Audit Guidance for Friend of the Sea Fish Welfare Standards

FOS Aqua – Fish Welfare
Standards for Aquaculture Products

www.friendofthesea.org

Revisions

REV	DATE	REASON	APPROVED	RATIFIED
1	05/11/2021	New standard	Friend of the Sea Technical Committee	Friend of the Sea Board of Directors

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1. Introduction

1.1. Friend of the Sea

Founded in 2008, Friend of the Sea (FOS) is a non-governmental organization committed to improving the global of seafood by developing international certification schemes for sustainable fisheries and aquaculture products. The mission of FOS is to safeguard the marine environment and its resources by incentivising a market and implementing specific conservation projects. The present document is a guideline for auditors who are operating with the FOS standards for fish welfare in aquaculture.

1.2. Purpose of the document

The purpose of this document is to provide guidance on the FOS standards for Certification Bodies (CBs) for auditors, to ensure consistent interpretation and application across countries and CBs, hence improving the efficiency of the assessment process. This Audit Guidance document provides this guidance through:

1- Description of how to interpret the principles and criteria from the FOS standards.

2- Audit instructions to verify compliance through indicators.

3- Information relating to exceptional situations.

4- Objective criteria for critical limits.

5- Instructions to complete the audit report.

A brief explanation is given for each criterion, together with the description of indicators and a list of documentation to collect and attach to the report.

This audit guidance is related to the following standards:

- **FOS-Aqua – *Acipenser baerii* – Fish Welfare Standard**
- **FOS-Aqua – *Acipenser gueldenstaedtii* – Fish Welfare Standard**
- **FOS-Aqua – *Acipenser naccarii* – Fish Welfare Standard**
- **FOS-Aqua – *Acipenser ruthenus* – Fish Welfare Standard**
- **FOS-Aqua – *Acipenser stellatus* – Fish Welfare Standard**
- **FOS-Aqua – *Acipenser transmontanus* – Fish Welfare Standard**
- **FOS-Aqua – *Argyrosomus regius* – Fish Welfare Standard**
- **FOS-Aqua – *Dentex dentex* – Fish Welfare Standard**
- **FOS-Aqua – *Dicentrarchus labrax* – Fish Welfare Standard**
- **FOS-Aqua – *Diplodus puntazzo* – Fish Welfare Standard**
- **FOS-Aqua – *Huso huso* – Fish Welfare Standard**
- **FOS-Aqua – *Liza ramada* – Fish Welfare Standard**
- **FOS-Aqua – *Mugil cephalus* – Fish Welfare Standard**
- **FOS-Aqua – *Oncorhynchus mykiss* – Fish Welfare Standard**
- **FOS-Aqua – *Rachycentron canadum* – Fish Welfare Standard**
- **FOS-Aqua – *Salmo carpio* – Fish Welfare Standard**
- **FOS-Aqua – *Salmo salar* – Fish Welfare Standard**
- **FOS-Aqua – *Salmo trutta* – Fish Welfare Standard**
- **FOS-Aqua – *Salvelinus alpinus* – Fish Welfare Standard**
- **FOS-Aqua – *Salvelinus fontinalis* – Fish Welfare Standard**
- **FOS-Aqua – *Scophthalmus maximus* – Fish Welfare Standard**
- **FOS-Aqua – *Seriola dumerilii* – Fish Welfare Standard**
- **FOS-Aqua – *Seriola lalandi* – Fish Welfare Standard**
- **FOS-Aqua – *Sparus aurata* – Fish Welfare Standard**

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1.4. Definitions and Abbreviations

(10) Abnormal behaviour: see **Stereotypical behaviour** and **Vacuum behaviour.**

(3) Accreditation: Procedure by which a competent authority consistent with applicable law gives formal recognition that a qualified body or person is competent to carry out specific tasks.

(3) Accreditation body: A body that conducts and administers an accreditation system and grants accreditation.

(3) Accreditation system: A system that has its own rules of procedure and management for carrying out accreditation. Accreditation of certification bodies is normally awarded following successful assessment and is followed by appropriate surveillance.

(Modified from (2) & (17)) Aquaculture production systems: Any premises for the production of aquatic animals, i.e., fish or shellfish intended for human consumption, including the supporting inner infrastructure and surroundings under the control of the same management. Broadly speaking, production environments can be divided into inland (freshwater) and coastal (marine and brackish water) habitats, and production systems can vary according to the intensity of stocking densities, type of cultured species, and amount of feed input.

(2) Ammonia: This is a colourless gas and a major metabolic waste product from fish.

(2) Anesthesia: Any agent that produces a local or general loss of sensation, including pain. Anesthetics achieve this effect by acting on the brain or peripheral nervous system to suppress responses to sensory stimulation.

(18), (20) & (21) Animal health and animal welfare: The state of the individual as it copes with the environment; this definition of welfare has several implications: 1) Welfare is a characteristic of an animal, not something that is given to it; 2) Welfare will vary from

very poor to very good, , i.e.,, the individual may be in a poor state at one end of the welfare continuum or in a good state at the other, 3) Welfare can be measured objectively and independently of moral considerations; 4) Measures of failure to cope and measures of how difficult it is for an animal to cope both give information about how poor the welfare is; 5) Knowledge of the preferences of an animal often gives valuable information about what conditions are likely to result in good welfare, but direct measurements of the state of the animal must also be used in attempts to assess welfare and improve it; and 6) Animals may use a variety of methods when trying to cope.
There are several consequences of failure to cope, so any one of a variety of measures can indicate that welfare is poor, and the fact that one measure, such as growth, is normal does not mean that welfare is good.

(3) & (17) Aquaculture: The farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated, the planning, development and operation of aquaculture systems, sites, facilities and practices, and the production and transport.

(2) Aquaculture species: All life stages (including eggs and gametes) of fish, molluscs, crustaceans and amphibians originating from aquaculture establishments or removed from the wild, for farming purposes, for release into the environment, for human consumption or for ornamental purposes.

(6) Aquatic animal health professional: A person who, for the Aquatic Code, is authorised by the Competent Authority to carry out the actions identified in the Prudent Use of Antibiotics section of the OIE Aquatic Animal Health Code 2014 (or latest version), including identifying, preventing and treating aquatic animal diseases, as well as the promotion of sound animal husbandry methods, hygiene procedures, vaccination and other alternative strategies to minimise the need for antimicrobial use in aquatic animals.

(3) Audit: A systematic and functionally independent examination to determine whether activities and related results comply with a conforming scheme.

(1) Auditor: A person qualified to carry out audits for or on behalf of a certification body.

(10) Back-up power generator: An independent source of electrical power that supports important electrical systems on loss of normal power supply.

(2) Biomass: The total live weight of a group (or stock) of living organisms, e.g., fish, in a production unit, e.g., tank, cage, pen, etc., at a given time.

(12) Biosecurity: A strategic and integrated approach that encompasses both policy and regulatory frameworks aimed at analysing and managing the risks of the sectors dealing with food safety, animal life and health, plant life and health and the environment.

(12) Bleeding: Bleeding is carried out to improve the flesh quality of fish. In most cases, bleeding is done by cutting all the gill arches on one side of the fish. This should be done reasonably soon after stunning. Also known as Exsanguination.

(2) Broodstock: Sexually mature specimens of both sexes kept for controlled reproduction (independent of whether a first or subsequent generation is produced) as well as younger specimens destined to be used for the same purpose.

(15) Cannibalism: Cannibalism is a natural feeding strategy defined as the practice of eating one's own kind.

(14) & (17) Captive environment: An aquaculture production unit (either land- or water-based); usually consisting of holding facilities, i.e., tanks, ponds, raceways, cages, etc.

(3) Certification: The procedure by which official certification bodies or officially recognized certification bodies provide written or equivalent assurance that foods or food control systems conform to requirements. Certification of food may be, as appropriate,

based on a range of inspection activities which may include continuous on-line inspection, auditing of quality assurance systems, and examination of finished products.

(3) Certification body or entity: Competent and recognized body, governmental or non-governmental, that conducts certification and audit activities. A certification body may oversee certification activities carried out on its behalf by other bodies.

(12) Crowding: The process of concentrating the fish in a production area to enable them to be easily sampled or removed.

(2) Culling: The reduction of a population by selective slaughter.

(Modified from (12)) Degree days: A unit that is the product of multiplying the average ambient environmental temperature by the number of days. It has particular application for expressing the incubation period, based on **i)** the average temperature (in degrees Celsius) over the period of egg development to hatching and **ii)** the number of days to hatching.

(8) Disinfection: The reduction, by means of chemical agents and/or physical methods, in the number of micro-organisms in the environment to a level that does not compromise food safety or suitability.

(2) Eggs: Meaning eggs, spawn, offspring, progeny or brood of the aquatic organism being cultured. During these early life stages, seeds may also be referred to or known as fry, larvae, post-larvae, spat, and fingerlings. They may originate from two principal sources: from captive breeding programmes e.g., hatchery or caught from the wild.

(Modified from (11)) Enrichment (environmental): This is defined as a deliberate increase in environmental complexity with the aim to reduce maladaptive and aberrant traits in fish reared in otherwise stimuli-deprived environments. (See **Structural Enrichment**).

(12) Ex-sanguination: see **Bleeding**.

(1) Feed: Fodder intended for the aquatic animal in aquaculture establishments, in any form and of any composition.

(2) Fish: Any of the cold-blooded (ectothermic) aquatic vertebrates. Amphibians and aquatic reptiles are not included.

(12) Fish welfare: see **Animal health and animal welfare**.

(16) Fish Health and Welfare Plan: An active management tool aimed at promoting the health and welfare of farmed animals through good practice. Also known as a Farm Health Management Plan (FHMP*)*.

(12) Grading: A means of separating larger fish from smaller ones.

(12) Grading equipment: Any equipment used to grade fish.

(12) Harvesting: Operations involving taking the fish from the water.

(2) Hatchery: A facility used for the artificial and controlled breeding, hatching and rearing of aquatic organisms, on a commercial or experimental basis, through their early life stages. A hatchery is usually closely associated with a nursery facility where the cultured organism is grown to the appropriate size before being released to the wild or an on-growing structure.

(Modified from (12)) Induced spawning: Gamete production that is brought about by manipulation of the environment or treatment of the animal, e.g., temperature and fertility cycle, osmotic shock, UV irradiation of water, hormone injections, etc.

(1) Inspection: The examination of food or systems for control of food, raw materials, processing, and distribution including in-process and finished product testing, to verify that they conform to requirements.

(15) Moribund: A term used to describe an individual in a dying state or near death.

(15) Mortality: The number of deaths in a given area or period, or from a particular cause.

(Modified from (12)) Natural spawning: Spawning with little or no outside intervention.

(2) "non-target species": organisms that are not the direct target of the applied treatment, , i.e., invertebrates, other fish species, marine mammals, etc.

(16) Passive grading: Method of grading in which an empty holding unit is temporarily linked to one containing fish by a graded connector through which only fish below a certain size can pass.

(1) Pest control substances: see **Veterinary drugs.**

(Modified from (10)) pH: A figure expressing the acidity or alkalinity of a solution on a logarithmic scale on which 7 is neutral, lower values are more acidic and higher values more alkaline. The pH is equal to $-\log_{10}c$, where c is the hydrogen ion concentration in moles per litre.

(2) Photoperiod: The duration of time in a given day during which the culture organisms are exposed to light and dark. The light source can be natural or artificial.

(1) Production unit: An individual tank, cage, or pond holding a single batch of aquatic animals.

(Modified from (16)) Protein skimmer: A **protein skimmer** or foam fractionator is a device used to remove organic compounds such as food and waste particles from water.

(1) Salinity: An expression for the concentration of soluble minerals (often restricted to salts of the alkali metals or of magnesium) and chlorides in water or soil; usually expressed as parts per thousand (ppt).

(2) Sedation: see **Anaesthesia**.

(15) & (19) Slaughter: The controlled killing of animals for food.

(2) Spawners: see **Broodstock.**

(Modified from (12)) Spawning: The external method of reproduction by aquatic animals whereby gametes are released. Females release unfertilised eggs, which are fertilised by the male's milt/sperm.

(2) Spawning period: A defined extent of time during the spawning season when spawning of a particular species usually occurs.

(1) Standard: A document approved by a recognized organization or arrangement that provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory under international trade rules. It may also include or deal exclusively with terminology, symbols, packaging, marking or labelling requirements as they apply to a product, process or production method.

(2) Standard Operational Procedures (SOPs): A set of step-by-step instructions compiled by an organization to help workers carry out **complex** routine operations. SOPs aim to achieve efficiency, quality output, and uniformity of performance, while reducing miscommunication and failure to comply with industry regulations.

(10) Starvation: The deliberate withholding of food prior to procedures such as transportation, treatment, grading, etc.

(10) Stereotypical behaviour: A term to describe behaviour as a pattern that is repetitive, invariant, and with no obvious goal or function.

(1) Stock: the total population of animals in a unit of production.

(2) Stocking: see **Stocking density.**

(2) Stocking density: an expression of the number of fish per unit area or weight of fish per unit of volume of water at stocking. Usually expressed in kg/m^3.

(2) Stripping: Physical removal of milt or ova from sexually mature fish.

(Modified from (11)) Structural enrichment: The addition of physical or structural enrichment, including modifications or additions to the tanks, that is, structural complexity to reduce maladaptive and aberrant traits in fish reared in otherwise stimuli-deprived environments.

(16) Stunning: The process of rendering fish unconscious by stunning with electricity prior to exsanguination.

(15) Transfer: The movement of individuals of a species or population of an aquatic organism from one location to another.

(4) Transportation: The movement of fish stocks between aquaculture facilities.

(2) Temperature: Water temperature is a physical property expressing how hot or cold water is. The most common scale is the Celsius scale (formerly called *centigrade*, denoted °C). It is an empirical scale that was developed through historical progress, which led to its zero point, 0 °C, being defined by the freezing point of water, and additional degrees defined so that 100 °C was the boiling point of water, both at sea-level atmospheric pressure.

(1) Traceability: The ability to follow the movement of a product of fisheries or aquaculture or inputs such as feed and seed, through specified stage(s) of production, processing, transport and distribution.

(1) Treatment: can include any chemical substance, either natural or synthetic, that can affect the live fish, its pathogens, the water, equipment used for production, or the land within the aquaculture establishment.

(1) Unit of certification (Aquaculture): The scale or extent of the aquaculture operation(s) assessed and monitored for compliance. The unit of certification could consist of a single farm, production unit or other aquaculture facility. The certification unit could also consist of a group or cluster of farms that should be assessed and monitored collectively.

(3) Vaccine: A substance used to stimulate the production of antibodies and provide immunity against one or several diseases, prepared from the causative agent of a disease, its products, or a synthetic substitute, treated to act as an antigen without inducing the disease.

(3) Vaccination: The induction of immunity protection against disease by deliberate exposure to pathogen antigens or to immunogens to induce defence system recognition and enhance subsequent responses to exposure to the same antigens/immunogens.

(10) Vacuum behaviour: Vacuum activities (or vacuum behaviours) are innate, fixed action patterns (FAPs) of animal behaviour that are performed in the absence of a sign stimulus (releaser) that normally elicits them.

(6) Veterinarian: see **Aquatic animal health professional**.

(1) Veterinary drugs: Definitions of veterinary drugs vary from source to source; they may be considered to include antimicrobials, antibacterials, therapeutants, antibiotics, and veterinary medicinal products. If misused, they can result in food safety implications, including residues, as well as environmental implications, such as the spread of resistance to treatments in pathogenic organisms.

(16) Veterinary Health and Welfare Plan: see **Fish Health and Welfare Plan.**

(14) Water quality criteria: Specific levels of water quality desired for identified uses, including drinking, recreation, farming, aquaculture production, propagation of other aquatic life, and agricultural and industrial processes.

(12) Welfare assessment: Welfare assessment can be carried out with the observation of welfare indicators and can be measured by farm personnel trained to recognize normal and abnormal physical health, water quality, and behaviour in farmed stock. Regular inspections of the culture facility, water quality analysis, and assessment of the behaviour and condition of stock should be conducted regularly.

Abbreviations

AB: Accreditation Body;

AU: Auditor;

CA: Corrective action;

CAR: Corrective action report;

CB: Certification Body;

CO: Unit of certification (owner or manager) requesting the certification;

CoC: Chain of Custody;

FOS: Friend of the Sea

FOS-Aqua: Certification criteria for sustainable freshwater aquaculture;

FOS-FF: Certification criteria for sustainable fish feed;

FOS-FM: Certification criteria for sustainable fishmeal;

FOS-FO: Certification criteria for sustainable fish oil;

FOS-O3: Certification criteria for sustainable fish-based nutraceutical products (Omega-3);

FOS-Wild: Certification criteria for sustainable seafood from wild fisheries;

NC: Non-conformity.

1.5. Friend of the Sea Certification System

The Friend of the Sea certification program allows for the assessment of fisheries and aquaculture products according to criteria and requirements.

The Friend of the Sea certification system is defined by the following documents:

1. **Certification procedure (FOS 0001):** description of procedures and regulation of the certification and accreditation process for COs and CBs. This includes 1) rules and regulations for the accreditation of CBs; 2) rules and regulations for the certification of COs against FOS standards; 3) minimum qualifications of auditing staff.
2. **Standards:** documents that contain criteria and indicators in the form of a checklist for ensuring sustainable seafood production and seafood traceability. A complete list of standards can be found in section 1.6.
3. **Audit Guidance:** guidance document to provide clarification and training to auditors, enabling CBs to operate consistently.

Therefore, the present document is an integral part of the FOS Standard and shall be applied together with the standards and the FOS 0001 procedure to all aquaculture FOS Fish Welfare audits, if the species audited are part of the list in this document.

The procedure to follow for the certification of FOS standards, from the assessment to the issue of certificates, is described in detail in Chapter 3 of FOS 0001. The assessments shall be carried out following the standards documents appropriate for the production type, provided by FOS. The auditor shall complete all parts of the standard document during the assessment and provide corrective action reports (CARs) when NCs are detected.

2. Audit guidance

2.1 General requirements for the audit process

The auditor shall contact the unit of certification well before the on-site inspections to collect and review all the documentation necessary to assess compliance with FOS standards. Details of how to prepare and implement this first part of the audit process are given in chapter 3 of FOS 0001. All audits shall be carried out in compliance with ISO 19011. Before the audit date, an auditor shall review all the relevant documentation possible to reduce the on-site visit duration, including corrective actions and past audit findings. During an audit, the auditor needs to see evidence that the processes are implemented in accordance with the standard's requirements.

To be recommended for certification by the CB, the unit of certification shall not have open major NCs. In addition, the unit of certification shall elaborate a corrective action plan to come into compliance with all minor NCs, which are verified in the surveillance audit. An exception is only made for those requirements that are not applicable due to a specific type of activity (e.g., requirements for tuna fisheries do not apply to fisheries targeting species different from tuna). The auditor decides independently whether the unit of certification is fully compliant based on the evidence collected before and during the audit. Recommended indicators are not compulsory to achieve the certification. Nonetheless, all the aspects related to these indicators shall be reviewed, and any NCs detected shall be highlighted in the audit report as a "recommendation". The auditor is responsible for assessing and reporting the implementation of recommendations during the subsequent audit. **Downgrading the level of any requirement**, e.g., changing classification of an important requirement to a recommendation, **is not permitted under any circumstance.**

- Only Y, N and N.A. are considered acceptable answers to the requirement followed by respective comments.
- The CB shall submit to FOS all information and data that are part of the assessment and surveillance process together with the audit report.
- The auditor shall attach complete documents in PDF format. Clear references to paragraph and page numbers shall be included in the report.

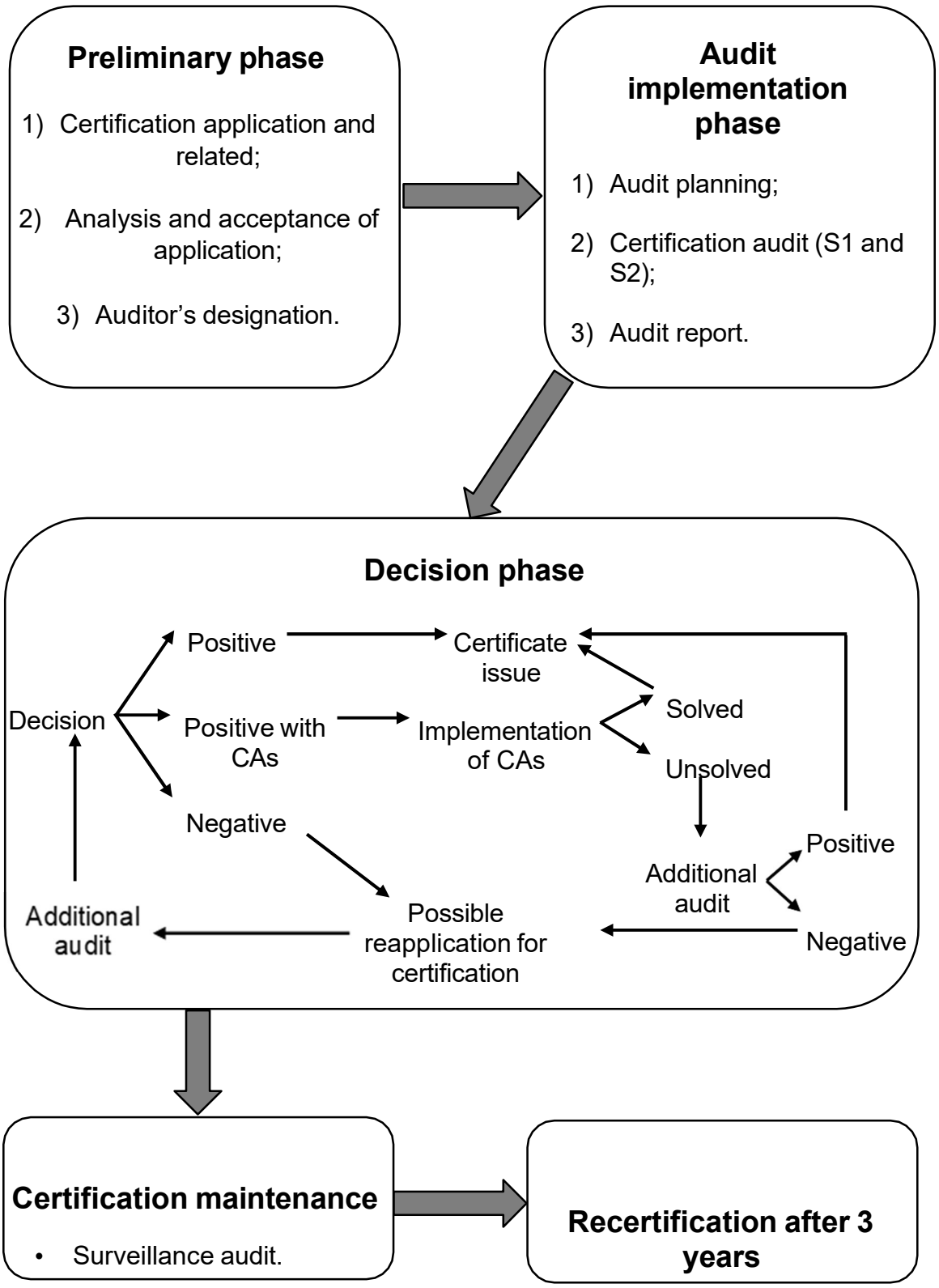


Figure 1. Steps for issuance and maintenance of certification.

Opening meeting, gathering information

All audits shall begin with an opening meeting, in which auditors shall confirm with the client at least:

- The audit plan, including how the audit activities will be undertaken and any visits to vessels, sites and/or sub-contractors;
- The access required and the type of information and documentation needed;
- The proposed scope of certification, including the complete list of vessels, farming sites, processing sites to be included in the certification;
- The list of certified suppliers and of any subcontractors that are or will be handling certified products, identifying which ones are independently certified.

Methods for gathering evidence during the audit include:

- Interviewing relevant personnel;
- Inspection of records and written procedures;
- Observation of ongoing activities;
- Photos.

Types of documentary evidence that shall be gathered and reported during the audit include:

- Procedures, including operational procedures, management review and other relevant reports;
- Internal audits, corrective and preventive action records;
- Quality and management objectives;
- Statements and meeting records;
- Audit records;
- Key Performance Indicators (KPI) and process monitoring records;
- Purchasing records, sales receipts and supplier payment records;
- Employee training records.

Closing meeting

Auditors shall conduct a closing meeting at the conclusion of each audit with the applicant's representative(s) to verify that the applicant understands:

- Any actions the client may have to complete, and their timeframes before certification can be awarded;
- That all CAs addressing major NCs shall be implemented and verified by the auditor before the certification can be awarded;
- That proposal(s) of implementation of any minor NC(s) shall be presented to the CB and approved by the auditor before the certification can be awarded;
- That until the certification process is concluded and the certificate is issued, the applicant is not certified and cannot make any claim concerning certification;
- That the client must inform the CB and FOS of any significant future changes that affect certification;
- That the scope, subcontractor and supplier list is correct and agreed.

2.2 FOS Aqua – Fish Welfare Requirements

2.2.1 Scope

For aquatic animals in aquaculture, welfare can be defined as supporting an animal that is healthy and whose needs are met by the farmer, leading to good health, *i.e.,* freedom from disease through providing conditions that are conducive to good growth and high survival. FOS – Aqua Fish Welfare requirements outline criteria and indicators for CBs' use when assessing species-specific FOS Aqua Standards. This certification is required for all aquaculture operations that are engaged in the propagation and culture of aquatic animals with the aim of monitoring aquaculture activities and supporting good welfare for farmed aquatic animals.

Friend of the Sea (FOS) works in close and active collaboration with Fair-fish International Association and its Fish Ethology and Welfare Group (FishEthoGroup), which have developed these species-appropriate standards for farmed aquatic fish species based on extensive data collection from the field.

2.2.2 General Instructions for the auditor

Only aquaculture products/fish originating from producers positively assessed against FOS Aqua Fish Welfare Standards may be eligible to be sold as FOS certified products.

The checklist is divided into **2** main sections: **1] Hatchery requirements** and **2] On-growing requirements.** If only one section is applicable, then the auditor must specify this in Section p) ADDITIONAL INFORMATION within Section 'Description of the unit of certification'. In addition, the auditor must also specify as N/A **any requirements** that do not apply to the unit of certification from within a non-applicable section.

This Audit guidance provides **complete guidance** for the requirements for **Section 2.2.3. FOS-Aqua – *Sparus aurata* – Fish Welfare Standard for the certification of Gilthead seabream in aquaculture.** The ensuing **Sections 2.2.4. – 2.2.27 Fish Welfare Standards**

for other fish species, only detail **the requirements that differ** from **Section 2.2.3. F0S-Aqua – *Sparus aurata*.**

The unit of certification needs to be contacted in time to confirm the scope of certification and agree on a date on which the aquaculture operation is to be inspected. Guidance for the preliminary audit phase is provided in Appendix A. The auditor shall review all the information available and take his/her certification decision independently, based on the objective facts and best scientific data available.

Data are facts that result from measurements and observations. Only data that are relevant, reliable, and up-to-date shall be used as supporting evidence of conformity to FOS-Aqua Fish Welfare Standard requirements. Only data and/or other information that delivers the best scientific evidence available shall be considered and reported in the audit report. The currency of data and information is important because their capacity for supporting reliable assessment of current status and trends declines as they get older. Data sources shall always be reported.

Where limited information is available, the auditors should be more precautionary in their assessment of information adequacy. Remote audits shall assess applicants against the same criteria and requirements as an on-site audit. If the audit is remote, this may be carried out either on a call, video conference, or through an initial email exchange.

2.2.3 FOS Aqua – *Sparus aurata* – certification requirements

2.2.3.1 HATCHERY REQUIREMENTS

FOS-Aqua Fish Welfare Hatchery requirements are for the CBs' use when assessing the welfare of farmed aquatic species at the hatchery stage of the production system.
A fish hatchery is a place for artificial breeding, hatching and rearing of fish through the early life stages. A hatchery is usually closely associated with a nursery facility where the cultured organism is grown to the appropriate size before being transferred to an on-growing unit. Broodstock holding facilities may form a part of the facilities and hold the mature fish used for breeding purposes.

Captive environment

The following requirements refer to the captive environment of the farmed fish species targeted by the unit of certification. In this case, it refers to *Sparus aurata* but is equally applicable to other species as outlined in **Sections 2.2.4. – 2.2.27.**

The term "Captive Environment" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.1	**Production units should provide horizontal and vertical withdrawal space, optimizing fish welfare conditions regarding spatial constraints.**	**Important**

The auditor shall verify that the units of production are suitable for the early life stages that they support. Aquaculture production units should be designed to create a restricted volume in which aquatic organisms are reared and provide the best conditions for growth and welfare. Units should be of an appropriate size to accommodate the required stocking density of fish and should be able to receive the necessary water flow. Enclosures should be of an appropriate shape to accommodate the behavioural needs and preferences of the cultured fish species.

The terms “Production units” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.2	**Production units must not have sharp protrusions which may be injurious to the larvae and young.**	**Important**

The auditor shall verify that the materials used to construct the production units are non-toxic, durable, and have a smooth internal surface to prevent abrasions to the fish.

The term “Production units” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.3	**Back-up power generators must exist, must be functional, and must be ready to support essential equipment in case of a power failure. Generators should be tested and maintained weekly.**	**Important**

The auditor shall ensure that an alternative power supply is available in case of power supply interruption and identify internal records of regular weekly testing and maintenance.

The term “back-up power generator” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.4	**Production units and equipment must be checked for holes, faults, and fouling. All equipment must be maintained regularly.**	**Important**

The auditor shall check production unit integrity, ensuring that there is no damage leading to containment breaches and escapes of aquatic animals, and shall also collect evidence that all equipment, *i.e.,* nets, screens, *etc*., is tested and checked according to a regular schedule and maintained in good order. A programme should be in place for regular maintenance and repair of containment infrastructure and equipment. A reporting system shall be in place to indicate inspection results and preventative maintenance undertaken. In addition, all equipment and holding facilities should be easy to clean and to disinfect and should be cleaned and disinfected regularly and as appropriate.

The term "Production units" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Sparus aurata*:

- **500-1,000 luxes**
- **Autumn-winter-spring spawning in North Atlantic latitudes, meaning 12-12 to 8-16 L:D photoperiod.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.6	**Additional lighting, either fixed or portable, must be available, but should only be switched on to allow examination of the animals and equipment.**	**Important**

The auditor should verify that alternative light sources are available to allow inspection of stock at all times.

Requirement		Level
1.7	**Any pest control substances or equipment must be enclosed in a secure location, so there is no risk of water contamination or accidental access by non-target species.**	**Important**

The auditor must verify that any pest control substances and related equipment are kept securely so as not to cross-contaminate or leach into the surrounding aquatic environment and ensure that a reporting system is in place to indicate inspection results.

The terms “pest control substances” and “non-target species” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.8	**Structural enrichment should be provided. If deemed impossible or harmful, another type of enrichment should be implemented (occupational, dietary, social, sensorial).**	**Recommended**

For some cultured species, environmental enrichment may be necessary to take account of their behavioural traits, *e.g.,* reproduction, hierarchy, *etc*., to enhance the welfare of fish.

The auditor must ensure that the presence of enrichment does not compromise the safety of cultured fish, *i.e., that it does not* have abrasive or sharp protrusions.
Environmental enrichment is often divided into different categories, depending on the goals of the enrichment programme. Commonly recognized categories are:

- physical or structural enrichment, including modifications or additions to the tanks;
- sensory enrichment, which concerns stimulation of the sensory organs and the brain;
- dietary enrichment, encompassing type and delivery of food (note the distinction from nutrient enrichment, which concerns addition of nutrients to the feed);
- social enrichment, adding contact and interactions with conspecifics;
- occupational enrichment, relating to reduction of physical and psychological monotony by introducing variation to the environment and possibilities for exercise and performance of preferred behaviours.

The terms "enrichment" and "structural enrichment" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
1.9	**The tanks should be located in a site protected from human-induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3 kHz frequency range at any point in the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003),

all impacting fish welfare. In a hatchery setting, these noises could come from air and water pumps, tractors, harvesters, and personnel activities.

Noise levels within the facility should be kept to a minimum. Where possible, separate equipment that causes noise or vibration, such as power generators or filtration systems, from fish-holding facilities.

Specific requirements for *Sparus aurata*:

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

The requirements listed in this section refer to the monitoring of water quality in the aquaculture production units. Aquaculture animals should be kept under farming conditions suitable for the species concerned, in particular, taking into account water temperature and water quality. Water quality is key in maintaining fish welfare and in reducing stress and the risk of disease. Water-quality parameters should at all times be within the acceptable range that sustains normal activity and physiology for a given species. The definition of acceptable range is complicated as the requirements of individual species may vary between different life-stages, *e.g.,* larvae, juveniles or adults or, according to physiological status, *e.g.,* metamorphosis, spawning, feeding, previous history of exposure *etc*.

These water quality parameters should include temperature, salinity, dissolved oxygen concentration, pH, ammonia and nitrite concentrations, and some index of solids concentration*, i.e.,* transparency, turbidity or total suspended solids concentration, and shall be measured regularly, as determined by culture system type and stocking density.

The term “water quality” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.1	**A contingency plan must exist to correct water quality parameters when they deviate from reference values.**	**Important**

The auditor shall ensure that water quality parameters within production units are routinely measured and fall within the tolerance range. Regular monitoring as part of good husbandry practices should be carried out, and a contingency plan should be in place to allow corrective measures, *i.e.,* removal and replacement of culture water, addition of oxygen, *etc*., should levels fall outside acceptable ranges/reference values. The auditor, in addition, will identify internal records of routine testing and reporting.

The terms “production unit”, “water quality” and “stocking density” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 11 and 30 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Sparus aurata*:

- **Optimum range is between 11 and 30 ºC.**

The term “temperature” is defined in Section 1.4 – Definitions and Abbreviations.

<u>Animal health and animal welfare</u>

The following requirements specifically refer to the fish health and welfare requirements of the cultured species. The term 'welfare' addresses the "physical and mental health and wellbeing of an individual or group" (Cambridge Dictionary, 2018). Assuming that observation of natural behaviour is a key indicator of the welfare of captive animals, then behavioural observational tools are the best way to understand both the physiological and mental state of the animal (Saraiva, J.L. et al. 2019). See above Fish Welfare in Abbreviations and Definitions for a detailed description.

The term "animal health and animal welfare" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
3.1	**Each site must either employ a qualified fish veterinarian or have access to one.**	**Important**

The auditor must ensure that the unit of certification either employs a qualified fish veterinarian or has access to one.

The term "veterinarian" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
3.2	**Each site must either employ a qualified fish welfare specialist or have access to one regularly.**	**Important**

The auditor must ensure that the unit of certification either employs a fish welfare specialist or has regular access to one.

The term "fish welfare specialist" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
3.3	**All sites must have a documented fish health and welfare plan.**	**Important**

This requirement specifically refers to a fish health and welfare management plan, which has been used historically in many terrestrial animal production systems to provide a formal veterinary health planning strategy and can offer a useful basis not only for maintaining strict health and welfare standards within the industry but also a gauge for quality assurance or certification schemes within that sector. The auditor must ensure that the unit of production has a valid fish health and welfare plan in place and that it is updated on an annual basis.

The term "fish health and welfare plan" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
3.4	**The documented fish health and welfare plan must be reviewed on at least an annual basis by an experienced fish veterinary and welfare specialist.**	**Important**

The auditor must ensure that the fish health and welfare plan is reviewed on an annual basis.

The terms "fish health and welfare plan", "veterinarian" and "fish welfare specialist" are defined in Section 1.4 – Definitions and Abbreviations.

Feeding

The following requirements specifically refer to the feed and feeding requirements of the cultured species in the unit of production.

Requirement		Level
4.1	**The farm must implement a system that ensures appropriate feed logistics (storage, transport, distribution, traceability), records, and a contingency plan.**	**Important**

The auditor shall verify and report on evidence that the unit of certification complies with the Code of Practice on good animal feeding. See Codex Alimentarius Commission (2004) Code of Practice for Fish and Fishery Products. Aquaculture. CAC/RCP 52-2003 for technical guidance:

- Feed and fresh stocks should be purchased, rotated and used before the expiry of their shelf-life.
- Dry fish feeds should be stored in cool and dry areas to prevent spoilage, mould growth and contamination. Moist feed should be properly refrigerated according to manufacturer instructions.
- Feed ingredients should not contain unsafe levels of pesticides, chemical contaminants, microbial toxins, or other adulterating substances.
- Industrially produced complete feeds and industrially produced feed ingredients should be properly labelled. Their composition must fit the declaration on the label, and they should be hygienically acceptable.
- Ingredients should meet acceptable, and if applicable, statutory standards for levels of pathogens, mycotoxins, herbicides, pesticides and other contaminants that may give rise to human health hazards.
- Only approved colours of the correct concentration should be included in the feed.
- Moist feed or feed ingredients should be fresh and of adequate chemical and microbiological quality.
- Fresh or frozen fish should reach the fish farm in an adequate state of freshness.
- Fish silage and offal from fish, if used, should be properly cooked or treated to eliminate potential hazards to human health.
- Feed that is compounded industrially or at the fish farm should contain only such additives, growth-promoting substances, fish flesh colouring agents, antioxidizing

agents, caking agents or veterinary drugs that are permitted for fish by the official agency having jurisdiction.

- Products should be registered with the relevant national authority as appropriate.
- Storage and transportation conditions should conform to the specifications on the label.
- Veterinary drugs and other chemical treatments should be administered in accordance with recommended practices and comply with national regulations.
- Medicated feeds should be clearly identified on the package and stored separately to avoid errors.
- Farmers should follow manufacturer instructions on the use of medicated feeds. t
- Product tracing of all feed ingredients should be assured by proper record-keeping.

The term “feed” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
4.2	**The farm must ensure that feeding regimes are according to the manufacturer's guidelines, farmer experience, and feeding behaviour. Adjustments of feeding regimes should be based on fish behaviour, appetite, expected biomass, and minimisation of feed waste.**	**Important**

The auditor must ensure that there is strict adherence to the manufacturer’s feeding guidelines as well as routine monitoring of group feeding behaviour of the cultured species. These observations and routine calculation of stock biomass will allow feeding regimens to be adjusted to suit stock and avoid overfeeding and deterioration of water quality due to excess feed. The auditor should be able to identify internal records of routine observations, monitoring, and reporting of these activities. Verification of appropriate record-keeping and suitable documentation from feed manufacturers is also expected.

The term “feeding regimen” and “biomass” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
4.3	**Feed must be dispensed and spread throughout the rearing space to minimise the risk of over- and under-feeding and to reduce feeding competition.**	**Important**

The auditor must verify that feed is dispensed in a way that maximises feeding efficiency, avoids over- and under-feeding and reduces feeding competition, *e.g.,* evidence of an even distribution of fish sizes at grading events, absence of cannibalism, minimal feed left a few hours after feeding event, *etc*.

The term "feed" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
4.4	**Fish must be observed at least once per day during feeding, and feeding behaviour should be registered. Records must be available for inspection.**	**Important**

The auditor must ensure that the feeding activity and feeding behaviour of the fish are observed at least once per day by site personnel during a feeding event and be able to identify internal records of routine monitoring and reporting of these activities. Personnel do not necessarily require specific training, but procedures should be supervised by a trained person.

Handling and manipulation procedures

The following requirements refer to handling and manipulation procedures of stock fish that can include crowding, transfers, counting, weighing, grading, chemical treatments, vaccination, and transportation.

During handling operations, aquatic animals experience stress and should be handled in a way that limits the stress experienced. The farm shall have Standard Operating Procedures (SOPs) in place for handling operations.

The terms “crowding”, “SOP”, “treatment”, “grading”, “vaccination” and “transportation” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
5.1	**Fish must be protected at all times from avoidable injuries, pain and stress. Farm operators must be able to demonstrate awareness at inspection.**	**Important**

Aquatic animals that are concentrated during handling and manipulation procedures experience stress, and farm personnel shall be trained in their roles and responsibilities in maintaining the welfare of farmed aquatic animals. The auditor shall ensure that fish are protected from avoidable injuries, pain and stress whilst operations are carried out, and that farm personnel are fully trained in recognising abnormal behaviour and stress during and immediately after the procedure and that SOPs are in place. In addition, internal records and documentation should be maintained of any handling events.

Requirement		Level
5.2	**Cleaning and maintenance operations must be carried out with minimal impact on fish welfare and health.**	**Important**

The auditor shall ensure that routine observations of fish during routine cleaning and maintenance operations, *i.e.,* tank cleaning, net washing, *etc*., are carried out, and that farm personnel are fully trained in recognising abnormal behaviour and stress during and immediately after the procedures and that SOPs are in place. In addition, internal records and documentation should be maintained regarding any cleaning and maintenance events.

Requirement		Level
5.3	**Live fish must only be removed from water and handled when absolutely necessary. The maximum emersion time without anesthesia is 15 seconds.**	**Important**

Aquatic animals that are concentrated during handling operations experience stress, and any handling operations should be conducted in a way to minimise stress, including limiting crowding time and time out of water. Time spent out of the water without anesthesia must be no more than 15 seconds. The auditor shall ensure that internal records and documentation are in place for all handling procedures.

The term "anesthesia" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
5.4	**When fish are handled, adequate support must be given to the body: live fish should never be held by the gills, tail only, or/and thrown.**	**Important**

The auditor must ensure that, while fish are out of the water, they should be handled with wet gloves or wet hands and on a moist surface to avoid scale and mucus loss. Particular attention should be paid to handling practices to avoid desiccation, suffocation, and other injury. While out of the water, fish must be fully supported at the head and tail end, *i.e.,* not held by opercular/gill structures or tail in order to prevent vertebral damage. The auditor shall ensure that internal records and documentation are in place for all handling procedures.

Requirement		Level
5.5	**Handling nets must be of a suitable size and ideally knotless. They must be kept clean, disinfected after each use, and replaced when damaged. Their design must not risk injuring the fish. If equipment other than nets is used, it must be in good condition and without protrusions.**	**Important**

When handling fish, nets with an appropriate frame and mesh size should be used. Knotted net mesh should be avoided to prevent scale loss and mechanical injury. Nets should be disinfected and rinsed in clean water before use. The auditor must ensure that farm personnel are aware that appropriate net design, type and mesh size are used to minimise injury to fish and that netting equipment used for handling operations should be maintained in good working order, disinfected after use and should be maintained and used

in ways that minimize the potential for animal injuries. In case other equipment apart from nets is used, it must be in good condition and without protrusions.

Vaccination

The following requirements refer to vaccination procedures of stock at the unit of production. Vaccination is an important procedure in modern aquaculture to protect and prevent disease outbreaks and, as a general rule, fish are vaccinated early in their production phase. Vaccines are used to boost immunity to certain infectious diseases and are part of a Veterinary Health and Welfare Plan. Staff will be appropriately trained before undertaking the vaccination procedure.

The term "vaccination" and "Veterinary Health and Welfare Plan" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
6.1	**The use of vaccines is encouraged for the prevention of disease, rather than relying on treatment.**	**Important**

The vaccination of farmed aquatic species has dramatically decreased the number of outbreaks of historically important bacterial diseases in farmed fish stocks. As a result, mortalities have decreased considerably; there has been a concomitant marked reduction in antibiotic use and animal welfare has improved. Although the vaccine and the vaccination process can potentially have negative impacts on welfare, it is accepted that the vaccination of fish with current vaccines results in a net benefit for both fish health and welfare (Midtlyng, 1997; Berg et al., 2006; Evensen, 2009). SOPs should be in place to ensure that vaccination is carried out in a manner that is efficacious.

The terms "vaccine", "vaccination" and "treatment" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
6.2	**All vaccination procedures must be conducted with care and with the minimum possible distress caused to the fish.**	**Important**

The auditor shall verify that vaccination procedures are conducted with care and that fish are protected from avoidable injuries, pain and stress whilst operations are carried out. The

auditor must also ensure farm personnel are fully trained in recognising abnormal behaviour and stress during and immediately after the vaccination procedure and that SOPs are in place. In addition, the auditor shall report evidence that the unit of certification maintains internal records and documentation of any vaccination events.

The term "vaccine" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
6.3	**All fish must be sedated before being injected, unless there are clear health and welfare reasons not to.**	**Important**

The auditor must verify that all fish are sedated prior to vaccination procedures in order to minimise distress and report evidence that the unit of certification maintains internal records and documentation. Anaesthesia of fish is usually administered prior to vaccination as it decreases the stress due to vaccination, prevents mechanical injury and helps the fish recover faster from the process.

The term "sedation" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
6.4	**Vaccines and anesthetics must be used according to the manufacturer's data sheet, unless otherwise specified by a vet. Vaccine use must be recorded in the Veterinary Health and Welfare Plan.**	**Important**

The auditor must ensure that all vaccines and anaesthetics are used in accordance with the manufacturer's data sheets, unless specified by the Veterinarian, and that vaccine use is delineated in the Veterinary Health and Welfare Plan. In addition, the auditor shall report evidence that the unit of certification maintains internal records and documentation of any vaccination events and vaccine usage.

The terms "Veterinary Health and Welfare Plan", "vaccine" and "anaesthetic" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
6.5	**There must be backup systems and contingency plans in place to deal with vaccination system malfunctions and breakdowns in order to safeguard fish welfare.**	**Important**

The auditor shall verify and report evidence that the unit of certification has contingency plans in place in the form of back-up systems that will minimise distress to the fish in the case that there is a malfunction of the vaccination system. This may include emergency external oxygen supplies, back-up holding tanks, *etc*.

Grading

The requirements listed in this section refer to grading procedures. Grading of fish stocks is conducted for a variety of reasons, *e.g.,* to ensure a uniform fish size before vaccination, for removing small or abnormal fish, to prevent cannibalism, and to select fish for harvest. Grading can be a stressful and potentially harmful procedure for the fish; therefore, fish should only be graded when essential, and in general, all handling of fish should be minimised. Grading can be conducted in a variety of ways throughout production cycle; it can be performed manually with small fish, with the use of grading machines, or passively with flexible net panels or similar. Grading is also conducted using boats from sea cages.

The term "grading" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
7.1	**Grading must be minimised and only be performed when absolutely necessary, *e.g.,* before vaccination, to avoid cannibalism, or before slaughtering.**	**Important**

Grading can be a stressful and potentially harmful procedure for the fish; therefore, fish should only be graded when essential, and in general all handling of fish should be minimised. The auditor must also ensure farm personnel are fully trained in recognising abnormal behaviour and stress during and immediately after the grading procedure and that SOPs are in place. In addition, internal records and documentation should be maintained of any vaccination events.

The terms “grading”, “slaughter” and “cannibalism” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
7.2	**All grading equipment must be designed and maintained in order to prevent damage or causing stress to the fish (*e.g.*, absence of protrusions to avoid injuries; fish should be kept submerged at all times).**	**Important**

The risks associated with grading include those associated with crowding and transfer when there is potential for hypoxia due to air exposure or exposure to water with low dissolved oxygen, and also potential for mechanical damage to the fish. The auditor must ensure that all grading equipment is designed and maintained to prevent unnecessary damage or distress to the fish and that fish are not exposed to air or hypoxic water during the procedures and that there are no protrusions to avoid injuries. In addition, the auditor shall report evidence that the unit of certification maintains internal records and documentation of any grading events and routine equipment checking and maintenance and that all grading procedures are observed.

The term “grading equipment” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
7.3	**A written protocol/working procedure for grading must be in place and carried out at all times.**	**Important**

The auditor shall report evidence that the unit of certification maintains a SOP or written protocol/working procedure for any grading procedures and that internal records and documentation of any grading events exist.

Requirement		Level
7.4	**Fish must be monitored throughout the operation by a designated person who is responsible for identifying welfare issues and taking appropriate action if necessary.**	**Important**

The auditor must provide evidence that an Aquatic animal health professional oversees any grading operations and can identify and take appropriate action in the case of any welfare issues.

The term "Aquatic animal health professional" is defined in Section 1.4 – Definitions and Abbreviations.

Transportation

The requirements listed in this section refer to any transportation of fish population from the unit of certification. Transportation of fish is a complex and stressful event, and therefore, fish must be handled in a manner that protects their health, minimizes the length of the stressful event, and mitigates risks to any fish at the receiving site.

The term "transportation" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
8.1	**Transport must be planned in order to minimise possible adverse effects on fish welfare. Transport on land: max 8 h.**	**Important**

During transportation of live fish, it is important to reduce stress, as stressing fish can lead to deterioration in welfare. The auditor shall report evidence that the unit of certification maintains internal records and documentation of any transportation events and ensures that these transportation events do not exceed 8 h on land.

The term "transportation" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
8.2	**Water quality parameters (oxygenation, ammonia levels, pH, temperature) must be monitored during transport and match the arrival tanks. A surface skimmer must be present in all transport containers.**	**Important**

The auditor must verify that water quality is closely monitored and maintained at all times

during transportation. Transport vessels should be equipped with supplemental oxygen tanks and air stones. Oxygen levels, ammonia, pH, and temperature should be checked and maintained throughout the transport procedures; frequency of monitoring will vary with the specifics of each transport. A surface or protein skimmer must be used in all transport vessels. Water quality parameters must match those at the holding tanks at the destination. The auditor shall report evidence that the unit of certification maintains internal records and documentation.

The terms "water quality criteria", "transportation", "oxygen", "pH", "ammonia", "temperature" and "protein skimmer" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
8.3	**Biosecurity and fish welfare should be considered before transporting fish populations.**	**Important**

The auditor shall ensure that the unit of certification considers all biosecurity and fish welfare issues before movement of fish populations. The auditor shall report evidence that the unit of certification maintains internal records and documentation.

The terms "biosecurity" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
8.4	**All equipment that the fish rely on for life support must be constantly monitored throughout the journey. Absence of protrusions (to avoid injuries) in the equipment is requested.**	**Important**

The auditor must ensure that all equipment for the transportation of live fish should be designed for rapid and efficient handling without causing physical damage or stress and that mitigation measures, *i.e., a* secondary oxygen source, are in place during transportation and that there is absence of protrusions in the equipment. Routine and regular monitoring of water quality parameters and fish welfare must be carried out throughout the journey. The auditor shall report evidence that the unit of certification

maintains internal records and documentation.

Requirement		Level
8.5	**Water quality parameters must always comply with those described in the requirement FOS Aqua-inland rev 3 (requirements 8.1.1 to 8.1.11) and FOS Aqua Inland-Marine Rev. 4 (requirements 8.1.1 to 8.1.7)**	**Important**

The auditor must ensure that water quality parameters comply with those described in the requirement FOS Aqua-inland rev 3 (requirements 8.1.1 to 8.1.11) and FOS Aqua Inland-Marine Rev. 4 (requirements 8.1.1 to 8.1.7). The auditor shall report evidence that the unit of certification maintains internal records and documentation.

The term "water quality parameters" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
8.6	**Supplementary oxygen or air supply must be sufficient to last 50% longer than the anticipated length of the journey (see Section 8.1 Transportation).**	**Important**

The auditor must verify that the unit of certification ensures that the water in the transportation tanks is well aerated before fish are transferred into them and that oxygen levels are maintained at all times during transportation. Transport vessels should be equipped with supplemental oxygen tanks and air stones and be sufficient to last 50% longer than the anticipated length of the journey. Oxygen levels should be checked and maintained throughout the transport procedures.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
8.7	**Excessive or rapid changes in water temperature or pH during transport must be avoided, unless there are clear health and welfare reasons to do so.**	**Important**

The auditor must ensure that sudden, high or rapid changes in water temperature or pH are avoided during transportation, unless there are clear health and welfare reasons to do so.

The terms "temperature" and "pH" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
8.8	**Any fish that die during transportation must be separated from live fish as soon as possible after arrival. The cause of death must be determined by a competent person.**	**Important**

Only healthy and undamaged fish should be chosen for live storage and transportation. The auditor must verify that dead fish are removed from the transportation tank before being introduced to the holding tank at the destination. The auditor shall report evidence that the unit of certification maintains internal records and documentation of such mortality events.

Requirement		Level
8.9	**Records of any deaths or injuries that occur during transportation must be kept.**	**Important**

The auditor shall report evidence that the unit of certification maintains internal records and documentation of any mortalities that occur during transportation.

The term "transportation" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
8.10	**Contingency plans must exist for all frequent transport problems.**	**Important**

The auditor shall report evidence that contingency plans exist for any potential problems*, i.e.,* unacceptable deviations from acceptable water quality criteria, hypoxia, *etc*. These may include back-up oxygen supplies or aeration devices.

The term "transport" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
8.11	**Starvation before transport should not be longer than 50-degree days and preferably just enough to achieve gut clearance (see Section 9 Starvation).**	**Important**

Before transportation of significant distance, it is advisable to deprive fish of food for a period sufficient to allow the gut to clear and reduce faecal contamination of the transport system. The auditor must verify that starvation before transport must not exceed 50 degree-days before transport of live fish. The auditor shall report evidence that the unit of certification maintains internal records and documentation.

The term "starvation" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

Starvation

The requirements listed in this section refer to the practice of starvation; a period of starvation is regarded as a sound practice in aquaculture before handling, transportation and harvest, to minimise impacts on welfare and ensure proper hygiene after harvest.

The term "starvation" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
9.1	**Starvation periods must be justified.**	**Important**

Transportation of live fish is a stressful event involving handling, crowding, and exposure to varying water qualities; therefore, starvation is practiced for welfare concerns since there is a general understanding that starved fish are calmer and more tolerant to stress. The auditor shall verify that starvation periods are justified and shall report evidence that the unit of certification maintains internal records and documentation of any starvation events.

The term "starvation" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
9.2	**The period during which fish are deprived of food to achieve gut clearance prior to certain procedures, or harvesting must be appropriate and as minimal as possible. Unless justified, this must always be < 50 degree days.**	**Important**

Transportation of live fish is a stressful event involving handling, crowding, and exposure to varying water qualities; therefore, starvation is practiced for welfare concerns since there is a general understanding that starved fish are calmer and more tolerant to stress. The auditor shall verify that starvation periods are appropriate and as minimal as possible and, unless justified, should always be less than 50 degree-days. The auditor in addition shall report evidence that the unit of certification maintains internal records and documentation of any starvation events.

The term “degree-days” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
9.3	**Feed withdrawal may form part of the response to the onset of adverse environmental conditions and in the treatment of certain diseases. Veterinary and welfare specialist advice should be sought, and appropriate feed withdrawal protocols should be included if deviation periods from above.**	**Important**

The auditor must ensure that Veterinary advice is taken before starvation of stock in the face of adverse environmental conditions or before treatments and report evidence that the unit of certification maintains internal records and documentation of these starvation events.

The term “Veterinary” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

The requirements listed in this section refer to requirements for crowding of fish stocks. Fish are crowded repeatedly throughout the aquaculture production cycle for various reasons such as vaccination, grading, transport, harvesting, and slaughter. At the hatchery stage, draining is the normal method to reduce the water volume and crowd the fish, thus

increasing biomass and reducing the oxygen content of the water. Stress can also increase the need for oxygen.

The term “crowding” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
10.1	**A written procedure for fish crowding must be validated by a welfare specialist and followed every time.**	**Important**

The auditor shall ensure that a written procedure for fish crowding is in place and that a fish health and welfare specialist is present at crowding events to monitor water quality criteria and assess fish welfare. In addition, the auditor shall report evidence that the unit of certification maintains internal records and documentation of any crowding events.

The terms “crowding” and “fish health and welfare specialist” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
10.2	**Operators must be trained in the appropriate crowding techniques.**	**Important**

The auditor shall ensure that personnel are trained in the appropriate fish crowding techniques and shall report evidence that the unit of certification maintains internal records and documentation of any training.

The term “crowding” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
10.3	**The frequency and duration of crowding should be kept to the minimum and clearly justified. The period for fish crowding on any occasion must not exceed 1.5 hours for grading or treatments and 2 hours for harvest.**	**Important**

The auditor shall present evidence that the unit of certification maintains internal records and documentation of any crowding events and that these crowding events have a clear

justification of purpose and do not exceed 1.5 hr for grading or treatments, or 2 hr for harvest. In addition, crowding events must be carried out with the same fish stock no more than once per week.

The terms “crowding”, “grading” and “treatment” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
10.4	**Operators must monitor fish behaviour during crowding and take actions if fish show signs of stress or damage. Surface activity should never reach stage 4 on the crowd intensity scale.**	**Important**

The auditor must ensure that farm personnel monitor fish behaviour during crowding events according to SOPs and that surface activity is measured on the Crowd Intensity Scale according to the ‘RSPCA welfare standards for farmed Atlantic salmon’ (2018) as an indicator of stress.

Crowd intensity scale:
1 (Optimum). Essentially no fins breaking the surface of the water.
2 (Acceptable). Fins above the water over a small part of the surface of the crowd.
3 (Undesirable). Fins and part of the fish above the water over the whole surface of the crowd. Some burrowing, gasping and vigorous activity in parts of the crowd.
4 (Unacceptable). The whole surface of the crowd vigorously burrowing, gasping and splashing.
5 .Whole surface of the pen boiling with violent splashing.

The term “crowding” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Gilthead sea bream: > 6 mg/L. See Section 2 Water.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding events and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical oxygen level for *Sparus aurata*: > 6 mg/L

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

<u>Culling</u>

The requirements listed in this section refer to requirements for culling.

The term "culling" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
11.1	**Any seriously sick or injured fish, or fish found not to be recovering, must be immediately removed and humanely killed without delay.**	**Important**

The auditor must verify that any fish which are unlikely to recover from a condition or are likely to be experiencing pain or distress are humanely killed or culled promptly in order to prevent pain and suffering. The auditor shall also report evidence that the unit of certification maintains internal records and documentation of any such culling activities.

The term "culling" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
11.2	**Fish must only be culled using an overdose of anesthetic.**	**Important**

The auditor shall report evidence that the unit of certification only carries out culling with an overdose of anaesthesia.

The terms "culling" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
11.3	**Culling of any fish must only be conducted by suitably trained and competent personnel.**	**Important**

The auditor shall also report evidence that the unit of certification only uses suitably trained and competent personnel to carry out culling procedures and maintains internal records and documentation of any training.

The term "culling" is defined in Section 1.4 – Definitions and Abbreviations.

Welfare assessment

The requirements listed in this section refer to the welfare assessment of farmed fish stocks. Farmed aquatic species experience numerous stressors that can affect welfare that can include handling, crowding, transport, grading, vaccination, chemical or therapeutic treatment, stocking density, water quality, light, feed supply and the threat of parasites and diseases. Changes in behaviour, *e.g.,* ventilatory activity, aggression, individual and group swimming behaviour, stereotypic and abnormal behaviour, have been linked with acute and chronic stressors in aquaculture and can therefore be regarded as likely indicators of poor welfare. Welfare assessment can be carried out with the observation of operational welfare indicators can be measured by farm personnel trained to recognise normal and abnormal behaviours, indicators of physical health, variations in water quality, *etc*. Regular inspections of the culture facility, water quality analysis, and assessment of the behaviour and condition of fish stocks should be conducted regularly.

The term "welfare assessment" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
12.1	**Appropriate systems for on-site or remote behavioural observations must be implemented: fixed or mobile live cameras underwater (preferred), live surface observations (if the previous is not possible), surface windows, or others. Behavioural observations should be regularly recorded during routine procedures or any other action which can cause stress or discomfort to fish, in order to identify caveats and improve protocols.**	**Important**

Behaviour represents a reaction to the environment as fish perceive it and is therefore a key element of fish welfare. The auditor shall safeguard that the unit of certification employs both on-site, *i.e.,* physical observations by farm personnel, and (preferred) remote, *i.e.,* fixed or mobile live underwater cameras, to monitor fish behaviour and allow identification of indicators of stress or welfare concerns. These behavioural observations may include any abnormalities in normal swimming and schooling behaviour, *i.e.,* panic, aggressive events, isolated individuals, *etc*. (see Points 12.2 – 12.13 below). The auditor shall also report evidence that the unit of certification keeps documented evidence, *e.g.,* videos of behavioural patterns.

Requirement		Level
12.2	**Fish must be inspected on a daily basis, and dead or moribund fish should be removed, minimising handling to avoid stress to the live fish within the enclosure (see Section 11 Culling).**	**Important**

The auditor shall verify that the unit of production maintains a programme of daily inspection of stock and removal of dead and moribund fish.

The term “moribund” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
12.3	**Abnormal behaviour must be investigated to identify its cause, and effective prevention strategies must be implemented to prevent recurrence.**	**Important**

The auditor shall verify that the farm personnel observe the behaviour of the stock and investigate abnormal behaviour of fish stock (see Point 12.1 above) in order to identify the cause of the issue and prevent reoccurrence by implementing effective prevention strategies.

Requirement		Level
12.4	**Fish should be shoaling or schooling (i.e., group swimming with polarized orientation).**	**Important**

The auditor shall verify that the farm personnel observe the swimming behaviour of the stock and verify that the fish are shoaling or schooling, *i.e.,* group swimming with polarized orientation (see Point 12.1 above).

Requirement		Level
12.5	**Aggression events should be absent in 5 consecutive minutes of observation (minimum).**	**Important**

The auditor shall verify that the farm personnel observe and monitor any aggression events and ensure that these events are absent in a minimum of 5 consecutive minutes of observation (see Point 12.1 above).

Requirement		Level
12.6	**Abnormal, vacuum or stereotypical behaviour should be absent in 5 consecutive mins. of observation (minimum).**	**Important**

The auditor shall verify that the farm personnel observe and monitor any abnormal, vacuum or stereotypical behaviour and ensure that these events are absent in a minimum of 5 consecutive minutes of observation (see Point 12.1 above).

The term “abnormal behaviour”, “vacuum behaviour” and “stereotypical behaviour” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
12.7	**Anticipatory behaviour must be apparent before feeding routines.**	**Important**

The auditor shall verify that the farm personnel observe and monitor that stock show anticipatory behaviour before routine feeding events.

Requirement		Level
12.8	**If individual observation is possible in detail, ventilatory activity should be normal (50-70 opercular beats per min. (bpm)); hyperventilation (>90 bpm) should be absent at all times. Abnormal values must be reported to the welfare specialist.**	**Important**

The auditor shall verify that the farm personnel observe and monitor the ventilatory activity of individuals, ensuring ventilatory activity is within the acceptable range, *i.e.,* 50-70 opercular beats per min. (bpm). Hyperventilation (>90 bpm) must be absent at all times.
Abnormal ventilatory activity must be reported to the fish welfare specialist.

The term "fish welfare specialist" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
12.9	**Swimming activity should be regular, without major or sudden changes.**	**Important**

The auditor shall verify that the farm personnel observe the swimming behaviour of the stock and verify that swimming activity is regular and without any sudden changes (see Point 12.1 above).

Requirement		Level
12.10	**Before transfer to on-growing sites, a sample of ca. 100 fish must be examined at the point of weight sampling for the following outcomes: a) fin damage, b) opercular damage, c) eye damage, d) spine or jaw deformities, e) poor skin condition.**	**Recommended**

The auditor shall verify that, before transfer to on-growing units, a subsample of *c.* 100 fish are sampled and examined for the following operational welfare indicators: a) fin damage, b) opercular damage, c) eye damage, d) spine or jaw deformities, e) poor skin condition. (See Noble et al. (2018). Welfare Indicators for farmed Atlantic salmon: tools for assessing fish welfare).

Requirement		Level
12.11	**Farmers should be aware of, and consider the use of, new technology that improves the welfare of fish.**	**Recommended**

The auditor must ensure that farm personnel are aware of and consider the use of new technology to improve fish welfare.

Requirement		Level
12.12	**Farmers should have access to reliable and relevant information on fish welfare.**	**Recommended**

The auditor must ensure that farm personnel have access to reliable and relevant information on fish welfare.

Requirement	Level

12.13	**Farmers must implement a protocol to perform routine monitoring and assessment of fish welfare status in their facilities, i.e., an internal evaluation based on welfare indicators.**	**Important**

The auditor shall verify that the farm personnel observe, monitor, and assess on a routine and regular basis the fish welfare status of their stock according to acknowledged fish welfare indicators. (See Noble et al. (2018). Welfare Indicators for farmed Atlantic salmon: tools for assessing fish welfare).

Stocking and mortality

The requirements listed in this section refer to stocking or stocking density and mortality in the units of production. Stocking density (which can also be termed density or rearing density) is typically stated as being the "density of fish at any point in time" within the rearing system and is generally expressed as kg/m^3.

The terms "stocking", "stocking density" and "mortality" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
13.1	**Fish stock numbers, average weight, and total biomass must be monitored weekly. Records for monitoring and documentation must be available for inspection.**	**Important**

The auditor shall verify that fish stock numbers or stocking density, in terms of fish stock numbers, average weight and hence total biomass of production units, are monitored on a weekly basis and that these internal records and documentation are available.

The terms "stocking density" and "biomass" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement	**Level**

13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
13.3	**Mortality must be checked daily, and dead fish should be removed from the water immediately. Mortality records must be available at inspection.**	**Important**

The auditor shall verify that any mortality events are recorded, that dead fish are removed from production units and that these internal records and documentation are available. Mortality rates should not exceed 1% of biomass per month.

The term "mortality" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
13.4	**Deviation from expected mortalities (included in the Veterinary Health Plan) must be discussed with a Veterinary and a Welfare specialist.**	**Important**

The auditor shall verify that and deviations from expected mortality which is outlined in the Veterinary Health Plan or Fish Health and Welfare plan is discussed with a Veterinarian and an Aquatic animal health professional.

The term "Fish Health and Welfare Plan", "Aquatic animal health professional" and "Veterinarian" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
13.5	**Records for mortality causes must be in place per production unit. Operators must show awareness of mortality causes at inspection.**	**Important**

The auditor shall ensure that farm personnel are aware of causes of mortality events and that records are in place for inspection.

The term “mortality” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
13.6	**When unexplained mortalities exceed ≥ 0.5% per day, samples are submitted for analysis by a veterinarian.**	**Important**

The auditor must ensure that any mortality events that exceed 0.5% per day are recorded and a sample is submitted to a veterinarian to ascertain the cause of death.

The term “mortality” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
13.7	**Managers must:** **a) ensure that all staff working with stock are trained and competent in aspects of fish husbandry and welfare, relevant to their duties;** **b) ensure that staff working with stock must have attended a recognised fish welfare course.**	**Important**

The auditor shall ensure that all farm personnel are fully trained in fish husbandry and able to assess the welfare of stock and that they have attended a recognised fish welfare course.

Requirement		Level
13.8	**Operators must be able to demonstrate their proficiency in procedures that have the potential to cause pain or distress, including handling, crowding and culling.**	**Important**

The auditor must verify that farm personnel are proficient in any routine procedures that may negatively impact fish welfare, *e.g.* crowding, culling, grading, vaccination, *etc*.

The terms "crowding", "culling" and "vaccination" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
13.9	**Stock-keepers must be able to recognise indicators of poor welfare in fish, including abnormal behaviour, physical injury and symptoms of disease.**	**Important**

The auditor must verify that all farm stock-keepers are able to recognise indicators of poor fish welfare.

Broodstock and eggs

The principles of broodstock management require that biological (particularly reproductive) characteristics are well understood and used to create a culture environment that enables the organism to reach advanced stages of maturation, vitellogenesis (development of eggs or oocytes) and spermiation (development of sperm or milt) from which the spawning can be obtained with adequate egg quality and quantity for commercial hatchery production. Each fish species exhibits different reproductive strategies; however, the environment is the common factor that directly and indirectly controls the progress of reproduction and spawning success. When the correct environmental signals are not present, maturational development does not proceed

development is arrested or, in extreme cases, maturational development may be suspended, and developing oocytes or eggs may enter atresia or reabsorption.

The terms “broodstock” and “eggs” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species.**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving many males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Sparus aurata:*

- **Ratio of sexes is 2 males: 1 female.**

The terms “broodstock” and “spawning” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 3 kg/m^3 both for stocking and spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Sparus aurata:*

- **Density of spawners must be kept < 3 kg/m^3 both for stocking and spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.3	**Tank sizes must be > 5 m^3 and > 1 m deep, rounded or avoiding angles, and contain structural enrichment, provided that it does not hinder fish swimming activities or tank cleaning operations.**	**Important**

The captive environment can be very different from the natural environment, and optimal captive environmental conditions should be maintained to promote reproductive activity. The auditor must confirm that broodstock holding tanks are > 5m^3 and > 1m deep, rounded or avoiding angles, and contain structural enrichment, provided that it does not hinder fish swimming activities or tank cleaning operations.

The term "structural enrichment" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variations, and ranges of their original habitat.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, *e.g.,* temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms “temperature” and “photoperiod” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Apart from natural spawning, other methods to promote spawning are not allowed.**	**Important**

The auditor must ensure that only natural spawning is implemented, *i.e.*, fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention. The auditor must ensure that other artificial methods are not used for propagation.

The term “natural spawning” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree-days (about 2 days at 19-20 ºC).**	**Important**

Hatching success and viability of larvae are an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions relevant to the cultured species and that internal records and documentation are available.

Specific requirements for *Sparus aurata:*

- eggs are maintained in dim light or darkness to reduce mortality;
- eggs must not be handled after placement for 40-45 degree-days (about 2 days at 19-20 ºC)

The terms “eggs” and “degree-days” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.3.2 ON-GROWING REQUIREMENTS

FOS-Aqua Fish Welfare on-growing requirements are for the CBs’ use when assessing the welfare of farmed aquatic species at the on-growing stage of the production system.

Captive environment

The following requirements refer to the captive environment of the farmed fish species targeted by the unit of certification. In this case, it refers to *Sparus aurata* but is equally applicable to other species as outlined in Section 2.2.4. – 2.2.20.

The term “Captive Environment” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.1	**Production units should provide horizontal and vertical withdrawal space, optimising fish welfare conditions regarding spatial constraints.**	**Important**

The auditor shall verify that the units of production are suitable for on-growing stages they support. Aquaculture production units should be designed to create a restricted volume in which aquatic organisms are reared and provide the best conditions for growth and welfare. The enclosure dimensions, including depth, should permit active swimming and shoaling of the fish.

The terms “Production units” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.2	**Production units must not have sharp protrusions which may be injurious to the fish.**	**Important**

The auditor shall verify that the materials used to construct the production units are non-toxic, durable, and have a smooth internal surface to prevent abrasions to the fish.

The term "Production unit" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.3	**Production units and equipment must be checked for holes, faults and fouling. All equipment must be maintained regularly, and records must be ready for inspection.**	**Important**

The auditor shall check production unit integrity, ensuring that there is no damage leading to containment breaches and escapes of aquatic animals, *e.g.,* netting for cages and pens, anchoring systems, rings, *etc*., as well as equipment*, i.e.,* crowding nets, aeration equipment, *etc*. These should be tested and checked according to a regular schedule and maintained in good order. A program should be in place for regular preventative maintenance and repair of containment infrastructure and equipment. A reporting system shall be in place to indicate inspection results and preventative maintenance undertaken. In addition, all equipment and holding facilities should be easy to clean and to disinfect and should be cleaned and disinfected regularly and as appropriate.

The term "Production unit" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.4	**Farm design should be such that inspection of all stock is possible.**	**Important**

The auditor shall verify that the design of the production units allows regular inspection of stock using ROVs, underwater cameras, *etc*.
The term "stock" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Sparus aurata*:

- **500-1,000 luxes.**
- **Autumn-winter-spring spawning in North Atlantic latitudes, meaning 12-12 to 8-16 L:D photoperiod.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.6	**Production units must be of adequate depth to prevent damage from ultraviolet radiation, or shade must be provided if considered appropriate.**	**Important**

The auditor must verify that production units are of an adequate depth to prevent ultraviolet damage to the stock and shade must be used if considered appropriate.

The term “production unit” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.7	**Additional lighting, either fixed or portable, must be available, but should only be switched on to allow examination of the animals and equipment.**	**Important**

The auditor should verify that alternative light sources are available to allow inspection of stock at all times.

Requirement		Level
15.8	**Structural enrichment should be provided. If deemed impossible or harmful, another type of enrichment should be implemented (occupational, dietary, social, sensorial).**	**Recommended**

For some cultured species, environmental enrichment may be necessary to take account of their behavioural traits, *e.g.* feeding, hierarchy, *etc*., in order to enhance the welfare of fish. The auditor must ensure that the presence of enrichment does not compromise the safety of cultured fish, *i.e.,* abrasive or sharp protrusions.

Environmental enrichment is often divided into different categories, depending on the goals of the enrichment programme. Commonly recognized categories are:

- physical or structural enrichment, including modifications or additions to the tanks;
- sensory enrichment, which concerns stimulation of the sensory organs and the brain;
- dietary enrichment, encompassing type and delivery of food (note the distinction from nutrient enrichment, which concerns addition of nutrients to the feed);
- social enrichment, adding contact and interactions with conspecifics;
- occupational enrichment, relating to reduction of physical and psychological monotony by introducing variation to the environment and possibilities for exercise and performance of preferred behaviours.

The terms “enrichment” and “structural enrichment” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The cages should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the cage at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noise generated by marine traffic from different types of boats, *etc*.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Sparus aurata*:

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

Water

The requirements listed in this section refer to the monitoring of water quality in the aquaculture production units. Aquaculture animals should be kept under farming conditions suitable for the species concerned, in particular taking into account water temperature and quality. Water quality is key in maintaining fish welfare and in reducing stress and the risk of disease. Water-quality parameters should at all times be within the acceptable range that sustains normal activity and physiology for a given species. The definition of acceptable range is complicated as the requirements of individual species may vary between different life-stages, *e.g.,* larvae, juveniles, adults, or according to physiological status, *e.g.,* metamorphosis, spawning, feeding, previous history of exposure.

These water quality parameters should include temperature, salinity, dissolved oxygen concentration, pH, ammonia and nitrite concentrations, and some index of solids

concentration*, i.e.,* transparency, turbidity or total suspended solids concentration, and shall be measured regularly, as determined by culture system type and stocking density.

The term "water quality" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.1	**A contingency plan must exist to correct water quality parameters when they deviate from reference values.**	**Important**

The auditor shall ensure that water quality parameters within production units are routinely measured and fall within the tolerance range. Regular monitoring as part of good husbandry practices should be carried out, and a contingency plan should be in place to allow corrective measures, *i.e.,* removal and replacement of culture water, addition of oxygen, *etc*., to be taken if levels fall outside acceptable ranges/reference values. The auditor, in addition, will identify internal records of routine testing and reporting.

The terms "production unit", "water quality" and "stocking density" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 11 and 30 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Sparus aurata*:

- **Optimum range is between 11 and 30 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

<u>Animal health and animal welfare</u>

The following requirements specifically refer to the fish health and welfare requirements of

the cultured species. The term 'welfare' addresses the "physical and mental health and wellbeing of an individual or group" (Cambridge Dictionary, 2018). Assuming that observation of natural behaviour is a key indicator of the welfare of captive animals, then behavioural observational tools are the best way to understand both physiological and mental state of the animal (Saraiva, J.L. et al. 2019). [See above Fish Welfare in Abbreviations and Definitions for detailed description.]

The term "animal health and animal welfare" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
17.1	**Each site must either employ a qualified fish vet or have access to one.**	**Important**

The auditor must ensure that the unit of certification either employs a qualified fish veterinarian or has access to one.

The term "veterinarian" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
17.2	**Each site must either employ a qualified fish welfare specialist or have regular access to one.**	**Important**

The auditor must ensure that the unit of certification either employs a fish welfare specialist or has regular access to one.

The term "fish welfare specialist" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
17.3	**All sites must have a documented fish health and welfare plan.**	**Important**

This requirement specifically refers to a fish health and welfare management plan, which has been used historically in many terrestrial animal production systems to provide a

formal veterinary health planning strategy and can offer a useful basis not only for maintaining strict health and welfare standards within the industry but also as a gauge for quality assurance or certification schemes within that sector. The auditor must ensure that the production unit has a valid fish health and welfare plan in place and that it is updated on an annual basis.

The term "fish health and welfare plan" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
17.4	**The documented fish health and welfare plan must be reviewed on at least an annual basis by an experienced fish veterinary and welfare specialist.**	**Important**

The auditor must ensure that the fish health and welfare plan is reviewed on an annual basis.
The terms "fish health and welfare plan", "veterinarian", and "fish welfare specialist" are defined in Section 1.4 – Definitions and Abbreviations.

Feeding

The following requirements specifically refer to the feed and feeding requirements of the cultured species in the unit of production.

Requirement		Level
18.1	**The farm must implement a system that ensures appropriate feed logistics (storage, transport, distribution, traceability), records, and contingency plans.**	**Important**

The auditor shall verify and report on evidence that the unit of certification complies with the Code of Practice on good animal feeding. See Codex Alimentarius Commission (2004) Code of Practice for Fish and Fishery Products. Aquaculture. CAC/RCP 52-2003 for technical guidance:

- Feed and fresh stocks should be purchased, rotated, and used before the expiry of their shelf-life.

- Dry fish feeds should be stored in cool and dry areas to prevent spoilage, mould growth, and contamination. Moist feed should be properly refrigerated according to manufacturer instructions.
- Feed ingredients should not contain unsafe levels of pesticides, chemical contaminants, microbial toxins, or other adulterating substances.
- Industrially produced complete feeds and industrially produced feed ingredients should be properly labelled. Their composition must fit the declaration on the label, and they should be hygienically acceptable.
- Ingredients should meet acceptable, and if applicable, statutory standards for levels of pathogens, mycotoxins, herbicides, pesticides and other contaminants that may give rise to human health hazards.
- Only approved colours of the correct concentration should be included in the feed.
- Moist feed or feed ingredients should be fresh and of adequate chemical and microbiological quality.
- Fresh or frozen fish should reach the fish farm in an adequate state of freshness.
- Fish silage and offal from fish, if used, should be properly cooked or treated to eliminate potential hazards to human health.
- Feed that is compounded industrially or at the fish farm should contain only such additives, growth-promoting substances, fish flesh colouring agents, antioxidizing agents, caking agents or veterinary drugs that are permitted for fish by the official agency having jurisdiction.
- Products should be registered with the relevant national authority as appropriate.
- Storage and transportation conditions should conform to the specifications on the label.
- Veterinary drugs and other chemical treatments should be administered in accordance with recommended practices and comply with national regulations.
- Medicated feeds should be clearly identified on the package and stored separately, to avoid errors.
- Farmers should follow manufacturer instructions on the use of medicated feeds.
- Product tracing of all feed ingredients should be assured by proper record-keeping.

The term “feed” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
18.2	**The farm must ensure that feeding regimes are carried out according to the manufacturer's guidelines, farmer experience, and feeding behaviour. Adjustments to feeding regimes should be based on fish behaviour, appetite, expected biomass, and minimisation of feed waste.**	**Important**

The auditor must ensure that there is strict adherence to the manufacturer's feeding guidelines as well as routine monitoring of group feeding behaviour of the cultured species. These observations and routine calculation of stock biomass will allow feeding regimens to be adjusted to suit stock and avoid overfeeding and deterioration of water quality due to excess feed. The auditor should be able to identify internal records of routine observations, monitoring, and reporting of these activities. Verification of appropriate record keeping and suitable documentation from feed manufacturers is also expected.

The term "feeding regimen" and "biomass" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
18.3	**Feed must be dispensed and spread throughout the rearing space to minimise the risk of over- and under-feeding and to reduce feeding competition.**	**Important**

The auditor must verify that feed is dispensed in a way that maximises feeding efficiency, avoids over- and under-feeding and reduces feeding competition, *e.g.,* evidence of an even distribution of fish sizes at grading events, absence of cannibalism, minimal feed left a few hours after feeding event, *etc*.

The term "feed" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
18.4	**Fish must be observed at least once per day during feeding , and feeding behaviour should be registered. Records must be available for inspection.**	**Important**

The auditor must ensure that the feeding activity and feeding behaviour of the fish are observed at least once per day by site personnel during a feeding event and be able to identify internal records of routine monitoring and reporting of these activities. Personnel do not necessarily require specific training, but procedures should be supervised by a trained person.

Handling and manipulation procedures

The following requirements refer to handling and manipulation procedures of stock fish that can include crowding, transfers, counting, weighing, grading, chemical treatments, vaccination, transportation, *etc*. During handling operations, aquatic animals experience stress and should be handled in a way that limits the stress experienced. The farm shall have Standard Operating Procedures (SOPs) in place for handling operations.

The terms "crowding", "SOP", "treatment", "grading", "vaccination" and "transportation" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
19.1	**Fish must be protected at all times from avoidable injuries, pain and stress. Farm operators must be able to demonstrate awareness at inspection.**	**Important**

Aquatic animals that are concentrated during handling and manipulation procedures experience stress, and farm personnel shall be trained in their roles and responsibilities in maintaining the welfare of farmed aquatic animals. The auditor shall ensure that fish are protected from avoidable injuries, pain and stress whilst operations are carried out, and that farm personnel are fully trained in recognising abnormal behaviour and stress during and immediately after the procedure, and that SOPs are in place. In addition, internal records and documentation should be maintained of any handling events.

Requirement		Level
19.2	**Cleaning and maintenance operations must be carried out with minimal impact to fish welfare and health.**	**Important**

The auditor shall ensure that routine observations of fish during routine cleaning and

maintenance operations, *i.e.,* net inspections, mort removals, net washing, *etc*., are carried out, and that farm personnel are fully trained in recognising abnormal behaviour and stress during and immediately after the procedures and that SOPs are in place. In addition, internal records and documentation should be maintained of any cleaning and maintenance events.

Requirement		Level
19.3	**Live fish must only be removed from water and handled where absolutely necessary. The maximum emersion time without anesthesia is 15 seconds.**	**Important**

Aquatic animals that are concentrated during handling operations experience stress, and any handling operations should be conducted in a way to minimise stress, including limiting crowding time and time out of water. Time spent out of the water without anesthesia must be no more than 15 seconds. The auditor shall ensure that internal records and documentation are in place for all handling procedures.

The term “anesthesia” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
19.4	**When fish are handled, adequate support must be given to the body: live fish should never be held by the gills or tail only and/or thrown.**	**Important**

The auditor must ensure that, while fish are out of the water, they should be handled with wet gloves or wet hands and on a moist surface to avoid scale and mucus loss. Particular attention should be paid to handling practices to avoid desiccation, suffocation, and other injury. While out of the water, fish must be fully supported at the head and tail end, *i.e.,* not held by opercular/gill structures or tail in order to prevent vertebral damage. The auditor shall ensure that internal records and documentation are in place for all handling procedures.

Requirement		Level
19.5	**Handling nets must be of a suitable size and ideally knotless. They must be kept clean, disinfected after use, and replaced when damaged. Their design must be as to not risk injuring the fish. If equipment other than nets is used, it must be in good condition and without protrusions.**	**Important**

When handling fish, nets with an appropriate frame and mesh size should be used. Knotted net mesh should be avoided to prevent scale loss and mechanical injury. Nets should be disinfected and rinsed in clean water before use. The auditor must ensure that farm personnel are aware that appropriate net design, type, and mesh size are used to minimise injury to fish and that netting equipment used for handling operations should be maintained in good working order, disinfected after use, and should be maintained and used in ways that minimize the potential for animal injuries. In case other equipment apart from nets is used, it must be in good condition and without protrusions.

Vaccination

The following requirements refer to vaccination procedures of stock at the unit of production. Vaccination is an important procedure in modern aquaculture to protect and prevent disease outbreaks and, as a general rule, fish are vaccinated early in their production phase. Vaccines are used to boost immunity to certain infectious diseases and are part of a Veterinary Health and Welfare Plan. Staff will be appropriately trained before undertaking the vaccination procedure.

The term “vaccination” and “Veterinary Health and Welfare Plan” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
20.1	**All vaccination procedures must be conducted with care and with the minimum possible distress caused to the fish.**	**Important**

The vaccination of farmed aquatic species has dramatically decreased the number of outbreaks of historically important bacterial diseases in farmed fish stocks. As a result, mortalities have decreased considerably; there has been a concomitant marked reduction in

antibiotic use and animal welfare has improved. Although the vaccine and the vaccination process can potentially have negative impacts on welfare, it is accepted that the vaccination of fish with current vaccines results in a net benefit for both fish health and welfare (Midtlyng, 1997; Berg et al., 2006; Evensen, 2009). SOPs should be in place to ensure that vaccination is carried out in a manner that is efficacious.

The auditor shall verify that vaccination procedures are conducted with care and that fish are protected from avoidable injuries, pain and stress whilst operations are carried out. The auditor must also ensure farm personnel are fully trained in recognising abnormal behaviour and stress during and immediately after the vaccination procedure and that SOPs are in place. In addition, the auditor shall report evidence that the unit of certification maintains internal records and documentation of any vaccination events.

The terms “vaccine”, “vaccination” and “treatment” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
20.2	**All fish must be sedated before being injected, unless there are clear health and welfare reasons not to.**	**Important**

The auditor must verify that all fish are sedated prior to vaccination procedures in order to minimise distress and report evidence that the unit of certification maintains internal records and documentation. Anaesthesia of fish is usually administered prior to vaccination as it decreases the stress due to vaccination, prevents mechanical injury and helps the fish recover faster from the process.

The term “sedation” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
20.3	**Vaccines and anaesthetics must be used according to the manufacturer's data sheet, unless otherwise specified by a vet. Vaccine use must be recorded in the Veterinary Health and Welfare Plan.**	**Important**

The auditor must ensure that all vaccines and anaesthetics are used in accordance with the manufacturer's data sheets unless specified by the Veterinarian and that vaccine use is delineated in the Veterinary Health and Welfare Plan. In addition, the auditor shall report evidence that the unit of certification maintains internal records and documentation of any vaccination events and vaccine usage.

The terms "Veterinary Health and Welfare Plan", "vaccine" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
20.4	**There must be back-up systems and contingency plans in place to deal with vaccination system malfunctions and breakdowns in order to safeguard the welfare of the fish.**	**Important**

The auditor shall verify and report evidence that the unit of certification has contingency plans in place in the form of back-up systems that will minimise distress to the fish in the case that there is a malfunction of the vaccination system. This may include emergency external oxygen supplies, back-up holding tanks, *etc*.

Grading

The requirements listed in this section refer to grading procedures during on-growing. Grading of fish stocks is conducted for a variety of reasons, *e.g.,* for removing small or abnormal fish, to prevent cannibalism and to select fish for harvest. Grading can be a stressful and potentially harmful procedure for the fish; therefore, fish should only be graded when essential, and in general, all handling of fish should be minimised. Grading can be conducted in a variety of ways throughout the production cycle; it can be performed manually with small fish, with the use of grading machines, or passively with flexible net

panels or similar. Grading is also conducted using well boats from sea cages.

The term “grading” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
21.1	**Grading must be minimised and only be performed when absolutely necessary, e.g., before vaccination, to avoid cannibalism, before slaughtering.**	**Important**

Grading can be a stressful and potentially harmful procedure for the fish; therefore, fish should only be graded when essential and, in general, all handling of fish should be minimised. The auditor must also ensure farm personnel are fully trained in recognising abnormal behaviour and stress during and immediately after the grading procedure and that SOPs are in place. In addition, internal records and documentation should be maintained of any vaccination events.

The terms “grading”, “slaughter” and “cannibalism” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
21.2	**All grading equipment must be designed and maintained in order to prevent damage or cause stress to the fish (e.g., absence of protrusions to avoid injuries; fish should be kept submerged at all times).**	**Important**

The risks associated with grading include those associated with crowding and transfer when there is potential for hypoxia due to air exposure or exposure to water with low dissolved oxygen, and also potential for mechanical damage to the fish. The auditor must ensure that all grading equipment is designed and maintained in order to prevent unnecessary damage or distress to the fish and that fish are not exposed to air or hypoxic water during the procedures and that all grading procedures are observed. In addition, the auditor shall report evidence that the unit of certification maintains internal records and documentation of any grading events and routine equipment checking and maintenance and that all grading procedures are observed.

The term “grading equipment” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
21.3	**A written protocol/working procedure for grading must be in place and carried out at all times.**	**Important**

The auditor shall report evidence that the unit of certification maintains a SOP or written protocol/working procedure for any grading procedures and that internal records and documentation of any grading events exist.

Requirement		Level
21.4	**Fish must be monitored throughout the operation by a designated person who is responsible for identifying welfare issues and taking appropriate action if necessary.**	**Important**

The auditor must provide evidence that an Aquatic animal health professional oversees any grading operations and can identify and take appropriate action in the case of any welfare issues.

The term “Aquatic animal health professional” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
21.5	**If passive grading is used, the size and design of the grading panel must be appropriate for the size of fish that are to be graded, and the enclosure they are contained within.**	**Important**

A challenge associated with passive grading with nets or panels with appropriate gaps can be that fish nearing the size of the gaps may become stuck. However, passive grading is potentially less harmful to welfare since feed is not normally withdrawn and the fish are not pumped or handled. The auditor must ensure that all passive grading equipment is suitable to the size of the fish to be graded.

The term “passive grading” is defined in Section 1.4 – Definitions and Abbreviations.

Transportation

The requirements listed in this section refer to any transportation of fish population from the unit of certification. Transportation of fish is a complex and stressful event and therefore fish must be handled in a manner that protects their health, minimizes the length of the stressful event, and mitigates risks to any fish at the receiving site.

The term “transportation” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
22.1	**Transport must be planned in order to minimise possible adverse effects on fish welfare. Transport on land: max 8 h.**	**Important**

During transportation of live fish, it is important to reduce stress, as stressing fish can lead to deterioration in welfare. The auditor shall report evidence that the unit of certification maintains internal records and documentation of any transportation events and ensures that these transportation events do not exceed 8 h on land.

The term “transportation” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
22.2	**Water quality parameters (oxygenation, ammonia levels, pH, temperature) must be monitored during transport and match the arrival tanks. A surface skimmer must be present in all transport containers.**	**Important**

The auditor must verify that water quality is closely monitored and maintained at all times during transportation. Transport vessels should be equipped with supplemental oxygen tanks and air stones. Oxygen levels, ammonia, pH, and temperature should be checked and maintained throughout the transport procedures; frequency of monitoring will vary with the specifics of each transport. A surface or protein skimmer must be used in all transport

vessels. Water quality parameters must match those at the holding tanks at the destination. The auditor shall report evidence that the unit of certification maintains internal records and documentation.

The terms “water quality criteria”, “transportation”, “oxygen”, “pH”, “ammonia”, “temperature” and “protein skimmer” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
22.3	**Biosecurity and fish welfare should be considered before transporting fish populations.**	**Important**

The auditor shall ensure that the unit of certification considers all biosecurity and fish welfare issues before the movement of fish populations. The auditor shall report evidence that the unit of certification maintains internal records and documentation.

The term “biosecurity” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
22.4	**All equipment that the fish rely on for life support must be constantly monitored throughout the journey. Absence of protrusions (to avoid injuries) in the equipment is requested.**	**Important**

The auditor must ensure that all equipment for the transportation of live fish is designed for rapid and efficient handling without causing physical damage or stress, that mitigation measures, *i.e., a* secondary oxygen source, are in place during transportation and that there is an absence of protrusions in the equipment. Routine and regular monitoring of water quality parameters and fish welfare must be carried out throughout the journey. The auditor shall report evidence that the unit of certification maintains internal records and documentation.

Requirement		Level
22.5	**Water quality parameters must always comply with those described in the requirement FOS Aqua-inland rev 3 (requirements 8.1.1 to 8.1.11) and FOS Aqua Inland-Marine Rev. 4 (requirements 8.1.1 to 8.1.7)**	**Important**

The auditor must ensure that water quality parameters comply with those described in the requirements of FOS Aqua Inland Rev. 3 (requirements 8.1.1 to 8.1.11) and FOS Aqua Inland- Marine Rev. 4 (requirements 8.1.1 to 8.1.7). The auditor shall report evidence that the unit of certification maintains internal records and documentation.

The term "water quality parameters" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
22.6	**Supplementary oxygen or air supply must be sufficient to last 50% longer than the anticipated length of the journey (see Section 22.1 Transportation).**	**Important**

The auditor must verify that the unit of certification ensures that the water in the transportation tanks is well aerated before fish are transferred into them and that oxygen levels are maintained at all times during transportation. Transport vessels should be equipped with supplemental oxygen tanks and air stones and be sufficient to last 50% longer than the anticipated length of the journey. Oxygen levels should be checked and maintained throughout the transport procedures.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
22.7	**Excessive or rapid changes in water temperature or pH during transport must be avoided, unless there are clear health and welfare reasons to do so.**	**Important**

The auditor must ensure that sudden, high or rapid changes in water temperature or pH are avoided during transportation, unless there are clear health and welfare reasons to do so. The terms "temperature" and "pH" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
22.8	**Any fish that die during transportation must be separated from live fish as soon as possible after arrival. The cause of death must be determined by a competent person.**	**Important**

Only healthy and undamaged fish should be chosen for live storage and transportation. The auditor must verify that dead fish are removed from the transportation tank before introduction to the holding tank at the destination. The auditor shall report evidence that the unit of certification maintains internal records and documentation.

Requirement		Level
22.9	**Records of any deaths or injuries that occur during transportation must be kept.**	**Important**

The auditor shall report evidence that the unit of certification maintains internal records and documentation of any deaths that occur during transportation.
The term "transportation" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
22.10	**Contingency plans must exist for all frequent transport problems.**	**Important**

The auditor shall report evidence that contingency plans exist for any potential problems*, i.e.,* unacceptable deviations from acceptable water quality criteria, hypoxia, *etc*. These may include back-up oxygen supplies or aeration devices.

The term "transport" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
22.11	**Starvation before transport should not be longer than 50 degree-days and preferably just enough to achieve gut clearance (see Section 23 Starvation).**	**Important**

Before transportation of significant distance, it is advisable to deprive fish of food for a period sufficient to allow the gut to clear and reduce faecal contamination of the transport system. The auditor must verify that starvation before transport must not exceed 50 degree-days before transport of live fish. should occur during storage and transportation of live fish. The auditor shall report evidence that the unit of certification maintains internal records and documentation.

The term "starvation" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

Starvation

The requirements listed in this section refer to the practice of starvation; a period of starvation is regarded as a sound practice in aquaculture before handling, transportation and harvest, to minimise impacts on welfare and ensure proper hygiene after harvest.

The term "starvation" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
23.1	**Starvation periods must be justified.**	**Important**

Transportation of live fish is a stressful event involving handling, crowding, and exposure to varying water qualities; therefore, starvation is practiced for welfare concerns since there is a general understanding that starved fish are calmer and more tolerant of stress. The auditor shall verify that starvation periods are justified and shall report evidence that the unit of certification maintains internal records and documentation of any starvation events.

The term "starvation" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
23.2	**The period during which fish are deprived of food to achieve gut clearance prior to certain procedures, or harvesting must be appropriate and as minimal as possible. Unless justified, this must always be < 50-degree days.**	**Important**

Transportation of live fish is a stressful event involving handling, crowding and exposure to varying water qualities; therefore, starvation is practiced for welfare concerns since there is a general understanding that starved fish are calmer and more tolerant to stress. The auditor shall verify that starvation periods are appropriate and as minimal as possible and, unless justified, should always be less than 50 degree-days. The auditor, in addition, shall report evidence that the unit of certification maintains internal records and documentation of any starvation events.

The term “degree-days” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
23.3	**Feed withdrawal may form part of the response to the onset of adverse environmental conditions and in the treatment of certain diseases. Veterinary and welfare specialist advice should be sought, and appropriate feed withdrawal protocols should be included if deviation periods from above.**	**Important**

The auditor must ensure that Veterinary advice is taken before starvation of stock in the face of adverse environmental conditions or before treatments and report evidence that the unit of certification maintains internal records and documentation of these starvation events.

The term “Veterinary” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

The requirements listed in this section refer to requirements for crowding of fish stocks. Fish are crowded repeatedly throughout the aquaculture production cycle for various reasons such as vaccination, grading, transport, harvesting, and slaughter. During the on-growing stages, fish are crowded using sweep nets or by forcing the fish into a smaller volume by lifting part or all of the cage. The water exchange per biomass is reduced during crowding in cages, and the risk of low oxygen therefore increases unless oxygen is added to the water.

The term “crowding” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
24.1	**A written procedure for fish crowding must be validated by a welfare specialist and carried out every time.**	**Important**

The auditor shall ensure that a written procedure for fish crowding is in place and that a fish health and welfare specialist is present at crowding events to monitor water quality criteria and assess fish welfare. In addition, the auditor shall report evidence that the unit of certification maintains internal records and documentation of any crowding events.

The terms “crowding” and “fish health and welfare specialist” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
24.2	**Operators must be trained in the appropriate crowding techniques.**	**Important**

The auditor shall ensure that personnel are trained in the appropriate fish crowding techniques and shall report evidence that the unit of certification maintains internal records and documentation of any training.

The term “crowding” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
24.3	**The frequency and duration of crowding should be kept to the minimum and clearly justified. The period for fish crowding on any occasion must not exceed 1.5 hours for grading or treatments and 2 hours for harvest.**	**Important**

The auditor shall present evidence that the unit of certification maintains internal records and documentation of any crowding events and that these crowding events have a clear justification of purpose and do not exceed 1.5 hr for grading or treatments or 2 hr for harvest. In addition, crowding events must be carried out with the same fish stock no more than once per week.

The terms “crowding”, “grading” and “treatment” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
24.4	**Operators must monitor fish behaviour during crowding and take actions if fish show signs of stress or damage. Surface activity should never reach stage 4 on the crowd intensity scale.**	**Important**

The auditor must ensure that farm personnel monitor fish behaviour during crowding events according to SOPs and that surface activity is measured on the Crowd Intensity Scale according to the 'RSPCA welfare standards for farmed Atlantic salmon' (2018) as an indicator of stress.

Crowd intensity scale:

1 (Optimum). Essentially no fins breaking the surface of the water.

2 (Acceptable). Fins above the water over a small part of the surface of the crowd.

3 (Undesirable). Fins and part of the fish above the water over the whole surface of the crowd. Some burrowing, gasping, and vigorous activity in parts of the crowd.

4 (Unacceptable). The whole surface of the crowd vigorously burrowing, gasping, and splashing.

5 Whole surface of the pen boiling with violent splashing.

The term "crowding" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Gilthead sea bream: > 6 mg/L. See Section 16 Water.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for Gilthead sea bream: > 6 mg/L.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Culling

The requirements listed in this section refer to requirements for culling.

The term “culling” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
25.1	**Any seriously sick or injured fish, or fish found not to be recovering, must be immediately removed and humanely killed without delay.**	**Important**

The auditor must verify that any fish which are unlikely to recover from a condition or are likely to be experiencing pain or distress are humanely killed or culled promptly in order to prevent pain and suffering. The auditor shall also report evidence that the unit of certification maintains internal records and documentation of any such culling activities.

The term “culling” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
25.2	**Fish must only be culled using an overdose of anesthetic.**	**Important**

The auditor shall report evidence that the unit of certification only carries out culling with an overdose of anaesthesia and maintains internal records and documentation of any training required in such procedures.

The terms “culling” and “anaesthesia” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
25.3	**Culling of any fish must only be conducted by suitably trained and competent people.**	**Important**

The auditor shall also report evidence that the unit of certification only uses suitably trained and competent personnel to carry out culling procedures and maintains internal records and documentation of any training.
The term "culling" is defined in Section 1.4 – Definitions and Abbreviations.

Welfare assessment

The requirements listed in this section refer to the welfare assessment of farmed fish stocks during the on-growing stage. Farmed aquatic species experience numerous stressors that can affect welfare that can include handling, crowding, transport, grading, vaccination, chemical or therapeutic treatment, stocking density, water quality, light, feed supply and the threat of parasites and diseases. Changes in behaviour, *e.g.,* ventilatory activity, aggression, individual and group swimming behaviour, stereotypic and abnormal behaviour, have been linked with acute and chronic stressors in aquaculture and can therefore be regarded as likely indicators of poor welfare. Welfare assessment can be carried out with the observation of operational welfare indicators can be measured by farm personnel trained to recognise normal and abnormal behaviours, indicators of physical health, variations in water quality, *etc*. Regular inspections of the culture facility, water quality analysis, and assessment of the behaviour and condition of fish stocks should be conducted regularly.

The term "welfare assessment" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
26.1	**Appropriate systems for on-site or remote behavioural observations must be implemented: fixed or mobile live cameras underwater (preferred), live surface observations (if the previous is not possible), surface windows, or others. Behavioural observations should be regularly recorded**	**Important**

	during routine procedures or any other action that can cause stress or discomfort to fish, in order to identify caveats and improve protocols.	

Behaviour represents a reaction to the environment as fish perceive it and is therefore a key element of fish welfare. The auditor shall safeguard that the unit of certification employs both on-site*, i.e.,* physical observations by farm personnel, and (preferred) remote, *i.e.,* fixed or mobile live underwater cameras, to monitor fish behaviour and allow identification of indicators of stress or welfare concerns. These behavioural observations may include any abnormalities in normal swimming and schooling behaviour, *i.e.,* panic, aggressive events, isolated individuals, *etc*. (see Points 12.2 – 12.13 below). The auditor shall also report evidence that the unit of certification keeps documented evidence, *e.g.,* videos, of behavioural patterns.

Requirement		**Level**
26.2	**Fish must be inspected on a daily basis and dead or moribund fish should be removed, minimising handling to avoid stress to the live fish within the enclosure (see Section 25 Culling).**	**Important**

The auditor shall verify that the unit of production maintains internal records and documentation of daily inspection of stock and removal of moribund fish.

The term “moribund” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
26.3	**Abnormal behaviour must be investigated to identify its cause, and effective prevention strategies must be implemented to prevent recurrence.**	**Important**

The auditor shall verify that the farm personnel observe the behaviour of the stock and investigate abnormal behaviour of fish stock (see Point 26.1 above) in order to identify the cause of the issue and prevent reoccurrence by implementing effective prevention strategies.

Requirement		Level
26.4	**Fish should be shoaling or schooling (i.e., group swimming with polarized orientation).**	**Important**

The auditor shall verify that the farm personnel observe the swimming behaviour of the stock and verify that the fish are shoaling or schooling, *i.e.,* group swimming with polarized orientation (see Point 26.1. above).

Requirement		Level
26.5	**Aggression events should be absent in 5 consecutive minutes of observation (minimum).**	**Important**

The auditor shall verify that the farm personnel observe and monitor any aggression events and ensure that these events are absent in a minimum of 5 consecutive minutes of observation (see Point 26.1 above).

Requirement		Level
26.6	**Abnormal, vacuum, or stereotypical behaviour should be absent in 5 consecutive mins. of observation (minimum).**	**Important**

The auditor shall verify that the farm personnel observe and monitor any abnormal, vacuum, or stereotypical behaviour and ensure that these events are absent in a minimum of 5 consecutive minutes of observation (see Point 26.1 above).

The term “abnormal behaviour”, “vacuum behaviour” and “stereotypical behaviour” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
26.7	**Anticipatory behaviour must be apparent before feeding routines.**	**Important**

The auditor shall verify that the farm personnel observe and monitor that stock show anticipatory behaviour before routine feeding events.

Requirement		Level
26.8	**Swimming activity should be regular, without major or sudden changes.**	**Important**

The auditor shall verify that the farm personnel observe the swimming behaviour of the stock and verify that swimming activity is regular and without any sudden changes (see Point 26.1 above).

Requirement		Level
26.9	**Before transfer to on-growing sites, a sample of ca. 100 fish must be examined at the point of weight sampling for the following outcomes: a) fin damage, b) opercular damage, c) eye damage, d) spine or jaw deformities, e) poor skin condition.**	**Recommended**

The auditor shall verify that before transfer to on-growing units, a subsample of *c.* 100 fish are sampled and examined for the following operational welfare indicators: a) fin damage, b) opercular damage, c) eye damage, d) spine or jaw deformities, e) poor skin condition. (See Noble et al. (2018)). Welfare Indicators for farmed Atlantic salmon: tools for assessing fish welfare.

Requirement		Level
26.10	**Farmers should be aware of, and consider the use of, new technology that improves the welfare of fish.**	**Recommended**

The auditor must ensure that farm personnel are aware of and consider the use of new technology to improve fish welfare.

Requirement		Level
26.11	**Farmers should have access to reliable and relevant information on fish welfare.**	**Important**

The auditor must ensure that farm personnel have access to reliable and relevant information on fish welfare.

Requirement		Level
26.12	**Farmers must implement a protocol to perform routine monitoring and assessment of fish welfare status in their facilities, i.e., an internal evaluation based on welfare indicators.**	**Important**

The auditor shall verify that the farm personnel observe, monitor, and assess on a routine and regular basis the fish welfare status of their stock according to acknowledged fish welfare indicators. (See Noble et al. (2018)). Welfare Indicators for farmed Atlantic salmon: tools for assessing fish welfare).

Stocking and mortality

The requirements listed in this section refer to stocking or stocking density and mortality in the units of production. Stocking density (which can also be termed density or rearing density) is typically stated as being the "density of fish at any point in time" within the rearing system and is generally expressed as kg/m^3.

The terms "stocking", "stocking density" and "mortality" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
27.1	**Fish stock numbers, average weight, and total biomass must be monitored weekly. Records for monitoring and documentation must be available for inspection.**	**Important**

The auditor shall verify that fish stock numbers or stocking density, in terms of fish stock

numbers, average weight and hence total biomass of production units, are monitored on a weekly basis and that these internal records and documentation are available.

The terms “stocking density” and “biomass” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 26 Welfare Assessment). Limit stocking to 20 kg/m^3 max. Water quality must be monitored frequently and on demand.**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

The terms “stocking density” and “water quality” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
27.3	**Mortality must be checked daily, and dead fish should be removed from the water immediately. Mortality records must be available at inspection.**	**Important**

The auditor shall verify that any mortality events are recorded, that dead fish are removed from production units, and that these internal records and documentation are available. Mortality rates should not exceed 1% of biomass per month.

The term “mortality” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
27.4	**Deviation from expected mortalities (included in the Veterinary Health Plan) must be discussed with a Veterinary and a Welfare specialist.**	**Important**

The auditor shall verify that and deviations from expected mortality which is outlined in the Veterinary Health Plan or Fish Health and Welfare plan is discussed with a Veterinarian and an Aquatic animal health professional.

The term "Fish Health and Welfare Plan", "Aquatic animal health professional" and "Veterinarian" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
27.5	**Records for mortality causes must be in place per production unit. Operators must show awareness of mortality causes at inspection.**	**Important**

The auditor shall ensure that farm personnel are aware of causes of mortality events and that records are in place for inspection.

The term "mortality" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
27.6	**When unexplained mortalities exceed ⩾0.5% per day, samples are submitted for analysis by a veterinarian.**	**Important**

The auditor must ensure that any mortality events that exceed 0.5% per day are recorded and a sample is submitted to a veterinarian to ascertain the cause of death.

The term "mortality" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
27.7	**Managers must:**	**Important**
	a) ensure that all staff working with stock are trained and competent in aspects of fish husbandry and welfare, relevant to their duties; **b) ensure that staff working with stock must have attended a recognised fish welfare course.**	

The auditor shall ensure that all farm personnel are fully trained in fish husbandry and able to assess welfare of stock and that they have attended a recognised fish welfare course.

Requirement		Level
27.8	**Operators must be able to demonstrate their proficiency in procedures that have the potential to cause pain or distress, including handling, crowding and culling.**	**Important**

The auditor must verify that farm personnel are proficient in any routine procedures that may negatively impact fish welfare, *e.g.* crowding, culling, grading, vaccination, *etc*.
The terms "crowding", "culling" and "vaccination" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
27.9	**Stock-keepers must be able to recognise indicators of poor welfare in fish, including abnormal behaviour, physical injury and symptoms of disease (see Section 26 Welfare Assessment).**	**Important**

The auditor must verify that all farm personnel are able to recognise indicators of poor fish health and welfare.

Harvesting, stunning and slaughter

The requirements in this section refer to harvesting, stunning and slaughter of fish stock within the unit of certification. Appropriate harvesting techniques should be applied to minimise physical damage and stress throughout the process.

The terms “harvesting”, “stunning” and “slaughter” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
28.1	**Harvesting can only be performed using fish pumps. The dimensions of pumps and tubes must be scaled to the operation and approved by an engineer. The maximum flow rate should be 3m/s.**	**Important**

Fish being moved via live haul to be harvested will be moved into transport vessels via pumps and must be handled in a stress-free manner. The auditor must ensure that only dedicated fish pumps are used and that the dimensions of these pumps and associated tubing is suitable for the size of the fish being moved. The auditor shall also gather evidence that there are appropriate observations and relevant documentation of any procedures relating to harvesting.

Note: Pipes used for pumping fish should have smooth surfaces and minimal bends. Water flow during fish pumping must be neither excessive nor inadequate.

The term “harvesting” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
28.2	**The only permitted stunning and subsequent killing methods are:** **a) an effectively applied percussive blow,** **b) electronarcosis followed by bleeding, asphyxia or other slaughter method that must be applied while the fish is unconscious, c) electrocution (i.e., killing by electrical current).**	**Important**

Chapter 7.3 of the OIE Aquatic Animal Health Code (2019) provides detailed guidance on welfare aspects of stunning and killing of farmed fish for human consumption. The choice of stunning and killing method should be appropriate for the species and life stage of the relevant fish species. Stunning should be sufficient to render fish unconscious rapidly, as indicated by lack of opercular movement or other indicators. The auditor must verify that only permitted stunning and slaughter methods are used, *i.e.*:

a) an effectively applied percussive blow,

b) electronarcosis followed by bleeding, asphyxia or other slaughter method that must be applied while the fish is unconscious,

c) electrocution (i.e., killing by electrical current).

The auditor shall also gather evidence that there are appropriate observations and relevant documentation of any procedures relating to stunning and slaughter.

The terms "bleeding" and "stunning" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
28.3	**A backup system, e.g., 'priest' must be available throughout the killing process.**	**Important**

It is important to observe fish immediately after stunning. In a properly stunned fish, a reflex shudder or tail flap will usually occur for a few seconds after stunning. The auditor must confirm that a priest, *i.e.,* a manual tool for killing fish, is available as a back-up during the procedures.

Requirement		Level
28.4	**Any fish that fall to the ground during the process must be humanely killed with the main or back-up system.**	**Important**

The auditor must ensure that farm personnel are aware that any fish that exits the stunning and slaughter processing line and falls to the ground must be immediately killed by the main system (Section 28.2) or the back-up system (Section 28.3).

Requirement		Level
28.5	**External damage such as scale loss, fin erosion, predator bites, lesions resulting from aggression, handling scars, parasite lesions and deformities must be noted at slaughter or upon arrival to the processing station.**	**Important**

The auditor must gather evidence that fish are observed and that any external damages such as scale loss, fin erosion, predator bites, lesions, handling scars and deformities are noted at slaughter or upon arrival to the processing station, and that there is relevant documentation.

Requirement		Level
28.6	**All staff involved with the stunning and killing process must have received full training.**	**Important**

The auditor must verify that each person involved in killing is aware of the importance of good killing practice, *i.e.,* to rapidly and effectively apply stunning and slaughter to minimise stress, and that they have received full training.

The terms "stunning" and "slaughter" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
28.7	**There must be a named person responsible for fish welfare throughout the killing process. This person is responsible for harvest records, including stunning and slaughtering efficiency.**	**Important**

The auditor must confirm that there is a named person responsible for fish welfare throughout the killing process and that that person is responsible for any relevant documentation of any procedures relating to the process.

The terms “stunning” and “slaughter” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
28.8	**A written procedure for humane fish stunning and slaughtering (see Section 28.1 – 28.4 Harvesting, stunning and slaughter) must be in place and carried out at all times.**	**Important**

The auditor must verify that there is a written procedure in place (SOP) for the killing process and that it is followed at all times.

The term “stunning” and “slaughter” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
28.9	**Video recordings of harvesting, stunning and slaughtering must be performed regularly (once per month or every time there is any change in protocols).**	**Important**

The auditor must confirm that video recordings of the killing process are performed monthly or every time there is a change in procedures/protocols.

The terms “harvesting”, “stunning” and “slaughter” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.4 FOS Aqua – *Acipenser baerii* – certification requirements

2.2.4.1 HATCHERY REQUIREMENTS

1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species.

Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Acipenser baerii:*

- **Maximum range: 8:16 to 16:8 L:D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, etc.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection

results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 16- 20 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser baerii:*

- **Range between 16- 20 °C.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point. Critical level for Siberian sturgeon: 4 mg/L (or above 60% saturation).**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Acipenser baerii*: 4 mg/L (or above 60% saturation).

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.2	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms for overwintering.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.3	**Natural spawning methods, *i.e.*, without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.*, stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning, *i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.* stripping, must be performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree-days (e.g. 4 days at 10 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Acipenser baerii:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (*e.g.* 4 days at 10 ºC).**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.4.2 ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Acipenser baerii:*

- **Maximum range: 8:16 to 16:8 L:D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.6	**Production units must be of adequate depth to prevent damage from ultraviolet radiation (> 45 cm) or shade must be provided if considered appropriate.**	**Important**

The auditor must verify that production units are of an adequate depth to prevent ultraviolet damage to the stock and shade must be used if considered appropriate.

Specific requirements for *Acipenser baerii*;

- **production unit depth must be > 45 cm or shade should be provided.**

The term "production unit" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, etc.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be below 26 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser baerii:*

- **Temperature must always be below 26 °C.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point. Critical saturation levels for Siberian sturgeon: 10 °C = 30%; 15 °C = 38%; 20 °C = 45%; 25 °C = 53%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.
Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical levels for *Acipenser baerii*: 10 °C = 30%; 15 °C = 38%; 20 °C = 45%; 25 °C = 53%.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Density of fish must be between 7 and 22 kg/m^3.**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

Specific requirements for *Acipenser baerii*:

- **Density of fish must be between 7 and 22 kg/m^3**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.5 FOS Aqua – *Acipenser gueldenstaedtii* – certification requirements

2.2.5.1 HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should

be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Acipenser gueldenstaedtii:*

- **Maximum range: 8:16 to 16:8 L:D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
1.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, etc.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could come from air and water pumps, tractors, harvesters, and personnel activities.

Noise levels within the facility should be kept to a minimum. Where possible, separate equipment that causes noise or vibration, such as power generators, air compressors, or filtration systems, from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times, and must be between 10-20 ºC, preferably 15-20 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser gueldenstaedtii:*

- **Range between 10-20 °C; optimum range is between 15-20 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Russian sturgeon: 5 mg/L.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Acipenser gueldenstaedtii*: 5 mg/L.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Density of spawners must be kept < 10 kg/m^3 for overwintering (stocking during winter conditions prior to spawning).**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Acipenser gueldenstaedtii:*

- **Density of spawners must be kept at < 10 kg/m^3 for overwintering (stocking during winter conditions before spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.3	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms for overwintering.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature and photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning, *i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that

all artificial spawning procedures, e.g. stripping, must be performed under anesthesia by a trained staff member or team.

The terms “natural spawning” and “anaesthesia” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree-days (e.g., 4 days at 10 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Acipenser gueldenstaedtii:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (*e.g.*, 4 days at 10 ºC).**

The terms “eggs” and “degree-days” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.4.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Acipenser gueldenstaedtii:*

- **Maximum range: 8:16 to 16:8 L:D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
15.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, etc.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could come from air and water pumps, tractors, harvesters, and personnel activities.

Noise levels within the facility should be kept to a minimum. Where possible, separate equipment that causes noise or vibration, such as power generators, air compressors, or filtration systems, from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times, and must be below 25º C.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser gueldenstaedtii:*

- **Temperature must always be below 25° C.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Russian sturgeon: 5 mg/L.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Acipenser gueldenstaedtii*: 5 mg/L.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Density of fish must be below 10kg/m^3.**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

Specific requirements for *Acipenser gueldenstaedtii*:

- **Density of fish must be below 10kg/m^3**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.6 FOS Aqua – *Acipenser naccarii* – certification requirements

2.2.5.2. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Acipenser naccarii:*

- **Maximum range: 8:16 to 16:8 L:D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
1.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, etc.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could come from air and water pumps, tractors, harvesters, and personnel activities.

Noise levels within the facility should be kept to a minimum. Where possible, separate equipment that causes noise or vibration, such as power generators, air compressors, or filtration systems, from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times, and must be below 25 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser naccarii:*

- **Temperature must always be below 25 C.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Adriatic sturgeon: 5 mg/L.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans

must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Acipenser naccarii*: 5 mg/L.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Density of spawners must be kept <15kg/m^3 for overwintering (stocking during winter conditions prior to spawning).**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific.

The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirements for *Acipenser naccarii:*

- **Density of spawners must be kept at < 15 kg/m^3 for overwintering (stocking during winter conditions before spawning).**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.3	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms for overwintering. Temperature during this phase should be < 7º C.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

Specific requirements for *Acipenser naccarii:*

- **Temperature during overwintering should be < 7 ºC**.

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Natural spawning methods, *i.e.*, without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.*, stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning, *i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, e.g. stripping, must be performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (e.g., 4 days at 10 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Acipenser naccarii:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 2 days at 19-20 ºC).**

The terms “eggs” and “degree-days” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.5.2 ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that optimal photoperiod for cultured species is maintained.

Specific requirements for *Acipenser naccarii*:

- **Maximum range: 8:16 to 16:8 L:D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in**	**Recommended**

	the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, *etc*.	

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could come from air and water pumps, tractors, harvesters, and personnel activities.

Noise levels within the facility should be kept to a minimum. Where possible, separate equipment that causes noise or vibration, such as power generators, air compressors, or filtration systems, from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		**Level**
16.2	**Temperature should be verifiable at all times, and must be below 25 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser naccarii:*

- **Temperature must always be below 25 °C.**

The term “temperature” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Adriatic sturgeon: 5 mg/L.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Acipenser naccarii*: 5 mg/L.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Density of fish must be below 20 kg/m^3.**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

Specific requirements for *Acipenser naccarii*:

- **Density of fish must be below 20 kg/m^3**

The terms “stocking density” and “water quality” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.7. FOS Aqua – *Acipenser ruthenus* – certification requirements

2.2.7.1. HATCHERY REQUIREMENTS

1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 4:20 to 20:4 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Acipenser ruthenus:*

- **Maximum range: 4:20 to 20:4 L:D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, etc.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 10- 15 °C.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser ruthenus:*

- **Range between 10- 15 °C.**

The term “temperature” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Sterlet sturgeon: 4 mg/L (or above 60% saturation).**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Acipenser ruthenus*: 4 mg/L (or above 60% saturation).

The term “oxygen” is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.2	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms for overwintering.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.3	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning, *i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, should be implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, e.g., stripping, must be performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree-days (e.g. 4 days at 10 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Acipenser ruthenus:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (*e.g.*, 4 days at 10 ºC).**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.4.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 4:20 to 20:4 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Acipenser ruthenus:*

- **Maximum range: 4:20 to 20:4 L:D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.6	**Production units must be of adequate depth to prevent damage from ultraviolet radiation; walls and bottom should be of a dark colour or shade must be provided.**	**Important**

The auditor must verify that production units are of an adequate depth to prevent ultraviolet damage to the stock, and shade must be used if considered appropriate.

Specific requirements for *Acipenser ruthenus*;

- **walls and bottom of production units should be of a dark colour or shade must be provided.**

The term "production unit" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.8	**Structural enrichment should be provided, but not long and soft vegetation, as it may entangle the animals. If deemed impossible or harmful, other types of enrichment should be implemented (occupational, dietary, social, sensorial).**	**Recommended**

For some cultured species, environmental enrichment may be necessary to take account of their behavioural traits, *e.g.* reproduction, hierarchy *etc*., to enhance the welfare of fish. The auditor must ensure that the presence of enrichment does not compromise the safety of cultured fish, *i.e.,* that it does not have abrasive or sharp protrusions.
Environmental enrichment is often divided into different categories, depending on the goals of the enrichment programme. Commonly recognized categories are:

- physical or structural enrichment, including modifications or additions to the tanks;
- sensory enrichment, which concerns stimulation of the sensory organs and the brain;
- dietary enrichment, encompassing type and delivery of food (note the distinction from nutrient enrichment, which concerns addition of nutrients to the feed);
- social enrichment, adding contact and interactions with conspecifics;

- occupational enrichment, relating to reduction of physical and psychological monotony by introducing variation to the environment and possibilities for exercise and performance of preferred behaviours.

Specific requirements for *Acipenser ruthenus*;

- **Structural enrichment should be provided, but not long and soft vegetation as it may entangle the animals.**

The terms "enrichment" and "structural enrichment" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, etc.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times, and must be below 26 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser ruthenus:*

- **Temperature must always be below 26 °C.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical saturation levels for Sterlet sturgeon: 60%.	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical levels for *Acipenser ruthenus*: 60%.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Density of fish must be below 12 kg/m^3 for Sterlet sturgeon.**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

Specific requirements for *Acipenser ruthenus*:

- **Density of fish must be below 12 kg/m^3**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.8. FOS Aqua – *Acipenser stellatus* – certification requirements

2.2.6.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Acipenser stellatus:*

- **Maximum range: 8:16 to 16:8 L:D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors,**	**Recommended**

	loading docks, air guns, machinery, etc.	

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Water

Requirement		**Level**
2.2	**Temperature should be verifiable at all times and must be between 10- 20 °C.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser stellatus:*

- **Temperature must always be between 10- 20 °C.**

The term “temperature” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Stellate sturgeon: 5 mg/L.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Acipenser stellatus*: 5 mg/L.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare

Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Density of spawners must be kept < 15 kg/m^3 for overwintering (stocking during winter conditions prior to spawning).**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirements for *Acipenser stellatus:*

- **Density of spawners must be kept at < 15 kg/m^3 for overwintering (stocking during winter conditions prior to spawning).**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.3	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms for overwintering. Spawning temperatures must be between 12-29 ºC.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental

requirements for reproduction are species specific. The auditor shall ensure that environmental parameters, *e.g.,* temperature and photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

Specific requirements for *Acipenser stellatus:*

- **Spawning temperatures must be between 12- 29 °C.**

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning, *i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.,* stripping, are performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (e.g., 4 days at 10 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained

appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Acipenser stellatus:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (e.g., 4 days at 10 ºC).**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.6.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Acipenser stellatus:*

- **Maximum range: 8:16 to 16:8 L:D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, etc.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 10- 25º C.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser stellatus:*

- **Temperature must always be between 10- 25º C.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Stellate sturgeon: 5 mg/L.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Acipenser stellatus*: 5 mg/L.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Density of fish must be below 10 kg/m^3.**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

Specific requirements for *Acipenser stellatus*:

- **Density of fish must be below 10 kg/m^3**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.9 FOS Aqua – *Acipenser transmontanus* – certification requirements

2.2.9.1. HATCHERY REQUIREMENTS

1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 6:18 to 18:6 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Acipenser transmontanus:*

- **Maximum range: 6:18 to 18:6 L:D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.8	**Structural enrichment should be provided (*e.g.* gravel substrate 1.2-1.9 cm ø), but sand must be avoided. If deemed impossible or harmful, another type of enrichment should be implemented (occupational, dietary, social, sensorial).**	**Recommended**

For some cultured species, environmental enrichment may be necessary to take account of their behavioural traits, *e.g.* reproduction, hierarchy *etc*., to enhance the welfare of fish. The auditor must ensure that the presence of enrichment does not compromise the safety of cultured fish, *i.e.,* that it does not have abrasive or sharp protrusions.
Environmental enrichment is often divided into different categories, depending on the goals of the enrichment programme. Commonly recognized categories are:

- physical or structural enrichment, including modifications or additions to the tanks;
- sensory enrichment, which concerns stimulation of the sensory organs and the brain;
- dietary enrichment, encompassing type and delivery of food (note the distinction from nutrient enrichment, which concerns addition of nutrients to the feed);
- social enrichment, adding contact and interactions with conspecifics;
- occupational enrichment, relating to reduction of physical and psychological monotony by introducing variation to the environment and possibilities for exercise and performance of preferred behaviours.

Specific requirements for *Acipenser transmontanus*;

- **Structural enrichment should be provided, *e.g.*, gravel substrate 1.2-1.9 cm ø), but sand must be avoided.**

The terms "enrichment" and "structural enrichment" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, etc.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be below 20 ºC., preferably 14- 17 °C.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser transmontanus:*

- **Range: below 20 ºC., preferably 14- 17 °C.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for White sturgeon: 4 mg/L.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Acipenser transmontanus*: 4 mg/L.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.2	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms for overwintering.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms “temperature” and “photoperiod” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.3	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning, *i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, should be implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, e.g. stripping, must be performed under anesthesia by a trained staff member or team.

The terms “natural spawning” and “anaesthesia” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree-days (*e.g.,* 4 days at 10 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Acipenser transmontanus:*

- **eggs are maintained in dim light or darkness to reduce mortality;**

- **eggs must not be handled after placement for 40-45 degree-days (*e.g.* 4 days at 10 ºC).**

The terms “eggs” and “degree-days” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.4.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 6:18 to 18:6 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Acipenser transmontanus:*

- **Maximum range: 6:18 to 18:6 L:D.**

The terms “photoperiod”, “production unit”, and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, *etc*.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise, *i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be below 19 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Acipenser transmontanus:*

- **Temperature must always be below 19 ° C.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical saturation levels for White sturgeon: 5 mg/L**.	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical levels for *Acipenser transmontanus*: 5 mg/L.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Density of fish must be below 15 kg/m^3 for White sturgeon.**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare

Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

Specific requirements for *Acipenser transmontanus*:

- **Density of fish must be below 15 kg/m^3**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.10 FOS Aqua – *Argyrosomus regius* – certification requirements

2.2.7.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis matching the natural limits and using practical experience, research and welfare specialist advice. North Atlantic latitudes photoperiod optimum range: 12L:12D; Intensity range: 500 lux.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Argyrosomus regius*:

- **North Atlantic latitudes photoperiod optimum range: 12L:12D.**
- **Intensity range: 500 lux.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1- 3 kHz frequency range at any point in the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Argyrosomus regius*:

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 18 and 25 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Argyrosomus regius:*

- **Temperature must always be between 18 and 25 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation (> 5.6 mg/L).**	**Important**

The auditor shall ensure that regular monitoring of temperature and oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Argyrosomus regius:*

- **Oxygen levels must always be > 70% oxygen saturation (> 5.6 mg/L).**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (Recommended oxygen saturation for Meagre > 70%).**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Argyrosomus regius*:

- **Oxygen saturation: 70%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species (1M:1F).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Argyrosomus regius:*

- **Ratio of sexes is 1 male: 1 female.**

The term "broodstock" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept <5kg/m^3 both for stocking and spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Argyrosomus regius:*

- **Density of spawners must be kept <5kg/m^3 both for stocking and spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms,**	**Important**

	variation, and ranges of the original habitat. (Temperature range: 14-25 ºC. Photoperiod: 12L:12D or 10L:14D).	

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, *e.g.,* temperature and photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

Specific requirements for *Argyrosomus regius:*

- **Temperature range: 14-25 ºC.**
- **Photoperiod: 12L:12D or 10L:14D).**

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, i.e., without handling or manipulation, should be implemented. In the absence of such, all handling procedures (e.g., stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, e.g., stripping, are performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree-days (about 2 days at 19-20 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Argyrosomus regius*

- **eggs are maintained in dim light or darkness to reduce mortality**
- **eggs must not be handled after placement for 40-45 degree-days (about 2 days at 19-20 ºC)**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.7.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis matching natural limits using practical experience, research and welfare specialist advice. (North Atlantic latitudes photoperiod optimum range: from 12L:12D to 8L-16D.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to the cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Argyrosomus regius*

- **North Atlantic latitudes photoperiod optimum range: from 12L:12D to 8L-16D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1- 3 kHz frequency range at any point in the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noise generated by marine traffic from different types of boats.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Argyrosomus regius:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times, and must be between 13 and 28 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Argyrosomus regius*

- **Temperature must always be between 13 and 28 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels in production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Argyrosomus regius:*

- **Oxygen levels must always be > 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Meagre: > 6 mg/L. See Section 16 Water.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Argyrosomus regius*:

- **Oxygen content: > 6 mg/L.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 26 Welfare Assessment). Limit stocking to 20 kg/m^3 max. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

Specific requirements for *Argyrosomus regius:*

- **Density of fish must be below 20kg/m^3**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.11 FOS Aqua – *Dentex dentex* – certification requirements

2.2.8.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Mediterranean latitudes photoperiod optimum range: from 12L:12D to 8L:16D/16L:8D; Intensity range: 500-1500 lux.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Dentex dentex:*

- **Mediterranean latitudes photoperiod optimum range: from 12L:12D to 8L:16D/16L:8D.**
- **Intensity range: 500-1500 lux.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement	Level

1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1- 3 kHz frequency range at any point in the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility. Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Dentex dentex:*

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 15 and 25 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Dentex dentex:*

- **Temperature must always be between 15 and 25 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Dentex dentex:*

- **Oxygen levels must always be > 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point. Recommended oxygen saturation for *Dentex dentex* is > 70%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Dentex dentex:*

- **Oxygen saturation: >70%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species (1M:1F).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females or mass spawning involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Dentex dentex:*

- **Ratio of sexes is 1 male: 1 female.**

The term "broodstock" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 7 kg/m^3 both for stocking and spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow

maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Dentex dentex:*

- **Density of spawners must be kept < 7 kg/m^3 both for stocking and spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variations and ranges of their original habitat.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.
The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning, *i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.* stripping, must be performed under anesthesia by a trained staff member or team.

The terms “natural spawning” and “anaesthesia” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (about 2 days at 19-20 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Dentex dentex:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 2 days at 19-20 ºC)**

The terms “eggs” and “degree-days” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.8.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis matching the natural limits and using practical experience, research and welfare specialist advice. Mediterranean latitudes photoperiod optimum range: from 12L:12D to 8L:16D/16L:8D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Dentex dentex:*

- **North Atlantic latitudes photoperiod optimum range: 12L:12D to 8L:16D/16L:8D.16D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The cages should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1- 3 kHz frequency range at any point in the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noise generated by marine traffic from different types of boats.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Dentex dentex:*

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range in any point of the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 15 and 25 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Dentex dentex:*

- **Temperature must always be between 15 and 25 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Dentex dentex:*

- **Oxygen levels must always be > 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). (Recommended oxygen saturation for *Dentex dentex* > 70%).**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Dentex dentex:*

- **Oxygen content: > 70%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 26 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.13 FOS Aqua – *Dicentrarchus labrax* – certification requirements

2.2.9.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis matching natural limits and using practical experience, research and welfare specialist advice. North Atlantic latitudes photoperiod max. range: 16L:8D-8L:16D. Intensity range for larvae: <100 lux, for juveniles: 150-1000 lux.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.
The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Dicentrarchus labrax:*

- **North Atlantic latitudes photoperiod max. range: 16L:8D-8L:16D.**
- **Intensity range for larvae: <100 lux; for juveniles: 150-1000 lux.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2- 1 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Dicentrarchus labrax:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2-1kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 8 and 24 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Dicentrarchus labrax:*

- **Temperature must always be between 8 and 24 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Dicentrarchus labrax:*

- **Oxygen levels must always be > 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

<u>Crowding</u>

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point. Recommended oxygen saturation for European seabass > 70%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Dicentrarchus labrax:*

- **Oxygen saturation: >70%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species (1M:2F).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Dicentrarchus labrax:*

- **Ratio of sexes is 1 male: 2 females.**

The term "broodstock" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 5 kg/m^3 both for stocking and spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow

maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Dicentrarchus labrax:*

- **Density of spawners must be kept < 5 kg/m^3 both for stocking and spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variations, and ranges of their original habitat.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature and photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning, *i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.,* stripping, must be performed under anesthesia by a trained staff member or team.

The terms “natural spawning” and “anaesthesia” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (*e.g.*, around 2 days at 19-20 °C).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Dicentrarchus labrax:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 2 days at 19-20 ºC).**

The terms “eggs” and “degree-days” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.9.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis matching natural limits and using practical experience, research and welfare specialist advice. North Atlantic latitudes photoperiod max. range: 16L:8D-8L:16D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle

influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Dicentrarchus labrax:*

- **North Atlantic latitudes photoperiod max. range: 16L:8D-8L:16D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The cages should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2- 1 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noise generated by marine traffic from different types of boats.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Dicentrarchus labrax:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2-1kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 8 and 30 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Dicentrarchus labrax:*

- **Temperature must always be between 8 and 30 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.3	**Oxygen levels must be verifiable at all times and must be ≥ 70% oxygen saturation.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Dicentrarchus labrax:*

- **Oxygen levels must always be ≥ 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for European seabass: > 6 mg/L. See Section 16 Water.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.
Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Dicentrarchus labrax:*

- **Oxygen content: > 6 mg/L.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators. Limit stocking to 20 kg/m^3 max. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

Specific requirements for *Dicentrarchus labrax:*

- **Density of fish must be below 20 kg/m^3**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.14 FOS Aqua – *Diplodus puntazzo* – certification requirements

2.2.10.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Photoperiods should match species' natural limits. Larvae in light conditions (30-450 lux) had a better ability to digest.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

Specific requirements for *Diplodus puntazzo:*

- **Larvae in light conditions (30-450 lux) had a better ability to digest.**

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 16 and 28 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Diplodus puntazzo*:

- **Temperature must always be between 16 and 28 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below 70%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Diplodus puntazzo*:

- **Oxygen saturation: > 70%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species (1M:1F).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Diplodus puntazzo*:

- **Ratio of sexes is 1 Male: 1 Female.**

The term "broodstock" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 8 kg/m^3 both for stocking and spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Diplodus puntazzo*:

- **Density of spawners must be kept < 8 kg/m^3 both for stocking and spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variations, and ranges of their original habitat.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms “temperature” and “photoperiod” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Apart from natural spawning, other methods to promote spawning are not allowed.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.,* stripping, must be performed under anesthesia by a trained staff member or team.

The terms “natural spawning” and “anaesthesia” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (about 2 days at 19-20 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Diplodus puntazzo*:

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 2 days at 19-20 ºC).**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.10.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Requirement		Level
15.9	**The cages should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the cage at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noise generated by marine traffic from different types of boats.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Diplodus puntazzo*:

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 16 and 28 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Diplodus puntazzo*:

- **Temperature must always be between 16 and 28 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below 70%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.
Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Diplodus puntazzo*:

- **Oxygen content: > 70%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour (see Section 26 Welfare Assessment). Limit stocking to 20 kg/m^3 max. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

Specific requirements for *Diplodus puntazzo:*

- **Density of fish must be below 20 kg/m^3**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.15 FOS Aqua – *Huso huso* – certification requirements

2.2.9.2. HATCHERY REQUIREMENTS

1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and

matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Huso huso:*

- **Maximum range: 8:16 to 16:8 L:D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
1.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, *etc.***	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 11-15 ºC for egg hatching and below 18 ºC for larval rearing.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Huso huso:*

- **Range: between 11- 15 °C for egg hatching.**
- **Below 18 ºC for larval rearing**.

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Starvation

Requirement		Level
9.2	**The period during which fish are deprived of food to achieve gut clearance prior to certain procedures, or harvesting must be appropriate and as minimal as possible. Unless justified, it must always be < 50 degree days, but special monitoring must be performed as this species is highly sensitive to starvation.**	**Important**

Transportation of live fish is a stressful event involving handling, crowding and exposure to varying water qualities; therefore, starvation is practiced for welfare concerns since there is a general understanding that starved fish are calmer and more tolerant to stress. The auditor shall verify that starvation periods are appropriate and as minimal as possible and, unless justified, should always be less than 50 degree-days. The auditor, in addition, shall report evidence that the unit of certification maintains internal records and documentation of any starvation events.

Specific requirement for *Huso huso*;

- **Special monitoring must be performed as this species is highly sensitive to starvation.**

The term “degree-days” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point. Recommended oxygen saturation for Beluga sturgeon: > 70%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Huso huso*: > 70%.

The term “oxygen” is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms “stocking density” and “water quality” are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	Density of spawners must be kept < 25kg/m^3 for overwintering (stocking during winter conditions prior to spawning).	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Huso huso:*

- **Density of spawners must be kept at < 25kg/m^3 for overwintering.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.3	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms for overwintering.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, should be implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.* stripping, must be performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree-days (e.g. 4 days at 10 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Huso huso:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (*e.g.* 4 days at 10 ºC).**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.4.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Huso huso:*

- **Maximum range: 8:16 to 16:8 L:D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

The term “production unit” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The tanks should be located in a site protected from human induced noise. No loud noises are permitted in the vicinity of the tanks or raceways: air compressors, loading docks, air guns, machinery, *etc.***	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times, and must be below 20 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Huso huso:*

- **Temperature must always be below 20 ° C.**

The term “temperature” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species, and with environmental factors). Critical level for Beluga sturgeon: 60%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical levels for *Huso huso*: 60%.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators. Limit stocking to below 15 kg/m^3 max. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

Specific requirements for *Huso huso*:

- **Density of fish must be below 15 kg/m^3**

The terms “stocking density” and “water quality” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.16 FOS Aqua – *Liza ramada* – certification requirements

2.2.11.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis matching natural limits and using practical experience, research and welfare specialist advice. Photoperiod optimum range: 12L:12D-10L:14D, Light intensity for juveniles: 600-1400 lux.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Liza ramada:*

- **Photoperiod optimum range: 12L:12D-10L:14D.**
- **Light intensity for juveniles: 600-1400 lux.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and

Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the tank at all times.**	**Important**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Liza ramada:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times, and must be between 10 and 35 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Liza ramada:*

- **Temperature must always be between 10 and 35 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation or above 5 mg/L.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Liza ramada:*

- **Oxygen levels must always be > 70% oxygen saturation or above 5 mg/L.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.4	**Salinity levels must be verifiable at all times and must be between 20-40 psu.**	**Important**

The auditor shall ensure that regular monitoring of salinity levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Liza ramada:*

- **Salinity levels must always be between 20-40 psu.**

The term "salinity" is defined in Section 1.4 – Definitions and Abbreviations.

Grading

Requirement		Level
7.5	**If passive grading is used, the size and design of the grading panel must be appropriate for the size of fish that are to be graded, and the enclosure they are contained within.**	**Important**

A challenge associated with passive grading with nets or panels with appropriate gaps can be that fish nearing the size of the gaps may become stuck. However, passive grading is potentially less harmful to welfare since feed is not normally withdrawn and the fish are not pumped or handled. The auditor must ensure that all passive grading equipment is suitable for the size of the fish to be graded.

The term "passive grading" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (Recommended oxygen saturation > 70%).**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.
Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Liza ramada:*

- **Oxygen saturation: >70%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species (1M:1-2F).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Liza ramada:*

- **Ratio of sexes is 1 male: 1-2 females.**

The term "broodstock" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 2 kg/m^3 both for stocking and spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Liza ramada:*

- **Density of spawners must be kept < 2 kg/m^3 both for stocking and spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variation, and ranges of the original habitat. Natural temperature range: 15-35 ºC, optimum during spawning: 20-25 ºC. Optimum salinity range: 20-40 psu. Lighting period should match the natural distribution range: 12L:12D-10L:14D.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

Specific requirement for *Liza ramada:*

- **Natural temperature range: 15-35 ºC, optimum during spawning: 20-25 ºC.**
- **Optimum salinity range: 20-40 psu.**
- **Lighting period should match the natural distribution range: 12L:12D-10L:14D.**

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, should be implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, e.g. stripping, must be performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (about 2 days at 19-20 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Liza ramada:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 2 days at 19-20 ºC)**

The terms “eggs” and “degree-days” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.11.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis matching natural limits and using practical experience, research and welfare specialist advice. Photoperiod optimum range: 12L:12D-10L:14D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Liza ramada:*

- **Photoperiod optimum range: 12L:12D-10L:14D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noise generated by marine traffic from different types of boats.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Liza ramada:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range in any point of the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times, and must be between 10 and 35 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Liza ramada:*

- **Temperature must always be between 10 and 35 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation or above 5 mg/L.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Liza ramada:*

- **Oxygen levels must always be > 70% oxygen saturation or above 5 mg/L.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.4	**Salinity levels must be verifiable at all times and must be between 20-40 psu.**	**Important**

The auditor shall ensure that regular monitoring of salinity levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Liza ramada:*

- **Salinity levels must always be between 20-40 psu.**

The term “salinity” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). (Recommended oxygen saturation > 70%).**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Liza ramada:*

- **Oxygen content: > 70%.**

The term “oxygen” is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 26 Welfare Assessment). Limit stocking to 20 kg/m^3 max. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis.

Specific requirements for *Liza ramada:*

- **Density of fish must be below 20kg/m^3**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.17 FOS Aqua – *Mugil cephalus* – certification requirements

2.2.12.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis matching natural limits and using practical experience, research and welfare specialist advice. Photoperiod optimum range: 12L:12D-10L:14D, Light intensity for juveniles: 600-1400 lux.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Mugil cephalus:*

- **Photoperiod optimum range: 12L:12D-10L:14D.**
- **Light intensity for juveniles: 600-1400 lux.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 10 and 34 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production

units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Mugil cephalus:*

- **Temperature must always be between 10 and 34 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation or above 5 mg/L.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Mugil cephalus:*

- **Oxygen levels must always be > 70% oxygen saturation or above 5 mg/L.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.4	**Salinity levels must be verifiable at all times and must be between 20-40 psu.**	**Important**

The auditor shall ensure that regular monitoring of salinity levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Mugil cephalus:*

- **Salinity levels must always be between 20-40 psu.**

The term "salinity" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (Recommended oxygen saturation > 70%).**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Mugil cephalus:*

- **Oxygen saturation: >70%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species (1M:1F).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Mugil cephalus:*

- **Ratio of sexes is 1 male: 1 female.**

The term "broodstock" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 1 kg/m^3 both for stocking and spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Mugil cephalus:*

- **Density of spawners must be kept < 1 kg/m^3 both for stocking and spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variation, and ranges of the original habitat. Natural temperature range: 15-35 ºC, optimum during spawning: 20-25 ºC. Optimum salinity range: 20-40 psu, optimum during spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

Specific requirements for *Mugil cephalus:*

- **Natural temperature range: 15-35 ºC, optimum during spawning: 20-25 ºC.**
- **Optimum salinity range: 20-40 psu.**
- **Lighting period should match the natural distribution range, 12L:12D-10L:14D.**

The terms “temperature” and “photoperiod” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, i.e., without handling or manipulation, should be implemented. In the absence of such, all handling procedures (e.g., stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning, the auditor must ensure that all artificial spawning procedures, *e.g.,* stripping, are performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (about 2 days at 19-20 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Mugil cephalus:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 2 days at 19-20 ºC).**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.12.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis matching natural limits and using practical experience, research and welfare specialist advice. Photoperiod optimum range: 12L:12D-10L:14D.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Mugil cephalus:*

- **Photoperiod optimum range: 12L:12D-10L:14D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1- 3 kHz frequency range at any point in the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noise generated by marine traffic from different types of boats.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Mugil cephalus:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 10 and 34 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Mugil cephalus:*

- **Temperature must always be between 10 and 34 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation or above 5 mg/L.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Mugil cephalus:*

- **Oxygen levels must always be > 70% oxygen saturation or above 5 mg/L.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.4	**Salinity levels must be verifiable at all times and must be between 20-40 psu.**	**Important**

The auditor shall ensure that regular monitoring of salinity levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Mugil cephalus:*

- **Salinity levels must always be between 20-40 psu.**

The term "salinity" is defined in Section 1.4 – Definitions and Abbreviations.

<u>Crowding</u>

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). (Recommended oxygen saturation > 70%).**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.
Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Mugil cephalus:*

- **Oxygen content: > 70%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 26 Welfare Assessment). Limit stocking to 20 kg/m3 max. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored regularly.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.18 FOS Aqua – *Oncorhynchus mykiss* – certification requirements

2.2.13.1. HATCHERY REQUIREMENTS
Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 12:12 to 8:16 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Oncorhynchus mykiss:*

- **Photoperiod maximum range: 12:12 to 8:16 L:D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2- 2 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that

human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility. Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Oncorhynchus mykiss:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 0 and 20 ºC, preferably below 15 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Oncorhynchus mykiss:*

- **Temperature must always be between 0 and 20 ºC, preferably below 15 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels must be verifiable at all times and must be > 9 mg/L for eggs, 4 mg/L for juveniles < 15ºC, 6 mg/L > 15ºC.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Oncorhynchus mykiss:*

- **Oxygen levels must always be > 9 mg/L for eggs, 4 mg/L for juveniles < 15 ºC, 6 mg/L > 15 ºC.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Rainbow trout: > 9 mg/L for eggs, 4 mg/L for juveniles < 15 ºC, 6 mg/L > 15 ºC.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Specific requirements for *Oncorhynchus mykiss:*

- **Oxygen levels must always be > 9 mg/L for eggs, 4 mg/L for juveniles < 15 ºC, 6 mg/L > 15 ºC.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement	Level

13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		**Level**
14.1	**Density of spawners must be kept <10kg/m^3 for stocking.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Oncorhynchus mykiss:*

- **Density of spawners must be kept < 10 kg/m^3 both for stocking and spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
14.3	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variations and ranges as in their original habitat.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow

maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anaesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, e.g., stripping, must be performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (e.g., 4 days at 10 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Oncorhynchus mykiss:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 4 days at 10 ºC).**

The terms “eggs” and “degree-days” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.13.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Oncorhynchus mykiss:*

- **Photoperiod optimum range: 8:16 to 16:8 L:D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement	Level

15.9	**The rearing facilities should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2-2kHz frequency range at any point in the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noise generated by marine traffic from different types of boats.

The auditor must ensure that sound is checked with a hydrophone, that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Oncorhynchus mykiss:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 0 and 20 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Oncorhynchus mykiss:*

- **Temperature must always be between 0 – 20 ºC.**

The term “temperature” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.3	**Oxygen levels must be verifiable at all times and must be > 4 mg/L for juveniles < 15 ºC, 6 mg/L > 15 ºC.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Oncorhynchus mykiss:*

- **Oxygen levels must always be > 4 mg/L for juveniles < 15 ºC, 6 mg/L > 15 ºC.**

The term “oxygen” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Rainbow trout: 4 mg/L < 15 ºC, 6 mg/L > 15 ºC.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Oncorhynchus mykiss:*

- **Oxygen content: 4 mg/L < 15 ºC, 6 mg/L > 15 ºC.**

The term “oxygen” is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators. Density must be above 10 kg/m^3 and below 60 kg/m^3. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis.

Specific requirements for *Oncorhynchus mykiss:*

- **Density of fish must be above 10 kg/m^3 and below 60 kg/m^3**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.19 FOS Aqua – *Rachycentron canadum* – certification requirements

2.2.9.3. HATCHERY REQUIREMENTS

1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis, matching natural limits and using practical experience, research and welfare specialist advice. Subtropical photoperiod max. range: 14L:10D-10L:14D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Rachycentron canadum:*

- **Subtropical photoperiod max. range: 14L:10D-10L:14D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the cage at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Specific requirements for ***Rachycentron canadum;***

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the cage at all times.**

<u>Water</u>

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 17 and 32 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Rachycentron canadum:*

- **Range: between 17 and 32 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Rachycentron canadum:*

- **Oxygen levels must always be > 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point. Recommended oxygen saturation for Cobia: > 70%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place and, should levels fall below critical levels, appropriate action must be

taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Rachycentron canadum*: > 70%.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species (1M: 1-2.5F).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving many males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Rachycentron canadum:*

- **Ratio of sexes; (1M: 1-2.5F).**

The terms "broodstock" and "spawning" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 2 kg/m^3 for spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Rachycentron canadum:*

- **Density of spawners must be kept at < 2 kg/m^3.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.3	**Tank sizes must be > 5m^3 and > 5m deep, rounded or avoiding angles, and contain structural enrichment, provided that it does not hinder fish swimming activities or tank cleaning operations.**	**Important**

The captive environment can be very different from the natural environment, and optimal captive environmental conditions should be maintained in order to promote reproductive activity. The auditor must confirm that broodstock holding tanks are > $5m^3$ and > 1m deep, rounded or avoiding angles, and contain structural enrichment, provided that it does not hinder fish swimming activities or tank cleaning operations.

Specific requirement for *Rachycentron canadum:*

- **Tank sizes must be > $5m^3$ and > 5m deep.**

The term "structural enrichment" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms for overwintering.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, i.e., without handling or manipulation, should be implemented. In the absence of such, all handling procedures (e.g., stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.,* stripping, must be performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (about 2 days at 19-20 ° C).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Rachycentron canadum:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (e.g., 2 days at 19-20 ºC).**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.4.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis, matching natural limits and using practical experience, research and welfare specialist advice. Subtropical photoperiod max. range: 14L:10D-10L:14D.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Rachycentron canadum:*

- **Subtropical photoperiod max. range: 14L:10D-10L:14D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

The term “production unit” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The cages should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the cage at all times.**	**Important**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Specific requirements for *Rachycentron canadum:*

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range in any point of the cage at all times.**

<u>Water</u>

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 17 and 32 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Rachycentron canadum:*

- **Temperature must always be between 17 and 32 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Rachycentron canadum:*

- **Oxygen levels must always be > 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

<u>Crowding</u>

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Cobia: > 6 mg/L.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans

must be in place and, should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical levels for *Rachycentron canadum*: > 6 mg/L.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators. Limit stocking to 10 - 15 kg/m^3 max. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

Specific requirements for *Rachycentron canadum*:

- **Limit stocking to 10 - 15 kg/m^3 max.**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.20 FOS Aqua – *Salmo carpio* – certification requirements

2.2.14.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Photoperiod max. range: 9L:16D-16L:14D.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Salmo carpio:*

- **Photoperiod max. range: 9L:16D-16L:14D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2- 2 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic

environment has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Salmo carpio:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between -2 °C and 27 °C.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salmo carpio:*

- **Temperature must always be between -2 °C and 27 °C.**

The term “temperature” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels must be monitored, and corrective action must be taken if levels fall below 70-80%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Salmo carpio:*

- **Oxygen saturation: 70 - 80%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species.**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

The term "broodstock" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 21 kg/m^3 for stocking.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Salmo carpio:*

- **Density of spawners must be kept < 21 kg/m^3 both for stocking and spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental

requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms “temperature” and “photoperiod” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.,* stripping, must be performed under anesthesia by a trained staff member or team.

The terms “natural spawning” and “anaesthesia” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (e.g., 4 days at 10 ºC). Deformed and dead eggs/fry should be carefully removed at least twice per week to prevent the development of fungus.**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained

appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Salmo carpio:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 4 days at 10 ºC);**
- **deformed and dead eggs/fry should be carefully removed at least twice per week to prevent the development of fungus.**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.14.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.4	**Farm design should be such that inspection of all stock is possible. Total suspended solids 15 mg/L.**	**Important**

The auditor shall verify that the design of the production units allows regular inspection of stock using ROVs, underwater cameras, *etc*. Total suspended solids must remain <15 mg/L.

The term "stock" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Photoperiod max. range: 9L:16D-16L:14D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured

species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Salmo carpio:*

- **Photoperiod optimum range: 9L:16D-16L:14D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
15.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2-2kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noise generated by marine traffic from different types of boats.
The auditor must ensure that sound is checked with a hydrophone, that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Salmo carpio:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times, and must be between -2 °C and 27 °C.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salmo carpio:*

- **Temperature must always be between -2 °C and 27 °C.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels must be monitored, and corrective action must be taken if levels fall below 70-80%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Salmo carpio:*

- **Corrective action must be taken if levels fall below 70-80%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 26 Welfare Assessment). An average of 21 kg/m^3 is best for welfare according to the SWIM model (Salmon Welfare Index Model). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis.

Specific requirements for *Salmo carpio:*

- **Optimal density of fish must be 21 kg/m^3**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.21 FOS Aqua – *Salmo salar* – certification requirements

2.2.15.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice.**	**Important**

The fish's perception of day length influences development, physiology and behaviour and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that optimal photoperiod for cultured species is maintained.

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2- 2 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Salmo salar:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 0 and 22 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salmo salar:*

- **Temperature must always be between 0 – 22 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels must be monitored, and corrective action must be taken if levels fall below 70-80%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Salmo salar:*

- **Corrective action must be taken if levels fall below 70-80%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species (1M:1F).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Salmo salar:*

- **Ratio of sexes is 1 male: 1 female.**

The term "broodstock" is defined in Section 1.4 Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 22 kg/m^3 for stocking.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Salmo salar:*

- **Density of spawners must be kept < 22 kg/m^3 for stocking.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms. Atlantic salmon is naturally an autumn spawner, and eggs are normally produced at 4-8 °C.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, *e.g.,* temperature, photoperiod, match the environmental

conditions in nature. The auditor must also ensure that internal records and documentation are available.

Specific requirement for *Salmo salar:*

- **Atlantic salmon is naturally an autumn spawner, and eggs are normally produced at 4-8 °C.**

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning, *i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, e.g., stripping, must be performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (e.g., 4 days at 10 °C). Deformed and dead eggs/fry should be carefully removed at least twice per week to prevent the development of fungus.**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Salmo salar:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 4 days at 10 ºC);**
- **deformed and dead eggs/fry should be carefully removed at least twice per week to prevent the development of fungus.**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.15.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.4	**Farm design should be such that inspection of all stock is possible. Total suspended solids 15 mg/L.**	**Important**

The auditor shall verify that the design of the production units allows regular inspection of stock using ROVs, underwater cameras, *etc*. Total suspended solids must remain <15 mg/L.

The term "stock" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that optimal photoperiod for cultured species is maintained.

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
15.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2- 2 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noises generated by marine traffic from different types of boats.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Salmo salar:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 0 and 22 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salmo salar:*

- **Temperature must always be between 0 and 22 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below 70% saturation.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Salmo salar:*

- **Oxygen content: > 70%.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 26 Welfare Assessment). Density < 22 kg/m^3 best welfare according SWIM model (Salmon Welfare Index model). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis. (See Stein et al. (2013)). Refer to the Salmon Welfare Index Model (SWIM 1.0).

Specific requirements for *Salmo salar:*

- **Density < 22 kg/m^3 is best for welfare according to the SWIM model (Salmon Welfare Index model).**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.22 FOS Aqua – *Salmo trutta* – certification requirements

2.2.16.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice.**	**Important**

The fish's perception of day length influences development, physiology and behaviour and it is therefore important to use appropriate light regimes specific to specific cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and match natural limits of the cultured species and that optimal photoperiod for cultured species is maintained.

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2-2kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper

and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Salmo trutta:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 18 and 24 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salmo trutta:*

- **Temperature must always be between 18 and 24 ºC.**

The term “temperature” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels must be monitored, and corrective action must be taken if levels fall below 9 mg/L for eggs between 4 and 12 °C and 7 mg/L for juveniles.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Salmo trutta:*

- **Corrective action must be taken if levels fall below 9 mg/L for eggs between 4 and 12 °C and 7 mg/L for juveniles.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions

and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species. (1M: 1.4F in Sea trout but 6M: 1F in Brown trout. No spontaneous spawning in holding tanks, at least for domesticated broodstock).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawnings involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Salmo trutta:*

- **Ratio of sexes 1M: 1.4F in Sea trout but 6M: 1F in Brown trout.**

The term "broodstock" is defined in Section 1.4 Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 22 kg/m^3 for stocking.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Salmo trutta:*

- **Density of spawners must be kept < 22 kg/m^3 for stocking.**

The term “spawners” is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms. *Salmo trutta* is naturally a winter spawner (usually November-December), and eggs are normally produced at 4-12 °C.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, *e.g.,* temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

Specific requirement for *Salmo salar:*

- ***Salmo trutta* is naturally a winter spawner (usually November-December), and eggs are normally produced at 4-12 °C.**

The terms “temperature” and “photoperiod” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, should be implemented; however in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.,* stripping, must be performed under anesthesia by a trained staff member or team.

The terms “natural spawning” and “anaesthesia” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Eggs can be manipulated between 30 minutes and 24 h following fertilisation, after which any shock should be avoided until the eyed stage (typically 300 degree-days). Developing eggs may be maintained in dim light or darkness and water exchange should be moderate (one renewal per hour) and the dissolved oxygen level kept at 100 percent saturation. Deformed and dead eggs/fry should be carefully removed daily to prevent the development of fungus. At the eyed stage, eggs can be manipulated again.**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Salmo trutta:*

- **eggs can be manipulated between 30 minutes and 24 h following fertilisation, after which any shock should be avoided until the eyed stage (typically 300 degree-days);**
- **developing eggs may be maintained in dim light or darkness, and water exchange should be moderate (one renewal per hour);**
- **deformed and dead eggs/fry should be carefully removed at least twice per week to prevent the development of fungus;**
- **at the eyed stage, eggs can be manipulated again.**

The terms “eggs” and “degree-days” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.16.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.4	**Farm design should be such that inspection of all stock is possible. Total suspended solids < 25 mg/dm^3.**	**Important**

The auditor shall verify that the design of the production units allows regular inspection of stock using ROVs, underwater cameras, *etc*. Total suspended solids < 25 mg/dm^3.

The term "stock" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2- 2 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noise generated by marine traffic from different types of boats.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Salmo trutta:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 18 and 24 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salmo trutta:*

- **Temperature must always be between 18 and 24 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels must be monitored, and corrective action must be taken if levels fall below 7 mg/L.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.
Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Salmo trutta:*

- **Corrective action must be taken if levels fall below 7 mg/L.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators. Optimum density of about 40 kg/m³. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis.

Specific requirements for *Salmo trutta:*

- **Optimum density < 40 kg/m^3.**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.23 FOS Aqua – *Salvelinus alpinus* – certification requirements

2.2.17.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 12:12 to 8:16 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that optimal photoperiod for cultured species is maintained.

Specific requirements for *Salvelinus alpinus*:

- **Photoperiod maximum range: 12:12 to 8:16 L:D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2- 2 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Salvelinus alpinus:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times, and must be between 0 and 8 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salvelinus alpinus*:

- **Temperature must always be between 0 and 8 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels should be verifiable at all times and must be > 9 mg/L for early stages.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salvelinus alpinus:*

- **Oxygen levels must always be > 9 mg/L for early stages.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Arctic char: > 9 mg/L for early stages.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.
Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Salvelinus alpinus:*

- **Oxygen level: > 9 mg/L for early stages.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Males and females from broodstock should be kept together at 1:1 ratio.**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Salvelinus alpinus:*

- **Ratio of sexes is 1 male: 1 female.**

The term "broodstock" is defined in Section 1.4 Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 25 kg/m^3 for stocking.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Salvelinus alpinus:*

- **Density of spawners must be kept <25 kg/m^3 for stocking.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variation, and ranges of the original habitat: temperature of broodstock tanks must never rise above 10 ºC, and photoperiod must vary from 8:16 to 16:8 L:D according to seasons.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

Specific requirements for *Salvelinus alpinus:*

- **Temperature of broodstock tanks must never rise above 10 ºC**
- **Photoperiod must vary from 8:16 to 16:8 L:D according to seasons.**

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, *i.e.*, without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.*, stripping) must be performed under anaesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning, *i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.,* stripping, must be performed under anesthesia by a trained staff member or team.
The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree-days (*e.g.*, 4 days at 10 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are

maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Salvelinus alpinus:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 4 days at 10 ºC).**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.17.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2-2kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noises generated by marine traffic from different types of boats.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Specific requirements for *Salvelinus alpinus:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 0 and 12- 15 °C.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salvelinus alpinus:*

- **Temperature must always be between 0 and 12- 15 °C.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Arctic char: 4 mg/L < 15 ºC, 6 mg/L > 15 ºC.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, provide supplementary aeration of the water.

Critical level for *Salvelinus alpinus:*

- **Oxygen content: 4 mg/L < 15º C, 6 mg/L > 15 ºC.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 26 Welfare Assessment). Density must be above 20 kg/m^3 and below 60 kg/m^3. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare

Assessment). In addition, water quality parameters should be monitored on a regular basis.

Specific requirements for *Salvelinus alpinus:*

- **Density above 20 kg/m^3 and below 60 kg/m^3.**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.24 FOS Aqua – *Salvelinus fontinalis* – certification requirements

2.2.18.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 12:12 to 8:16 L:D.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Salvelinus fontinalis*

- **Photoperiod maximum range: 12:12 to 8:16 L:D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2- 2 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Salvelinus fontinalis:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 0 and 20 ºC, preferably under 16 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salvelinus fontinalis:*

- **Temperature must always be between 0 and 20 ºC, preferably under 16 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels should be verifiable at all times and must be > 7 mg/L.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salvelinus fontinalis:*

- **Oxygen levels must always be > 7 mg/L.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Brook trout: > 7 mg/L for early stages.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, provide supplementary aeration of the water.

Critical level for *Salvelinus fontinalis:*

- **Oxygen level: > 7 mg/L for early stages.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Density of spawners must be kept < 25 kg/m^3 for stocking.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Salvelinus fontinalis:*

- **Density of spawners must be kept < 25 kg/m^3 for stocking.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.3	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variation, and ranges of the original habitat: temperature of broodstock tanks must never rise above 16 ºC, and photoperiod must vary from 8:16 to 16:8 L:D respecting seasons.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, *e.g.,* temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

Specific requirements for *Salvelinus fontinalis:*

- **Temperature of broodstock tanks must never rise above 16 ºC;**
- **Photoperiod must vary from 8:16 to 16:8 L:D according to seasons.**

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team. Records for mortality causes must be in place per production unit. Operators must show awareness of mortality causes at inspection.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, should be implemented; however, in the absence of natural spawning. The auditor must ensure that

all artificial spawning procedures, e.g., stripping, must be performed under anesthesia by a trained staff member or team.

The terms “natural spawning” and “anaesthesia” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (e.g. 4 days at 10 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Salvelinus fontinalis:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 4 days at 10 ºC).**

The terms “eggs” and “degree-days” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.18.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis using practical experience, research and welfare specialist advice. Maximum range: 8:16 to 16:8 L:D.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that optimal photoperiod for cultured species is maintained.

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
15.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.2-2kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In offshore cages, fish are exposed to the natural sea background noise and noises generated by marine traffic from different types of boats.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Salvelinus fontinalis:*

- **The maximum sound pressure level should be under 150 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the tank at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 0 and 20 ºC, preferably under 16 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salvelinus fontinalis*:

- **Temperature must always be 0- 20 ºC, preferably under 16 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.3	**Oxygen levels should be verifiable at all times and must be > 7 mg/L.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Salvelinus fontinalis:*

- **Oxygen levels must always be > 7 mg/L.**

The term “oxygen” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Brook trout: > 7 mg/L.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, provide supplementary aeration of the water.

Critical level for *Salvelinus fontinalis*:

- **Oxygen content: > 7 mg/L.**

The term “oxygen” is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 26 Welfare Assessment). Density must be below 30 kg/m^3.**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis.

Specific requirements for *Salvelinus fontinalis:*

- **Density must be below 30 kg/m^3.**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.25 FOS Aqua – *Scophthalmus maximus* – certification requirements

2.2.9.4. HATCHERY REQUIREMENTS

1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis, matching natural limits and using practical experience, research and welfare specialist advice. Temperate waters photoperiod max. range: 16L:8D-8L:16D. Intensity at water surface: about 200 lux. Blue/green lights recommended for juveniles.**	**Important**

The fish's perception of day length influences development, physiology and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Scophthalmus maximus:*

- **Temperate waters photoperiod max. range: 16L:8D-8L:16D.**
- **Intensity at water surface: about 200 lux.**
- **Blue/green lights recommended for juveniles.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the tank at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Specific requirements for *Scophthalmus maximus;*

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the cage at all times.**

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 13 and 20 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Scophthalmus maximus*:

- **Range: between 13 and 20 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Scophthalmus maximus:*

- **Oxygen levels must always be > 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored and corrective action must be taken if levels fall below a critical point. Recommended oxygen saturation for Turbot: > 70%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken. Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Scophthalmus maximus*: > 70%.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms “stocking density” and “water quality” are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species (1M: 1F).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving many males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for *Scophthalmus maximus:*

- **Ratio of sexes (1M: 1F).**

The terms “broodstock” and “spawning” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 5 kg/m^3 for stocking and < 3 kg/m^3 for spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for *Scophthalmus maximus:*

- **Density of spawners must be kept at < 5 kg/m^3 for stocking and < 3 kg/m^3 for spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.3	**Tank sizes must be > 30m^3 and > 1m deep, rounded or avoiding angles, and contain structural enrichment, provided that it does not hinder fish swimming activities or cleaning.**	**Important**

The captive environment can be very different from the natural environment, and optimal captive environmental conditions should be maintained in order to promote reproductive activity. The auditor must confirm that broodstock holding tanks are > 5m^3 and > 1m deep, rounded or avoiding angles, and contain structural enrichment, provided that it does not hinder fish swimming activities or tank cleaning operations.

Specific requirement for *Scophthalmus maximus:*

- **Tank sizes must be > 30m^3 and > 1m deep, rounded or avoiding angles, and contain structural enrichment, provided that it does not hinder fish swimming activities or cleaning.**

The term "structural enrichment" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variation, and ranges of the original habitat.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under anesthesia by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, is implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.* stripping, must be performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (about 2 days at 19-20˚C).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for *Scophthalmus maximus:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (e.g., 2 days at 19-20 ºC).**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.4.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis, matching natural limits and using practical experience, research and welfare specialist advice. Temperate waters photoperiod max. range: 16L:8D-8L:16D.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Scophthalmus maximus:*

- **Temperate waters photoperiod max. range: 16L:8D-8L:16D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

The term "production unit" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The cages should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the cage at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators, air compressors, or filtration systems, should be separated from fish-holding facilities.

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and that a reporting system is in place to indicate inspection results.

Specific requirements for *Scophthalmus maximus;*

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the cage at all times.**

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 13 and 18 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Scophthalmus maximus:*

- **Temperature must always be between 13 and 18 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Scophthalmus maximus:*

- **Oxygen levels must always be > 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Turbot: > 6 mg/L.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and do not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, provide supplementary aeration of the water.

Critical levels for *Scophthalmus maximus*: > 6 mg/L.

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators. Limit stocking to < 15 kg/m^3 max. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation are available.

Specific requirements for *Scophthalmus maximus*:

- **Limit stocking to < 15 kg/m^3 max.**

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions

and Abbreviations.

2.2.26 FOS Aqua – *Seriola dumerili* – certification requirements

2.2.19.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis, matching natural limits and using practical experience, research and welfare specialist advice. Subtropical photoperiod max. range: 14L:10D-10L:14D; Intensity range: 200-800 lux.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species and that the optimal photoperiod for the cultured species is maintained.

Specific requirements for *Seriola dumerili:*

- **Subtropical photoperiod max. range: 14L:10D-10L:14D.**
- **Intensity range: 200-800 lux.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the cage at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Seriola dumerili:*

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point on the cage at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 20 and 26 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Seriola dumerili:*

- **Temperature must always be between 20 and 26 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Seriola dumerili:*

- **Oxygen levels must always be > 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point. Recommended oxygen saturation > 70%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and not fall below the critical level for the farmed species. Contingency plans

must be in place, and should levels fall below critical levels, appropriate action must be taken.
Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Seriola dumerili:*

- **Recommended oxygen level: > 70% saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species (1M:1F).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for S*eriola dumerili:*

- **Ratio of sexes is 1 male: 1 female.**

The term "broodstock" is defined in Section 1.4 Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 5 kg/m^3 for stocking and < 0.5 kg/m^3 for spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for S*eriola dumerili*:

- **Density of spawners must be kept <5 kg/m^3 for stocking and < 0.5 kg/m^3 for spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variation, and ranges of the original habitat.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, *i.e.,* without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under proven humane alternatives by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, should be implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures*, e.g.,* stripping, must be performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (about 2 days at 19-20 ºC).**	**Important**

Egg quality is an indication of whether optimal conditions were provided during the incubation period. The auditor must ensure that developing or incubating eggs are maintained in appropriate conditions for the species and that internal records and documentation are available.

Specific requirements for S*eriola dumerili:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 2 days at 19 – 20 ºC).**

The terms "eggs" and "degree-days" are defined in Section 1.4 – Definitions and Abbreviations.

2.2.19.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis matching natural limits and using practical experience, research and welfare specialist advice. Subtropical photoperiod max. range: 14L:10D-10L:14D.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Seriola dumerili:*

- **Subtropical photoperiod max. range: 14L:10D-10L:14D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		**Level**
15.9	**The cages should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the cage at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Seriola dumerili:*

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the cage at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 14 and 30 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for S*eriola dumerili:*

- **Temperature must always be between 14 and 30 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.
Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, provide supplementary aeration of the water.

Critical level for S*eriola dumerili:*

- **Oxygen content: must be > 70% oxygen saturation.**

The term “oxygen” is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Amberjack: > 6 mg/L. See Section 16 Water.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and not fall below the critical level for the farmed species. Contingency plans must be in place and, should levels fall below critical levels, appropriate action must be taken.
Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, provide supplementary aeration of the water.

Critical level for S*eriola dumerili:*

- **Oxygen content: > 6 mg/L.**

The term “oxygen” is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 26 Welfare Assessment). Limit stocking to 10 kg/m^3 max. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored regularly.

Specific requirements for S*eriola dumerili:*

- **Limit stocking to 10 kg/m^3 max.**

The terms “stocking density” and “water quality” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.27 FOS Aqua – *Seriola lalandi* – certification requirements

2.2.20.1. HATCHERY REQUIREMENTS

Captive environment

Requirement		Level
1.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis, matching natural limits and using practical experience, research and welfare specialist advice. Subtropical photoperiod max. range: 14L:10D-10L:14D.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that optimal photoperiod for cultured species is maintained.

Specific requirements for *Seriola lalandi:*

- **Subtropical photoperiod max. range: 14L:10D-10L:14D.**

The terms "photoperiod" and "fish welfare" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
1.9	**The tanks should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the cage at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Seriola lalandi*:

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the cage at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range, and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
2.2	**Temperature should be verifiable at all times and must be between 18 and 24 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Seriola lalandi*:

- **Temperature must always be between 18 and 24 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
2.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor shall ensure that regular monitoring of oxygen levels of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for *Seriola lalandi:*

- **Oxygen levels must always be > 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
10.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point. Recommended oxygen saturation > 70%.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.
Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, supplementary aeration of water should be provided.

Critical level for *Seriola lalandi:*

- **Recommended oxygen level: > 70% saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
13.2	**Stocking density should be monitored in relation to fish health and behaviour indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 2 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 3 Animal Health and Welfare and Section 12 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis and upon demand, and these internal records and documentation should be available.

The terms "stocking density" and "water quality" are defined in Section 1.4 – Definitions and Abbreviations.

Broodstock and eggs

Requirement		Level
14.1	**Stocking of broodstock should match the natural sex ratio of the species (1M: 1-1.5F).**	**Important**

Spawning behaviour is species-specific and can be in pairs (monogamy), a female with many males, a male with many females, or mass spawning involving males and females. The auditor shall ensure that the stocking ratio of broodstock matches the natural sex ratio of the cultured species and that internal records and documentation are available.

Specific requirement for S*eriola lalandi:*

- **Ratio of sexes is 1 male: 1.5 females.**

The term "broodstock" is defined in Section 1.4. Definitions and Abbreviations.

Requirement		Level
14.2	**Density of spawners must be kept < 5 kg/m^3 for stocking and < 3 kg/m^3 for spawning.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, in order to provide the optimal conditions that allow maturation to proceed. Environmental requirements for reproduction are species-specific. The auditor shall ensure that the tank density of broodstock matches the requirements of the cultured species and that internal records and documentation are available.

Specific requirement for S*eriola lalandi:*

- **Density of spawners must be kept < 5 kg/m^3 for stocking and < 3 kg/m^3 for spawning.**

The term "spawners" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.4	**Environmental parameters (temperature and photoperiod) of broodstock tanks should follow the natural rhythms, variation, and ranges of the original habitat.**	**Important**

The critical points in the reproductive development of a species are those that require control of the culture environment, to provide the optimal conditions that allow maturation to proceed. Spawning requires a precise environment; therefore, environmental requirements for reproduction are species-specific. The auditor shall ensure that environmental parameters, e.g., temperature, photoperiod, match the environmental conditions in nature. The auditor must also ensure that internal records and documentation are available.

The terms "temperature" and "photoperiod" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.5	**Natural spawning methods, i.e., without handling or manipulation, should be implemented. In the absence of such, all handling procedures (*e.g.,* stripping) must be performed under proven humane alternatives by a trained staff member or team.**	**Important**

The auditor must ensure that natural spawning*, i.e.,* fish are placed together in a breeding area/tank where they spawn naturally without any chemical (hormonal) intervention, should be implemented; however, in the absence of natural spawning. The auditor must ensure that all artificial spawning procedures, *e.g.,* stripping, must be performed under anesthesia by a trained staff member or team.

The terms "natural spawning" and "anaesthesia" are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
14.6	**Developing eggs may be maintained in dim light or darkness to reduce mortality and must not be handled after placement for 40-45 degree days (about 2 days at 19- 20 ºC).**	**Important**

Specific requirements for S*eriola lalandi:*

- **eggs are maintained in dim light or darkness to reduce mortality;**
- **eggs must not be handled after placement for 40-45 degree-days (about 2 days at 19 – 20 ºC).**

The terms “eggs” and “degree-days” are defined in Section 1.4 – Definitions and Abbreviations.

2.2.20.2. ON-GROWING REQUIREMENTS

Captive environment

Requirement		Level
15.5	**Optimal photoperiod for fish welfare must be determined on a site-by-site basis, matching natural limits and using practical experience, research and welfare specialist advice. Subtropical photoperiod max. range: 14L:10D-10L:14D.**	**Important**

The fish's perception of day length influences development, physiology, and behaviour, and it is therefore important to use appropriate light regimes specific to cultured species. Many fish require light for feeding and other behavioural activities. Fish should be maintained on an appropriate photoperiod as far as possible since the day/night cycle influences the physiology and the behaviour of fish.

The auditor should verify that the facility is allocated within the natural photoperiod and matches the natural limits of the cultured species, and that the optimal photoperiod for cultured species is maintained.

Specific requirements for *Seriola lalandi:*

- **Subtropical photoperiod max. range: 14L:10D-10L:14D.**

The terms “photoperiod” and “fish welfare” are defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
15.9	**The cages should be located in a site protected from human induced noise. The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1- 3 kHz frequency range in any point of the cage at all times.**	**Recommended**

Fish can be acutely sensitive to sounds, even at very low levels. There is evidence that human-induced noise*, i.e.,* sound generated by anthropogenic sources in the aquatic environment, has the potential to have adverse physiological and physical effects (Popper and Hawkins 2018; Howkins and Popper 2018), affect behaviour (Zhou et al. 2016), decrease growth (Filiciotto et al. 2013), and damage hearing (McCauley et al. 2003), all impacting fish welfare. In a hatchery setting, these noises could originate from air and water pumps, tractors, harvesters, and the activities of personnel managing the facility.

Noise levels within the facility should be kept to a minimum. Where possible, equipment causing noise or vibration, such as power generators or filtration systems, should be separated from fish-holding facilities.

Specific requirements for *Seriola lalandi:*

- **The maximum sound pressure level should be under 128 dB re 1 µPa rms in the 0.1-3kHz frequency range at any point in the cage at all times.**

The auditor must ensure that sound is checked with a hydrophone and that noise levels are within the appropriate range and a reporting system is in place to indicate inspection results.

Water

Requirement		Level
16.2	**Temperature should be verifiable at all times and must be between 18 and 24 ºC.**	**Important**

The auditor shall ensure that regular monitoring of the temperature of production units is carried out and identify internal records of routine testing and reporting.

Specific requirements for S*eriola lalandi:*

- **Temperature must always be between 18 and 24 ºC.**

The term "temperature" is defined in Section 1.4 – Definitions and Abbreviations.

Requirement		Level
16.3	**Oxygen levels must be verifiable at all times and must be > 70% oxygen saturation.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and not fall below the critical level for the farmed species. Contingency plans must be in place and, should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, provide supplementary aeration of the water.

Critical level for S*eriola lalandi:*

- **Oxygen content: must be > 70% oxygen saturation.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Crowding

Requirement		Level
24.5	**Oxygen levels during crowding must be monitored, and corrective action must be taken if levels fall below a critical point (the critical point will vary between species and with environmental factors). Critical level for Yellowtail Amberjack: > 6 mg/L. See Section 16 Water.**	**Important**

The auditor must ensure that oxygen levels are monitored and recorded throughout all crowding and not fall below the critical level for the farmed species. Contingency plans must be in place, and should levels fall below critical levels, appropriate action must be taken.

Oxygen concentration should be appropriate to the species and the context in which they are held. Where necessary, provide supplementary aeration of the water.

Critical level for S*eriola lalandi:*

- **Oxygen content: > 6 mg/L.**

The term "oxygen" is defined in Section 1.4 – Definitions and Abbreviations.

Stocking and mortality

Requirement		Level
27.2	**Stocking density should be monitored in relation to fish health and behaviour indicators. Limit stocking to 10 kg/m^3 max. Water quality must be monitored frequently and on demand (see Aqua-inland point 8 and Section 16 Water).**	**Important**

The auditor shall verify that stocking density is monitored in relation to fish health and behavioural indicators (see Section 17 Animal Health and Welfare and Section 26 Welfare Assessment). In addition, water quality parameters should be monitored on a regular basis.

Specific requirements for S*eriola lalandi:*

- **Limit stocking to 10 kg/m^3 max.**

The terms “stocking density” and “water quality” are defined in Section 1.4 – Definitions and Abbreviations.

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