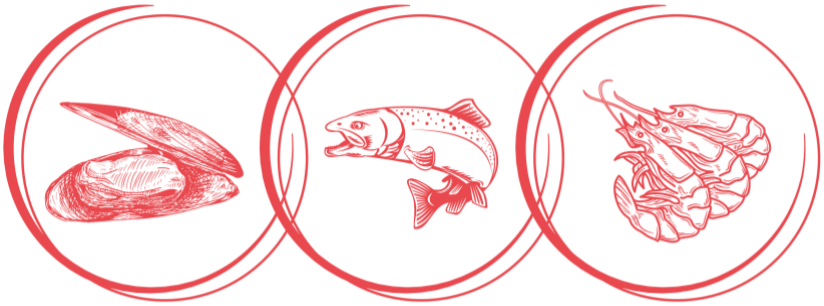
CODE • EFABAR

The commitment to responsible breeding

Species Specific Template
Code EFABAR



AQUACULTURE
Code EFABAR 2023
7th Edition

Company: _____

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The code of good practices for sustainable and balanced aquaculture breeding

1 Introduction

1.1 Impact and structure of breeding in the EU aquaculture sector

1.1.1 Past and Present

Selective breeding is recent in aquaculture, as aquaculture production's first breeding programs were initiated in the mid-70s and were multiplied since the mid-90s' in Europe, with applications mostly to salmonids, marine fishes, and oysters. In the last three decades, **breeding companies/organisations (BC/O)** have learned and have adapted their breeding strategies to include sustainability with more emphasis on animal health and welfare traits by the domestication of more adapted individuals to the farming environments and practices and selection on disease resistance traits and animal integrity in preventing defects. These aspects have been translated into six pillars, the foundation of modern responsible and balanced breeding and Code EFABAR.

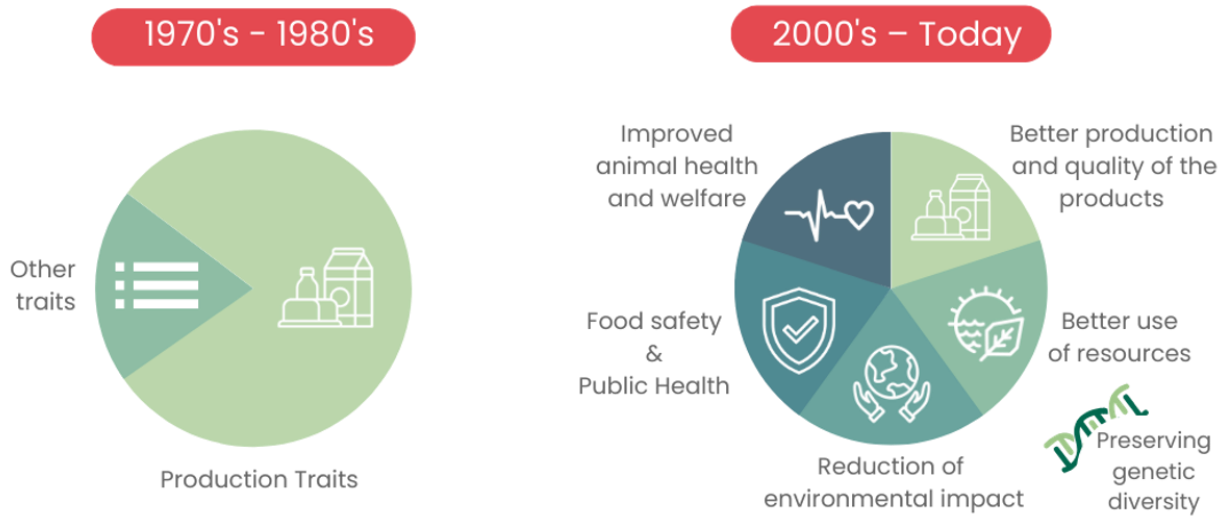

Figure 1 The pie charts represent the progress in the last 50 years in animal breeding.

Modern breeding consists of defining a balanced combination of traits to ensure the sustainability of the different production systems. The combination of these traits varies **from species, region to region, country to country and production system to production system;** the choice of farmers and many other factors related to the availability of resources and different social, environmental, political, and economic situations. Modern aquaculture is based on these principles.

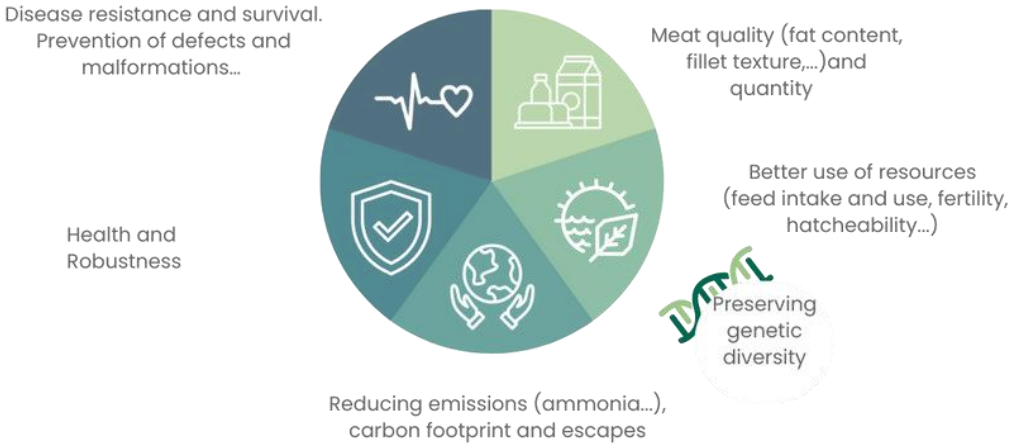

Figure 2 Modern Aquaculture: defining a balanced combination of traits to ensure the sustainability of the different aquaculture production systems.

1.1.2 Modern Aquaculture Breeding

In aquaculture, breeding programs are developed under **responsible and balanced breeding programs,** aiming to produce more healthy and robust aquatic populations for food production and for the restoration of endangered or disappearing populations or species. These programs are designed for a variety of aquaculture systems, including ponds, re-circulated aquaculture systems, land-based raceways or tank and sea pens, and diverse animal species, including finfish, bivalves and crustaceans. A lack of selective breeding programs using principles of quantitative genetics is being recognised in micro and macroalgae.

In aquaculture, modern breeding programmes aim to adapt and improve the quality and performance of aquatic organisms, including fish and various other species. These programmes prioritise the cultivation of robust breeding populations, also known as broodstock. These populations are bred to carry on the most favourable traits, such as disease resistance to various aquatic diseases (original strategy compared to terrestrial livestock) and optimised feed utilisation. By focusing on these traits, aquaculture activities elevate the well-being of marine and freshwater organisms by minimising mortalities, minimising environmental impact, and producing premium seafood, all while reducing reliance on resources such as feed, water, and energy. This comprehensive framework incorporates several pivotal components:

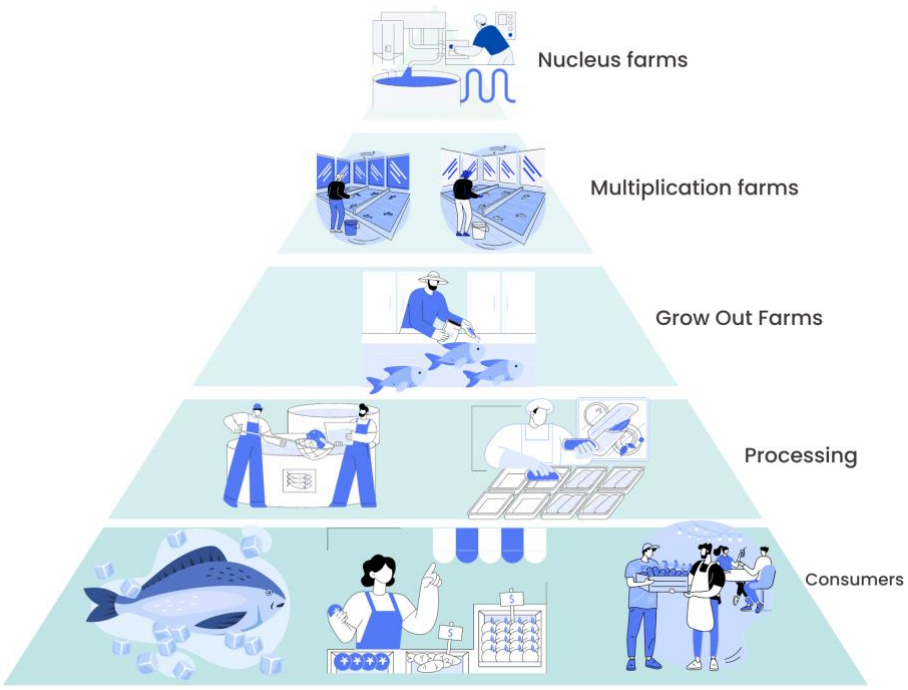

Figure 3 The simplified structure of the aquaculture sector designed to foster genetic advancements and efficient production methods

Establishing structured breeding systems and utilising techniques such as controlled breeding and advanced reproductive technologies such as sperm cryopreservation are essential in modern aquaculture breeding. These practices contribute to securing and making aquaculture food production systems more resilient, progress on genetic advancement, efficient production, improved animal welfare, and producing high-quality seafood products for the next 10-20 years. This structured approach ensures continuous progress for better sustainability and resilience within the aquaculture sector.

1.1.3 Vision for the future

The aquaculture breeding sector is going through a significant transformation, with a bright future filled with potential. This transformation is driven by genetic improvements, supported by both traditional and innovative breeding technologies.

Traditional breeding tools have been the sector's backbone and will continue to play a crucial role. Perfected over centuries, these tools provide a solid foundation for breeding programs. They offer tried-and-tested methods that ensure the health and diversity of our aquatic species. While we embrace new technologies, the importance of these traditional tools should not be underestimated.

We foresee a transformative impact on the sector as we continue to innovate and adapt. The commitment to expanding breeding program goals, applying new technologies, and prioritising sustainability and animal welfare is shaping the future of this vital sector.

A key aspect of this vision is the sector's commitment to the protection and welfare of wild populations. It is crucial that breeders' practices do not negatively impact wild fish populations and their habitats. This balance between innovation and conservation underscores the sector's vision for a sustainable and prosperous future.

Moreover, research and development play a critical role in this transformation. Collaboration with researchers and academia is essential to drive innovation and keep the sector at the forefront of technological advancements. This collaboration extends across the agri-food value chain, promoting a holistic approach to sustainable aquaculture. By working together, we can ensure the sector thrives while maintaining a solid commitment to sustainability and animal welfare.

As we look forward, we are excited to witness the positive ripple effects of these commitments on the aquaculture breeding sector.

Breeding Technologies in Aquaculture

The aquaculture sector employs various breeding technologies, each with unique approaches and benefits. These technologies, from traditional methods like artificial insemination and selective breeding to advanced techniques such as gene editing, play a crucial role in the sector's development.

Functional Annotation, Novel Traits and Epigenomics in Aquaculture

The future of the aquaculture sector is not just about the present but also about the potential of what could be. This is where functional annotation, novel traits, and epigenomics come into play. These three areas are critical for the future development and sustainability of the aquaculture sector, and their advancement relies heavily on the collaboration between breeders, researchers, and academia.

Precision Livestock Farming (PLF) in Aquaculture

Precision livestock farming (PLF) is an approach that enables the farmer to have more objective information about the animal to make better choices about the sustainability of their production system. By adopting several core principles from PLF, Precision Fish Farming (PFF) contributes to:

- Moving commercial aquaculture from the traditional experience-based to a knowledge-based production regime.
- Facilitating and automating aquaculture operations based on data collected by sensors and other technology.

Further details and examples can be found in Section 7.2

1.2 Contribution to the United Nations Sustainable Development Goals (UN SDGs)

Sustainable production is becoming a significant focus across the farmed animal sector in order to ensure that efficient and high-output systems are environmentally and animal welfare friendly. The United Nations have agreed on 17 sustainability development goals to be addressed by various industrial and production methods (https://sustainabledevelopment.un.org/). Aquaculture production systems have the ability to address 6 of these goals, as summarised below directly:

Figure 4 The Aquaculture sector contributes to these six UN SDGs

1.3 The vision and the role of _____ towards their journey to sustainable and balanced breeding

This section asks BC/O to describe their vision and how they implement it through breeding goals. It's important to mention the variety of production systems and species to which the companies provide genetics, and which are the difference between breeding programs and goals for those different systems, if any.

1

2 Responsible and balanced breeding

Responsible and balanced animal breeding in aquaculture encompasses strategies to maintain the long-term well-being of aquatic animals, the environment, and expectations from the food supply chain and society. It emphasises achieving a balance between genetic improvement and preserving **genetic diversity**. Additionally, it prioritises the **efficient utilisation of resources**, **improving animal health and welfare**, **safeguarding the environment, and ensuring public health and food safety**.

These principles, collectively known as the six pillars of Code EFABAR, form the foundation of responsible aquaculture breeding practices.

Figure 5 The six pillars of Code EFABAR

2.1 Guidelines and Instructions for Breeders

This section will explore the breeding and management elements incorporated into your breeding company's (BC) breeding programme for each of the 6 pillars:

1. We will examine the implementation of specific breeding and management elements and request detailed information on how each element is incorporated. If any elements still need to be implemented, we encourage you to share the reasons behind this decision, fostering a transparent understanding of your breeding practices.
2. Additionally, we kindly request data showcasing the progress made; this can be confidential data or published papers. Please note that **EFFAB respects confidentiality**, and all information provided will be considered confidential unless explicitly stated otherwise.
3. Alternatively, describe the current progress and provide insights into the expected advancements for each breeding element.

These questions aim to facilitate a comprehensive understanding of your breeding programme and its achievements. By sharing your self-regulated practices, we can collectively promote the importance of balanced and sustainable breeding programmes to a wider audience, including stakeholders, policymakers, and the broader society.

2.2 Animal Health and Welfare

Aquaculture breeders prioritize the well-being of the aquatic species under their care through a combination of breeding and management strategies. They select for traits related to disease resistance, stress tolerance, and overall health in breeding programs. Simultaneously, breeders implement proper husbandry practices, such as optimal nutrition, disease monitoring, and regular health assessments, to ensure the welfare of animals. Additionally, they emphasise the responsible use of antibiotics, employing strict protocols and guidelines to minimize their usage and prevent the development of antibiotic resistance.

Have the following breeding elements been implemented in the BC breeding programme?		**Can you provide more details about how the breeding element has been implemented? And if not, why not?**	**Can you provide data to show progress in the last 3 years and include the animal's stage of life the data is relevant? Alternatively, describe the current and expected progress.**
Genetic defects Eg:_____	☐Yes ☐No ☐NA		
Disease resistance	☐Yes ☐No ☐NA		
Liveability/Survival	☐Yes ☐No ☐NA		
Robustness	☐Yes ☐No ☐NA		
Improve ability to cope with farming practices (different environment and climate change)	☐Yes ☐No ☐NA		
Preventing external and/or internal malformation	☐Yes ☐No ☐NA		
Prevention of sexual maturation	☐Yes ☐No ☐NA		
Multi-traits and balanced breeding goal	☐Yes ☐No ☐NA		
New/Faster technology for accurate recording of traits to improve welfare	☐Yes ☐No ☐NA		
Are there any other breeding elements that are important to your BC and should be considered?	☐Yes ☐No	**List Here:**	

Have the following management elements been implemented in the BC breeding programme?		**If yes, give a short explanation and provide supporting documents if possible.**	**If no, can you explain why? Is there a possibility for these management elements to be implemented in the next 3 years?**
Has the BC a biosecurity policy on its own premises (to avoid diseases and the spreading of diseases to other premises) Is it implemented?	☐Yes ☐No ☐NA ☐Yes ☐No ☐NA		
Has the BC a welfare policy on its own premises making a reference to the Five Freedoms[1] : Or Five Domains[2] : Is the welfare policy implemented?	☐Yes ☐No ☐NA ☐Yes ☐No ☐NA ☐Yes ☐No ☐NA		
Has the BC procedures to minimise stress when handling individuals, for example when collecting phenotypes, treatments (e.g., vaccination) or sorting?	☐Yes ☐No ☐NA		
Does the BC used specific pathogen free (SPF) broodstock to some pathogens that it control to protect its genetic line and avoid transmission of these diseases?	☐Yes ☐No ☐NA		
Has the BC a policy on how to handle its animals prior to and during transport? Is it implemented?	☐Yes ☐No ☐NA ☐Yes ☐No ☐NA		

[1] Five Freedoms: https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-welfare/
[2] Five Domains: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5575572/

Has the BC a policy in place to periodically train and update its animal care takers on how to manage and handle the animals and is it implemented?	☐Yes ☐No ☐NA		
Has the BC a monitoring programme to ensure welfare of animals during mid/long distance routes?	☐Yes ☐No ☐NA		
Can the BC list the bio-securities measured applied during the safe transport of the animals?	☐Yes ☐No ☐NA		
Does the BC follow requirements for transport of breeding stock as outlined in annex?	☐Yes ☐No ☐NA		
Are there any other management elements that are important to your BC and should be considered?	☐Yes ☐No	**List Here:**	

2.3 Environment

Aquaculture breeders undertake measures to minimise the environmental footprint of their operations through both breeding and management approaches. They select directly or indirectly for traits such as improved feed conversion efficiency, reduced waste production, and better tolerance to environmental conditions in breeding programs. Additionally, breeders employ strategies such as efficient feed management, responsible waste management, and sustainable farming techniques to mitigate environmental impacts.

Have the following breeding elements been implemented in the BC breeding programme?		**Can you provide more details about how the breeding element has been implemented? And if not, why not?**	**Can you provide data to show progress in the last 3 years and include the animal's stage of life the data is relevant? Alternatively, describe the current and expected progress.**
Feed efficiency (decrease of water pollution)[3]	☐Yes ☐No ☐NA		
Use of alternative feed sources to limit overexploitation of marine resources	☐Yes ☐No ☐NA		
Production of sterile fish or shellfish (to prevent potential negative effect of escapees and to minimise feed waste)	☐Yes ☐No ☐NA		
Genetic resistance to diseases to limit the release of drugs and the contamination of wild populations	☐Yes ☐No ☐NA		
Genomic traceability of escapees	☐Yes ☐No ☐NA		
Increase capacities to fix or synthetize w3-fatty acids (limitation of fishing pressure on wild stocks and improve Human health)	☐Yes ☐No ☐NA		

[3] Environmental impacts of genetic improvement of growth rate and feed conversion ratio in fish farming under rearing density and nitrogen output limitations. *Journal of Cleaner Production* 116 (2016): 100_109. https://doi.org/10.1016/j.jclepro.2015.12.084.

Are there any other breeding elements that are important to your BC and should be considered?	☐Yes ☐No	**List Here:**	
Have the following management elements been implemented in the BC breeding programme?		**If yes, give a short explanation and provide supporting documents if possible.**	**If no, can you explain why? Is there a possibility for these management elements to be implemented in the next 3-5 years?**
Has the BC an environment policy on its own premises and is it implemented?	☐Yes ☐No ☐NA		
Has the BC procedures to feed slightly below satiation (to minimise waste of feed)	☐Yes ☐No ☐NA		
Has the BC procedures to monitor disease outbreaks or parasite levels on site?(related to the impact on wild populations)	☐Yes ☐No ☐NA		
Has the BC had a policy to reduce carbon footprint?	☐Yes ☐No ☐NA		
Are there any other management elements that are important to your BC and should be considered?	☐Yes ☐No	**List Here:**	

2.4 Better Use of Resources

Aquaculture breeders strive to optimize the use of resources through both breeding and management strategies. In breeding programs, they select for traits related to improved growth rates, feed conversion efficiency, and resource utilization. At the same time, breeders employ management practices that promote resource efficiency, such as efficient feeding regimes, water recirculation systems, and sustainable farming techniques.

Have the following breeding elements been implemented in the BC breeding programme?		**Can you provide more details about how the breeding element has been implemented? And if not, why not?**	**Can you provide data to show progress in the last 3 years and include the animal's stage of life the data is relevant? Alternatively, describe the current and expected progress.**
Improving growth rate, but not at the expense of health and welfare **Note: the progress should be shown as "final body weight", growth rate between two stages" and "time at sea"**	☐Yes ☐No ☐NA		
Feed efficiency	☐Yes ☐No ☐NA		
Ability to use feed substitutes with vegetal ingredients or alternative sources	☐Yes ☐No ☐NA		
Improvement of survival to limit the loss of feed and energy	☐Yes ☐No ☐NA		
Improve yields at processing (gutting, filleting, trimming) or yield of edible part (shellfish) to improve the efficiency of feed and energy resources used related to the final consumed or edible part	☐Yes ☐No ☐NA		
Are there any other breeding elements that are important to your BC and should be considered?	☐Yes ☐No	**List Here:**	

Have the following management elements been implemented in the BC breeding programme?		**If yes, give a short explanation and provide supporting documents if possible.**	**If no, can you explain why? Is there a possibility for these management elements to be implemented in the next 3 years?**
Has the BC a resource efficiency policy on its own premises and is it implemented?	☐Yes ☐No ☐NA		
Has the BC investigated methods to measure feed efficiency in their program?	☐Yes ☐No ☐NA		
Are there any other management elements that are important to your BC and should be considered?	☐Yes ☐No	**List Here:**	

2.5 Genetic diversity

Aquaculture breeders recognise the importance of genetic diversity and implement breeding and management strategies to preserve and promote it. They actively manage breeding populations, avoid excessive reliance on a limited number of genetic lines, and incorporate genetic variation from multiple sources. By maintaining diverse genetic backgrounds, breeders ensure the resilience and adaptability of farmed populations.

Have the following breeding elements been implemented in the BC breeding programme?		**Can you provide more details about how the breeding element has been implemented? And if not, why not?**	**Can you provide data to show progress in the last 3 years and include the stage of life of the animal to which this data is relevant? Alternatively, describe the current and expected progress.**
Initiation of domestication or genetic selection of new species with an initial large genetic variation	☐Yes ☐No ☐NA		
Management of genetic variability in selected lines to limit increase of inbreeding rate	☐Yes ☐No ☐NA		
In-situ conservation of genetic resources	☐Yes ☐No ☐NA		
Mid-term live backup	☐Yes ☐No ☐NA		
Long-term cryo-banking of genetic resources (germ, stem cells, sperm, oocyte or larvae)	☐Yes ☐No ☐NA		
Amount of cyro conservation (% male nucleus frozen)	☐Yes ☐No ☐NA		
Use of pedigree to manage inbreeding	☐Yes ☐No ☐NA		
Use of a minimal number of parents per generation and appropriate measures to minimise inbreeding in respecting < 1% of increase in the rate of inbreeding	☐Yes ☐No ☐NA		

Are there any other breeding elements that are important to your BC and should be considered?	☐Yes ☐No	**List Here:**	
Have the following management elements been implemented in the BC breeding programme?		**If yes, give a short explanation and provide supporting documents if possible.**	**If no, can you explain why? Is there a possibility for these management elements to be implemented in the next 3 years?**
Does the BC operate its own or contribute to a public gene bank for commercial breed?	☐Yes ☐No ☐NA		
Does the BC operate its own or contribute to a public gene bank for commercial lines?			
Does the BC contribute to the conservation of genes of rare and threatened breeds?	☐Yes ☐No ☐NA		
Does the BC use pedigree management using physical tagging and genomic selection?	☐Yes ☐No ☐NA		
Are there any other management elements that are important to your BC and should be considered?	☐Yes ☐No	**List Here:**	

2.6 Product Quality

Aquaculture breeders prioritise the production of high-quality seafood products through a combination of breeding and management practices. They select for traits related to desirable product attributes, such as flavour, texture, colour, and nutritional content, in breeding programs. Additionally, breeders implement proper handling, processing, and quality control measures to ensure the final products meet the expectation of their farmers.

Have the following breeding elements been implemented in the BC breeding programme?		**Can you provide more details about how the breeding element has been implemented? And if not, why not?**	**Can you provide data to show progress in the last 3 years and include the animal's stage of life the data is relevant? Alternatively, describe the current and expected progress.**
Improvement of body or shell conformation and morphology	☐Yes ☐No ☐NA		
Improvement of skin or shell colour	☐Yes ☐No ☐NA		
Improvement of flesh quality, lipid content or composition of the fillet or the edible part	☐Yes ☐No ☐NA		
Improvement of the colour of the fillet or the edible part	☐Yes ☐No ☐NA		
Proposal of new product by the domestication of new species	☐Yes ☐No ☐NA		
Prevention of external and/or internal malformation (appearance)	☐Yes ☐No ☐NA		
Are there any other breeding elements that are important to your BC and should be considered?	☐Yes ☐No		
Are there any other management elements that are important to your BC and should be considered?	☐Yes ☐No	**List Here:**	

2.7 Food Safety and Public Health

Aquaculture breeders prioritise public health and food safety through breeding and management approaches. Breeders incorporate genetic selection for traits related to immune response and disease resistance, improving the overall health and resilience of the aquaculture stock. Moreover, breeders implement robust biosecurity protocols, and conduct regular health screenings in breeding populations to minimise the risk of disease transmission.

Have the following breeding elements been implemented in the BC breeding programme?		**Can you provide more details about how the breeding element has been implemented? And if not, why not?**	**Can you provide data to show progress in the last 3 years and include the animal's stage of life the data is relevant? Alternatively, describe the current and expected progress.**
Reduction of use of antimicrobials and anti-parasitic medicines.	☐Yes ☐No ☐NA		
Meat quality (related to food safety and public health, for instance by minimizing the spreading of zoonotic diseases	☐Yes ☐No ☐NA		
Suppression antifungals treatments	☐Yes ☐No ☐NA		
Are there any other breeding elements that are important to your BC and should be considered?	☐Yes ☐No	**List Here:**	
Have the following management elements been implemented in the BC breeding programme?		**If yes, give a short explanation and provide supporting documents if possible.**	**If no, can you explain why? Is there a possibility for these management elements to be implemented in the next 3 years?**
Has the BC a biosecurity policy on its own premises (to avoid spreading zoonoses) and is it implemented?	☐Yes ☐No ☐NA		
Does the BC perform a diagnosis before the use of antibiotics?	☐Yes ☐No ☐NA		

Has the BC an antimicrobial policy on its own premises and is it implemented?	☐Yes ☐No ☐NA		
Has the BC, as part of their biosecurity processes, procedures to reduce the potential risk of contamination from staff and equipment?	☐Yes ☐No ☐NA		
Has the BC a method for screening prior to breeding and screening eggs/fish/larvae prior to transport for bacterial/fungal infections and is it implemented?	☐Yes ☐No ☐NA		
Are there any other management elements that are important to your BC and should be considered?	☐Yes ☐No	**List Here:**	

3 Responsible use of technologies

Modern animal breeding comes with advancements in tools and technologies used for breeding and reproduction. Therefore, prioritising the conscientious and ethical application of technologies in breeding, considering the welfare of the animals, their genetics, the environment in which they evolve, the resources available and their optimal use, the quality of the products, the one health concept, and broader ethical implications are crucial.

- Is the BC responsibly using established breeding and reproduction technologies (e.g., Genomic Selection, BLUP, Artificial Insemination, sperm cryopreservation, Germ cell Transfer, Polyploidisation?
- If yes, which ones and for which purpose

Technology used	Purpose (Benefits)

- What does responsibly mean in this context for the BC?

- Is the BC responsibly using new breeding or reproduction technologies (e.g., Novel Traits, Precision Livestock Farming for new traits in welfare, or product quality, Marker Assisted Selection, Genomic Prediction, Gene Editing, Cloning)?

  ☐Yes ☐No

  If yes, which ones and for which purpose?

Technology used	Purpose (Benefits)

- Is BC excluding any technologies? Why?

4 Research, innovation, and public perception

Research, innovation, and public perception are vital in modern aquaculture breeding. The research contributes to advancements in genetics, health, nutrition, and breeding technologies, enabling the identification of desirable traits and the development of efficient breeding strategies in limiting environmental impacts. The innovation introduces new tools and practices that enhance productivity, sustainability, and the welfare of species farmed in aquaculture. Additionally, public perception guides the sector towards transparent and ethical practices, aligning breeding systems with societal values and fostering trust between breeders and consumers. Integrating research, innovation, and public perception ensures modern aquaculture breeding practices' continuous improvement and responsible development.

- Does the BC invest in research and development in new breeding and reproductive technologies and novel traits?

  ☐Yes ☐No

- Which ones and for what?

- Does the BC collaborate with research institutes?

  ☐Yes ☐No

- What novel traits or breeding goals should be considered for aquaculture breeding in the future?

- Is the BC aligned with the principle of the Three Rs principle[4] (3Rs)/Responsible research and innovation[5](RRI) when using animals for research and innovation (RI)?
  ☐Yes ☐No

- If not, what is the BC's current policy to ensure welfare and ethics are applied during RI?

- Does the BC takes action to engage with society and other stakeholders than aquaculture producers? (e.g., advocate animal health and welfare, balance aquaculture breeding, etc.)

  ☐Yes ☐No

- How is the BC collaborating, and for which purpose? (e.g., at the consumer or farmer level, balanced breeding advocacy, etc.)

[4] The three Rs (3Rs): https://ec.europa.eu/health/scientific_committees/opinions_layman/en/non-human-primates/glossary/tuv/three-rs-principle.htm
[5] Responsible Research and Innovation (RRI): https://op.europa.eu/en/publication-detail/-/publication/ee9bacdf-fdad-46eb-8cd8-32879e310191/language-en

5 Breeding Policy Declaration

Company Name:
Manager/CEO Name:

We are committed to ensuring that the rules of Code EFABAR are implemented and maintained throughout our operational and producing activities related to animal breeding and reproduction.
This is achieved by:

1. Compliance and implementation of the relevant and applicable legislation.
2. Implementation of Good Practices for Responsible and Balanced Breeding and Reproduction as indicated in the Code EFABAR, Version 2023.
3. Information and training of our staff in Code EFABAR requirements to ensure that it is continuously implemented.

Date:
Signature:

6 Declaration of Approval by the EFFAB Director

Having evaluated the indications as provided by the applicant breeding/reproduction company,
I have concluded and propose that the certificate of compliance, according to the regulations of Code EFABAR shall be issued to the applicant.

Date:

Place: Brussels
Period of validity:
EFFAB Director Signature:

7 ANNEXE

7.1 Animal Health and Welfare: Transport of breeding animals

Has the following transportation policy element been implemented in the BC breeding programme?		**If yes, give a short explanation and provide supporting documents if possible.**	**If no, can you explain why? Is there a possibility for these management elements to be implemented in the next 3-5 years?**
Are all persons involved with the transport of breeding stock **aware of and comply** with relevant EU/National/international laws and best practices, such as WOAH standards[6] or the EPAHW Guide[7]?	☐Yes ☐No ☐NA		
Does the BC verify all the certificates and authorizations of the operator transporting breeder aquatic animals on their behalf?	☐Yes ☐No ☐NA		
Is the vehicle in use being maintained and kept in a condition which ensures that all animals can be transported under the expected conditions to which it was designed to ensure biosecurity and animal welfare?	☐Yes ☐No ☐NA		
Does the BC ensure the quality of water is maintained during transport?	☐Yes ☐No ☐NA		
Does the BC have a system in place to monitor the levels of - CO_2 - pH levels - Temperature - and other gases: _____ in the water tank during transport?	☐Yes ☐No ☐NA ☐Yes ☐No ☐NA ☐Yes ☐No ☐NA ☐Yes ☐No ☐NA		

[6] World Organisation for Animal Health: Control of Aquatic Animal Health associated with transport of aquatic animals
[7] EU Platform of Animal Health and Welfare (EPAHW) in Aquaculture

Does the BC have emergency measures in place if the levels of CO_2, pH temperature or other gasses in the water tank become imbalanced during transport?	☐Yes ☐No ☐NA		
Are all relevant legislation in relation to stocking density during transport of any species applied?	☐Yes ☐No ☐NA		
Has the BC a robust policy to check that breeding animals fit for transport before leaving?	☐Yes ☐No ☐NA		

7.2 Glossary

7.2.1 Breeding Technologies

Here's a brief introduction to some of the technologies addressed above:

- **Artificial Insemination (AI):** This technique involves manually combining the sperm and eggs of aquatic species for controlled dissemination of genetic material from superior parental stock, improving the robustness and performance of offspring. For example, AI has been used in externally fertilised fish like zebrafish as a tool for ex-situ and in-situ conservation of valuable populations.
- **Gene Editing**: While gene editing is not currently in use, it represents a promising area of research. This advanced technology has the potential to allow breeders to incorporate advantageous genes, thereby enhancing disease resistance and overall well-being in diverse aquaculture species. Any research in this area is conducted responsibly under the Responsible Research and Innovation (RRI) framework, ensuring a transparent, inclusive approach that is responsive to societal needs and values.
- **Genomic Selection**: Genomic selection, a modern breeding approach, involves the analysis of individual fish DNA to identify valuable genetic traits at an early stage. This enables the selection of fish exhibiting the most desirable characteristics. The sector's focus remains on using this tool responsibly, considering the welfare of animals.
- **Marker-Assisted Breeding:** This technique uses molecular markers, which are identifiable DNA sequences located near a gene of interest on a chromosome. These markers can be used to select individuals carrying desirable traits, even without knowing the exact location of the genes that control those traits. For example, molecular markers have been used in aquaculture for breeding programmes and planning conservation strategies based on genetic diversities of various fish species.
- **Selective Breeding:** This is a traditional method where individuals with desirable traits are chosen to parent the next generation. Over time, this method has led to significant improvements in traits such as yield and health. The sector's focus remains on using this tool responsibly, considering the diversity of the population, and managing inbreeding levels.

7.2.2 Functional Annotation, Novel Traits and Epigenomics

- **Epigenomics:** These studies show how the environment can change how genes work in fish. For example, if a fish is exposed to stress, certain genes might become more active or less active. Understanding these changes can help us learn how to create better conditions in aquaculture.

- **Functional annotation:** This is like giving a job description to each gene in a fish. By doing this, we can understand what each gene does and how it affects the fish's characteristics. For example, a gene might make the fish resistant to a certain disease. Knowing this can help us breed healthier fish and also ensure the reduction of anti-microbial use.

- **Novel traits:** These are new characteristics that scientists are trying to develop in fish. For instance, they might be trying to breed fish that are more tolerant to warmer water temperatures, which could be useful as the climate changes.

7.2.3 New Technologies and PLF

Within the framework of PLF, several technologies and methods are integrated to enhance the efficiency and sustainability of aquaculture:

- **Artificial Intelligence and Machine Learning (AI-ML)**: These technologies are significantly improving the efficiency and sustainability of global aquaculture. They have become increasingly relevant in aquaculture research and production. Examples include:
    - **Vision systems**: AI-ML are used to monitor the growth conditions and behaviour of the livestock.
    - **Data extraction and integration:** AI-ML automate the extraction of data on ponds from satellite images and integrate it with georeferenced survey data. This provides comprehensive and real-time information about the farming conditions, enabling better decision-making.
- **Fish Tagging**: This is another important aspect of PLF in aquaculture. It involves attaching a tag to the fish to monitor its movement and behaviour. This is particularly relevant in European breeding aquaculture where:
    - Fish tagging helps in tracking the movement of fish, understanding their behaviour, and monitoring their health.

It provides valuable data that can be used to improve the efficiency and sustainability of aquaculture operations.