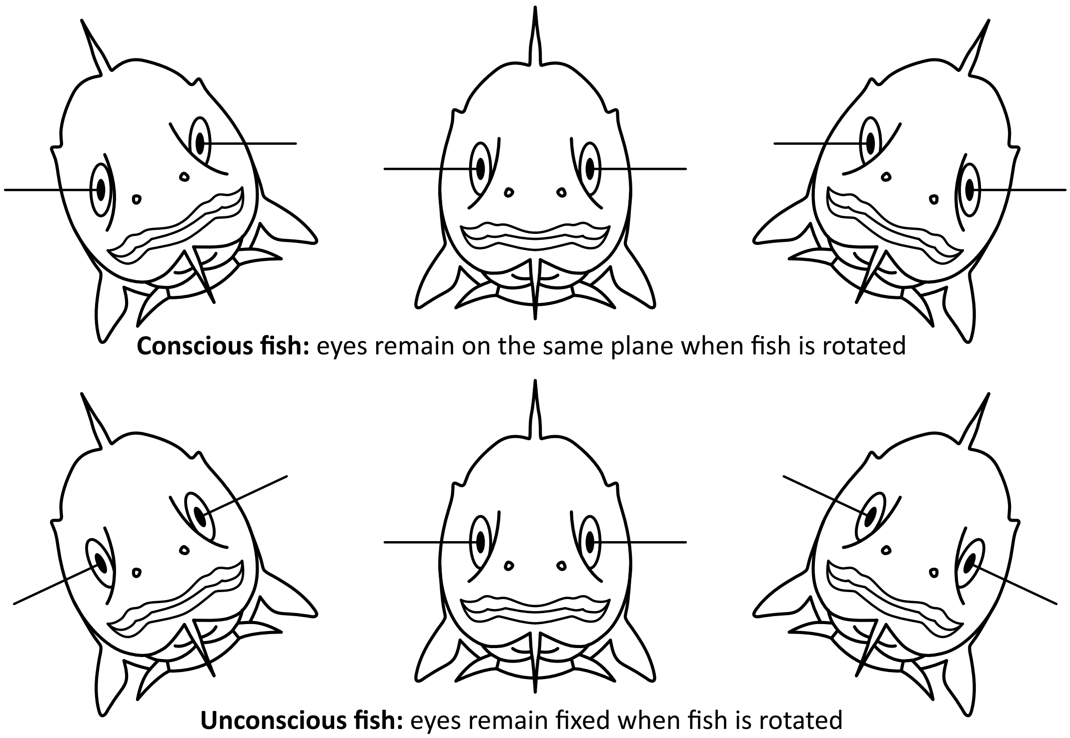


Figure 4. *Using eye-rolling reflex to assess consciousness. Source: Adapted from Kestin et al, 2002.*

Fish that present signs of consciousness after primary or secondary slaughter must be re-stunned immediately.[3]

Confirming Unconsciousness

The absence of behavioural/brainstem indicators such as opercular movement (breathing activity) and eye-rolling reflex are correlated with insensibility.[3],[11],[22]

Multiple indicators are needed to confirm unconsciousness:[3],[11],[22]

- opercular movement (breathing activity) has stopped; and[3],[22]
- eye-rolling reflex (vestibulo-ocular reflex, VOR) is no longer present[3],[22]

Irregular muscle contraction or trembling movements of the jaw or fins after primary slaughter (stunning) is not an indicator of consciousness.[3]

Confirming Death

Death can be confirmed on-farm by the absence of opercular movement (breathing activity) and eye rolling reflex for at least 10 minutes.[8]

A fish's heart may continue to beat or muscle contractions may be present even after a fish is dead.[23]

Percussive Stunning

Percussive stunning delivers a blow to the top of a fish's head with sufficient force to cause immediate loss of consciousness and may result in death. Not all percussive stunning devices are capable of causing death in all fish, your equipment must be calibrated for the task. The percussive strike should be located on top of the head, centered between the eyes and slightly back towards the dorsal fin (Figure 5).[8]

Figure 5. *Correct position for percussive stunning. Source: Ontario Aquaculture Research Centre.*

Some percussive stunning devices accomplish the primary (stun) and secondary (kill) slaughter methods at the same time because the force causes sufficient trauma to the brain to result in death. Under these circumstances exsanguination is commonly performed quickly after stunning to preserve flesh quality and to ensure death in a small proportion of fish who may not die in a single step.[8]

Percussive stunning devices range in size, rendering capacity (fish per minute), degree of automation and operator requirements. The size and volume of fish harvested are two of the main factors influencing the selection of percussive stunning equipment. Large volumes of fish demand automated stunning technology with high throughput efficiency, while small volumes of fish can be effectively stunned with the use of a handheld pneumatic powered percussive stunning device.

Blunt Force Trauma (Clubbing)

Manually applied blunt force trauma or clubbing (Figure 6) is limited by operator fatigue, a lack of training and practical only for a small number and size of fish.[8],[21] As the operator fatigues the effectiveness of blunt force trauma diminishes resulting in mis-hits, poor animal welfare and/or operator injury. Blunt force trauma does not consistently result in irreversible insensibility and a secondary slaughter method is necessary to ensure death.[19]

Figure 6. *Blunt force trauma (clubbing). Source: Ontario Aquaculture Research Centre.*

Handheld Pneumatic Stunning

Pneumatic powered handheld percussive stunning devices (Figure 7) deploy a non-penetrating bolt that delivers a stun and kill within 5 milliseconds and are suitable for large salmonids. They allow the handler to have strike accuracy, less fatigue and stun a high volume of fish per day. The Ontario Animal Health Network has developed information on humane slaughter for small and medium sized producers using a handheld pneumatic stunning device.

Figure 7. *Handheld pneumatic percussive stunning. Source: Bock Industries Inc.*

Automated Percussive Stunning

Slaughter practices for large-scale aquaculture requires automated stunning equipment.[11] Automated percussive stunning equipment uses a pneumatic powered device to deliver a non-penetrating blow to the fish's head.[18]

Uniformity of fish size is an important consideration for automated stunning (Figure 8). These devices do not work well in fish that have varying head size or unusual skull shapes, such as cichlids and flatfish. Small salmonids (less than 500 g) are generally not suitable for automated percussive stunning equipment and should be stunned manually with a handheld device.[19] Users should consult the manufacturer guidelines and the technology provider for detailed usage information.

Automated percussive stunning equipment includes both semiautomatic and automatic (swim-in) percussive stunning systems. In semiautomatic systems, fish are transferred onto a dewatering table where an operator manually handles the fish and directs it headfirst into the opening channel. The fish's snout touches a trigger, activating a bolt which immediately delivers a percussive blow to the top of the head.[11],[18]

Figure 8. *Automated percussive stunning. Source: Baader.*

Automatic (swim-in) percussive stunning systems use water current and channels to direct fish freely into the stunning device. Fish instinctively swim against water currents into opening channels leading themselves toward the stunner where they activate the percussive bolt. Automatic (swim-in) systems have proven effective for Atlantic salmon but are not well suited for all salmonids including rainbow trout based on behavioural differences. Users should consult the manufacturer guidelines and the technology provider for detailed usage information.

Semiautomatic and automatic (swim-in) percussive stunning systems can be paired with automated exsanguination equipment whereby a blade is deployed immediately following the percussive stun, striking the fish from the underside in the gill septum area to initiate bleeding.

Selecting a percussive stunning device which is appropriate for the size, species and volume of fish rendered is particularly important. To achieve effective percussive stunning the device must be calibrated for the size of fish based on manufacturer specifications and operated by workers who have received appropriate training with the equipment.

Electric Stunning

Electric stunning (Figure 9) is a humane primary slaughter method that applies an electrical current to fish with sufficient strength, duration and frequency to cause immediate loss of consciousness.[21] Electric stunning may be reversible, and fish will typically experience a short disruption in normal brain function resulting in a temporary loss of consciousness for approximately 3 minutes. When using electric stunning it is particularly important to perform the secondary slaughter method immediately after stunning and before fish regain consciousness. Other forms of electric stunning equipment can induce a disruption of normal brain function for a prolonged period of time, resulting in death.

Appropriate electrical field strength is essential for proper stunning as too weak an electrical field will not induce unconsciousness and too strong an electrical field may cause carcass damage and a loss of product quality.[10] It is necessary to establish suitable electrical current parameters for the targeted species and water source. Users should consult the manufacturer guidelines and the technology provider for detailed usage information.

During electric stunning fish size can vary, so long as the equipment has been calibrated for the species and water source, as it is calibrated for a total mass rather than a surface area of the skull.

The conductivity of water varies by source and this impacts the required strength of the electrical current at a given site.[21]

Figure 9. *In-water electric stunner. Source: Ace Aquatec, Scotland.*

Greater water conductivity, electrical field strength, and duration of electrical application typically produces longer periods of unconsciousness. In some instances, fish may develop mild tonic and clonic spasms lasting 20–50 seconds. Fish can die during these spasms or regain consciousness within a few minutes.[18]

Humane electric stunning systems have been developed as in-water continuous throughput units (stun tubes). In-water electric stunning systems pump fish through an electrified stun tube containing grounded electrodes at the inlet and outlet, preventing electricity from leaving the stun tube. Fish are rendered immediately unconscious after spending less than one second in the stun tube and are then discharged for secondary slaughter.

In-water electric stunning systems are appropriate for stunning large volumes of fish and are suitable for use on land, on a boat or barge and at a processing facility. By keeping fish submerged in water until consciousness is lost, in-water electric stunning systems avoid fish handling and thrashing while conscious, reduce fish stress and muscle activity during harvesting, which helps to protect fish welfare and flesh quality.

Humane Secondary Slaughter Methods

Exsanguination

Exsanguination is the most effective secondary slaughter (Figure 10) method used for humane slaughter. It is performed by cutting or removing the gill arches and can be carried out, with or without a beating heart provided major blood vessels are severed.[17],[18],[23]

Exsanguination should occur immediately after primary slaughter (stunning) to ensure fish are killed while unconsciousness and to preserve flesh quality.[8],[17]

Figure 10. *Exsanguination by gill cutting. Source: Ontario Aquaculture Research Centre.*

Exsanguination while conscious produces undo suffering and only fish that have first been rendered unconscious by percussive or electric stunning methods should be exsanguinated.[8] Once bleeding has been initiated fish are placed into cold water to bleed-out for approximately 10–15 minutes before processing (blood evacuation rates can vary).[18]

Exsanguination can be performed manually (by-hand) using a sharp blade or with the use of automated technology for high volumes processed. Automated exsanguination technology includes the use of robotic guillotine blades to sever the blood vessels for bleeding. When performed correctly exsanguination can be a highly effective and humane secondary slaughter method helping to protect fish welfare and preserve flesh quality.[17]

Contingency Planning and Alternative Slaughter

Contingency planning and training for emergency situations are effective ways to mitigate or prevent unwanted emergencies. Unexpected events can occur during slaughter (e.g., equipment failure, mis-hits, injured fish) which disrupt the slaughter process and jeopardize both fish welfare and product quality. Alternative (back-up) slaughter equipment is required to be readily available in the event of a mechanical breakdown or when an individual fish is injured in the slaughter process and requires on-the-spot euthanasia.

Decapitation and pithing may be useful as an alternative slaughter method during an emergency but are seldom used under normal operating conditions. Decapitation is used as a secondary slaughter method and requires a primary slaughter (stun) method in advance to effectively bring about unconsciousness in fish prior to decapitation.

Decapitation involves severing the spinal cord from the brain typically with the use of a sharp knife or blade. The operator locates the junction between the skull and the first vertebra and with one rapid and continuous motion removes the head from the body.[19],[24]

Pithing (spiking, coring or ikejime) is a standalone slaughter method which does not require a primary method in advance.[19] It is a very difficult slaughter method to properly execute and should be conducted only by skilled operators trained to accurately locate and time the pithing strike.[25]

Pithing causes irreversible physical injury to the fish resulting in death by inserting a spike into the hindbrain, damaging brain tissue through rotary movement of the spike.[25] Fish are handled and restrained by the operator while conscious out of water making it difficult to apply the spike. Inaccurate pithing can cause injury and suffering.[21] Pithing is a particularly involved slaughter method which can impact the mental and emotional health of the operator.

Ensuring Your Slaughter is Humane

To ensure you are using the most humane slaughter methods consult with technical experts and a veterinarian to develop a plan for humane slaughter.

Your **Humane Slaughter Plan** should ensure:

All reasonable efforts are made pre-slaughter to protect fish welfare and reduce fish stress by optimizing conditions during feed withdrawal, crowding, handling and transportation.

The primary slaughter (stunning) method renders fish immediately unconsciousness in less than 1 second.[18]

After primary slaughter fish never regain consciousness. The secondary slaughter method rapidly kills fish while they are unconscious.

All workers are properly trained in humane slaughter methods and emergency procedures in the event of an equipment malfunction or an unanticipated return to sensibility in fish.

The humane slaughter process is internally and externally audited to ensure both daily slaughter is humane and the overall slaughter program is humane.[8]

Conclusion

Humane slaughter is a challenging component of the production cycle carrying with it a duty of care for fish welfare and the potential to negatively impact flesh quality. Humane slaughter is a process which depends on proper planning and execution throughout the pre-slaughter, primary slaughter and secondary slaughter stages. Improper management of any one of these stages can have negative consequences for fish welfare and flesh quality. Incorporating humane slaughter methods into production practices will achieve better outcomes for fish welfare and contribute to improved product quality for the producer and consumer.

Euthanasia

Fish can develop illness, disease or physical injury which compromises their health and welfare. When treatment options are not available, too expensive, or ineffective, euthanasia can often provide the most humane outcome. Deciding to euthanize a fish is a difficult decision to make. The final decision on euthanasia should be made by evaluating what is the best welfare outcome for the fish.

"Euthanasia is an end-of-life procedure intended to alleviate the pain and distress felt by fish experiencing a state of compromised welfare."

What is Euthanasia?

Euthanasia is an end-of-life procedure intended to alleviate pain and distress felt by fish experiencing a state of compromised welfare. It can often be planned out in advance and conducted in a controlled environment, helping to facilitate optimal conditions.[9]

When is Euthanasia Needed?

Euthanasia is needed when a fish is experiencing compromised welfare without the likelihood of improvement, including not responding to treatment(s) or where no humane treatment options exist.[19] Fish are most often euthanized because of illness, disease, injury or extreme environmental conditions (e.g., water temperature, low oxygen levels).[26]

Best Practices for Euthanasia

When culturing large numbers of fish with limited capacity to monitor and access individual fish it can be challenging for producers to identify fish that require euthanasia.[19] It is important to routinely perform fish health assessments to identify health and welfare issues which may need treatment or euthanasia.

Standard operating procedures (SOPs) for euthanasia should be developed in consultation with a veterinarian and all staff trained in implementing euthanasia SOPs and audited for effectiveness.

When working with an unfamiliar species and/or euthanasia method first test the euthanasia method on a small number of fish before euthanizing a larger population.[9] The environment in which euthanasia is performed should be as non-stimulatory as possible, minimizing surrounding noise, vibration and light intensity, while providing a safe and effective work environment.[9]

Anesthetics used for euthanasia have the potential to harm humans if misused, consult Material Safety Data Sheets (MSDS), manufacturer and veterinarian guidelines for safe handling and usage.[27] As well, anesthetics may have special requirements for disposal and should not be poured into storm drains or other municipal systems or natural watercourses.

Goals of Euthanasia

The goals of euthanasia are to:

- alleviate suffering felt by fish experiencing compromised welfare
- minimize or remove pain and distress during the euthanasia process
- prevent or reduce disease transmission
- prevent fish that are unfit for consumption from entering the food chain

Determining an Appropriate Endpoint

Standard operating procedures (SOPs) for determining an appropriate endpoint can help producers make the right decision regarding when to euthanize a fish. When making a determination on euthanasia it is important producers are familiar with the appearance, behaviour and physiology of the fish in a healthy state. It is also important to recognize that there are natural variations that occur in appearance, behaviour and physiology depending on seasonality, life stage and sex of the fish.[27]

The following criteria can help producers assess fish for health and welfare concerns which may require further investigation, fish health treatments or euthanasia.

Physical Appearance

- ✓ normal/abnormal
- ✓ eye condition
- ✓ fin and skin condition
- ✓ mucus production
- ✓ colour change (usually a darkening associated with disease or bilateral blindness)

Measurable Signs

- ✓ feed consumption
- ✓ respiratory rate
- ✓ posture in water column (upright, upside down, tilted)

Unprovoked Behaviour

- ✓ position in the water column (crowding near inlet or outlet pipe, shoaling, holding in slack water)
- ✓ social interactions (direct attacks, social isolation, not responsive to external stimuli)
- ✓ hyperactivity (flashing, scraping or unexpected escape behaviour)
- ✓ hypoactivity (lethargy)

Provoked Behaviour

- ✓ feeding activity (willingness to feed)
- ✓ threat response
- ✓ avoidance behaviour (reaction to mechanical prod or light beam)

Source: Canadian Council on Animal Care.[27]

Euthanasia Methods

Humane euthanasia methods may be similar to humane slaughter methods in some circumstances; however, the intention is different as euthanasia does not produce food and so anesthetics can be administered to fish that do not enter the food chain.

Humane euthanasia is performed using either a 2-Step or 1-Step method as shown.

2-Step Euthanasia Method

This is the most common method for large scale euthanasia.

Step 1

A primary physical (stunning) method or a chemical (anesthetic) method is performed to rapidly render fish unconscious.

Primary methods include:

- ✓ percussive stunning
- ✓ electrical stunning
- ✓ blunt force trauma to the head
- ✓ anesthetic agent (conditional upon veterinary consultation)[19]

Step 2

A secondary (kill) method is then performed quickly after loss of consciousness to ensure death before consciousness is regained.[19]

Secondary methods include:

- ✓ exsanguination (prefer method)
- ✓ decapitation
- ✓ cervical transection
- ✓ immersion in ice slurry
- ✓ pithing[19]

1-Step Euthanasia Method

This method is more suitable for individual fish or small numbers of fish.

Step 1

A chemical or physical method is used to produce immediate loss of consciousness and death in one step.

Method options include:

Chemical Method

An anesthetic agent is administered at an elevated concentration to induce an intentional overdose resulting in death. This is conditional upon veterinary consultation.[19]

This method requires constant monitoring for anesthetic levels, dissolved oxygen, ammonia and organic load. It is best used on species that are not hypoxia tolerant such as salmonids.[9]

Physical Method

- ✓ pithing (fish greater than 1 g)
- ✓ maceration (fish less than 1 g)[19]

Unacceptable Methods for Euthanasia

Inhumane methods of euthanasia include:

- asphyxiation (in water or air)
- live chilling (ice slurry) prior to loss of consciousness
- freezing fish out of water before loss of consciousness
- exsanguination prior to loss of consciousness
- releasing fish into natural watercourses or municipal water systems
- exposure to caustic chemicals[9],[19]

Anesthetics and Euthanasia

General Usage

In Canada, anesthetics used in aquaculture require a veterinary prescription and will come with directions on usage.

Anesthetics used for euthanasia are administered as either:

- a moderate anesthetic dose intended to induce loss of consciousness before a secondary method is performed to ensure death, or
- an intentional overdose concentration used as a 1-step euthanasia method resulting in death.[9]

Moderate Anesthetic Dose

When administered at a moderate dose, anesthetics are used to reduce fish stress and pain associated with the secondary euthanasia methods.[27] Typically, the anesthetic is administered to fish in an anesthetic bath at a concentration sufficient to induce rapid loss of consciousness persisting until the secondary method is performed. Fish remain in the anesthetic bath until stage 4 of anesthesia when fish are immobilized and opercular (gill) movement has stopped. At this point fish can easily be handled for the secondary euthanasia method.[23]

Intentional Overdose

Intentional overdose via anesthetics can also be used as a method of euthanasia and may not require a secondary method.[19],[27] For the purposes of euthanasia an intentional overdose is commonly administered to salmonids in an anesthetic bath.

Fish remain in the anesthetic bath for 30 minutes after opercular (gill) movement has stopped to ensure death.[9] Even after death via an anesthetic overdose or a secondary euthanasia method a fish's heart may continue to beat and muscle twitching is common.[23] Intentional overdose via anesthesia limits the spread of bodily fluids which have the potential to transmit disease and is a preferred method when euthanizing for a disease that may be spread by exsanguination.

Different stages of anesthesia can be achieved by adjusting the anesthetic concentration and/or duration of exposure according to veterinary directions. Low anesthetic concentrations induce a sedative effect, moderate concentrations produce anesthesia and overdose concentrations can result in death.

Stages of Anesthesia

The following describes the stages and effects of anesthesia on fish:

1. **Losing equilibrium:** equilibrium loss begins with fish starting to roll belly up, still able to swim and evade capture.
2. **Loss of equilibrium:** equilibrium can no longer be maintained, swimming on sides or belly up, still able to swim and evade capture.
3. **Immobilization:** loss of equilibrium, loss of major body movement including swimming, with continued opercular (gill) movement (respiration).
4. **Immobilization and respiratory arrest:** loss of equilibrium and all body movement including opercular (gill) movement (respiration). Prolonged stage 4 anesthesia without gill irrigation can result in death.[28]

Anesthetic Baths

Anesthetics are typically administered to salmonids via immersion in an anesthetic bath.[29] The anesthetic is dissolved in water which passes over the gills during respiration and is absorbed across respiratory membranes entering the circulatory system and depressing the fish's central nervous system.[28]

The anesthetic bath should be sufficiently large to allow fish to be fully submerged in water and move freely (Figure 11). Anesthetic baths are filled with the same source water that fish are reared in and acclimated to, ensuring fish are exposed to a consistent water quality and temperature. After the anesthetic agent has been thoroughly mixed into the bath and water quality parameters have been checked one fish is added to the anesthetic bath to observe the anesthetic effect before introducing more fish. Never add the anesthetic agent while fish are in the anesthetic bath.

Figure 11. *Rainbow trout in an anesthetic bath. Source: Ontario Aquaculture Research Station.*

Euthanizing large numbers of fish in an anesthetic bath is particularly challenging and requires continuous monitoring of water quality (temperature, dissolved oxygen, ammonia, and organic waste). Anesthetic bath water should be changed if fish waste accumulates, water temperature rises, or dissolved oxygen drops beyond acceptable limits.[9] Regardless of water quality conditions anesthetic bath water will need to be changed periodically because the anesthetic agent is removed by the fish when absorbed through the gills.

The following supplies/equipment are needed to prepare an anesthetic bath:

- anesthetic agent
- portable tank or basin
- air/oxygen diffuser, regulator and oxygen source or air blower
- handheld digital dissolved oxygen/ temperature probe
- personal protective equipment (long-sleeved gloves, glasses, rainwear)
- dip net and a small seine net or screen for crowding
- cleaning and disinfection supplies

Euthanasia for Disease Control

Veterinary examination, diagnostics and fish health treatments are the first steps in managing a disease outbreak. In the absence of effective fish health treatment options or when confronted with a highly contagious disease outbreak, often the best strategy to prevent disease transmission and protect healthy fish is euthanasia.

Euthanasia is used for disease control when a lack of action will lead to greater proliferation of disease and fish health implications.[30] Euthanasia strategies for disease control range from euthanizing fish with clinical signs and/or a confirmed diagnosis to euthanizing an entire rearing unit(s) or all fish on-site.[31]

During a highly contagious disease outbreak the rapid initiation of euthanasia procedures and biosecurity measures are critical to containing disease and preventing pathogen transmission. Response time and efficiency of actions during a disease outbreak can be improved through contingency planning and training to help workers act quickly, confidently, and decisively in a fish health emergency.[31]

Humane euthanasia methods (e.g., electric stunning, anesthetic overdose) which avoid contaminating water and equipment with blood and other bodily fluids (e.g., reproductive fluids, urine) are preferred methods when euthanizing for disease control.

Euthanasia for disease control can include pathogens with zoonotic risks (e.g., Piscine lactococcosis). Under these circumstances, human health and disease containment are primary considerations. Appropriate personal protective equipment is mandatory when euthanizing fish containing a zoonotic risk.[9]

Pathogens can survive in the environment, an aquaculture facility or intermediate host and may not be eliminated by euthanizing the host fish. Post-euthanasia the implementation of disease eradication measures such as cleaning, disinfecting and fallowing the rearing unit can break the cycle of disease and related mortality.[32] Following euthanasia for disease control, proactive measures including on-going fish health monitoring, a review of biosecurity protocols and the euthanasia contingency plan can help prevent future disease introduction and transmission.[9]

Establishing a Temporary Isolation Area

During a highly contagious disease outbreak a temporary isolation area can be created by enclosing the infected rearing unit(s) with a physical barrier. Biosecurity measures are applied to the newly formed isolation area to prevent cross-contamination with healthy fish in other rearing units.

Temporary isolation areas adhere to many of the same principles as a permanent production level quarantine facility, although the same degree of biosecurity can seldom be achieved.

The fundamental requirements of an effective temporary isolation area include:

- physical infrastructure separating infected and uninfected areas (e.g., tarp walls)
- entry and exit point disinfection procedures (e.g., hand and footwear washing station, designated clothing, footwear and gloves)
- entry and exit points identified with highly visible signage (e.g., “Isolation Area–Authorized Persons Only”)
- equipment and materials sufficient to conduct all husbandry, euthanasia, cleaning, disinfection and carcass disposal requirements[33]

It is best to limit access to the temporary isolation area and assign designated staff to work in the area. Staff enter a staging space where they change into designated isolation area work wear (e.g., coveralls, gloves and footwear). Before entering the isolation area staff use a sanitizing station to disinfect their work wear. Upon completing work in isolation area, the sequence is reversed to exit the isolation area.

While the temporary isolation area is active no fish, equipment or materials are removed from the isolation area. When possible, euthanasia is conducted within the temporary isolation area, as transferring fish out to be euthanized increases the risk of disease transmission. Euthanized carcasses are placed within a watertight container that is externally disinfected before being transferred out of the isolation area for disposal. The temporary isolation area is cleaned and disinfected following euthanasia and before being returned to normal operation.[33]

Conclusion

Euthanasia is an unpleasant act to perform and although difficult for producers at the time, humane euthanasia can often provide the best option when faced with a critical fish health issue. Euthanasia can relieve the immediate need to alleviate suffering in compromised fish and improve future fish health outcomes through disease control. When proper planning, preparations, training, and humane methods are incorporated into euthanasia, producers can provide a "good death" for fish, mitigate traumatic stress risks for workers and safeguard against disease transmission.

Chapter 3

Humane Depopulation

Depopulation can occur under a range of circumstances which impacts the degree of difficulty in performing this end-of-life procedure. It can be performed routinely under normal operating conditions for stock management purposes or may be necessitated by the unexpected and constrained circumstances of an on-farm emergency.

Depopulation has the potential to have significant psychological impacts on staff involved and financial implications for ownership. Mental health support for farmers is available at the Farmer Wellness Initiative.

"One of the most challenging aspects of depopulation is managing an aggressive and rapid response to an on-farm emergency while ensuring worker safety and the ethical treatment of fish"

Mitigation strategies should be developed through contingency planning and protocols to minimize the negative psychological impacts on workers and prevent circumstances from arising which require depopulation. While challenging and problematic at the time, depopulation is intended to improve future stock productivity, prevent imminent animal suffering, eradicate disease, protect agricultural economies and safeguard public health.

What is Depopulation?

Depopulation is the rapid extermination of a large number of often healthy fish. It is a production management strategy and can occur under the constrained circumstances of an on-farm emergency, closure of an abattoir or a border closure.

When performed under constrained circumstances all reasonable efforts should be made to protect fish welfare given the present circumstances.[34]

Best Practices for Depopulation

One of the most challenging aspects of depopulation is managing an aggressive and rapid response to an on-farm emergency while ensuring worker safety and the ethical treatment of fish.[34]

On-farm emergencies can compromise not only fish welfare, but worker safety as well and depopulation should always be conducted with worker safety as the main consideration.[35]

Why Depopulation is Necessary?

The following circumstances may require depopulation:

- stock management (unproductive broodstock, excess inventory)
- an on-farm emergency compromising fish welfare
- federal or provincial mandates in response to a foreign animal disease (including border closures)
- human and food safety issues[21],[34]

Workers involved in depopulation should be made aware that their actions are critically important in preventing animal suffering, eliminating disease and protecting public health. Employers should provide traning to workers in standard operating procedures (SOPs) for depopulation, monitoring fish welfare and auditing for effectiveness of depopulation procedures. Workers that have a clear understanding of farm goals and why depopulation is necessary will have an improved outlook and greater sense of purpose when conducting depopulation.[31]

Goals of Depopulation

Farm operators should establish depopulation goals that address the following areas:

Farm Safety

- ✓ Ensure worker safety and a safe working environment.
- ✓ Mitigate the negative emotional impacts of depopulation on workers, ownership, and the public.[31]

Animal Welfare

- ✓ Provide fish with the most humane treatment possible under the given circumstances.[31]
- ✓ Eliminate or minimize pain and distress felt by fish prior to loss of consciousness, with consideration given to fish welfare during handling and induction of unconsciousness.[34]
- ✓ Reduce on-farm disease transmission.

Economic

- ✓ Minimize economic losses associated with a foreign animal disease or on-farm emergency.
- ✓ Improve future farm productivity.
- ✓ Prevent contaminated or potentially contaminated meat products from entering the food supply.
- ✓ Safeguard national agricultural economies.[31]

Depopulation Methods

Humane slaughter and euthanasia methods (e.g., percussive stunning, electric stunning or anesthesia) followed by exsanguination are the preferred options for depopulation. Producers may choose to outsource depopulation and hire a service provider with specific training and experience in depopulation.[19] When depopulating fish intended for human consumption euthanasia methods involving the use of anesthetics with mandatory withdrawal periods are prohibited.

On-farm emergencies can create constrained circumstances which prevent the use of preferred humane slaughter or euthanasia methods, and an alternative depopulation method may be required. Alternative depopulation methods may be less humane and efficient than preferred humane slaughter or euthanasia methods and should be developed in consultation with a veterinarian. They should only be used when the circumstances of an on-farm emergency prevents the use of preferred humane slaughter or euthanasia methods and when not taking action will result in greater fish suffering than the utilization of alternative depopulation methods.[34]

During an on-farm emergency the following depopulation methods can provide an alternative when preferred methods have constraints such as worker safety, urgency of action or equipment failures:

- blunt force trauma to the head
- decapitation
- immersion in ice slurry
- cervical transection
- pithing (greater than 1 g)
- maceration (less than 1 g)[34]

The most appropriate alternative depopulation methods are those which minimize pain and distress before loss of consciousness, rapidly induce unconsciousness and quickly result in death before consciousness is regained.[34] If depopulation methods do not produce immediate loss of consciousness then the induction of unconsciousness should be as non-aversive as possible and not cause avoidable distress or suffering.[21]

When selecting an alternative depopulation method, the following considerations can help determine the most appropriate option:

- worker safety and maintaining a safe working environment
- emotional comfort level of workers
- fish welfare risks
- number and size of fish to depopulate
- timeline to complete depopulation (urgency of action)
- availability of equipment, materials and labour
- disease containment, biosecurity risks and carcass disposal options

Depopulation methods should be evaluated based on their risk of spreading pathogens through aerosol, blood, or waterborne transmission routes and pathogen containment measures included in contingency planning. A depopulation method may need to be excluded from use based on a high risk of pathogen transmission and when mitigation measures are not available or inadequate.[34]

Depopulation During an On-Farm Emergency

When fish welfare is compromised by an on-farm emergency, depopulation may be considered as a means of alleviating the imminent risk of animal suffering.

Emergency situations where depopulation for compromised fish welfare may occur, include (but are not limited to):

- environmental stressors (e.g., infectious, or parasitic diseases, extremes in water temperature, low oxygen conditions)
- natural disasters (e.g., preventing access for animal care)
- production system failures (e.g., power outages or mechanical system failures leading to the deterioration of rearing conditions)
- contaminated water and feed supplies[34]

In response to an on-farm emergency, depopulation for compromised fish welfare most often requires immediate and decisive action as a delayed response leads to greater welfare implications. Given the urgency of action during an on-farm emergency human safety should always be a primary concern when conducting depopulation under stressful and constrained circumstances. Creating a comprehensive depopulation plan for on-farm emergencies and proper training is vital to ensuring a well-managed response.

Conclusion

Depopulation can present significant challenges when faced with an on-farm emergency. Humane slaughter and euthanasia methods are the preferred options for depopulation however they may not be available based on the circumstances during the emergency. The most appropriate alternative depopulation method and procedures will vary based on the requirements of the site and situation but should always incorporate the core principles of human safety, animal welfare and disease containment (biosecurity).

Chapter 4

Planning, Protocols and Training

Developing and implementing a plan and protocols for humane slaughter, euthanasia and depopulation is the best way to promote fish welfare and staff wellbeing during these end-of-life procedures. Planning, protocols and training should take place well in advance of conducting these procedures. Planning and protocols are needed for normal operating conditions as well as contingency plans for when circumstances prevent the use of standard operating procedures.

Plans and protocols are effective only when staff have received proper training and direction. Training exercises which are both announced and unannounced can help maintain a state of readiness. Well trained staff are better able to perform humane slaughter, euthanasia and depopulation consistently and reliably resulting in better outcomes for fish welfare.

Planning and protocols for humane slaughter, euthanasia and depopulation should address requirements for fish welfare, workplace safety and biosecurity.

Plans and protocols often identify:

- ✓ measures to ensure worker safety and a safe working environment
- ✓ measures to minimize the psychological impact on workers, indicators of traumatic stress and emotional supports for workers
- ✓ preferred primary and secondary methods and an alternative (back-up) method
- ✓ roles and responsibilities of each team member
- ✓ operating procedures for workers
- ✓ scheduled staff training and a review of the plan and protocols

- ✓ required equipment/supplies and scheduled routine maintenance
- ✓ strategies for improving or maintaining a consistent level of fish welfare during handling and induction of unconsciousness
- ✓ written standard operating procedures (SOP's) for diagnosing disease and fish health monitoring
- ✓ criteria for determining an appropriate endpoint for euthanasia, biosecurity measures to contain the spread of disease, cleaning and disinfection procedures, carcass and wastewater disposal methods
- ✓ contact information for important personnel outside the team who can deliver emergency management support (e.g., rendering services, equipment suppliers, service technicians[19],[21],[31]

The implementation of a written contingency plan for humane slaughter, euthanasia and depopulation with veterinarian input is a requirement of the National Farm Animal Care Council (NFACC) *Code of Practice for the Care and Handling of Farmed Salmonids* and will help producers take preventive measures to mitigate fish welfare risks and traumatic stress for workers involved.[19]

Chapter 5

Carcass Disposal

Carcass disposal is an important consideration following slaughter, euthanasia and depopulation. Fish that are used for food production undergo processing and generate offal waste (organs, skin, bones), while fish not used for food are disposed of as whole intact carcasses.

Nutrients found in offal waste and carcasses provide a potential asset for producers and the ability to capture value added opportunities (e.g., health or medical products, agricultural fertilizers). Best practice carcass disposal methods prevent disease transmission, negative environmental impacts and adverse public perceptions, while generating revenue for the producer. Options for fish carcass disposal include on-farm and off-farm methods.

On-Farm Carcass Disposal

Composting

When performed correctly composting kills pathogens and provides an excellent source of organic nutrients for plant agriculture. There are several different methods of composting, including a three-bin system, windrow composting and in-vessel (Figure 12). Additional information on composting is available at ontario.ca/deadstock.

Burial

Carcasses are placed in a burial pit and covered with at least 0.6 m of soil. Burial is not permitted in areas where the bottom of the burial pit is less than 0.9 m above bedrock or an aquifer. Burial pits must be monitored for one year after covering for signs of scavenging and soil subsiding.

Figure 12. *In-Vessel Ecodrum™ Composter with forced air system.*
Source: Ecodrum™ Composters.

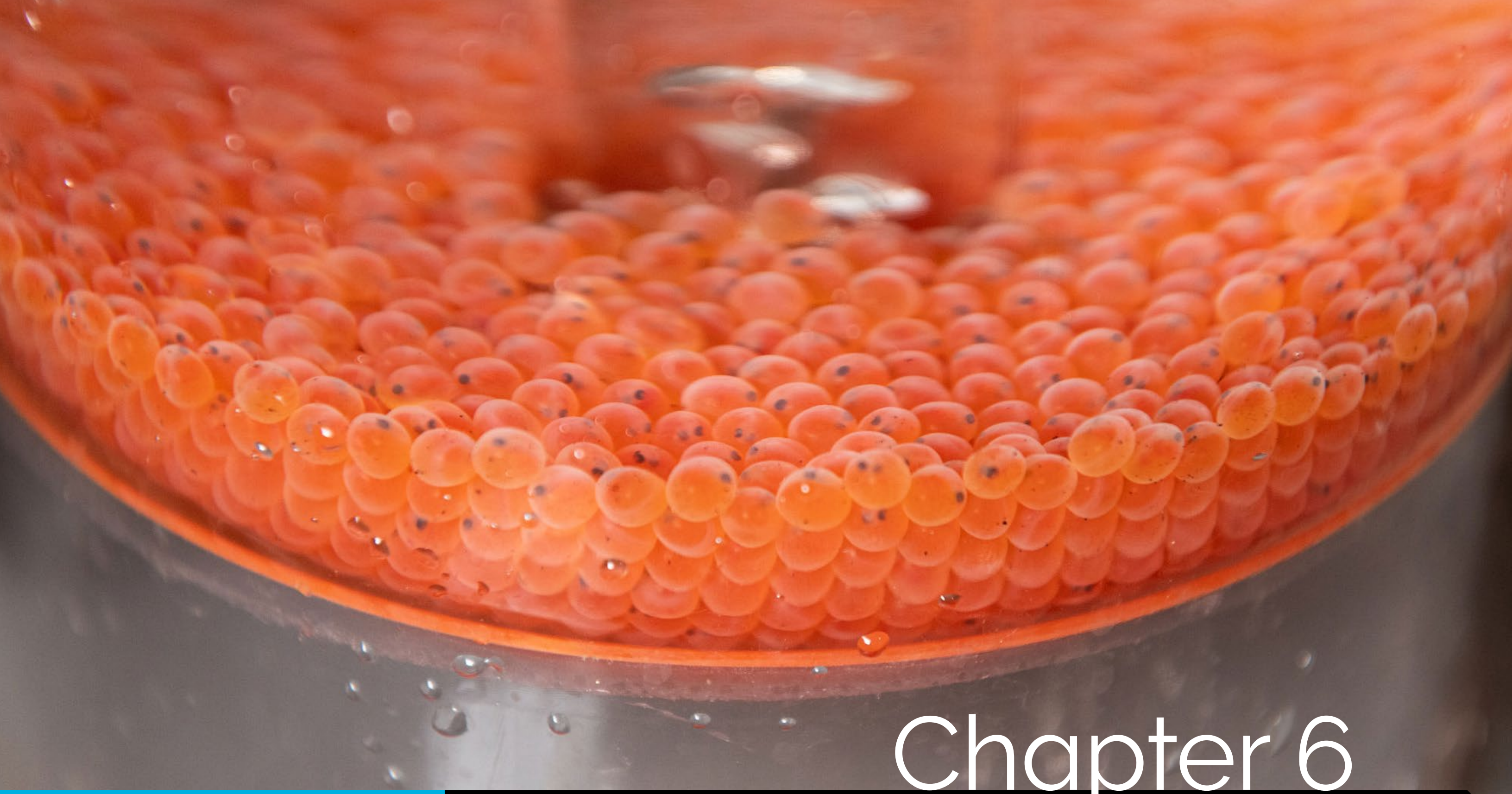
Off-Farm Carcass Disposal

Pick-Up

Off-farm carcass disposal can be done through pick-up by a licensed collector under the Food Safety and Quality Act (FSQA) (e.g., rendering service). Carcasses awaiting pick-up by a licensed collector should be concealed from public view, held within a sealed watertight container and stored in a cold location away from direct sunlight and scavengers. Improper storage of carcasses can attract scavengers, predators and pose a biosecurity risk for the aquaculture facility.

Transportation

Producers may transport their own deadstock on a public highway to a licensed land fill site, rendering facility, veterinarian, common collection point or permissible storage location. During transport, carcasses must be concealed from public view and the vehicle, trailer or transport container in which they are transported must be designed to prevent leakage. Operators must be able to clean and disinfect the container after transport to reduce the potential for disease transmission. Additional information on deadstock management can be found at ontario.ca/deadstock.



Chapter 6

Cleaning and Disinfection

Cleaning and disinfection is the final stage of the humane slaughter, euthanasia and depopulation process. It is vital to the prevention of disease transmission and in maintaining sanitary conditions at an aquaculture facility. Cleaning and disinfection protocols should be included as an integral part of an effective biosecurity plan.

Immediately following humane slaughter, euthanasia or depopulation all equipment and surrounding areas are thoroughly cleaned and disinfected to kill remaining pathogens. Cleaning is the most important part of the cleaning and disinfection process as disinfectants are highly ineffective when applied to a soiled surface covered by organic matter.

Cleaning should follow a four-step process in sequence:

1. Dry Clean

Physically remove all matter that can be lifted from the surface, disposed of, or cannot be washed away.

2. Wet Wash

Using hot water and a soap or detergent solution, scrub, scrap or power wash all surfaces to breakdown any biofilm. When wet washing is completed, the surfaces should look visibly clean.

3. Rinse

Wash away soap or detergent residue which may react unfavorably with disinfectants.

4. Dry

Allow surfaces to dry completely before applying the disinfectant as residual water will dilute the disinfectant.[36]

After the cleaning process is completed, the disinfectant is applied to clean surfaces as per manufacture guidelines and then rinsed away before future use. Disinfectants used in aquaculture are either physical or chemical in nature.

Physical disinfection methods use heat (e.g., submersion in water, steam and composting), UV light (e.g., sunlight and mercury vapour lamps) and filtration (e.g., mechanical separation) to kill or remove unwanted aquatic pathogens. Physical disinfectants are advantageous in many aquaculture settings as they have fewer negative discharge consequence to the environment when compared to chemical disinfectants.[36]

Selecting the most appropriate chemical disinfectant will primarily depend on choosing a disinfectant which is most effective at killing the targeted pathogen. Broad spectrum, nonspecific chemical disinfectants can be convenient but may not be effective against a specific pathogen of concern. This may require an aquaculture facility to have on-hand a selection of chemical disinfectants for a variety applications and pathogens. Additionally, the composition of materials/equipment, the production environment, human safety, product availability, cost and local regulations governing usage and disposal are all important considerations when selecting a chemical disinfectant.[36]

Chapter 7

Conclusion

When performed incorrectly slaughter, euthanasia and depopulation have the potential to compromise animal welfare, worker safety and the aquatic environment. These end-of-life procedures require a duty of care to prevent potential negative impacts.

Fish welfare can be compromised at any stage of the slaughter, euthanasia or depopulation process. Consistency is needed to provide appropriate welfare conditions throughout these processes.

Prior to the induction of unconsciousness fish welfare considerations are required for humane feed withdrawal, crowding, handling and transportation. The primary (stun) method should rapidly and painlessly produce unconsciousness and the secondary (kill) method should quickly result in death before consciousness is regained.

Best practice humane slaughter, euthanasia and depopulation methods are those which mitigate welfare risks throughout the entire process by minimizing pain and stress, producing immediate loss of consciousness and rapidly bringing about death before consciousness is regained.[19]

Fish welfare during the slaughter process has a direct impact on flesh quality. As fish welfare conditions deteriorate during the slaughter process so to does the final product quality. The same techniques that go into protecting fish welfare during pre-slaughter, primary slaughter and secondary slaughter are also responsible for the beneficial effects that protect flesh quality.

Primary and secondary humane slaughter methods are important for ensuring appropriate fish welfare and excellent product quality. Equally important is the handling of fish during pre-slaughter and post-slaughter processing. Humane slaughter methods that keep fish calm, reduce muscle activity, minimize pain and stress, will produce better fish welfare and have a positive impact on flesh quality.

The process of ending an animal's life can have a psychological impact on personnel involved and preventative strategies are needed to reduce the potential for traumatic effects on workers. Worker safety is an on-going consideration during normal operating conditions and can become more challenging during the constrained circumstances of an on-farm emergency. Developing a plan and protocols for humane slaughter, euthanasia and depopulation which includes measures for workplace safety and routine training exercises are effective ways to ensure worker safety.

Humane slaughter, euthanasia and depopulation procedures including wastewater and carcass disposal have the potential to spread disease and negatively impact the environment. Disease transmission associated with these procedures can affect healthy populations of fish at an aquaculture facility and have the potential to extend into the aquatic environment. Humane slaughter, euthanasia and depopulation methods may need to be changed or modified to mitigate the risks of disease transmission. Environmental management strategies for biosecurity, wastewater discharge, carcass disposal, cleaning and disinfection are essential in preventing disease transmission and should be incorporated into planning and protocols for humane slaughter, euthanasia and depopulation.

When performed correctly humane slaughter, euthanasia and depopulation methods can avoid negative fish welfare implications associated with these end-of-life procedures and create positive outcomes. Fish welfare conditions during the slaughter process and flesh quality post-slaughter are directly connected.

By using humane slaughter methods producers can positively influence their final product quality. Humane euthanasia methods and sound biosecurity practices can be applied to reduce the incidence of disease at an aquaculture facility and improve future fish health status. When faced with the constrained circumstances of an on-farm emergency humane depopulation can often provide the best long-term outcomes for producers during emergency situations.

Humane slaughter, euthanasia and depopulation methods are effective management strategies that can be used by producers to improve product quality, enhance animal welfare and are critically important for maintaining public trust in aquaculture.

Glossary

Animal (fish) Welfare: Multiple measures are considered when assessing animal welfare. Freedom from hunger and thirst, discomfort, pain, injury, disease, fear and distress. The ability of the animal to express normal behaviour and have good physical health are all indicators of good welfare.[10]

Biosecurity: On-farm protocols and actions intended to reduce the risk of introducing, establishing and transmitting animal diseases.[19]

Cervical Transection: A secondary method performed when fish are unconscious that severs the spinal cord at the cervical vertebrae.[19]

Consciousness: A mental state of awareness of internal and external stimuli experienced by an organism.[37]

Contingency Plan: A documented workplan that can be followed if the original plan is not possible for some reason.[38]

Exsanguination: Death caused by loss of blood and rapid deoxygenation of the brain and critical organs.[24]

Evisceration: To take out the entrails of a fish: disembowel.[38]

Fallowing: The practice of leaving a rearing unit(s) empty for an extended period of time to reduce the likelihood of pathogen transmission.[19]

Foreign Animal Disease: A transboundary animal disease or pest, whether terrestrial or aquatic, not known to exist in the country or region where it is discovered.[35]

Gill Arches: A series of bony supports of the gills.[5]

Hypoxia Tolerant: Fish species that can withstand low dissolved oxygen levels in water.[18]

Insensible: Incapable of and without feeling or sensation. Lacking sensory perception or ability to react.[38]

Operculum (gill cover): The boney covering of the gill cavity.[5]

Rearing Unit: An enclosure housing fishes for aquaculture production. Typically, in the form of a tank, raceway or net pen.

Rigor Mortis: A phenomenon which occurs after death, whereby the fish becomes stiff. Stiffening results from muscle contraction due to a shortage of ATP (adenosine triphosphate). Rigor or stiffening will resolve after some time.[39]

Slaughter: The humane killing of animals intended for human consumption for food or other uses.[7]

Sentience: The capacity of an individual to experience positive or negative feelings.[40]

Stress: A state caused by a stress factor, or stressor, that deviates from a normal resting or homeostatic state.[41]

Teleost Fish: Fishes having a bony skeleton, in contrast to a shark which is a cartilaginous fish.[5]

Tonic and clonic spasms: Seizures affecting the muscle. Tonic seizures produce a stiffening of the muscles and clonic seizures cause jerking or twitching.[42]

Unconsciousness: A mental state in which an animal cannot perceive and respond to stimuli or its environment.[19]

Pathogen: An infectious agent (e.g., bacterium, virus, or other microorganism) capable of causing disease.[19]

Zoonosis: An infection or disease that is transmissible from animals to humans under natural conditions.[38]

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FC Fish farmer holding an anesthetised rainbow trout, Springhills Fish

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p. 3 Closed-containment floating raceway production system, Izumi Aquaculture

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Notes

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