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Salmon Group wants to take part in the discussion on fish welfare in fish farming and do our part in improving the entire industry also in this area. This contribution from the industrial actors’ side is made on behalf of the Salmon Group network’s small and medium-sized producers of salmon and trout all along the Norwegian coast.

Fish welfare in fish farming is an extensive and complex topic. The industry has strengthened its focus on fish welfare, and as this field has become a more prominent part of the public debate, this is a natural development. It has been spurred on by demands from food safety authorities, veterinary authorities and the average consumer. The Norwegian Veterinary Institute and the Norwegian Food Safety Authority issue guidelines for the industry’s treatment of animals. Simultaneously, the fish farmers have to comply with numerous laws, official bodies and other interested parties. With all the competing needs, or requests from different parts of the administration, it is not always given that this complex whole is being maintained in an optimal manner.

Food production must take place under conditions that meet the requests linked to the environment, welfare and end product. The greatest welfare challenges in fish farming today are all related to the handling of lice, and the mortality rate is high for both salmon and cleaner fish, for which the industry itself must take responsibility.

Aspects concerning fish health and welfare affect society’s perception of the industry and to which extent it takes responsibility. The manner in which measures are taken also affects public confidence in the industry. Public confidence and trust are vital in all parts of the food chain. Today’s public are conscious consumers who are concerned with balanced resource management and responsible food production. Today’s consumers care about where the food comes from and how it is produced, and they expect every food producer to provide good answers.

What is fish welfare? Why is it that we accept the high mortality rate in salmon production? And is it okay to sacrifice cleaner fish in order to save our treasured salmon? We will take a closer look at these and other frequently asked questions about fish farming.

WELFARE AND THE LEGISLATION

Balancing economy, environment and animal welfare in intensive food production can be demanding. In the competition to produce
cheap food while at the same time complying with numerous requirements and orders, animal welfare is often the losing party. In aquaculture there are three laws regulating fish welfare: The Animal Welfare Act, the Aquaculture Act and the Food Act.

The Animal Welfare Act states that every animal is an individual being and has intrinsic value independently of its utility value. We have an ethical and moral responsibility for our domestic animals. This applies whether they are pets or recreation animals or are primarily held as production animals on land or in water. With this follows a responsibility for us as food producers and animal owners. We must always be prepared to take measures if our animals are threatened by illness or environmental challenges that might reduce their welfare.

Both the Animal Welfare Act and the Food Act describe regulations on a general basis for all animals. In addition, the Animal Welfare Act has separate regulations for poultry and the Food Act separate regulations for production animals where fish are not included.

The Aquaculture Management Regulations, which are subsidiary to the Aquaculture Act, outline general requirements for responsible operations and state that operations must be responsible concerning the fish's health and welfare, but also contains content to secure the industry's profitability, value creation at the coast and sustainable development in addition to the welfare requirements. In the regulations for production animals where fish are not included, the animal's psychological health and wellbeing is described, among other aspects. In the regulations for poultry, the wellbeing of animals is taken into consideration. This kind of wording is absent in the Aquaculture Management Regulations. As mentioned, the descriptions are more neutral and state that operations should be “responsible”. Would it be possible for commercial interests, environmental considerations and animal welfare to walk hand in hand? Does neutral legislation create a greater distance...
to the fish’s need for good psychological health and wellbeing than what is true for other production animals? Is it easier to make decisions that go against the fish’s welfare needs where the wording in the legislation is lacking emotional words?

**FISH IS LIVESTOCK – SENSE AND SENSIBILITY**

While animal welfare in farms and barns have been given more attention the last few years, it has taken longer to establish acceptance for sense of pain and consciousness in fish. Norway is a fishing nation with strong fishing roots and traditions, and many Norwegians also has fishing as a leisure activity. The fact that fish make no sound or change facial expression when they are harmed may strengthen the wrongful notion that fish and other aquatic animals do not feel pain. This may lead to increased tolerance for inhumane handling of these animals.

The more animals one has, the more difficult it may be to monitor or treat single animals who needs it. The solution is often treatment of populations, which is very common when handling lice and other parasites. This leads to both excess use of medication and handling of animals that does not need it. Being able to treat only those individuals who needs it will be a valuable contribution to promoting animal welfare, in addition to reducing the environmental impact. When treatment of the fish is necessary, it is less of a burden to the surrounding environment if only a small number is treated. We are still quite far away from individual recognition and sorting of fish, but we are working on this on many fronts, and it will be an important step forward for animal welfare.

**CONSUMER POWER**

The public confidence in Norwegian food production is strong, and price is still the most important factor when consumers are choosing what to have for dinner in the shop. Still, in the younger consumers there is an evident will to choose differently. For instance, environmental impact and animal welfare are increasingly more important arguments and influential on their consumer behaviour. One might ask whether the industry has been good enough at providing the consumers with proper information. Meat from farmed fish has a lower carbon footprint than both beef, pork and chicken. Nonetheless, surveys show that many are reluctant to eat farmed fish due to environmental and health concerns. The consumer’s degree of closeness to the food production seems to be a factor. In the study *Forstudie om nedadgående norsk sjømatkonsum* (Bugge & Schjøll, SIFO 2018) (“preliminary study on declining Norwegian seafood consumption”), it is pointed out that people in big cities are for instance more willing to change their food habits to improve animal welfare than those living in rural areas.

Consumer power should not be underestimated. A well-known example is palm oil, that was previously used in a number of foods such as biscuits, cakes and chocolate. Consumers’ initiative brought palm oil production methods into focus, and the producers were eventually forced to remove palm oil from their list of raw materials – this as a direct result of a consumers’ initiative that more than anything resembled a campaign.

Every year, Norwegian aquaculture contributes to great value creation in the Norwegian society. It is also an industry that faces many challenges, and it still struggles with a somewhat dubious reputation when it comes to pollution, the environment, welfare and the end product’s nutritional value. If the industry wants to be recognized as a growth industry for future generations, it needs to address its own “palm oils” and demonstrate a willingness to change and alter its attitude.
STRONG FEELINGS ABOUT FARMED FISH AND THE ENVIRONMENT. A preliminary study about the decline in seafood consumption (Bugge & Schjøll, SIFO 2018) revealed that 22% of those surveyed (N = 1431) thought that fish in fish farms were animal / fish cruelty, and 39% thought that farmed fish were harmful for the environment.

COST AND TASTE ARE STILL MOST IMPORTANT WHEN IT COMES TO CONSUMER HABITS. In this survey from 2018, we see that animal welfare is important for about one fifth of consumers. For the time being, it is the price and taste that determines most consumers when choosing food at the store. (Bugge & Alfsnes 2018, Meat-Free Eating Habits).
HOW DO WE TALK ABOUT FISH?

FISH WELFARE IN FISH FARMING

DEVELOPED
SALMON GROUND
How do we talk about fish?

Our wording plays a part in shaping our attitude towards fish and the way we handle it. It is reasonable for the industry to seek understanding for the challenges they face every day. Greater insight into what kind of production requirements and challenges one is facing builds trust and displays a more nuanced picture to the public.

The language being used for communication between producer and consumer is of greater significance than may have been taken into account. The images and words being used to show the reality of the industry make up the foundation for building credibility and a good reputation.

FACTS AND EMOTIONS

Few of us will associate salmon or trout with cuteness. As opposed to other animals, fish do not stir these emotions in us. In a TV commercial for pork you will likely see playful piglets gazing curiously into the camera, and words like “playful” and “wellbeing” are being used. Dairies sell milk from cows enjoying their life to the full on their summer pastures. What does this do to us and the way we think about the food we produce? And how does it affect the debate with the consumers? Most of us think the animals are pretty and have a good life. How can salmon stir the same emotions?

In a study from the Norwegian University of Science and Technology on metaphors and rhetoric linked to facts, they have gone through around 300 articles discussing aquaculture and salmon farming in Norway, and they found that in articles describing fish farming positively, words like “growth potential”, “innovation” and “spin-off effect” are frequently used, and the texts are often fact-oriented. Even though these are positive words, the communication is not consumer directed. The readers’ emotional reaction rather gives rise to the feeling that fish farming is a “heavy industry”. On the other hand, the negative mentions the industry receives has a sensational and emotional touch, a type of rhetoric that strikes home with the average consumer. We also see this in countries and markets of importance to Norwegian seafood export. Because who wants to serve their children salmon when one of Germany’s most reputable newspapers prints headlines like “Salmon to the world – poisonous fish soup”?

Here Norwegian salmon is singled out as the worst in the class, and this of course affects the consumer’s perception of the salmon product as well as the fish farming industry.

HOW DOES THE INDUSTRY ITSELF COMMUNICATE?

The industry is itself responsible for taking charge of the way it is talked about publicly. Using words like “chemicals” for approved medication and “loss” when talking about death creates a distance to reality. It is hard for most people to understand that you are not “dumping chemicals” but providing approved treatment for sick animals if it is not communicated properly. If you use the word “loss”, it may look as though you try to
obscure the fact that a large number of fish die in Norwegian fish cages every year.

There are projects where one has looked at rhetoric and semantics concerning the use of language and imagery within aquaculture. Recently, the Regfishwell project went through the wording in regulations where fish are mentioned. They point out how the wording differs in several ways in regulations for land animals and regulations for fish. There is room for language that creates a stronger awareness in the regulations for farmed fish. For instance, in the regulations for production animals’ welfare it says that production should happen without any harmful effect on the animal’s physical or mental health or welfare, while in the regulations concerning fish, the Aquaculture Management Regulations, such considerations are completely absent. When it comes to general requirements for responsible operations it says that operations must be responsible concerning fish health and welfare. This example emphasizes the fact that animals in general have the right to wellbeing not merely physically, but also psychologically. The absence of this aspect in the aquaculture regulations points in the direction of fish not really being equal to animals on land where psychological health is concerned.

Freedom from fear and distress
Freedom to express normal behavior
Freedom from discomfort
Freedom from hunger, malnutrition and thirst
Freedom from pain, injury, or disease

† THE FIVE FREEDOMS. Animal husbandry has changed over several thousand years. In 1965, the British Brambell Commission drafted the term “animal welfare”, and put forward five pillars of what good animal welfare for domesticated animals should be based on. These five freedoms are just as relevant today as they were in the 1960s, and even if one thinks that they have come longer in animal husbandry today than just over 50 years ago, there are still animal groups that we are unable to fulfill their needs for. Cleaner fish is an example on livestock that we have not managed to take care of in a good way.
What is fish welfare?

What is fish welfare? How do we know that the fish are doing well? As mentioned above, these questions would likely have been easier to answer if we had replaced “fish” with “sheep” or “goat”. Our domestic land animals all have the ability to communicate verbally and non-verbally, and in such a way that humans also can interpret this communication. But how do we interpret salmon and the salmon’s body language? How can we assess whether the salmon merely has its basic needs covered or whether it actually thrives?

Even if fish do not stir the same emotions as other animals might do, we have an obvious responsibility for the fish’s wellbeing. How does one know what is “good” or “good enough” and whether fish welfare in the fish cages is good enough?

WELFARE INDICATORS IN DAILY OPERATIONS – A COMMON FORMAT FOR ASSESSING WELFARE

Until recently, the way we assess welfare has varied greatly, and at times proved difficult. Some are of the opinion that absence of disease and injuries is good welfare, while others will define a prerequisite for good welfare as also having the freedom to express natural behaviour.

Before the Animal Welfare Act was established and animals got their own legislation securing their basic needs, work on welfare was based on the Brambell committee’s (1965) “Five Freedoms”. The objective of the Five Freedoms was to secure good health and welfare for all domestic animals, and they have since influenced the development of legislations for animal husbandry in the EU and in Norway. Through the EEA agreement, Norway follows EU regulations for food safety, which applies to all food and food production. This applies to goods produced on land and for fish. In Norway, The Animal Welfare Act is the current legislation on animal husbandry. In just a few years cleaner fish has also become the second largest group of domestic animals in Norway. In 2019, 49.3 million cleaner fish were set out in Norwegian fish cages. Even though they are not meant for consumption, the cleaner fish are equally the fish farmer’s responsibility and subject to the same legislation.

Welfare Indicators for Farmed Atlantic Salmon: tools for assessing fish welfare was published in 2018 and has become a guide for how to define and evaluate different welfare parameters in salmon farming. To put it simply, mortality rate is an example of such an indicator. The mortality rate is relatively easy to register, and if we also know why there was mortality, measures can be made to prevent the same thing from happening again.

This is why we have to assess fish on the basis of other circumstances as well. This is thoroughly described in the publication mentioned above. This work is highly important when it comes to changing the perception of what fish
welfare is. Also, it has finally made it possible to use a common tool for assessment of welfare. When assessment is based on a common format it is possible to monitor progress. Then we see how utilization of these indicators can make welfare a variable we can enter into the traffic light system, where louse exposure is still the only factor today.

The fish’s environment cannot be controlled, but it is vital it is closely watched to secure that the fish are doing well. Small changes in the environment can have severe consequences. Having emergency plans specific to the fish farm and a list of measures in case of fish tank environment or water quality becoming suboptimal may prove decisive to further production and the fish’s welfare. Today’s technology allows for logging and monitoring practically every parameter in the production. For instance, you have drones and cameras that can count lice or estimate biomass. Monitoring eating behaviour will influence feeding. This way one can also reduce feed waste to a minimal level if gathered data are utilized properly. Real-time transmission of data is increasingly becoming part of production management tools. Establishing platforms that can help us making sound decisions based on comparison of large amounts of data will be an important measure in order to optimise conditions for the fish in the fish cages.

THE TRAFFIC LIGHT SYSTEM

The traffic light system is a management model that will take account of the growth the industry wants, as well as environmental protection and wild salmonids. This is to ensure that growth is pre-eminent for the industry players, and that it is done in a sustainable way. It is the Ministry of Trade and Fisheries that determines the colors of the different production areas.

___ Green areas is allowed to have a 6% production growth. In this production area, it is estimated that less than 10% of wild salmon smolt die as a result of salmon lice infestations.

___ Yellow color in the production area means no change. 10-30% of wild salmon smolt is calculated to die as a result of salmon lice infestations in the yellow area.

___ Red color production areas can be forced to reduce the production by 6%. Fish farms operating within the red area can apply for exemptions from the reduction if they can show low lice counts. It is expected that over 30% of wild salmon smolt can die from sea lice infestations in red areas.

___ SOURCE: MINISTRY OF TRADE AND FISHERIES.
Where does the shoe pinch?

During the different stages of its life, the fish has different criteria for acceptable welfare. Some of these criteria are easy to meet, others more demanding. Certain topics are difficult to discuss.

While new technology becomes available also for use in fish farming, there is an emergent need for documentation and regulations to regulate the use of these and ensure fish welfare is not reduced. We see changes both concerning the production of roe and the production of fish. Which direction should one choose to secure good fish welfare?

Obviously, one must cover basic needs. Feed is the most important production factor in salmon and trout farming, and proper feed is essential to secure growth as well as fish health. Healthy growth is an example of an indicator for good fish welfare. We have seen how a wrong feed composition can cause injury and deformities and thereby contribute to reduced animal health and welfare. During a period of just 50 years of farming salmon and trout in Norway, we have come a long way in providing feed that meets the requirements for good animal welfare as well as nutritious food. Salmon and trout are important sources for marine omega-3 in the Norwegian diet. As in many other industries, we look for production factors where we can reduce the product’s carbon footprint, and salmon and trout farming is no exception. Feed constitutes as much as 60% of fish farming’s carbon footprint globally, much due to feed containing raw materials that are grown in countries far away and shipped by boat to the factory. It has been pointed out that this production is not sustainable. The early formulated feeds contained much fishmeal, but because many fisheries’ resources are strained, we do not want to increase the quantity of fishmeal. Neither do we have control when it comes to the amount of environmental pollutants wild fish consume. Today, PCB and dioxin are removed form fish oil from the northern hemisphere to meet the requirements for environmental pollutants in food. A strong control of the content in raw materials for feed is essential to secure proper food safety as well as animal welfare. With this follows an exciting development of new raw materials for feed based on insects, yeast fungus or wood, to mention a few. The advantage is that the production of these is closer to the market, and the nutritional content are kept more stable. For instance, variations in fishmeal have turned out to affect the mineralization in the fish’s bone structure.

BREEDING, GENETICS AND WELFARE

There is a public responsibility in setting limits for how breeding and genetics should be utilized in the work with animal welfare. Salmon production in Norway has its origin in salmon populations from Norwegian salmon rivers. These have been refined through focused breeding where good fish welfare and health is a statutory prerequisite today. In paragraph 51 of the Aquaculture Management Regulations concerning breeding and reproduction one has stated the importance of breeding healthy and robust fish and that “domestication of the fish must be emphasized”.

Traditional breeding takes time, but one has shown that by use of conventional methods one can reduce diseases to a great extent. A specific example of how fish breeding companies work on promoting fish welfare is how the salmon disease IPN (Infectious
Pancreatic Neurosis) has been reduced from being a great problem to becoming almost a non-issue in just a few years. Today, one is working determinedly on various breeding methods to breed fish that is more resistant also to other viral diseases, lice and amoeba, to mention a few.

In Norway, gene modification is illegal, but methods such as CRISPR (clustered regularly interspaced short palindromic repeats), that allows for editing of the animal's own DNA, challenge the regulations for gene modification. The method does not differ from the mutations that appear in nature but allows us to determinedly accelerate alterations. The method can be used to increase welfare, increase profitability and make animals and plants more resistant to climate changes. This way, CRISPR can contribute to a more sustainable food production. Then the following question arises: If we are able to create a salmon that is resistant to disease and lice using CRISPR technology, would it then be ethically justifiable not to? It is important we enter into a discussion about this topic to secure that our competence level, knowledge and regulations keep up with the development of such tools.

SMALL FISH, BIG CHALLENGES

Both salmon and trout are fish species that start their life in freshwater and go on to live their adult life in the sea, before, in nature, returning to the river. When the fish is preparing for life in the sea, it becomes what we call a smolt. In the production of salmon and trout we recreate this by the use of light and temperature, but the industry still faces big challenges linked to the time the fish spend in freshwater. Why is it that the mortality rate is highest before the fish enters the sea? Can a change in reporting lead to better welfare? How can we use established knowledge to improve smolt quality?

These are important questions we need to ask if we wish to take fish welfare seriously in this stage of the production.

Through a project initiated by the Norwegian Animal Protection Alliance, the Norwegian Veterinary Institute issued the report Småfiskvel (“welfare in smoltfarms”) in autumn 2019, an assessment of salmon and trout's fish welfare in smolt/freshwater production. Among other things it was revealed that the highest mortality rate in smolt production occurs before the fish reaches three grams. The study shows there are great variations between fish farms concerning the mortality rate at this stage of the fish's life. This despite the fact it is easier to monitor the welfare in smolt farms than welfare at sea. This points in the direction of human handling causing the differences. Why do some farms accept a high mortality rate at this stage while others manage to produce fish almost without mortality? Do the small fish receive less attention simply because it is so tiny and have less economical value?

ARE WE LEAKING KNOWLEDGE BECAUSE OF LACKING SYSTEMATIC REPORTING?

The most important revelation from the report was that there are serious shortcomings concerning which data being reported to the Norwegian Food Safety Authority and what they are used for. Despite this information being readily available in the fish farmers’ production systems, in the statistics for mortality in smolt production one does not differ between causes for mortality or whether the fish was killed due to other reasons. The reporting to the Norwegian Food Safety Authority also happens on a monthly basis, which makes it difficult to pick up cases of acute mortality. If relations between cause and effect are not systematically reported, we cannot learn from our own mistakes. If we do not have an overview over causes for mortality in freshwater facilities, neither do we have the opportunity for evaluation and improvement. How are we supposed to improve the prerequisites for production if we do not know what the conditions are? It is of great importance that we make demands for a report of causes for mortality also in smolt farms.
**SMOLT PRODUCTION IN CHANGE**

The production of smolt in fish farming has changed dramatically during the five short decades of our commercial salmon production. In nature, salmon may actually take anything from one to eight years before it migrates to the sea. Smoltification means adapting to life in saltwater and consists of several processes that affect both the behaviour, appearance and physiology of the fish. Light and temperature regulate this development. Going from being a freshwater fish to becoming a saltwater fish is demanding both physiologically and immunologically. It is highly important that the fish has optimal environmental and growing conditions during this stage.

In theory we can produce smolt any time of the year, but we still lack extensive knowledge of which type of production it is that yields the optimal smolt quality and high survival rate after the fish are placed in the sea. In this part of the production one opens up to high levels of manipulation on the expense of the fish's natural way of life. With new technology we will also often experience new challenges related to fish health and welfare. Take nephrocalcinosis for instance, a type of kidney stone in fish. This is a production problem that is well-known from farming of trout and char, and where there have been sporadic cases in salmon farming. Recently, nephrocalcinosis has returned, with more cases, in salmon production and can amongst several things, be linked to challenges related to osmoregulation and water quality. What gives rise to development in one area may sometimes cause unwanted effects in others. Many older smolt farms have been rebuilt or replaced with recirculating systems where we to a larger extent are able to turn up the production speed by keeping higher temperatures than what has been possible in flow through systems with a lower capacity for heating the water.

Poor smolt quality is often pointed out as the reason for mortality after the smolt is set out in the sea. We must adapt the production of smolts in order to reduce the risk of poor smolt quality and development of the so-called runts. Loser syndrome or runts are terms used for fish that do not keep up with the rest of the group when it comes to...
growth. In the Fish Health Report from 2019, it is revealed that what causes loser’s syndrome is still not clarified, but that it probably is a mix of environmental challenges during the brood stock stage where insufficient fish tank capacity, irregular light stimulation and bad water quality may give the fish a bad starting point. Subsequent stress at sea, like frequent handling and diseases, may weaken the fish further and lead to the development of loser’s syndrome. These fish may survive for a long time at sea, but are typically exposed to lice infestation, tape worms and other diseases. These fish are not doing well, and from a production perspective they are unwanted. Euthanizing them are sometimes a justifiable measure as the fish would not have a satisfying life under these conditions where animal welfare is concerned.

Mortality in salmon during the sea stage is given much attention, but the foundation for a robust fish is established already at the freshwater farm. It is important that we improve the quality of welfare work in the smolt production.

**POST-SMOLT – A CONTRIBUTION TO IMPROVED WELFARE?**

It may be difficult to pinpoint a single factor that will improve smolt quality, but it is pointed
out that the fish need better conditions not only to survive the first period after being transferred to sea, but also to be able to survive and grow until they are harvested. Newly transferred smolt is vulnerable and must be handled with care and as little as possible. Having to delouse smolts shortly after they are set out in the sea is not compatible with good fish welfare. Consequently, producing large smolt is now a common strategy for many producers, in the hope of shortening the sea phase production time. The average smolt size has increased steadily since 2012, and it seems this tendency will continue. Ten percent of the fish that was transferred to sea in 2018 weighed more than 250 grams, and the average weight was almost the double. This shows that huge efforts are now put into the post-smolt segment.

Despite the fact that the weight of smolt is increasing, the harvest weight is decreasing. The reason is that fish approaching harvest weight is not only difficult to handle, but also highly exposed to diseases. For instance, cardiomyopathy (CMS) is a non-notifiable viral disease that is probably widespread in Norway. Generally, it is associated with low mortality and few signs of disease, but during handling like transfer, crowding and delousing typically lead to increased mortality in large and healthy fish. The motivation for slaughtering the fish on an earlier stage instead of letting it go through delousing is therefore growing rapidly stronger. The financial losses linked to this disease are extensive, and the fish is hardest hit by this disease particularly during its second year in the sea.

Not taking one’s time in a critical phase like smoltification can bring challenges later in the production. If one can alter the production in the freshwater phase to obtain a more robust fish with better heart health, it will be better prepared for repeated handling at sea. Instead of viewing smoltification as an isolated period in the fish’s life we should look at it as a lap in a relay race.

**SALMON ON LAND**

One of the most common arguments for moving fish production onto land or into closed fish cages at is that escape, mortality and health challenges will be reduced. Even if we move fish from the sea and into tanks on land, they are not sheltered from diseases. Producing fish in a closed system brings with it very different health challenges than production in open cages at sea. Even if we picture we have full control of the water quality in a closed system, these systems have problems with for instance hydrogen sulphide, which can lead to acute and a very high mortality rate. In open cages at sea the volume is 98% water, 2% fish. This is impossible to follow up on land, and the fish will have significantly less space than at sea.
FISH WELFARE IN FISH FARMING

LICE AS A SUPPLIER OF TERMS FOR FISH WELFARE
Lice as a supplier of terms for fish welfare

The greatest welfare challenges in fish farming today are all linked to the handling of lice, and the mortality rate is too high both in salmon and cleaner fish, something which the industry itself must take responsibility for. The fish farmers have consideration for their stocks, but simultaneously they are challenged by requirements and regulations from the authorities that sometimes clash with fish welfare.

In optimal production we want the fish to have peace to grow after it is transferred to sea. Fish that are handled as little as possible have good feed utilization and may be ready for harvesting already after 12 months in the sea. Unfortunately, the sea lice situation along the coast is challenging and requires that measures are set in. As there is no efficient medical lice treatment available in the market today, methods including hot water, hosing, and scrubbing to remove the lice have emerged over time. These methods are called non-medicinal methods and can lead to stress in the fish. Such non-medicinal methods may go on for days at the same location and almost always implies the need for crowding and pumping the fish as it must be transferred to a barge or well boat for treatment before it is pumped back into the sea. This kind of handling is tough for the fish.

Fish who are exposed to tough handling will be stressed. Stress over time leads to a weakened immune system. A consequence of repeated handling is frequent detection of infectious diseases, reduced appetite and wounds, cuts and scale loss. These non-medicinal methods have been severely criticised for not considering animal welfare. Also, the methods have not been properly tested on a small scale before being utilized in commercial operations. In 2019, the Norwegian Food Safety Authorities announced a ban on thermal delousing over 28 degrees, aiming at a phase-out over two years. The reason for this is there has been detected injuries on the fish that can be linked to delousing in temperatures above 28 degrees.

It turns out several of the methods for delousing reduce fish welfare, but today’s methods are not illegal. What are the alternatives if one is to comply with the lice limit?

The development of non-medicinal methods is in itself a positive contribution to the fight against lice. But even so, both cleaner fish and salmon have become our guinea pigs, where testing has been largely based on empirical data. There have been cases of extensive acute fish mortality and long-term effects we are just starting to see the outline of. Reduced eyesight, behavioural changes and death are observed after the use of non-medicinal delousing methods.

At first glance, the story of the cleaner fish seemed to be some kind of Kinder Surprise where the cleaner fish would save the salmon from medication and unnecessary handling and create some sort of harmonic symbiosis...
In farming of salmon and trout, wrasse and lumpfish are used to keep the salmon lice under control. As a common name, they are called “cleaner fish”. In 2019, about half of the cleaner fish that were used for sea lice control, were farmed. These were mainly lumpsuckers and ballan wrasse. The rest were caught wild.

In the wild, lumpsuckers thrives on deep water during the winter, but goes up to shallower water in summer to spawn. It has a short, round body and small fins. On the abdomen, the abdominal fins are transformed into a suction cup, which means that lumpsuckers often adhere to any kind of substrate. The lumpsuckers are sought after as cleaner fish throughout the whole country because they are active even at lower temperatures.

In the case of the wrasse species ballan wrasse, corkwing wrasse, rock cook and goldsinny wrasse are extensively used as cleaner fish. Wrasses are active in the summer but goes often into a hibernation-like state in crevasses or between rocks in winter when the temperature drops. The ballan wrasse is robust and is the largest of the wrasse species and most used as cleaner fish of the wrasses. It is a sought-after species that can have similar size as the salmon short after sea transfer and grow along with the salmon the entire production cycle.

- Ballan wrasse (*Labrus bergylta*)
- Corkwing Wrasse (*Symphodus melops*)
- Goldsinny Wrasse (*Ctenolabrus rupestris*)
- Rock cook (*Centrolabrus exoletus*)
- Lumpfish (*Cyclopterus lumpus*)

Refer to page 25 for an overview of the different fish species.
in the fish cages. The intentions were purely good. Unfortunately, the cleaner fish are not well suited for a life in a fish cage together with salmon and trout. In our fight against the salmon louse, the cleaner fish has become our Japanese kamikaze pilot. Hardly any of them comes out of it alive. Is it right of us to sacrifice the cleaner fish in order to “save” our precious salmon? If the answer is no, what alternatives are we left with when it comes to lice treatment?

It is important and right to produce food, but is it acceptable to produce millions of cleaner fish simply for them to clean the salmon? In 2019, 49.3 million cleaner fish were placed into Norwegian fish cages\textsuperscript{15}. Of these about half are farmed while the rest are caught in the wild. Cleaner fish were not initially fed in the cages because of the notion that it would eat more lice without additional feed. The result was that for years cleaner fish were set out in cages without sufficient access to nutrition. After emaciation was strongly emphasized as the reason for mortality after fish were placed in sea cages, we now know that the cleaner fish need their own food and feeding stations. The species of wrasse used as cleaner fish are all naturally indigenous. This means they need their own home and shelter to thrive, which they are now largely provided with.

Contrary to what many believed of cleaner fish and their eating habits, the salmon louse is actually more of a snack to them. So, while “real” cleaner fish live in a symbiotic relationship with other species, the cleaner fish utilized in aquaculture needs to learn to eat lice. Wild-caught cleaner fish pose a challenge to both the industry and local ecosystems. It represents a real risk for the spreading of diseases\textsuperscript{16}. In addition, it is not used to eating pellets or lice as its main diet. Both lumpfish and wrasse species become sexually mature when they are 2–3 years old, and in the wild they can reach the age of 20 years or more. Excessive overuse may lead to collapse in these species along the coast.

All handling of salmon and trout are bad news for the cleaner fish. Crowding, pumping, and treatment are all operations it handles badly, and the mortality rate is high. A high mortality rate and frequent outbreaks of diseases in cleaner fish is a clear signal it is kept in an environment it struggles to adapting to.

In principle, cleaner fish should be separated before a non-medicinal delousing, but the Aquaculture Management Regulations allows for the fish to remain if it is better for the fish’s own welfare. Consequently, it will easily turn into a weighing of expenses and benefits if cleaner fish is to be separated. The Norwegian Food Safety Authority states clearly that today’s delousing methods are straining to the cleaner fish and therefore needs to be terminated. The reason so many cleaner fish are still going through non-medicinal treatment is that it is difficult to separate them from other fish in groups of hundreds of thousands of salmon.

In 2010, the Norwegian Food Safety Authority presented a report after the inspection campaign that was carried out during 2018–2019\textsuperscript{17}. The most important finding was the industry’s common problem with many cleaner fish “disappearing” throughout the production. About 40% of the cleaner fish that are set out were later registered as dead, but there is probably a large number of unrecorded cases. We also have little knowledge of what the cleaner fish die from and measures to prevent similar issues.

In the risk report for Norwegian fish farming for 2019, it is pointed out that strong currents and high temperatures contribute to weakening the fish’s welfare further. Salmon and trout are built for speed and continuous swimming, while both lumpfish and wrasse thrive better in conditions with weaker currents and possibilities for hiding in kelp forests and crevasses. In other words, conditions you do not find in a fish cage.

We should mention that cleaner fish welfare in fish cages is improving, and many industrial
actors are working on improving the health situation for both lumpfish and wrasse through improved breeding programmes, vaccines and feed. There is also a stronger focus on improving the conditions for cleaner fish during operations and handling of salmon. Still, about 150,000 cleaner fish die in Norwegian fish cages every day because of emaciation, bacterial diseases and insufficiently adapted living conditions. Cleaner fish are in fact the recipients of most of the small quantity of antibiotics being used in Norway today. Based on the knowledge we have today, should we rethink the use of cleaner fish as a remedy against lice?

MEDICATION OR HANDLING – WHICH ENSURES BEST WELFARE?

The salmon louse sets the premises for much of the activities within aquaculture today and is to a large extent driving the technology development in the industry. New fish cage constructions, digital monitoring tools, camera sensor technology, genetics and feed are just some examples of areas where the louse is a driver for the technology development.

This has however not always been the case. Bacterial diseases were almost crushing the industry in the 1980s and 1990s. Without the development of efficient vaccines, the industry would not be as profitable and sustainable as what we see today. Since the “peak year” in 1987, the use of antibiotics in Norwegian fish farming has been reduced with 99%. Of the small quantity being used today, most prescriptions are made for cleaner fish, not salmon or trout.

After barely two decades where medication has been the first choice for lice treatment, our current medicinal toolbox is empty. The louse has an enormous adaptive capacity and a reduced sensitivity to all medication with marketing licence in Norway today. One could be tempted to abandon all use of medicament in louse treatment for several reasons. As long as we are treating groups of fish, not individuals, there is always a chance that lice will survive. This does not only apply to medicinal treatment; the lice can also become more resistant to freshwater, hosing or hot water. The individuals who survive are most likely those with a higher tolerance than others and who will transfer these qualities to the next generation. This is a race we can hardly win. As long it is no “effort” for the louse to maintain the resistance mechanisms against different medication or measures, it will be able to maintain this resistance even if the industry halts the use of these measures for several years.

Some fish producers oppose the use of medication in production. After repeated newspaper publicity it is natural to feel uneasy when reading headlines like “fish farmers dump tons of chemicals directly into the ocean”. The truth is that these so-called chemicals is medication prescribed by a veterinarian or fish health biologist. When they are used, safety and considerations for both fish and environment are well documented and approved by the Norwegian Medicines Agency. From an animal welfare perspective, it is important to have access to medication for treatment of diseases and against parasites if other treatment is impossible.

A restrictive use of medication benefits the industry as a whole. Approval of new types of medication has long held a restrictive function in the industry. There should never be any doubt that new types of medication are safe to use both for the environment and for animals and humans, and enormous amounts of documentation are required to secure this. An administrative challenge is the lack of a dedicated group within the Norwegian Medicines Agency working with approval of medication for fish and aquatic animals. We still experience a need for more resources to handle incoming applications.
↑ **Goldsinny Wrasse** (*Ctenolabrus rupestris*)

↑ **Corkwing Wrasse** (*Symphodus melops*)

↑ **Ballan wrasse** (*Labrus bergylta*)

↓ **Lumpfish** (*Cyclopterus lumpus*)

↑ **Rock cook** (*Centrolabrus exoletus*)

Illustration: Stein Mortensen / Salmon Group
The fish farming industry is subject to a complex administration regime. It complies with nine central sector-specific acts: The Aquaculture Act, Food Safety Act, Animal Welfare Act, Pollution Control Act, Nature Diversity Act, Outdoor Recreations Act, Harbour Act, Water Resources Act and Planning and Building Act, in addition to six departments, six Government agencies plus county administrations and municipalities. The Norwegian Veterinary Institute and Norwegian Food Safety Authority issue important guidelines for how the industry should handle animals. Simultaneously, the fish farmers must comply with all the other acts and interests mentioned above. With all the competing needs, or requests from different parts of the administration, it is not always given that this complex whole is being dealt with the optimal way. The term “tragedy of the commons” has been used to describe this aspect also in farming of salmon and trout in Norway. \(^2\) In addition to sea lice, the handling of PD and location management constitute the greater challenges for fish welfare. Short-term solutions for the individual producer are not necessarily what is best for the industry or fish welfare in the long term.

For instance, there is reason to believe a more dynamic lice limit would benefit fish welfare. Today’s limit is fixed at a very strict number by the authorities, and it is absolute. This means fish are sometimes treated against lice to meet the requirements even when one knows the fish will be harvested in just a few days. This serves as an example of how fish are caused unnecessary pain and suffering simply to comply with rigid regulations and how short-term solutions do not benefit neither the industry nor the fish in the long term.

A higher level of cooperation and coordination across the sector’s authorities could make the implementation of changes and measures more efficient and thereby establish better solutions. On 23 March 2020, the Minister of Fisheries and Seafood Odd Emil Ingebrigtsen informed of a reorganization within the department that to a greater extent emphasizes the significance of aquaculture and takes the industry’s needs into consideration. The fisheries and aquaculture section of the Ministry of Trade, Industry and Fisheries will be divided into separate sections for fisheries and aquaculture respectively.

ZONE COLOURS AND MOTIVATION FOR SOUND PRODUCTION

The traffic light system was established in order to regulate growth in the fish farming industry, with the object of securing environmental
Navigating through legislations and the administration is a challenge for the industry. Nine sectoral laws, six ministries, six state agencies, county councils and municipalities must be considered at all times.
sustainability and predictability. In 2015, when the proposal of a traffic light system was introduced, the idea was it would help the industry to reach its goal of producing 5 million tons yearly by 2050. Today we produce approximately 1.3 million tons a year. Norway is divided into 13 production zones, and every zone is given the colour red, yellow or green, depending on the level of impact from salmon lice on wild salmon in the 13 zones. If the impact from lice is too extensive, the production zone is defined as red and every producer must decrease production with 6%. Likewise, in the green zone one is allowed to increase production with 6%. Yellow status means the situation is “frozen” where one neither has to decrease or is allowed to increase production.

The traffic lights were switched on for the first time February 4 2020. Fish farmers in nine of the 13 zones were given the green light. Two zones were given the yellow light: Karmøy to Sotra and Andøya to Senja. Two zones were categorised as red: Nordhordland to Stad and Stad to Hustadvika.

There is a positive intention behind the traffic light system, namely that consideration for the environment should come first. Reducing the number of available salmon louse hosts in the fish farms will probably reduce the impact on wild salmon. The fish farming industry holds a social responsibility in managing our natural resources and must take sustainability and critical levels into consideration. It is established that we shall have robust populations of wild salmon in Norway. There is full agreement on this between all parties, also seen from the fish farmers’ point of view. Still, the impact from salmon lice on wild salmon is one if many factors that indicate whether the production is sustainable or not. For instance, the traffic light system does not take welfare in the production into consideration. One might have a positive situation concerning lice and low impact on wild salmon but still inadequate fish welfare in the fish cages. It may seem the traffic light system has been established as a kind of compromise to please the environment and wild salmon advocates as opposed to viewing the salmon production as a whole. Production of fish in open cages along the coast is a complex process, but it should be possible to entertain more ideas than one simultaneously.

As mentioned earlier, most producers use the operative welfare indicators to document and monitor the welfare situation at the fish farms. Assembling these could make it possible for those who uphold satisfying welfare standards in their production to benefit from this even if the zone colour indicates otherwise. This will stimulate further efforts concerning welfare and be perceived as a less random practise. This way positive efforts will be rewarded, but since the number of lice is an indicator of fish welfare, lice impact will still be taken into consideration, but at the same time production would be turned in a more sustainable direction.
Fish welfare on top of the agenda

Fish farmers all along the coast measure up to their responsibility, putting in an effort every day to make sure their stock is doing well in the sea. They have a sincere wish to look after their fish in a manner that produce healthy and tasty food, in line with ethical frameworks for animal husbandry and the regulations that apply. The link between good animal welfare and good financial results is evident and well documented. Consequently, it is also in the fish farmers’ commercial interest to secure the best possible health and welfare for the fish.

Any kind of biological production is a complex operation. To which extent one succeeds depends on many factors that often lie outside the fish farmer’s control. Like the instance in Northern Norway in the early summer of 2019 when healthy fish were affected by algae bloom that caused mass death. This the fish farmers could not have foreseen.

The fish farmer’s responsibility is not limited to just securing the fish’s wellbeing. The environment where the fish is bred must also be considered. The industry is run on common land, and with that follows a great responsibility.

During the industry’s first fifty years one has worked systematically, by trying and failing and through research, to understand how to include both animal welfare and biology and environment in the best way. Experience, knowledge and new technology will provide the opportunity to handle these issues increasingly better in the future.

How can we be sure that we give our animals the opportunity to live a good life? In biological production we might never get a definite answer, but the fish farming industry still needs to demonstrate that this is a matter we take seriously. We need to show it through actions and a willingness to enter into the difficult discussions about it.

A lot of good work is done in this field by many producers of salmon and trout. The same is true for research institutions and administration – the administration regime the industry is subject to. This we need to emphasize and communicate more strongly. The globe needs more food.

The UN encourages us to view the entire food system as a whole, both locally, nationally and globally. Then maybe it is also high time for sea- and land-based animal husbandry to learn from each other and work and think together to a larger degree? The same factors are central to both: how health, welfare, sustainability and competitive ability are linked.

Fish welfare is absolutely on top of the agenda in the fish farming industry. We need to discuss the challenges we are facing; we must dare to address the difficult questions and we must have the courage to make demands on our own industry. This way we will all be better, and we lay the groundwork for a best possible animal husbandry.
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