

The background of the entire cover is a photograph of a fish, likely a salmon, swimming in water. The fish is seen through a dark, textured net, which creates a complex pattern of lines and shadows over the fish's body. The lighting is dramatic, with highlights on the fish's scales and the net's mesh.

# Benchmark<sup>®</sup> Insights

WELFARE 2021

ISSUE 2



**Welfare in  
aquaculture:**  
drivers, trends  
and best practice





Introduction

I am very pleased to introduce our second edition of Benchmark Insights, a publication dedicated to some of the most relevant topics in aquaculture.



**TROND WILLIKSEN**  
CEO, BENCHMARK  
HOLDINGS PLC

I am very pleased to introduce our second edition of Benchmark Insights, a publication dedicated to some of the most relevant topics in aquaculture. As a leader in aquaculture biotechnology our purpose is to drive sustainability in aquaculture. We do this in three ways: by being a proactive industry leader, working with our customers and partners to identify ways to help our industry grow sustainably; by being a responsible operator, looking after all aspects of environmental, social and governance (ESG) criteria; and by having a real impact across the value chain by providing solutions that support our customers to improve yield, quality, animal welfare and reduce environmental impact.

Welfare in aquaculture is an increasingly topical issue in the sustainability of aquatic farming. Research is somewhat behind that of the terrestrial animal and is high on the agenda of scientists, NGOs, producers and consumers.

Good welfare implies both physical fitness and a sense of well-being. Not only is it ethically the right thing to do: good welfare has production benefits and there is a shift towards higher-welfare products amongst consumers.

At Benchmark, good animal health and welfare is critical both in our operations and the development of new solutions for the industry. We have three core business areas – genetics, advanced nutrition and health – and focus on disease prevention and improving resilience through robust genetics and nutrition, as well as developing effective and high welfare treatment methods through our health solutions.

In this magazine we have gathered insights from experts including scientists, academics, producers and investors, covering topics from history, trends and awareness, fish sentience and behaviour to genetics, nutrition, technology and management practices. We conclude with looking into an investment

perspective and the link between good welfare and financial performance.

I would like to thank all the contributors to this publication. It is a collective effort bringing together key stakeholders to share experiences, research, best practice and areas of opportunity to further the development and improvement of welfare in aquaculture.

I have been in the aquaculture industry for more than 30 years and I have seen it evolve in a very significant way. We are still, however, a young industry and I am very optimistic about the collective ability of industry players to make this a sustainable growth industry whilst looking after the environment and the welfare of fish and all aquatic life.

Foreword

MARCELA SALAZAR  
SCIENTIFIC DIRECTOR AND CHAIR  
OF BENCHMARK'S ANIMAL  
WELFARE COMMITTEE

# Animal welfare at Benchmark

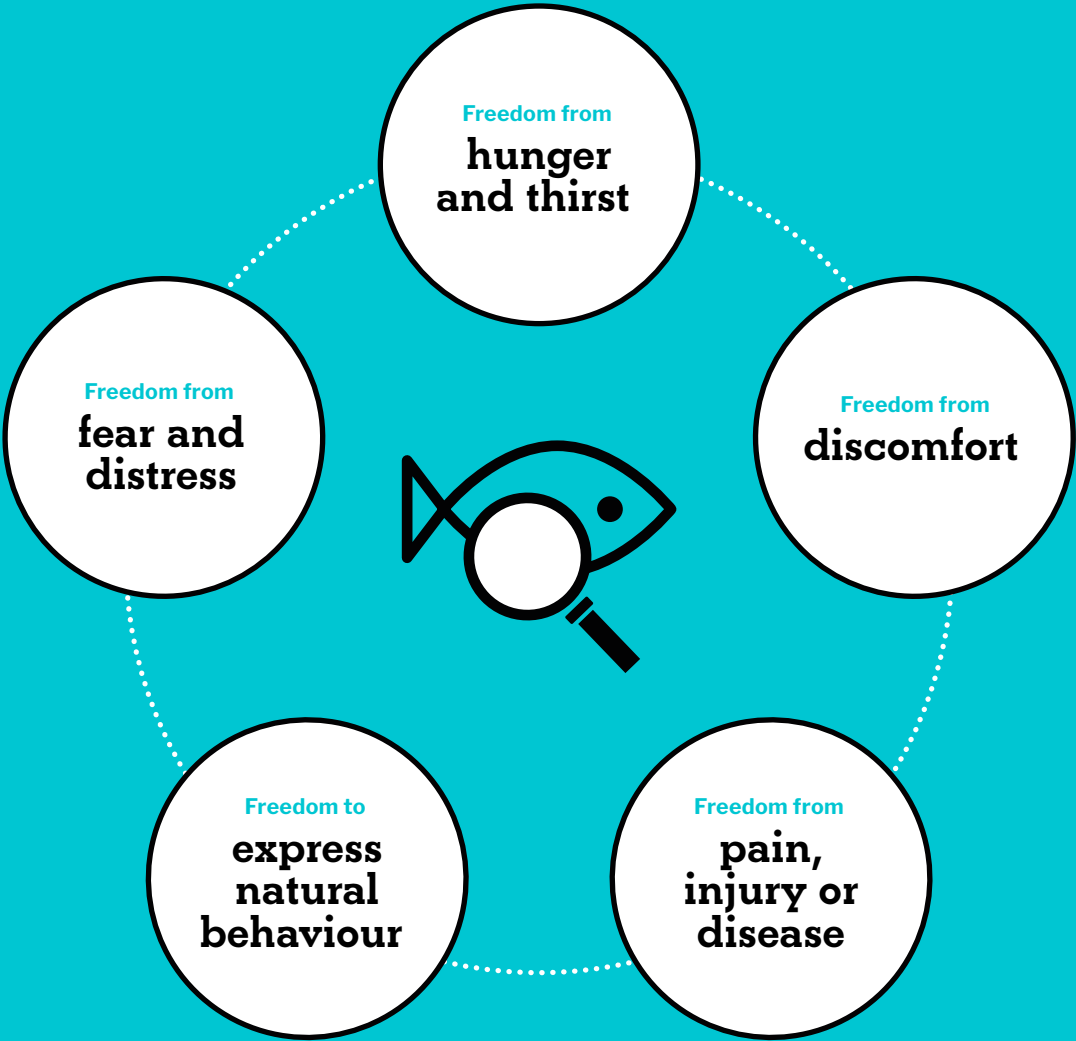


Animal health and welfare is part of the history of Benchmark, and one of the sustainability drivers that motivated the creation of the company 20 years ago. The passion for good animal welfare is still very much embedded in the business today.

Animal welfare is commonly defined by the Five Freedoms – freedom from hunger and thirst; freedom from discomfort; freedom from pain, injury or disease; freedom to express natural behaviour; and freedom from fear and distress. At Benchmark this is our baseline and we aim higher to take this further.

Last year we created a group-wide Animal Welfare Committee with representatives from our three business areas – genetics, health and advanced nutrition. Our mission is for all our employees to be welfare ambassadors – that they have welfare in their minds when working to ensure all our animals are safe and healthy, and that they transfer this knowledge and best practice to our customers globally. This is one more way in which we live our mission of driving sustainability in aquaculture for a sustainable future for all.

# Five Freedoms







Considering today's most pressing welfare problems, a major research effort is underway to find better ways of preventing disease. This must continue, using all the resources of modern molecular biology and technology.

**FELICITY HUNTINGFORD**  
A RECOGNISED EXPERT  
ON FISH WELFARE

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# Expert insights

Sharing experience, research, best practice and areas of opportunity to further the development and improvement of welfare in aquaculture.



# Society's awareness and understanding of welfare in aquaculture is evolving: we look back at the history and explore new trends



INTERVIEW WITH  
ØISTEIN THORSEN

FAI Farms works in partnership with producers and retailers across the food supply chain to deliver strategic advice, data services and education for a better food chain.

In this interview, CEO Øistein Thorsen explains the science and value-based concept of welfare, the rising interest from citizens, and the importance of streamlining and codifying data collection and sharing feedback practices among industry stakeholders to drive improvements.

## Can you explain the history of animal welfare and how it has evolved?

While this is nothing new, people's concern for farm animal welfare is growing around the world, in parallel with citizens' increased interest in where food comes from and how it is produced. Animal welfare is both a science-based and a value-based concept — being defined both by our evolving understanding of animals' innate physical and behavioural needs, as well as what is deemed socially and ethically acceptable.

Our concern for animals in our care typically starts with a recognition of sentience. This means acknowledging animals as living beings capable of experiencing both positive and negative emotions. Historically, much of animal welfare science and practice has focused on reducing negative experiences and suffering. For example, the well-known Five Freedoms, launched by the 1965 Brambell Report, codified welfare primarily as “freedom from”, or absence of negative circumstances. These included freedom from (1) hunger and thirst, (2) discomfort, (3) pain, injury and disease, and finally (5) fear and distress. The Five Freedoms are now widespread around the world and are frequently used as the basis for legislation, industry welfare protocols and company policies.

Emerging approaches to animal welfare seek to emphasise positive mental experiences and lift up the often neglected fourth “freedom”: to express natural behaviours that are important to the animal. Oxford scientist Marian Dawkins asks two questions to determine animal welfare: 1) is an animal healthy? and 2) does it have what it wants? David Mellor, a professor in New Zealand, proposed an update to the Five Freedoms, to move towards “A Life Worth Living”. Others are working to define what a “Good Life” for animals constitutes.

One thing all these approaches have in common was observed by Duncan and Fraser in 1997, when they argued the “assessment of an animal's Quality of Life can never be entirely objective because it involves a mixture of scientific knowledge and value judgement.”

## What trends have you observed in fish welfare?

Considerable work has been carried out to understand the welfare requirements of farmed mammals and birds; however, much less is understood about the welfare requirements of individual fish and the crustacean species commonly farmed in aquaculture. This is now changing. The initial focus in aquaculture has been on improving health and productivity outcomes. While this has given us understanding of the myriad physiological needs of fish, we are only now beginning to realise the behavioural requirements necessary for good fish welfare.

A 2019 survey of over 9,000 consumers across nine major European markets confirmed that fish welfare is of rising interest to consumers. 79% of respondents stated that fish welfare should be protected at the same level as other food animals and indicated they would like to see information on fish welfare on the labels of all fish products. Certification bodies like the Aquaculture Stewardship Council and Best Aquaculture Practices are responding by developing and including welfare requirements in their standards. Food brands are introducing welfare standards as part of their push for more transparency and traceability in their seafood supply chains. The leading UK food retailer Marks & Spencer is a good example of this trend. In 2019 they received the Aquaculture Award for animal welfare in recognition of their Welfare Outcome Measure Programme, developed and delivered by FAI. As such, we see fish welfare again form part of a wider sustainability improvement agenda, alongside issues like antibiotic usage, environmental impact, carbon footprint, and worker welfare.



We believe this rising interest in the welfare of fish is an opportunity for forward-looking brands and industry sectors. From other industries, we know that ensuring good animal welfare has the potential to mitigate a food business' brand risk and improve the public perception of whole sectors. A focus on welfare can also deliver financial returns linked to improved health and growth potential achieved through better production practices. As such, fish welfare represents a growth area to aquaculture businesses, with tangible improvement opportunities across the entire production value chain.

FAI is working hard to realise this opportunity through primary research and development of welfare assessments for tilapia, shrimp and carp. Our work in Brazil, Thailand and China is focused on developing deep relationships with key stakeholders, and through development and dissemination of cutting-edge research, data collection and best practice training we believe we can demonstrate that welfare is key to realising industry growth and resilience, and to better environmental impact.

### What are the key drivers/who are the key stakeholders in improving fish welfare?

At the moment the driver for improved fish welfare is citizens. Citizens, in turn, are influenced by growing scientific consensus around fish sentience, high-profile media stories (like Seaspiracy) and NGO campaigns calling for EU welfare regulations to also encompass fish. Consumer-facing retailers are typically the first industry actors to channel this concern up their supply chains to producers.

However, in order to drive real progress and improvement in fish welfare we must work with the stakeholders closest to the ponds, cages and recirculating systems where fish are produced. The critical points of welfare for fish are associated with farm design, feeding, crowding, water quality and handling at all life stages, as well as transport and slaughter. In addition to working directly with farmers, we must engage health, feed and genetics companies to help them develop products and services that make the lives of animals and farmers easier, which is the best way to reduce stress and mortality, and improve welfare.

One critical intervention point that we at FAI are particularly focused on is to streamline and codify data collection, sharing and feedback practices among industry stakeholders. Inclusion of welfare outcome measures like mortality, condition scores, behaviour and disease prevalence alongside genetic, feed and production data has the potential to revolutionise both small and large-scale aquaculture. Through careful analyses, these data can be used to tackle common challenges, benchmark producers and regions, and identify new best practices for dissemination. Facilitating industry engagement in this data exchange will be a key focus for FAI's fish welfare projects in Brazil, Thailand and China in the next two years.



### How do you see the future of fish welfare and its science?

According to the World Organisation for Animal Health (OIE), animal welfare is “the physical and mental state of an animal in relation to the conditions in which it lives and dies”. There is no doubt in my mind – or those of most fish welfare scientists – that fish are sentient beings able to experience both pain and positive emotions. Our job now is to help everybody involved – from hatchery workers to farmers, and from feed providers to companies managing and manufacturing pre-slaughter handling and slaughter equipment – understand their responsibility to ensure freedom from negative experiences and guarantee a life worth living for every individual.

Science and industry understanding of welfare in other sectors are moving beyond solely considering the avoidance of negative experiences (e.g. stress) and towards understanding the importance of positive experiences for animals (e.g. enjoyment). As such, the repertoire of measures determining “good” fish welfare will also evolve beyond health and mortality to include, for example, expression of positively rewarding, species-specific behaviours. While science defines the components of, and how to measure good welfare, what is “acceptable” welfare is ultimately a value judgement that should remain pliable and informed by evolving scientific knowledge and citizen norms.



# Power of genetics in creating healthy and robust animals



INTERVIEW WITH  
OSCAR HENNIG

In the early days of his career, Oscar Hennig, Operations Director (shrimp) at Benchmark Genetics, learned the motto "a happy shrimp is a tastier shrimp" and has followed this mantra ever since. Here he explains the role of genetics in creating healthier shrimp with higher welfare.

## Can you tell us a little bit about yourself and what inspired you to become involved in shrimp genetics?

I began work in the shrimp farming industry back in 1991 and worked in a number of different fields: from hatcheries to growout farms; from university R&D labs to disease diagnostics. It was in 1995, when I was working at Shimonoseki Suisan University lab in Japan on research investigating the disease challenges for white spot syndrome virus (WWSV), that I started thinking of the opportunity to select animals with outstanding immune qualities to help farmers manage disease.

I later joined the Oceanic Institute in Hawaii as General Manager of the Kona Facility. Here, I was assigned the responsibility, among others, of the day-to-day breeding operations of the Kona line. This was an R&D breeding line for *L. vannamei* used by researchers as a benchmark to develop disease resistant lines. It was there that I decided this was the path I wanted to pursue.

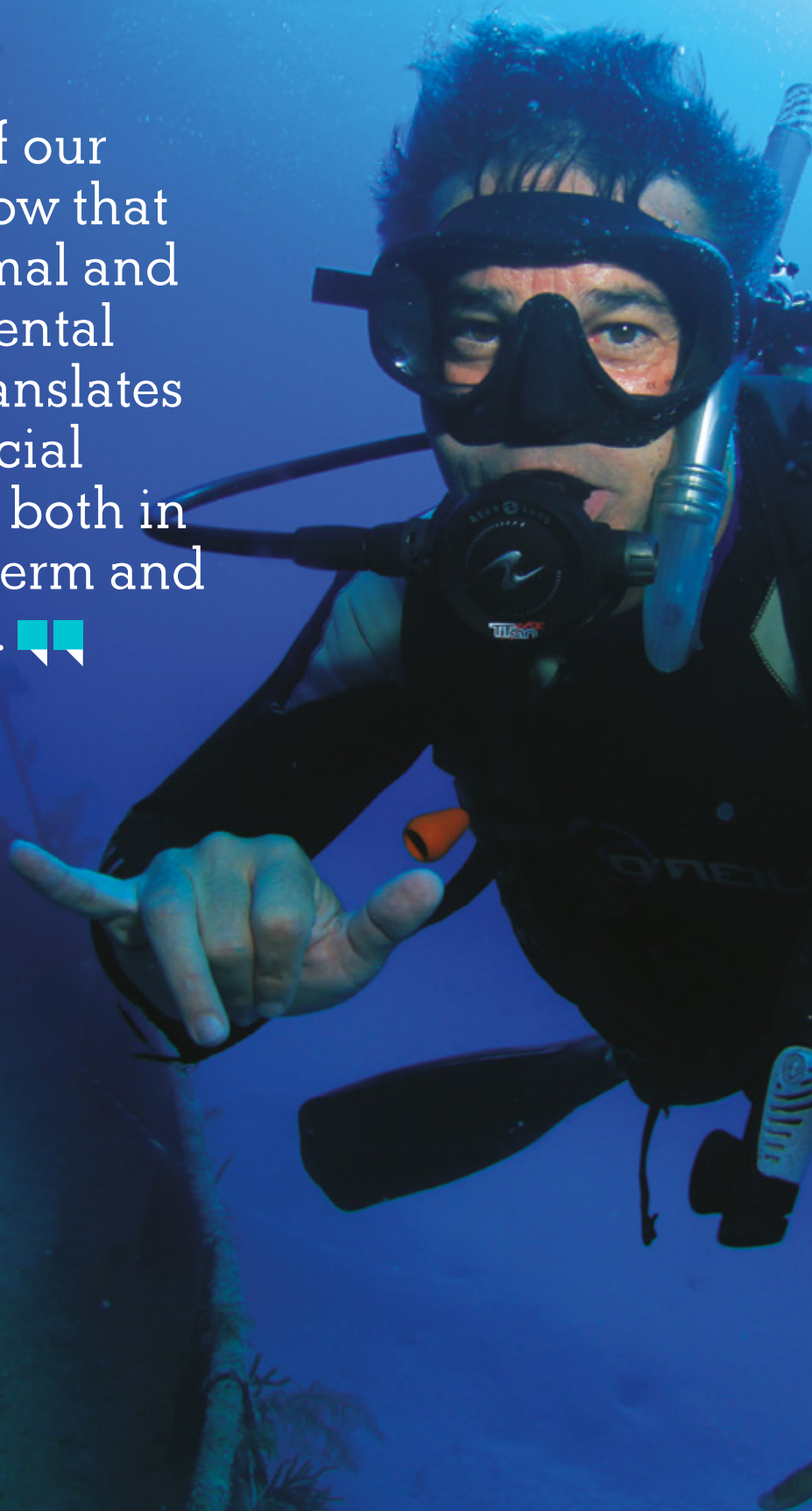
## When did you first come across animal welfare in aquaculture and why?

It was in the first shrimp farm I worked on in Australia in the early 90s. I can still remember the owner had a strong sense of doing all he could to take good care of the animals from stocking to harvest. His motto was "a happy shrimp is a tastier shrimp" and I have been following that motto ever since.





It is one of our jobs to show that good animal and environmental welfare translates into financial benefits – both in the short term and long term. ■■



### How does welfare influence your breeding programmes?

Welfare is a central part of our operations. First of all, we do not ablate shrimp at any of our facilities, and we encourage our clients to follow suit. Eyestalk ablation is used to manipulate hormone synthesis, making egg production more predictable and efficient, and is a common practice in shrimp hatcheries.

Our team first started trialing rearing non-ablated female shrimp in 2018 and found that there was a 30% reduction in nauplii production, which was offset somewhat by a higher survival during larval rearing in offspring. We have also found that non-ablated females tend to have a longer life, reducing the total number of breeders needed.

It's also important to recognise that for breeders to perform at full potential, good husbandry practices must be in place. For this we go back to the lesson learned early in my career.

### How do you ensure good shrimp welfare in your production facilities?

We have a number of standard operating procedures in place and dedication and commitment from our employees. The team understands the importance of creating the best possible conditions and environment for the shrimp. This includes daily feed monitoring to prevent pollution in the ponds, regularly checking water quality and assessing health status for all life stages to pick up early indications of any possible stresses.

### How important is welfare to your customers?

It is becoming more important to them and there is also a drive from retailers. We know welfare is linked to long-term production, sustainability of businesses and better prices.

It is one of our jobs to show that good animal and environmental welfare translates into financial benefits – both in the short term and long term.

### What trends have you observed through the course of your career?

Non-ablation is definitely getting more popular. It's not mainstream just yet but with the genetic advances we are seeing on maturation performance I can see this becoming standard practice in a few years.

Sludge removal of the ponds to keep shrimp in a cleaner environment has also become an everyday practice. In a cleaner environment shrimp have better productivity and are less likely to get sick.

### How do you see shrimp genetics developing in 10 or 20 years' time?

We have only scratched the surface on the potential of this species. At Benchmark Genetics we have a saying – “one size doesn't fit all” – this means different breeds need to be developed for different environments, which is what our model is based on. This has really been adopted across the industry; I see it evolving in different breeds and becoming more specialised and tailored.

There are also other areas in genetics that Benchmark is placing a significant amount of resources on, which we see as the future needs for this industry. Unfortunately, I can't comment on those just yet.

# Combining research with practical on-farm experience



INTERVIEW WITH  
**JIMMY TURNBULL**

Over the last 30 years, Jimmy Turnbull, professor of aquatic animal population health and welfare at the University of Stirling's Institute of Aquaculture, has played a key role in a number of high profile collaborative fish welfare projects involving the industry, academia and regulators. His most recent welfare-related role is with Aqua Care365 – an educational training model developed by Merck Animal Health for the aquaculture industry.

## **Can you give us an overview of the key fish welfare-related projects that you've been a part of?**

I've been involved in a large number of fish welfare-related projects over the years. These have included helping to develop the Freedom Food/RSPCA Assured standards, the FISHWELL project on farmed salmon and trout welfare indicators, and the Code of Good Practice for Scottish Finfish Aquaculture.

I've also been a member of several aquaculture-related organisations, including the BBSRC Animal Welfare Research Network and the Ministerial Working Group on Sustainable Aquaculture, and have been the president of the Fish Veterinary Society.

One of the key projects I'm currently involved in is Aqua Care365. This aims to turn all our previous research and practical work into accessible relevant training materials to give those working on the farms the skills they need to ensure the best possible welfare of the fish.

## **Are there any people in the fish welfare field who have been particularly influential/effective?**

There are many inspiring people who've been involved in fish welfare over the years and some of those I've been fortunate enough to work with, or encounter, include Felicity Huntingford, Ed Branson, John Avizienius, Malcolm Johnston, Bob Waller, Toby Knowles, Jeff Lines, Mike Appleby, Sonia Rey, Borge Damsgaard, Chris Noble and Kasha Cox.



**You have been at the interface between academia and the industry in a number of these projects. How have they improved on-farm practice?**

It's been a process of many parts, which has been dependent on developing a meaningful dialogue between the researchers, farmers and other stakeholders. Combining research with practical on-farm experience has helped to increase our understanding and allowed us to develop and refine strategies for the application of new techniques. These have then been disseminated through education, industry guidelines and – occasionally – regulation. This has been very far from a linear process and we are still moving forward in all these areas, but the result has been improved farming practices. In my opinion the most influential vehicle of this change has been the RSPCA's Freedom Food programme, which is now known as RSPCA Assured.

Another project I have been involved in is FISHWELL, which provided all the information on salmon and trout welfare indicators in a single, very comprehensive, document. This is not a working manual but more something that would inform strategy at a farm, or even industry, level.

This is complemented by other training activities such as Aqua Care365, which is a very practical education and training resource. It starts at a basic level, but the flexibility and convenience of the online programme ensures everyone who works with or touches fish is equipped with the knowledge, understanding and skills to ensure good fish welfare.

**What do you think are the main challenges in the aquaculture industry in terms of fish welfare?**

I believe that the more complex the animal, the greater the capacity for suffering and, therefore, the greater the need to protect its welfare. Cleanerfish species, such as wrasse and lumpstickers, have much more complex behaviours than salmon or trout and, therefore, probably need more consideration from a welfare perspective.

In other farming systems – such as tilapia, pangasius and carp – for a variety of reasons, fish welfare is quite low on the list of priorities unless it is demanded by markets. This can result from a lack of understanding, different cultural perspectives and a lack of resources.

**Do you think that fish welfare has gone up the agenda in recent years and, if so, why?**

We started talking to farmers about fish welfare in the 1990s and they all thought it was important. We repeatedly heard comments like, “how can you grow fish unless you care about their welfare?” or, “we don't know if fish can feel pain or not, but we have to give them the benefit of the doubt”.

Others have become more interested in fish welfare recently, for a variety of reasons, including more stringent welfare and environmental regulations, greater consumer scrutiny and interest in where our protein comes from and how fish are treated, and retailers who want to protect their reputation and markets. We have also seen some individuals using fish welfare as a vehicle to push an anti-farming agenda.



**Are there any species-specific issues that you'd like to highlight?**

I believe the vast majority of farmers really want to do their best to look after their fish. Problems may arise due to lack of training or expertise but are often due to process failure. For example, at times such as harvest where the wellboat will have priorities to deliver on time, the processor will want the fish to arrive at a certain time and the weather window may be limited, it is not always easy for the farmers to crowd the fish as gently as they would like. Such conflicting pressures on the farmers can result in problems that affect fish welfare.

**How would you like to see the welfare of farmed fish improve over the next 5 to 10 years?**

I'd like to see humane slaughter extended to a wider range of farmed species; improved vaccination, with fewer long-term side effects; and the increased use of

remote or automatic monitoring – for example, using video images. While there is no substitute for having skilled and experienced farmers on hand to spot changes in animal behaviour, some sites can't always be accessed or house very large populations of fish which make it nearly impossible to monitor in person. As a result, there is scope to increasingly use technology to supplement existing husbandry skills. I am also excited by some of the new technologies that are currently being developed, which will allow farmers to analyse the health and welfare status of every single fish within a production system during routine farming processes, such as vaccination. Equipment being developed by Aqualife Services is based on machine learning (or artificial intelligence) and can produce a lot of detailed information at the same time as the fish are vaccinated without any additional handling. It is an exciting time to be a part of aquaculture!



INTERVIEW WITH  
FELICITY HUNTINGFORD

# Understanding fish sentience and behaviour



INTERVIEW WITH  
FELICITY HUNTINGFORD

Felicity Huntingford is a recognised expert on fish behaviour and, as a result, fish welfare. Her distinguished career has focused on the differences in stress coping styles (or personalities) in fishes and her studies have been influential in showing that fish with different stress coping styles react differently to the challenges of intensive culture.

She has also inspired a whole generation of finfish aquaculture welfare specialists, with a sizable proportion of her 35 PhD students going on to become leaders in the field – both in research and production capacities.

## Can you give us an overview of your extensive research into fish behaviour?

My research has concentrated on how fish assess and react to risk – for example, when they encounter potential predators or rivals of the same species. My work, and that of many other behavioural biologists, has shown that prey fish keep a sharp eye out for predators, using a variety of cues to assess the risk they pose, and adjust their behaviour accordingly, perhaps moving to safety if the assessed risk is high or cautiously continuing whatever they were doing if it is low. For example, sticklebacks foraging under threat of predation switch to eating less profitable prey that can be captured while remaining vigilant.

Concerning aggression, my colleagues and many other researchers have shown that fish adjust their behaviour during a potentially aggressive encounter to their assessment of their own probability of winning, the value of the contested resource and the expected costs of fighting. They make detailed advanced assessments of how likely a rival is to injure and defeat them and of their own need for the disputed resource. Following such assessments, a fight over food, for example, is more likely if the fish concerned have been deprived of food (making a given food item more valuable) and less likely if they face a larger opponent or if the encounter takes place in flowing water (both of which would increase the costs of fighting).

## What conclusions on the sentience of fish have you drawn from research?

Sentience is a complex concept and difficult to define accurately and concisely, but simple dictionary definitions can help to explain broadly what it means. According to one such definition, an animal is sentient if “it is aware of its surroundings, its relationships with other animals and of sensations in its own body”.

Detailed studies of fish behaviour can throw light on the question of whether fish are sentient. One famous and intensively studied system involves a species of African cichlid. Consider a male cichlid fish defending a small territory in a colonial breeding site, as many do. These fish form detailed maps of territorial boundaries with all their neighbours and assess the risk each neighbour poses to their own territory. Assessed risk, based on memories of past fights and on observing fights between neighbours and other males, informs complex decisions about whether and how hard to fight. For example, having invested time and effort in assessing their complex ‘risk landscape’, territory owners do better with familiar neighbours. If such a neighbour is threatened with displacement by a stranger, our focal male often supports him in fighting off the intruder, especially if it is large. One could argue about what ‘aware’ means, but these fish certainly monitor and remember many details of their surroundings and their relationships with other animals and modify their behaviour in the light of the information they collect, so they meet at least two of the criteria in this definition of sentience.

According to another dictionary definition, sentience means being “capable of receiving internal sensation and information from its environment, and interpreting these as an emotion”. Among investigations of whether and how fish experience emotions, one is particularly revealing (Cerqueira *et al.*, 2017). These authors took an established model of core emotions in humans and asked whether (or not) it could be applied to fish. The model depicts affective space in two dimensions, namely valence (intrinsic attractiveness or aversiveness of experiences) and salience (strength of experiences) and predicts different emotions for different combinations of valence and salience, manifested by different behaviour and stress physiology, and activation of specific brain regions.

Sea bream were trained in one of four valence/salience combinations. Valence was manipulated by giving the fish food (positive) or a brief exposure to air (negative). Salience was manipulated by either always preceding food or exposure by a light cue (making them predictable) or providing the same number of light cues, but at random with respect to treatment (unpredictable). When subsequently exposed to the light alone, social behaviour was predominant in fish trained with food delivery, especially when predictable. Escape attempts were seen predominantly in fish trained with exposure, again, especially when predictable. Plasma cortisol levels were lower in fish trained with food as opposed to exposure and, for both treatments, in predictable versus unpredictable conditions.





The four valence/salience combinations were associated with unique patterns of activation in homologues in fish of subcortical structures involved in emotions in mammals. So these fish received sensations and information about themselves and their environment and showed responses conforming to core emotional states depicted in this model, though the authors cautiously describe these as “emotion-like”. Here, too, fish meet the criteria of this definition of sentience.

### How would you define fish welfare?

There are three distinct perspectives on what animal welfare means; they are different views of the same complex whole and not (necessarily) in conflict. From one perspective, an animal experiences good welfare if it can adapt to its environment, with all its biological systems functioning appropriately. According to such function-based definitions, animals that are in poor health or exposed to chronic stress have poor welfare, by definition, and the converse. At present, this is largely how welfare is conceptualised for fish used in aquaculture or captured in fisheries. It is (relatively) uncontroversial

and offers many tangible welfare indicators. Working within this framework has resulted in important improvements in fish welfare and will certainly continue to do so. However, somewhere down the line, we will probably need to grasp the nettle of how fish experience different levels of functioning – for example, when they have good or poor energy reserves. Think of a male salmon having swum hundreds of miles up-river without feeding and now fighting over females, so having seriously depleted energy reserves and very probably several injuries. Because these costs are incurred to gain fitness benefits, these fish are highly motivated to migrate and fight, and their resulting poor condition should not be regarded as indicative of poor welfare.

This relates to a second perspective on welfare, namely, that good welfare requires that an animal can lead a natural life, with the ability to show the full behavioural repertoire of its wild counterpart – welfare is compromised if this is not possible. Anyone who has seen a common carp (a highly social species) held in isolation without conspecifics would surely agree with this nature-based approach. It is less obvious (though not impossible) that fish need to fight, to interact with predators or to undergo periods of fasting and, therefore, that they suffer if denied such opportunities. To use this definition appropriately, we need to know how fish experience these various possibilities.

This leads on to the third perspective, from which good welfare means freedom from negative experiences, such as pain, fear and hunger, and access to positive experiences, such as companionship. This approach obviously requires that the animal concerned is sufficiently sentient to experience feelings and emotions, so those who are unconvinced by the evidence for emotions and sentience in fish argue that it is not applicable to this group. To those, such as myself, who are convinced, it is applicable and important, if only because a feelings-based approach best captures the concerns of the general public.

### How can the growing body of knowledge of fish behaviour be practically applied to improve the welfare of farmed fish? How has your research influenced practical projects to improve fish welfare in the aquaculture industry?

Though most farmed fish are protected from direct predation, they still assess and respond to apparent risk, in the form of cues (movements, smells, noises) that in nature would signal danger. If, like many fish in the wild, farmed fish experiencing a perceived risk feed sub-optimally, both production and welfare could be compromised. Exposing farmed fish to signals indicating possible danger should be avoided if possible. Size grading, for example, often involves capture and handling and considerable effort has gone into developing hands-off, passive grading, in which smaller fish can pass through a mesh in their cage or pen, without the need for crowding and handling.

Aggression and injury do occur in aquaculture and the fact that wild fish avoid fights when the contested resource is of low value and/or expected costs are high suggests ways of reducing both. I have been involved with several projects showing that feeding systems that match delivery to appetite (so that all fish can obtain food and fighting is not worthwhile) reduces aggression and fin damage. I have also been involved with other projects showing that aggression and injury are reduced when farmed fish are held in a water current or in the presence of larger conspecifics, both of which increase the actual or perceived costs of fighting.

I was recently part of a team of researchers who showed that when zebrafish housed in a thermal gradient are given a simulated infection, their preferred water temperature rises by several degrees (showing behavioural fever). More importantly, following a real disease challenge, zebrafish with access to such a gradient – and so able to move to warmer water – show markedly upregulated immune responses, clear the pathogen from their system and recover well. In contrast, fish held at a constant temperature fail to show a coordinated immune response and suffer severe disease symptoms, with high mortality. This offers the exciting possibility that farmed fish might be able to ‘self-medicate’ if allowed access to warmer water – a possibility that my colleagues are currently testing with tilapia.



### Are there any species-specific issues that you'd like to highlight?

Much academic debate has focused on whether, in general, fish of any kind display the cognitive and emotional capacities that underpin sentience. However, there are some 35,000 fish species and there is good reason to expect their cognitive capacities to differ, depending on environmental challenges encountered in the wild. For example, intertidal gobies, which often find themselves stranded at low tide in rock pools without suitable shelter, famously form mental maps of landmarks encountered when swimming about at high tide and use these to jump from pool to pool to reach safety; related subtidal gobies (not at risk of stranding) lack this ability. Growing understanding of cognitive and emotional capacities of fish will surely highlight such variability and its implications for fish welfare.

Focusing on the more practical issue of how to protect welfare in functional terms, some species and strains of fish may be particularly suited for welfare-friendly aquaculture, perhaps because they are inherently less aggressive. In nature, two forms of Arctic char exist, specialised for feeding on either benthic invertebrates or zooplankton. For various reasons, the pelagic form is less aggressive and so might be more suitable for culture than the benthic form. In any event, since the 35,000 fish species are all uniquely adapted to specific habitats and diets, the conditions required to keep each cultured species in good health and welfare will inevitably be distinct.

### What do you think are the main challenges in the aquaculture industry in terms of welfare?

There may be an organisational challenge to ensuring the welfare of farmed fish. With proper care, aquaculture can be intensified without necessarily compromising fish welfare – up to a point. Good, experienced fish farmers know where this point lies; they understand their fish, know the signs of poor welfare and can and do reduce stocking density (for example) if this gets too high. Problems arise if critical decisions (say, about how many fish to rear) are taken not by people who are in frequent contact with the fish and take pride in keeping them in good shape, but by people far removed from working farms and with the remit of maximising profits. In the medium term, it will likely become evident that pushing intensification too far does not pay off economically, but in the meantime the welfare of many fish could have been compromised.

More specifically, introduction of any new aquaculture species brings generic challenges, as optimal rearing conditions and welfare requirements must be established in each case. The necessary research can be streamlined and focused by previous experience in the industry, so the route towards overcoming this ongoing challenge is reasonably straightforward.

There are some major challenges to ensuring the welfare of farmed fish that are less tractable. Thus, serious problems can arise with keeping fish healthy in the face of a continually evolving disease risk, and with ensuring that

alternatives to fish meal in diets for piscivorous fish (essential for sustainable aquaculture) are nutritionally complete and do not cause any adverse effects. These two key problems will only be solved by continued major multi-disciplinary research efforts.

### How would you like to see fish welfare progress over the next five years? If you were to be funded for one project related to improving the welfare of fish what would it be?

Considering today's most pressing welfare problems, a major research effort is underway to find better ways of preventing disease. This must continue, using all the resources of modern molecular biology and technology; for example, exploring the use of nanotechnology for providing new ways of killing pathogens and delivering medication. Likewise, current efforts to find new sources of key nutrients for farmed fish (for example, products from various micro-organisms) must and will continue, always with fish welfare as well as effective growth as a required outcome. Ongoing research aimed at developing low stress techniques for necessary practices such as size grading and slaughter, as well as hands-off systems for monitoring fish status (biomass, body condition, stress, etc.) should, and will, continue.



Looking to the future, current multi-disciplinary research into the cognitive capacities and mental states of fish will surely continue. I hope that increased understanding here will facilitate a rapprochement between those who advocate only functional and nature-based definitions for fish welfare and those who argue for the addition of a feeling-based approach.

Also looking to the future – recently, moves have been initiated to apply the concept of positive welfare (mental and physical states that exceed what is necessary for immediate survival) to cultured fish. I do not particularly like the term positive welfare, as (implicitly and explicitly) it characterises, for example, reduced stress and injury (central to the well-being of farmed fishes), as negative welfare – a very misleading term. However, it is certainly important to explore the possibility that fish do some things just because these feel good, rather than for immediate satisfaction of some need. For example, fish spend a lot of time doing things that nurture and stimulate their body surface; in aquaria and rearing tanks they may often be seen rolling around in bubbles and the clients of cleaner wrasse work to get a back massage. A positive motivation to perform such behaviour probably evolved because well-tended skin and scales result in improved general health. It might seem unrealistic and uneconomic to try to provide farmed fish with the opportunity to do things that make them feel good, but this might not be the case if it helps them to resist disease. It might, therefore, be feasible to promote positive welfare in captive fish, to the benefit of both fish and farmers. If I were to be funded for one project on fish welfare, this is what I would choose to study.



There are some

**35,000**

fish species and there is good reason to expect their cognitive capacities to differ, depending on environmental challenges encountered in the wild.





# Happy fish, happy farmers and healthy business



INTERVIEW WITH  
**RUDI RIPMAN  
SEIM**

Rudi Ripman Seim is Head of production Norway and Global Fish Health at Benchmark Genetics. He is responsible for the health and welfare of the animals in the company's genetics breeding programmes. Here Rudi explains that happy fish means happy farmers and a healthy business.



## Can you start by explaining your background in aquaculture, and your role in Benchmark Genetics?

I have a biology and economics background and finished my degree in Aquamedicine (MSc.) in 2006. Since then I have been working in the aquaculture industry in various roles related to the health and welfare of aquatic animals. So far, I have worked within research, diagnostics and nutrition, and now breeding and production. I have always had a great interest in organisms living underwater, which pointed me in my career direction early on.

In my role at Benchmark Genetics I am responsible for the global fish health and welfare of the animals we breed. I'm part of a global team of fish health professionals who regularly assess the health and welfare status of the fish and shrimp. This includes setting standards and conducting regular health checks, screening for pathogens and fish welfare assessments, as well as identifying and implementing ways to improve welfare and reduce risk of compromised health and well-being.

Our aim is to reduce risk of diseases and improve fish welfare. This can include identifying all points in our sites where fish can be injured during jumping or handling and where risks are identified, we install solutions to protect our fish. Or it can include risk assessments of any pathogens entering our water source. High biosecurity is of utmost importance in our production as it is vital to hinder pathogens entering our site. If this were to happen the pathogens would spread across the site. Our business is based on production and sales of living organisms of high genetic value, so we need to be extra cautious in the area of biosecurity. When working with biosecurity we look at risk factors related to the fish (status and condition), vectors (staff, equipment, visitors, etc.) and water (source, treatment), all of which can compromise biosecurity. In the team, we are working on identifying risks factors and evaluating ways to mitigate these.





Image:  
Benchmark  
Genetics Salten

### What does fish welfare mean to you?

For me, fish welfare means rearing our fish in the right environment where they can express their behaviour without unnecessary stress, pain or injuries. We need to have the right nutrition and feed to correctly support body functions and development. To me, good fish welfare is a better bottom line; through better welfare, fish will grow better and have a higher health status.

Fish welfare is essential for ensuring a sustainable and profitable business. We are ultimately responsible for the animals in our care, and we must ensure that they thrive in the environment we rear them in. Fish have an incremental value apart from what they are worth in terms of number of possible eggs or kilograms of filet. This is important to acknowledge.

As a fish health authority, we are our animals' "spokesperson" and we have to use our voice. It is our responsibility to know when something needs to be changed or is not within our standards; and to make sure that these changes occur. This means as a team we all need to be looking out for signals indicating non-optimal welfare. Our animals live in an environment different from ours, and it is important that the team understands their biology and ensures that we work within best practice.

In my view, good fish welfare is essential in production. It affects everyone working with the fish; a happy fish means a happy farmer, and there is no other way of providing good fish welfare than by having dedicated people who care. It's important to talk about welfare with colleagues and have open discussions. We have come a long way in recent years in this area, but it will always be an ongoing process.

### Can you explain how genetics can help to improve fish welfare?

From the genetics perspective, we breed for more robust animals through various methods and techniques, but essentially it comes down to using the best performing genetics to breed for the next generation of fish. Our job is to humanely remove underperforming animals at different time points in the production, preferably as early as possible, so we let the best animals (genetics) breed for the next generation. In addition to the genetics that we deliver in the form of an egg, it is important that the egg has good vitality and a low biosecurity risk (high health status) to ensure that newly hatched fry are healthy, meaning we provide our customers the very best start to their production.

### What is Benchmark Genetics doing to improve fish welfare in its products, and at its sites?

Systematic work on welfare needs to be measured over time. Benchmark Genetics has implemented internal operative welfare indicators (the OWI) that we use to assess the welfare of our fish. By focusing on the OWI we regularly measure the welfare of our animals in production so that we can identify where we need to focus, as well as tracking progress or changes over time. The OWI includes some key performance indicators in relation to fish appearance; here we assess the fish condition, fin condition, skin health, deformity, operculum shortening and behaviour. In addition, we measure environmental conditions such as CO<sub>2</sub> levels and total gas, as well as the general order and hygiene of the site.

By using the OWI for fish welfare, we have established a system in which we can quickly understand which areas we need to focus on; this might sometimes require investment in both time and resources.

One of the key areas we have been working on in recent years in our production is the deformed operculum, which is often caused by too high density or not enough feeding (or a combination of both), resulting in fish biting each other's operculums. To address this, we have worked on the stocking density and focused more on feeding in the early phases. We have over 360 small tanks to feed, so it is quite a job. Other areas of focus are haemorrhagic smolt syndrome and nephrocalcinosis, which can occur in the smolt phase and can continue in the growing phases. We have invested in these areas, including through participating in research programmes and through regular sampling of fish and water to identify when the condition occurs and why.

Since 2012, we have been a partner on several projects with the animal welfare group at the Institute of Marine Research in Norway to look at genetics and fish behaviour in different farming environments. Some of the foremost fish welfare researchers are part of this working group and the results have given us more information on the potential of genetics in terms of stress handling. From a product perspective, we have a close dialogue with our customers on what the biggest challenges are so that we can focus our investments and development to supply robust genetic material. An example of this is the yearly customer meeting, where our customers provide feedback on their priorities in production during a round table discussion. This information is compiled and, together with other sources, used internally by Benchmark Genetics to prioritise our breeding goals.

### How would you like to see fish welfare progress over the next five years?

I would welcome more development in standardisation of assessing fish welfare as well as industry categories on mortality causes. I know from terrestrial animal production that there are professional farm inspectors that score animal welfare and standardised protocols are followed. Perhaps we will also see this in aquaculture. Furthermore, there is work ongoing on biomarkers, including blood chemistry and fish scale analysis, which can support fish welfare assessment and may become an important tool to assess the fish welfare status. I also believe that camera technology gives new possibilities in terms of assessing fish behaviour in an objective way. Machine learning, artificial intelligence and remote assessments are some of the elements of this development. Hopefully we will see a lot happening in this space in the years to come!

### In your view, what more needs/can be done in the aquaculture industry?

I think we need more standardisation, new technology and better awareness of the many small things that, together, lead to success. Using the same terminology and having the same interpretation of it would help in the benchmarking progress and push standards forward.



For me fish welfare means rearing our fish in the right environment where they can express their behaviour without unnecessary stress, pain or injuries.

**RUDI RIPMAN SEIM**  
BENCHMARK GENETICS



INTERVIEW WITH  
HUW GOLLEDGE &  
NATHAN PYNE-CARTER

# Welfare during fish harvesting



HUW GOLLEDGE



NATHAN  
PYNE-CARTER

The Humane Slaughter Association (HSA) has played an integral part in driving improved welfare of livestock – including farmed fish – at the time of harvest for over 100 years.

The charity recently awarded a £720,000 grant to a consortium led by Ace Aquatec, which aims to improve methods for stunning a range of farmed fish species prior to slaughter.

In this interview, Huw Golledge, CEO and Scientific Director at the Universities Federation for Animal Welfare and the Humane Slaughter Association and Nathan Pyne-Carter, CEO of Ace Aquatec, explain how their attitudes towards the humane slaughter of fish have been shaped and what they hope to achieve in the current project and beyond.



## What are the key fish welfare projects that you've been involved in?

**HG:** The HSA has a long-standing interest in the welfare of fish that are farmed for food. Back in the early 2000s, HSA Technical Officer, Tess Benson, undertook a Winston Churchill Travelling Fellowship to study fish harvesting operations overseas. Following this, the HSA became involved with Jeff Lines at the then Silsoe Research Institute, who researched and built a prototype electrical stunning system for farmed rainbow trout. This research was further developed in collaboration with John Ace Hopkins of Ace Aquatec and turned into commercial reality. HSA technical staff were also involved in the initial research on the humane harvesting of turbot through the EU-funded STUNFISHFIRST project.

HSA also provides information and educational resources about the welfare of farmed fish at the time of slaughter or during transport. We recently produced a very comprehensive report on 'Humane slaughter of finfish farmed around the world' (<https://www.hsa.org.uk/downloads/hsafishslaughterreportfeb2018.pdf>) and have also produced a video guide for consumers on the welfare issues relating to farmed fish.

**NPC:** We developed our first electric fish stunner for farmed trout with Tesco back in 2004. Since then, as we've continued to develop our machines, we've tried to increase awareness that commercial stunning equipment is available for a range of fish species, and applications such as wild catch. Developing pilot stunning systems with academic validation built into the projects helps to provide supermarkets and industrial producers with the empirical evidence they need to know that the systems will improve quality, lead to more efficiencies and result in cost savings for the farmer as well as a better, more humane death for the fish.

## Has fish welfare become more of an issue in recent years and, if so, why do you think it has gone up the agenda?

**HG:** Fish have definitely moved up the welfare agenda. Whilst there is still debate over the question that the late Victoria Braithwaite posed in her seminal book *Do Fish Feel Pain?* the evidence and the balance of opinion seems to be strongly in favour of giving them the benefit of the doubt these days. There is some really interesting research from scientists like Braithwaite and Lynne Sneddon over the past couple of decades that strongly suggests fish are sentient (that they have feelings that matter to them, such as pain or distress), which has definitely begun to influence public perceptions. We also know that fish are a lot smarter than we used to think. The myth of the goldfish with the three-second memory did a lot of damage but I'm pleased to see public attitudes starting to change as the evidence accumulates.

Another really important consideration that I think has focused people's minds on fish is awareness of the staggeringly vast number of these animals killed for food every year. Combined with a general increase in public concern for animal welfare and sustainable, healthy diets, this has pushed fish welfare up the agenda.

## Do you think there is enough legislation to protect the welfare of farmed fish?

**HG:** This is a tricky question. In Europe and the UK we have legislation that places a duty on us to protect fish from unnecessary suffering, which I wholeheartedly support. The problem is that, in many cases, we don't know exactly what is best for fish welfare – a case in point being the choice of the best stunning method for many species. Until we have better quality evidence it's hard to make specific legislation that makes a really meaningful difference.



## How do welfare issues differ between wild-caught and farmed fish?

**HG:** Wild-caught fish are in many ways the poor relations. Many wild-caught fish are not stunned and, therefore, may experience significant suffering for a significant length of time. There are, obviously, some enormous technical challenges we face in protecting the welfare of wild-caught fish, but I'm encouraged to see welfare scientists and the industry starting to tackle some of these challenges. Of course, until the point of capture, wild-caught fish are free to live a natural life, whereas farmed fish faced very significant man-made welfare challenges throughout their lives as a result of captivity.

## What inspired you to award the recent £720,000 grant funding to the consortium led by Ace Aquatec?

**HG:** The award was advertised as an open competition and we received a number of excellent applications for the funding. We undertook a rigorous scientific review process whereby the applications we received were reviewed by independent experts in the field as well as the HSA's own technical staff. The Ace Aquatec application was considered to be the most likely to come up with humane and practical stunning methods or parameters for the target species. The research goes from basic science all the way to development of commercial-scale devices, so it offers the possibility of producing a commercially viable solution for the species that will be studied. We were also impressed by the range of expertise of the team from both academia and industry. Finally, the team propose to test a method of stunning which is completely novel in fish and we're excited to see if this method might be superior to existing methods.

### How widely are your electrical stunners used at the moment?

**NPC:** Ace has stunners in place all over the world, from salmon stunners at Sanford in New Zealand to sea bass machines in the Mediterranean. We are currently operating in over 20 countries worldwide, and have recently set up regional offices in Chile, APAC and Norway to support these installations.

### How do they differ from conventional systems?

**NPC:** For the species we are looking at, conventional systems do not really exist. Fish farms are typically dropping fish into ice where they succumb to death after a long period of time. Unfortunately, this process can lead to a negative impact on quality as well as causing stress and pain to the fish over a prolonged period of time.

In other species, such as pangasius, they may have percussive stunners installed, which, if properly calibrated and serviced and used with a consistency of fish sizes, can result in humane stunning. However, with larger size variation and particularly energetic fish, the fixed percussive hammer and cutting knife can be incorrectly positioned for a humane death.

Farmers of some species, like sea bass, have utilised dry electric stunning. With a good control over flow and quantity, this can produce a humane stun. However, in farms where large quantities of fish are brailled and dropped into a machine, there are frequently pre-shocks and transmission of

the voltage from fish touching one another, which can lead to some fish receiving too much or too little voltage.

Our devices stun with an even electric field in water, ensuring the voltage surrounding the fish is always sufficient to render it unconscious. We avoid variability in stunning according to size, species and connectedness by guaranteeing an even field in whichever part of the pipe the fish are flowing through. This system works effectively for many years with zero maintenance and receives all parameter changes for new species via remote connection and updates.

### How do you intend to use the HSA grant funding?

**NPC:** The grant is divided broadly between academic validation and industrial equipment. Academic validation includes investigation of EEG recordings across a range of species and a full assessment of quality and efficiency improvements after electrical stunning. The industrial portion is divided into new system innovation (pulse stunning) and design and build of three pilot stunners, which can be rotated around the supply chain to give farmers around the world experience of the benefits of electrical stunning, both in terms of economies and fish welfare (and its impact on quality).

### Are there particular species that you aim to adapt your existing electrical stunner to, and what are the main difficulties in achieving this?

**NPC:** We are adapting the stunners to work with a range of species, each with their own challenges. Pangasius and tilapia, for example, are particularly tough to stun and require a new submerged conveyor design to carry the fish slowly through the electric fields for long enough to render them unconscious. Yellowtail has a different challenge, with its susceptibility to spinal damage during periods in electric fields: this fish requires development of a higher voltage system that avoids contraction of the muscles when fields are applied. Sea bass requires high power electronics and long pipelines to ensure insensibility in very salty Mediterranean water – and the challenge here will be to reduce size, both physical and electrical. Each of the pilot systems will be rotated around farming operations around the world and will be adapted to meet the challenges and overcome the objections on the farms we find ourselves on.



Fish have definitely moved up the welfare agenda. Whilst there is still debate over the question that the late Victoria Braithwaite posed in her seminal book *Do Fish Feel Pain?* the evidence and the balance of opinion seems to be strongly in favour of giving them the benefit of the doubt these days.

**HUW GOLLEDGE**





### When do you expect it will be commercially available?

**NPC:** There is a broad spectrum of systems being developed and adapted on this grant. The most radical new concept stunning devices we would not expect to be commercialising in less than three years. The adapted stunning systems benefit from an electronics system that has been developed to be as flexible as possible, to cater for different water types and fish types. The task here is much more focused, looking to validate stun fields and mechanisms (for delivery in, through and out of the system) in the field and find the parameters and processes that demonstrably produce the best insensibility, quality and shelf life for a particular species. Once we have the experience, data, and feedback from farms using our system on these new species, we are able to commercialise the systems within months. This work will be carried out on farm sites around the world – so our biggest concern is the ending of the COVID-19 pandemic, which has seen a global lockdown.

### What do you think are the main welfare challenges facing the aquaculture industry?

**HG:** In terms of slaughter, the real challenge is to make sure all animals are humanely slaughtered, which involves the kind of science we're funding to find humane and practical stunning techniques for all species, but also needs the industry to be willing to adopt these methods worldwide and to persuade consumers of the value of humanely stunned fish. The HSA is also concerned with the welfare of animals during transport and the transportation of farmed fish is also clearly an area of significant concern that would benefit from further research and innovation to improve welfare.

There are also lots of challenges to the welfare of farmed fish before they are harvested. Many of them are outside of the purview of the HSA, which only concerns itself with the welfare of farmed animals during marketing, transport or slaughter; but with my other hat on as the chief executive of the HSA's sister animal welfare charity, the Universities Federation for Animal Welfare (UFAW), I have to say that there seems to be a real need to find ways to address the welfare challenges that often arise as a result of fish farming, such as disease, the restriction of fishes' ability to display their natural behaviours, control of predators and so on.

Recently I've been following the debate about control of lice in salmon and in particular the use of thermal methods for de-lousing, which certainly raises some welfare concerns amongst fish welfare scientists. It seems likely that this method is not good for fish welfare, but I think some decisive research to demonstrate whether or not this method is humane is needed. It would be great to see some industry support for this kind of research. On a related note, I also think we could do a lot more to protect the welfare of cleaner fish, and again, I think this is an area where the industry could take the lead.

### How would you like to see fish welfare progress and are there any particular areas/species that you hope the HSA will help to tackle in the future?

**HG:** As I mentioned, we're very interested in the welfare of wild-caught fish and this is clearly an area ripe for innovation. Last year we awarded £166,000 to Nicola Randall and colleagues at Harper Adams University to undertake a review into the humane capture and slaughter of wild fish caught commercially for food worldwide. The review aims to identify what we currently know about the use and future feasibility of humane stunning for wild-caught fish. If the review suggests widespread use of on-board stunning might be feasible, we'd like to see research and development efforts focused on making this a reality.

The potential to ameliorate a vast amount of suffering by stunning wild-caught fish is really exciting.

I'd also love to see some of the research that aims to understand the whole lifetime experience of animals currently being done in mammals and birds translated to fish. This work uses some cutting-edge science to understand how much stress animals experience over a long period – possibly their entire lifetimes. It really tries to answer the fundamental question of whether the animals have “a life worth living”, and it might allow us to compare different production systems in terms of their impact on animals. It would be fascinating to see what the lifetime experience of a farmed salmon is compared to a wild one, for instance.

In terms of areas and species, whilst there are clearly still many welfare concerns about the farming of the species commonly raised in Europe, there is even more work to be done for the species raised in other parts of the world, some of which are raised in very large numbers. This is the appeal of the project we're supporting; it seeks to apply or adapt stunning methods to species raised in huge numbers around the world, which so far have had much less attention focused on their welfare at the time of slaughter.





Good welfare  
implies both  
physical fitness  
and a sense of  
well-being





# Good health, good welfare



INTERVIEW WITH  
FRANCESCO LENZI

For the last two decades, Francesco Lenzi has been managing Benchmark Advanced Nutrition's product testing centre in Italy. Here he explains how the perception of fish welfare has changed in recent years and the link between good animal health and welfare.



**Could you start by describing your role at Benchmark and your career and experience to date?**

I am the manager of Benchmark's Advanced Nutrition testing center for marine fish, based in Italy. I joined the company in 2000, which is when the site was established. I became responsible for the facility in 2002 and I also manage Artemia technical support for our shrimp customers.

I am a marine biologist by training and started working in the aquaculture sector in 1997 after graduating from the University of Pisa.

**When did you come across animal welfare for the first time in aquaculture and why?**

Animal welfare was an area of focus from the very beginning of my career but the approach was very different to what it is today. The attention to, and perception of, animal welfare has definitely grown over the years. I think this is primarily due to the focus and pressure from the end consumer. This has led to more research, as well as a drive for producers to think differently and adapt their ways of working to best support good welfare.



### What do you think are the key components of good fish welfare?

It's important to look at all aspects of animal welfare; from what they need, to what they want in their environment. One of the first aspects of this is biosecurity and hygiene procedures. If we keep fish and shrimp healthy in highly biosecure environments, we reduce the need for chemicals and antibiotics.

### How do you measure animal welfare in your operations?

We use some indirect parameters for welfare, for example, parasite monitoring and behaviour monitoring. By keeping a close eye on the animals' behaviour, we ensure that they are not stressed by external elements such as light and noise.

### How do you assess Benchmark's advanced nutrition products when it comes to animal welfare?

Welfare is one indicator of performance. Our products are created to boost and promote the development of the immune system, which as a result helps producers to grow more robust animals. More robust animals are healthier and are less likely to suffer from disease.

Our scientific data shows that boosting the immune system of early stage animals helps to create stronger fish for the grow-out, reducing mortality and resulting in better growth performance.

### What trends have you observed in animal welfare through the course of your career?

Definitely a reduction in the use of antibiotics. Antibiotics were historically used as a standard practice during transportation of live animals. This is absolutely no longer permitted and the welfare of animals during transportation is taken very seriously. We are also seeing that improved welfare leads to fewer treatments being used as the animals are healthier.

### Where do you see the future for sea bass /bream farming 10 years from now?

I see that we will prove that the sea bass/bream industry can grow while respecting the environment and fish welfare. I think we can learn a lot from terrestrial animal production to develop more sustainable systems. There will be challenges along the way but I see that there is a very good future for the sector and aquaculture worldwide.





# For Kvarøy Fiskeoppdrett, utilising technology and considering a fish as a whole being are **key to measuring and improving welfare**



INTERVIEW WITH  
**ALF-GØRAN KNUTSEN**

Alf-Gøran Knutsen, CEO of family-owned salmon-producing company Kvarøy Fiskeoppdrett, explains how welfare is embedded in the business' philosophy and the importance of new digital technologies in driving good production decisions.

## **Please could you start by describing your role and career to date?**

I am the CEO of Kvarøy Fiskeoppdrett. We are a small family-owned salmon producer in the mid-north of Norway and produce around 8,000 metric tonnes of salmon a year. We have a number of integrated companies in our organisation, including hatchery and smolt production as well as a service company for sales and marketing based in the US, where we sell our own brand.

I am a trained teacher and had planned to pursue a career in teaching until I met my wife and then my father-in-law. Back in 2005, my father-in-law asked me if I would be interested in doing something different. I said yes and I started working in Kvarøy Fiskeoppdrett's small harvesting station on the island. I went from running that for a year to managing farms for two years. After this, I became more and more engaged in office-based work and managing the company as whole.

Three years later, my father-in-law decided to retire and leave the company to me. So I took over the company in 2008. It was a much smaller company back then, we were selling salmon worth approximately \$5 to \$6 million compared to \$80 million today.

## **What do you think are the key components of good fish welfare?**

There are so many factors. It starts with how you breed the fish and how you care for them throughout the production cycle, including how you handle them.

Genetics, of course, is important – you have to begin with good genetics. In production, our philosophy has always been to handle the fish as little as possible. We don't use any chemicals or antibiotics and have reduced the stocking density in each pen according to government regulations. I have witnessed how density in pens can impact fish welfare. I have a friend that runs an organic farm which has a low stocking density and their average mortality level has been under 3% over the last 10 years.





Feed is also key; finding the right feed and not just buying the cheapest available has been one of the great successes we have had in managing fish welfare.

We are quite proud in the way we handle fish welfare; the mortality levels over the years have been much lower compared to other farms.

### How do you measure animal welfare in your operations?

Density and mortality are two ways of measuring but we are also seeing the increased opportunity for digitalisation in the industry with new technology such as cameras, which allows monitoring of the fish in a much better way.

With AI and being able to soon recognise each fish from smolt until it is a full grown salmon, you can log the whole life cycle and measure the fish welfare throughout.

I think measuring of welfare is really changing for the better and the technology-driven improvements are very big. Cameras can look at factors such as behaviours, feeding, parasite control, wounds and deformities – meaning decisions on what to do and how to improve can be taken a lot quicker.

### What are the main challenges?

Disease is one of the main challenges in Norway. We need to realise the problems we have with disease, such as pancreatic disease (PD) and infectious salmon anaemia (ISA). We need to start on a national scale to fight the disease on a national scale and find ways to vaccinate or utilise genetics to breed stronger fish.

### What trends have you observed in animal welfare through the course of your career?

As I mentioned, when you raise fish, you are working with biology so you need to look at the whole system. Often, if you solve one challenge, another one arises so it is important to find a solution to solve everything without creating new problems.

We've seen government regulations aimed at reducing parasite levels, which can cause other problems such as treating the fish, which can sometimes cause wounds. Also, focusing on one issue, we lose sight of other challenges, such as disease. It seems like the more we lose focus of the whole fish, the bigger the smaller problems are.

In terms of customer and consumer trends, we have been closely connected to the US market since I started back in 2008. US customers were already way ahead of other consumers back then. A lot of questions are asked about fish welfare, the sustainability of farming and what we are doing to improve it.

That's why we are where we are. We took the risk of being the first mover on some of the things we do. We've tried to move the way the market wanted us to in the way we farm; we moved to be more sustainable, change the feed, have more expensive production, and get paid better by premium customers that really care. They will pay extra to get something they can trust. This started in the US and it is now emerging in Europe. You have to document everything, be certified and be transparent.

### Where do you see the future for salmon farming 10 years from now?

I think I would have been wrong if someone asked me this question 10 years ago, but I can try! Now we are farming large numbers of salmon I think we will see a lot more technology being used. This data-driven production will allow us to create a lot more knowledge on how to plan production in a better way and be ahead of events like algae and parasites.

### What is your favourite life motto?


My favourite motto is one that I also tell my employees. "If you wake up one morning and don't really want to go to work, find something else to do." There are so many opportunities, you don't have to do something you don't like.



We are quite proud in the way we handle fish welfare; the mortality levels over the years have been much lower compared to other farms. ■■

**ALF-GØRAN KNUTSEN**  
CEO, KVARØY FISKEOPPDRETT



Disease is one of the main challenges in Norway. We need to start to fight the disease on a national scale and find ways to vaccinate or utilise genetics to breed stronger fish. 

ALF-GØRAN KNUTSEN  
CEO, KVARØY FISKEOPPDRETT



# For Grupo Culmarex, investing in fish welfare means sustainable growth, better results and better products

Over the last 30 years, Cooke Aquaculture Spain (Grupo Culmarex) has been leading the production of sea bass in Spain. The company has set high standards across its operations for sustainability, including fish welfare.

Senior Veterinarian and member of the group's animal welfare committee, Philippe Sourd, explains that investing in fish welfare means sustainable growth, better results and better products.

## Can you tell us a bit about Culmarex?

Cooke Aquaculture Spain (Grupo Culmarex) was founded in 1986 and forms part of the Cooke Family of Companies. We lead the production of sea bass with nine farming locations across Spain and as part of the Cooke Family of Companies, our mission is to be a global seafood leader, recognised for product quality, services and values.

Fulfilling our mission of delivering superior, fresh and healthy products produced in a safe and environmentally sustainable manner requires setting very high standards within our operations and strong values for our people. One of the company's mottos is that "no standards are higher than the ones we set for ourselves" and fish welfare is certainly part of this too.

Cooke Group leads a fantastic variety of sustainability and conservation efforts supporting rural coastal communities and is recognised as a top influencer and trailblazer in this space. This created the inspiration and high standards that our Spanish bass, bream and meagre production lives by.

The Spanish aquaculture sector leads European aquaculture production and is also actively engaged to produce sustainable products. The Spanish interprofessional body, APROMAR, set a clear roadmap towards sustainability efforts and, just as much as the social and environmental impact of fish farming, fish welfare forms part of it.

## When was the first time you came across the topic of animal welfare in aquaculture, and why?

Unlike what most bass/bream sector 'outsiders' might perceive, fish welfare has been up the agenda for a very long time. To start with, all fish farmers know that the better fish under their care are, the better the production and yields, and the better the product quality.

Besides, regulations and existing certification schemes have long included strict requirements in terms of fish health and welfare.





### What trends in fish welfare are you observing in the sea bass industry?

New standards are progressively emerging in response to increased and positive public awareness and consumer expectations. The salmonid farming countries certainly led the way by establishing internationally recognised standards for salmon and trout. The Mediterranean farms are certainly set on the same path with a progressive harmonisation of the fish welfare norms across the area.

Bass, bream and meagre physiology, biological requirements and farming environments are very different from salmonids' and it is important that the new emerging standards adjust to these specificities. In fact, through multiple national or European collaboration and investigation programmes, working with institutions and NGOs, and connecting with scientists, Grupo Culmarex

actively contributed to increasing knowledge of bass and bream physiology, allowing innovation in fish health and welfare.

### How do you ensure good welfare in your facilities/operations?

We aim for more than regulatory and certification compliances. This is because Grupo Culmarex is a leader driven by high standards, passion and continuous improvement, so we must promote and anticipate changes and set fish welfare high on our agenda.

We do this in a number of ways:

#### 1. A team on the ground:

To start with, every single farm we operate has a formally appointed and trained fish health and welfare officer. A team of trained divers, biologists and veterinarians are out on farms every single day to watch for the health and welfare of our stock, in land and at sea.

From broodstock held in our Mallorca hatchery to offshore harvest, all steps of production are overseen by this qualified team. Their mission is to monitor our fish, survey our environment, prevent adverse events and drive all processes towards best practices in terms of fish care.

#### 2. A steering committee:

Beside our daily operational watch, we formed a working group in charge of animating, promoting, and enhancing the fish welfare culture within our operations. This working group assembles complementary profiles to bring knowledge and expertise, as well as to reach all the layers of our organisation. This committee is free to operate transversally and take initiatives with all our divisions, from production to R&D, from logistics to top management. This, for example, includes close collaboration with HR, a must-have asset when one wants to promote a fish welfare culture within the company.

#### 3. Training and investing in our people:

We must reach out and engage with every single operator and employee in the company. While the salmon farming sector counts with many independent bodies and training courses, there are still few options in the Med, so we must be creative and connect with specialists to make this happen.

#### 4. Embracing science and high standards:

Inspired by our Cooke Aquaculture sister companies' high operating and culture standards, and embracing of scientific advances in bass and bream physiology, we developed a concrete methodology to assess bass and bream welfare at any time, basing our assessment methods on specific, simple, yet precise, biological indicators adapted to each phase of the production.

#### 5. Investing in technologies:

Cameras and environmental sensors have been deployed in our offshore operations and have certainly refined our ability to observe and understand our farming environment.

Generally speaking, Aquaculture 4.0, i.e. new technologies, machine learning, image analysis, fish tracking devices, big data and AI, will certainly be deployed in years to come and open new perspectives for fish welfare in the Mediterranean sector.

Grupo Culmarex is already anticipating changes to come for the bass and bream harvest process. To enhance product quality and fish welfare, we acquired an electric stunner that renders fish unconscious prior to immersion in iced water. This significant investment and the complex operational deployment efforts it meant truly highlight the group's engagement in leading changes.

### What are your main challenges?

The bass and bream farming sector remains fragmented; production is carried out in more than 15 countries, not all in the EU. This means all standards and norms are not equal, resulting in a non-levelled playing field. Our group, and the Spanish bass-bream sector in general, face fierce competition.

We truly believe our efforts towards the sustainable production of healthy and nutritious fish will not only be recognised internationally but also inspire our customers to prefer our origin and our brand.



# For Aquatropical, a natural environment and focus on resistance is fundamental in establishing healthy production



INTERVIEW WITH  
**ALEX ELGHOUL**

Alex Elghoul, owner and General Manager of shrimp hatchery Aquatropical SA in Ecuador, explains the importance of creating a natural environment for shrimp. The company works with non-ablated female shrimp and has seen excellent production benefits using this welfare-friendly approach to maturation.



## **Please could you start by describing your role and your career and experience to date?**

I am owner and General Manager of Aquatropical SA in Ecuador. My background is in aquaculture, having graduated from the Florida Institute of Technology in Aquaculture Technology. I have experience in a wide range of species. Our company was originally focused on tropical aquaculture species, hence the name Aquatropical.

## **Can you describe the history of your hatchery operations?**

At Aquatropical we now solely produce *P. vannamei* shrimp. When we first started out in 1986 we were extracting gravid females from the sea and would spawn them and seed the nauplii in the lab. This was very much the beginning of the industry in Ecuador.

There were no maturation facilities at the time and the technology was not defined on how to raise and grow shrimp and there was little knowledge of diseases.

After a while, we managed to control the maturation of the species, not depending on the gravid females from the sea. Extracting gravid females from the sea could have affected the population of the species and the government set laws to avoid the fishing of gravid females and larvae. This meant we were forced to develop technology so the industry no longer depended on the sea.

Since then, we have continued to develop the technology. The industry is now completely based on domesticated stocks using genetic markers to aid in the selection of the best shrimp families.



### How do you ensure good welfare in your production facilities?

When we first started our business, I remember shrimp labs were difficult to access. Visitors were required to dress in highly biosecure gear to prevent viruses and diseases. At this stage, the industry was protected but there wasn't a clear view of levels of contamination.

Something that we have learned at Aquatropical is that it is important to ensure good health and biosecurity but to isolate shrimp in a closed environment is not possible. We have learned to be careful, but we have to let the ecosystem have its own balance. We do this through good management procedures to have the best bacterial flora and have the best nutritional requirements in the system. We create the best environment for the animals to be in, but mimic the natural environment.

We have found that every time we have a challenge such as a disease outbreak and introduce chemicals that disrupt the balance, it is difficult to go back to where you started, so the best way is to maintain the environment and focus on prevention techniques. Some visitors from different countries are surprised that we don't have our production system "in a shell". This is not our main goal, and the animals are performing excellently. My view is that the less we disrupt the ecosystem and animals, the better they perform.

Resistance is also particularly important in genetics. You need to combine resistance with growth, otherwise you will have animals that grow spectacularly but have extremely high mortality rates.

### You have 100% non-ablated shrimp in your production, can you explain why you moved to this system and the benefits?

We have had a maturation system in place since the 90s, and at that time we could not mature females without eyestalk ablation. A few years later we started to notice that some females that were not ablated would still mature and in a much better way. They were in better physical condition and their ovaries had higher levels of maturation and growth. We would sometimes see a 20% improvement.

This is what we see in the natural environment, so we began to replicate this. One of the first things we changed was the photoperiod of the animals. Historically, we had used artificial light for maturation but we then moved to using natural light. We then began to genetically select animals that would mature without eye stalk ablation, so with every generation we would increase the percentage of animals that would mature without ablation.

In the late 90s our industry was impacted by white spot disease (WSSV) and we found that no larvae would resist. We tried different feeding regimes and there was still no resistance, so we started a system for full non-ablation to replicate the natural environment. We started to send some 'natural larvae' to the farms and began to see the difference in production immediately. We would see significant improvement with these non-ablated females. This was the beginning of the survival of the industry, and Ecuador started to slowly improve production year on year.

Following this we started to select animals genetically by mass production of the populations. After a couple of years, we began to work with family selection, and we are now testing around 320 families per year with the aid of genetic markers but this has taken years to develop.

### What are the challenges in adopting non-ablated shrimp?

I think that every year that passes people are getting more aware of their production systems. Shrimp ablation is directly linked to production. Non-ablated shrimp produce more eggs and more nauplii. The difference is that non-ablated females do not mature as fast as the ablated females and have better health conditions after a few spawns. Ablated females lose their vigour much before non-ablated females. When you have a healthy shrimp, their exoskeleton shines like a glass and is strong and active. Ablated shrimp exoskeletons lose their brilliance and shine, they get 'soft and crunchy'. There is also a difference in the nauplii, you have a higher percentage of deformities and nauplii phototropism is affected with ablated shrimp.

I'm sure this production system of non-ablation will spread all over the world eventually.

### How do you see the future of shrimp production?

We have seen significant improvements in technology, genetics, nutrition, and management, so we can produce more shrimp. I think the prospects are very good.

### What has been your proudest moment as a shrimp producer?

Every time we break a paradigm. What I mean by this is when you think of something differently and do it, and it works. We have discovered a few of those things in our systems. An unknown path is sometimes better than the conventional one, and when it works it gives you a moment of happiness. The limit is in your mind!



# A veterinarian's perspective



INTERVIEW WITH  
**PETER  
ØSTERGÅRD**

Peter Østergård, a veterinarian and independent advisor based in the Faroes with more than 25 years' experience, describes some of the challenges with sea lice control in salmon farming, as well as the need to closely monitor environmental factors in the new emerging land-based sector.



## Can you tell us a little bit about yourself and what inspired you to become involved in aquaculture health?

I am a Danish veterinarian, educated in Copenhagen, and I have worked with fish since the 90s in Norway, Denmark, Iceland and the Faroes.

From a young age I have always been fond of animals and I was also a passionate angler. During this time one of my friend's family had rainbow trout fish farms and we went to visit them. I found them fascinating and I think that was the beginning of my real interest in fish farming.

Whilst studying to be a veterinarian, I realised that some animals interested me more than others – I was not so keen on cows and found that microbiology and pharmacology suited me more.

Fish fitted well into this area with a lot of viral and bacterial diseases and the need for prophylactic measures as well as medicines.

## What do you think are the key components of good fish welfare and what are your views on how to measure it?

There are many factors and all are important. For example, dedicated staff to look after and care for the fish, the number of fish in a system and the amount of water of good quality available for the fish. My last point is important, you must have enough water to carry natural amounts of oxygen and remove waste. When we start to add oxygen, instead of supplying more water, there is a risk of accumulating waste products in the water like CO<sub>2</sub> and ammonia.

When moving to RAS (recirculating aquaculture systems) we still need dedicated people who have a very good knowledge of water chemistry and microbiology. A big issue today from my point of view is understanding the effect of the levels of different parameters in an artificial environment for the salmon, like ammonia, nitrite, nitrate, CO<sub>2</sub>, metals, etc.

We have guidelines and threshold limits for a lot of these compounds, but we still know too little about what happens when these parameters are combined with each other, and if some are getting more toxic in combinations than alone – and in addition, we have to consider these combinations under fluctuating or different pH values. Nephrocalcinosis might be an example of such a situation.

In a recirculation system you have a lot of bacteria and other microorganisms in the production water, and these are also producing CO<sub>2</sub> and waste products. I would prefer most of these to be removed before entering the fish tanks – and I like clean and more or less “crystal clear” water. I usually say “wysiwig” – what you see is what you get – if you can see everything quite clear through the water everything seems good, but if you are looking down into a micro-organic soup you might have a problem!

Regarding measuring welfare, it is important to look at the fish both as a group and as single individuals to check if some fish show any deviant behaviour. Fin shape and conditions are important indicators to monitor as well as the skin surface, must be checked for occurrence of abrasions, wounds, etc.

The fish behaviour in the tank or pen is the first and often easiest thing to observe – if the fish are swimming in schools, if it reacts as expected upon your appearance, on feeding and otherwise is expressing natural behaviour – then it is good.

### **Sea lice are a major issue in salmon farming; what are your views on current sea lice treatments/practices and their impact on welfare?**

A hard question; it is not managed in the same way in all companies and farms, but again, it is all about numbers. Number of fish and number of lice giving the total infection pressure – the more fish, the lower the number of adult females that should be allowed.

One of the big issues currently is mechanical and thermal treatments. What is important to realise is that these methods were not introduced because they were revolutionary for welfare or efficacy; it was because we did not manage to control the sea lice with other available tools – prophylactic as well as therapeutic. With a reduced sensitivity or resistance to most of the available medicinal compounds, there has until now been little choice on how to move on. But with new and very promising compounds being developed – one of them also being an environmentally friendly solution – there will soon be new and valuable tools in the medicine box.

Having the ability to treat against sea lice with a method that leaves no imprints on the environment, with close to a 100% efficacy, providing an excellent welfare profile for the treated fish, and to be able to treat all farms in whole areas or zones down to the zero-vision level is a big step forward. This would provide us with the possibility to test in real time, and hopefully prove that a zero tolerance for adult females is the right way to handle the sea lice. The Faroe Islands would be an ideal place to perform such a strategic zonal treatment including all sea sites – with its affordable number of sites, good logistics and geographically-limited area that could be treated quite fast.

Mechanical and thermal treatments were introduced to solve a very huge problem and they have helped many farmers through a troubled period, but the initial systems were quite rough to the fish and have caused high mortality and lost welfare. These systems have vastly improved

and some of them are now running very well. Last time I was in Norway, I saw one of these thermal treatments and they had no mortality nor welfare problems pumping the fish into the system and out again, and this was very good to see.

Non-medicinal treatments are important, and prophylactic measures, in combination with lower threshold values for adult females; but I realise that it will be difficult to run a huge salmon production without the potential to use effective medicinal treatments in critical situations.

Pulling a tarp around the pen and performing an effective bath treatment is still a very easy method to use and is normally very good regarding fish welfare. However, for environmental reasons, there are many concerns about this practice, and therefore medicinal treatments where you remove or neutralise the medicinal compound, should be preferred.

### **10 years ago sea lice were managed much better, where do you think things have gone wrong?**

It might be more than 10 years ago, but “in the good old days”, you would use a medicine and the lice disappeared! However, nowadays, due to the build-up of resistance, with existing medicines there is often a need to use high concentrations of compounds, and this pushes the welfare limits the wrong way.

In my opinion, I don’t think we have ever managed sea lice in a good way, but when we had problems we had medicines that could solve them. Today we are working in a more strategic way counting and looking at numbers

of sea lice, having limits and better legislation. We are also seeing the authorities working harder and pushing the farmers to act on both sea lice and fish welfare.

Back in 2008, we started to have problems in the Faroes with lower sensitivity and resistance against most available medicines – we stopped using some of them as they did not work or were too hard on the welfare of the fish when used with the increased doses needed to remove the lice.

Medicines have made a lot of difference, positively and negatively, but whether you like it or not, they are a necessity when producing salmon in huge industrial settings.

But an especially important part of the medicinal treatments is that we learn to use them in a much more strategic way. First by defining absolute and effective one-generation zones and implementing a zero-vision for adult females, with early interventions on pen level and, when necessary, with coordinated zonal treatment with effective and alternating methods.

Zonal treatments can be a game changer in the fight against sea lice – it might still be single-pen treatments in some farms, but the point is that at all pens in a zone showing rising lice numbers are treated at the same time or in a manner that follows currents or tidal zone spread of lice.







Being able to treat against sea lice with a method leaving no imprints on the environment, with close to a 100% efficacy and with an excellent welfare profile for the treated fish, it will also be possible to treat all farms in whole areas or zones down to the zero-vision level. ■■

**PETER ØSTERGÅRD**  
VETERINARIAN & INDEPENDENT ADVISOR





### How do you see aquaculture health developing in 5 or 10 years' time?

I think we are moving in the right direction towards better health and in the Faroe Islands we have really shown and proved the value of producing big smolts and using RAS facilities, and we also see this booming and coming in other countries as well.

With bigger smolts you reduce the time at sea for each production cycle and this increases the number of fallowing periods; together these provide an extremely helpful strategy against both sea lice infections and diseases such as ISA and CMS, which normally would require a longer time to become a problem in a single farm.

We really have the tools and possibilities to substantially improve health and the COVID-19 epidemic might be a game changer for fish health as well, with new methods and standards for production of vaccines. Maybe even opening for RNA and DNA vaccines for use in fish as well, possibly solving some of the biggest health issues we have currently with diseases like ISA, PD and CMS.

I really like the RAS systems, but I think they can and need to be improved, especially on biosecurity. Although there is a high focus on disinfecting and treating the incoming water with UV and ozone to remove pathogens, there is too little focus on the circulating water masses inside the farms, and we have

seen issues with ISA-HPRO and PMCV viruses spreading and building up in RAS farms. The biofilters might turn out to be bioreactors or at least effective vectors for maintaining and spreading the infections between groups and generations of fish, and the great risk in this is that we might end up stocking our sea sites with smolts almost 100% preinfected with a given pathogen and thereby ruling out the advantages of shorter time at sea.

### As a specialist Aquaculture Veterinarian, what is the best advice you can give on fish welfare?

The most important advice I can give is that numbers matter. Whatever you do, scaling up the production in biomass or number of individuals, you substantially increase the risk and most of your efforts really must be put into the biosecurity part.

Huge RAS farms mean tremendous amounts of air are pumped into biofilters and aerators and if situated close to the sea there is a high risk that ISA-HPRO are introduced this way. If our experiences in the Faroes are right, that proximity to the sea increases the risk of smolt farms being infected with HPRO.

When producing bigger smolts you soon realise you need wider tubes, bigger pumps and holding facilities – if an average weight of 500 grams is the plan, there might be a surprising number of fish close to 1kg or higher.

So, I would say that “numbers” is the most important thing to remember.

In addition, proactivity is another key area, like early intervention with treatment of single pens to keep low lice numbers at farm level, instead of waiting for the whole farm to exceed the threshold level – that will increase welfare by treating less fish.

There are new systems under development for lice-counting, and if they work as intended, we will be able to continuously monitor the sea lice status in all the pens in a farm, making it even easier to decide when necessary to act.

Surveillance of pathogens and undesired organisms by filtration and PCR analysis of water samples is also an example of proactivity and with this method a whole tank or holding facility can be monitored in very few samples at each sampling time and thereby performed much more often at lower cost, most likely resulting in earlier detection and more time to act.

I believe this change of strategy will make everything much better in terms of both productivity, health and welfare.





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# An investment perspective

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The catalysts for a stronger sustainability focus come from an increasing number of sources – spanning from consumers to regulatory bodies, investors, governmental schemes, new financial schemes and new enabling technologies.



# Good fish welfare leads to better financial performance and investments



INTERVIEW WITH  
FAAZI ADAM

Faazi Adam, aquaculture lead at the FAIRR Initiative explains the macro drivers for a sustainable aquaculture system, including consumer and investor demand for higher welfare.



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The FAIRR Initiative is a collaborative investor network that raises awareness of the environmental, social and governance (ESG) risks and opportunities brought about by intensive animal agriculture. FAIRR helps investors to exercise their influence as responsible stewards of capital.

## Can you explain your role at FAIRR and a bit about yourself?

I am Research and Engagement Manager at the FAIRR Initiative and lead our aquaculture programme. In 2019, FAIRR created the aquaculture industry's first report on ESG issues, which gave an overview of the industry's sustainability challenges and opportunities. Since then, we have continued to analyse the industry's performance as part of our Protein Producer Index, which assesses 60 global livestock and fish producers on 10 ESG factors.

In addition to leading FAIRR's aquaculture programme, I also manage several other engagements with global food companies related to managing climate, water and deforestation risks in livestock supply chains.

## What are the main challenges you see in aquaculture?

I think it very much depends on species and region. FAIRR's work in aquaculture is mainly focused on salmon farming and in this context I think most of the industry would agree that the most immediate challenges are biological challenges, such as sea lice and disease management. In addition, there are longer-term limits to growth such as the availability of suitable coastline and availability of feed.

Looking more broadly into shrimp, I think disease again is definitely one of the top issues that producers face, with some experts in the industry estimating that up to 40% of shrimp is lost every year to disease in southeast Asia. There is a lot of innovation ongoing to improve outcomes but when it comes to practically raising standards it is difficult as the Asian shrimp industry is quite fragmented, ranging from a large number of small family farms to large industrial producers. This means raising the standards throughout the region is a challenge that producers face.



**In a report published by FAIRR, you refer to fish welfare as an emerging risk, can you explain more about this?**

If we take the livestock industry as an example, we can see that animal welfare is rising up the agenda pretty quickly. Consumers are very concerned about welfare and there are many certification schemes that help producers communicate good welfare. When assessing “top end” livestock producers on animal welfare performance, best practice companies have production systems that enhance environmental enrichment for the animals to fulfil their needs for physical activity as well as enable them to exhibit their natural behaviour. These are systems that not only make them healthier, but happier as well.

When we look into aquaculture it's quite a different story. Aquaculture is a fairly young sector and stakeholders are beginning to work out what good welfare is, as opposed to just good health. As we see developments in new production systems such as RAS land-based farms, we know questions will be raised on how the welfare for salmon compares in systems that are much different than the salmon's natural habitat.

We are also seeing increased demand for better fish welfare standards from various parts of the food ecosystem, as well as leading retailers adopting assurance standards and welfare certifications for their supply.

From an investor perspective, in recent months we have received more questions from our investor network on fish welfare.

I think as time goes on welfare will become a bigger risk, not just in terms of health and survival outcomes, but understanding whether animals are living happy lives. This also represents an opportunity to develop aquaculture systems and solutions to address this risk and improve welfare across the production lifecycle.

**A recent FAIRR report links good fish welfare with better financial performance; can you expand on this?**

Part of our work to create the Protein Producer Index is to make sure that we assess companies on many aspects of sustainable production. When it comes to welfare, we see that a lot of companies that are good performers on welfare, are also good performers in other areas.

Specifically when it comes to aquaculture, ensuring good health and welfare is essential in ensuring a good product. Happy and healthy fish lead to higher survival rates and less wastage, which improves margins and profits in the end for producers.

**Where do you see the aquaculture industry in 10 or 20 years' time?**

One thing I'm pretty confident about is that the importance of sustainable production is only going to increase. Food production is a huge contributor to environmental degradation worldwide but there are also huge opportunities for mitigation and improvement.

Also, science focused on sustainable and healthy diets suggests that we need to rapidly reshape our diets to keep our soils productive and mitigate the threat of climate change. I believe aquaculture can be part of that solution when done sustainably, particularly in regions where populations need more protein.

In 10 to 20 years' time, I see a number of potential avenues such as alternative production systems, including offshore farms that can reduce the impact on marine ecosystems. I'm also very curious to see how cell-cultured meat and seafood progresses – if it reaches price parity with traditional animal products and is well-received by consumers, this could be a huge disruptor to the industry.



Happy and healthy fish lead to higher survival rates and less wastage, which improves margins and profits in the end for producers. ■■

**FAAZI ADAM**



**TONE BJØRNSTAD  
HANSTAD**  
INVESTMENT  
PROFESSIONAL,  
FERD



Fish welfare and sustainability is very important to us as we are long-term investors who want to create enduring value and leave clear footprints.

For Ferd, value creation is about generating more than just a financial return. It is also about making a positive contribution to the growth and development of society and our environment, in a way that supports the sustainability goals.

Future value creation will require organisations to understand and manage their risk and opportunities from an ESG perspective in a systematic and integrated way. We observe increased focus on sustainability and a lot of exciting development in the entire aquaculture value chain. We believe that Benchmark Holdings can bring valuable solutions to some of the fish welfare challenges in the industry.



**ANTHONY JAMES**  
EXECUTIVE  
DIRECTOR,  
WHEATSHEAF



Our approach to investing into food and agriculture is anchored in the beliefs that our choices over what we eat and how this food is grown, produced and distributed are all part of a complex interconnected system that influences our health, ecosystem and climate.

As one of the most sustainable and efficient meat-based proteins to produce, aquaculture has many attractive investment characteristics, however, there remains work to be done and further improvements to be made. Improving sustainability and consequently industry economics is at the core of our investment decisions.

Fish welfare is an essential and integral element of sustainable aquaculture production. As the global demand for fish and seafood products continues to grow, being able to produce in a manner that enhances fish welfare will also deliver ancillary benefits to human, environmental and climate health. Consumers today are increasingly demanding more transparent and ethically optimised production methods. Businesses that ensure high standards of fish welfare are always present in their operations and communicate this in a way that engages consumers to support these high standards will be well positioned for the future."



# Benchmark at a glance

Our mission is to enable aquaculture producers to improve their sustainability and profitability.

We deliver solutions in genetics, health and advanced nutrition that improve yield, quality, animal welfare, and reduce environmental impact.



The aquaculture industry is at an early stage with enormous potential for growth. Benchmark's solutions in genetics, health and advanced nutrition support the needs for aquaculture producers to develop in a sustainable way.

**TROND WILLIKSEN**  
CEO, BENCHMARK



## Genetics

Improved genetics provide a crucial starting point for production efficiencies and health resilience.



## Advanced Nutrition

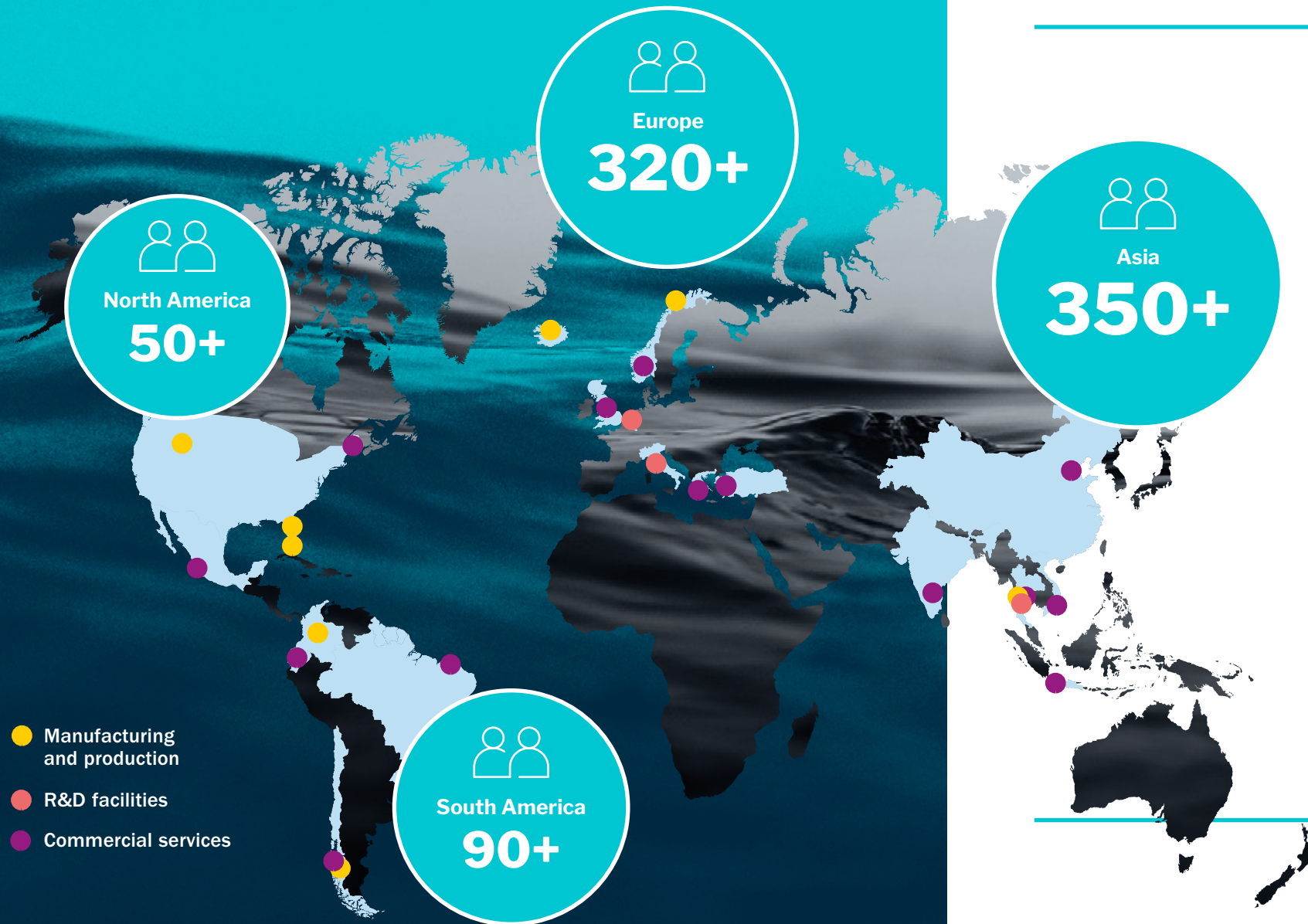
High performance nutritional solutions for shrimp and marine fin fish enhance fish health and production efficiency.



## Animal Health

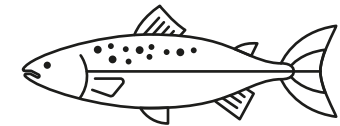
Solutions for some of the most persistent disease and fish welfare challenges.

# Global presence



We are present in every major aquaculture market and species.

Salmon



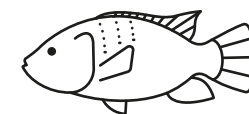
Shrimp



Sea bass/bream



Tilapia







CARE FOR  
GROWTH

## EVERYTHING YOU ALWAYS WANTED TO KNOW ABOUT ARTEMIA

The new Artemia knowledge hub comprehensively covers all the fundamental information and advanced data on this tiny little hero called Artemia.

You can find information on:

- Hatching and collecting
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A Benchmark  
Company



Benchmark  
Genetics Shrimp



## Breeding for a sustainable future with genomic precision

Benchmark's SPR/SPF certified *P. Vannamei* strains are designed to be robust. Using the latest genomic tools, we offer shrimp broodstock adapted to local environmental conditions with improved disease resistance, yield, health and welfare.

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[bmkgenetics.com](http://bmkgenetics.com) or email  
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### Our product range

#### Main line



**BMK Yield®**

Selected primarily  
for growth with  
high survivability

#### Specialized lines



**BMK Protect®**

Selected for improved  
resilience to WSSV  
and AHPND/EMS



**BMK LowSal®**

Selected to thrive in  
low salinity conditions



Investments in new technologies remain as important as ever to the sustainable growth of the industry





# Committed to the sustainable development of the aquaculture industry



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