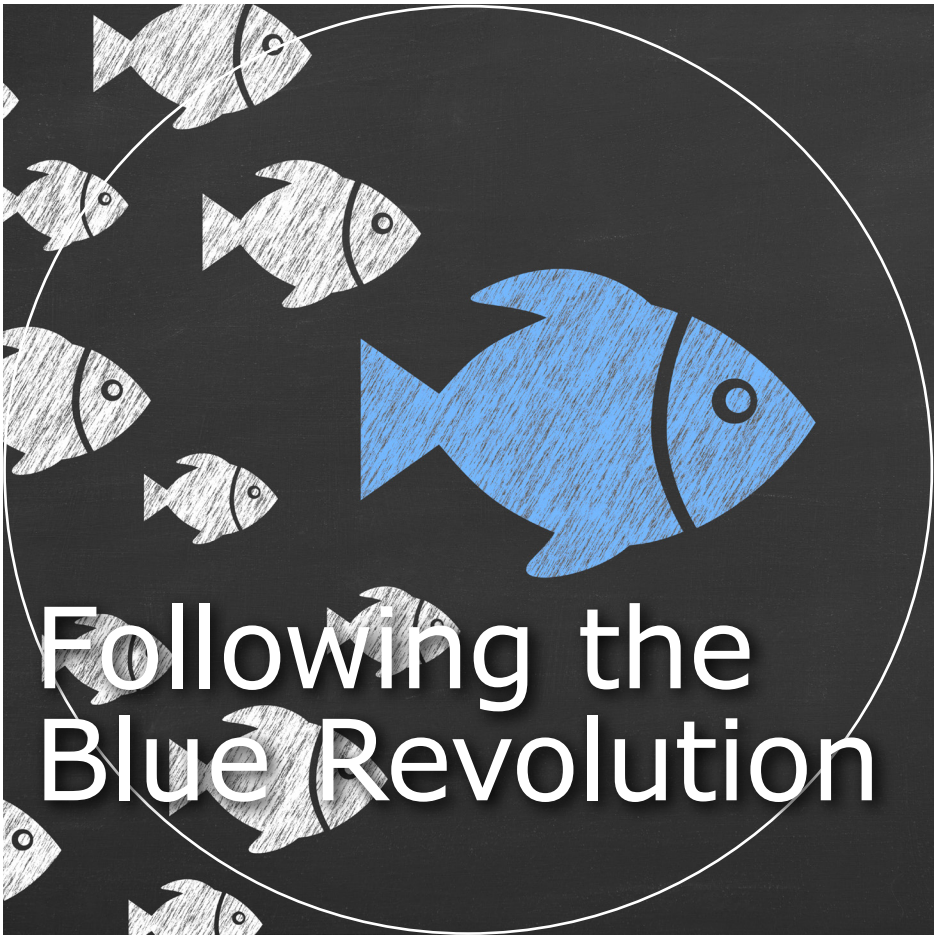

Following the Blue Revolution

Dr*ir.* G.F. Wiegertjes

Inaugural lecture upon taking up the position of Professor of Aquaculture and Fisheries at Wageningen University & Research on 16 May 2019

WAGENINGEN
UNIVERSITY & RESEARCH

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Following the Blue Revolution

Rector Magnificus, colleagues, family and friends,
We are here in the Aula where five years ago I also stood in front of you, a young and innocent personal professor, introducing you to the details of fish immunology and fish health. At that time, I took you on a journey under water and let you experience life as a fish in aquaculture where your health would be threatened by dangerous bacteria, viruses and parasites. I explained the building blocks that underpin immune-enhancement and vaccination, both excellent interventions available to help you as fish in aquaculture, fight infectious diseases and maintain fish health.

Today, again I stand in front of you, now as head of the Aquaculture and Fisheries group, in short AFI, still young but less innocent. Today, I will take you on a journey above water and let you experience life as a person dealing with fish, fish from aquaculture and fisheries, where your own human health could be threatened by under-nourishment and shortage of animal protein, or omega 3 fatty acids. But luckily you can be saved, saved by the Blue Revolution.

Fish proteins will feed the world

We are with many, many that sometimes live in low-income and food-deficient countries, where fish often is the cheapest and most accessible form of animal protein (*Figure 1*). Worldwide we eat, per capita, some 20 kg of fish. In the Netherlands we eat much less fish. This is not good. You could almost refer to us Dutch as bad, bad people. But if we forget about us for a second: at present, aquaculture and fisheries provide 3.2 billion people with 20% of their animal protein. And the sector's contribution is growing: if we aim to feed a growing world population that may reach 9.5 billion people in 2050, we need to produce more fish protein.

Figure 1. The 2030 Agenda for Sustainable Development provides a shared blueprint for peace and prosperity for people and the planet. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership.

We are with so many that, to meet this future demand for fish protein, production will need to double or even triple. The scale of this challenge requires research innovations across the whole spectrum of fisheries and aquaculture. Right now, it is capture fisheries that supplies most of the fish consumed in much of the developing world but, at the same time, we realize that the sustainable exploitation of these natural stocks is reaching a maximum. I refer to the latest 'State of World Fisheries and Aquaculture', or SOFIA report when I state: it is aquaculture that will have to be responsible for the continuing and impressive growth in the supply of fish protein for human consumption (*Figure 2*). This means the increase in consumption of fish protein can best be realized by a further expansion and refinement of aquaculture. And for this we need the Blue Revolution.

So: what is the Blue Revolution? Since we are part of the internet generation, at least some of you in the audience here, I looked it up for you. The Blue Revolution refers to the time of intense growth in the worldwide aquaculture industry starting in the mid 60's and ever-lasting since. And we are in the midst of the Blue Revolution. For your reference: there was also a Green Revolution, which lasted from the 60's to the 70's and refers to the time of intensive growth in the worldwide agricultural industry. The Green Revolution we at Wageningen played a central role in and we have been rightfully proud of this for a very long time, although to date we are

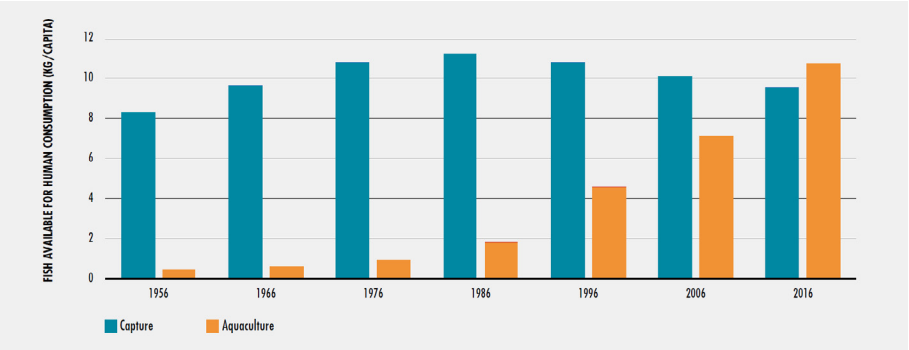

Figure 2. Relative contribution of aquaculture and capture fisheries to fish for human consumption over the last 60 years (Food and Agriculture Organization of the United Nations, FAO). From: State of World Fisheries and Aquaculture, 2018.

learning to circulize its outcomes. Now I am aware that circulize is not a verb, but I do think it should be; I will come back to this later. Some compare the Blue and Green Revolution by stating that the world has a need for safe, healthy and tasty food, produced in a sustainable and efficient way and that seafood has an enormous potential to do this. Especially once you realize that 70% of our globe is covered by water whereas right now only two percent of the world's food supply comes from the ocean. You will have to agree with me: the Blue Potential is enormous (*Figure 3*).

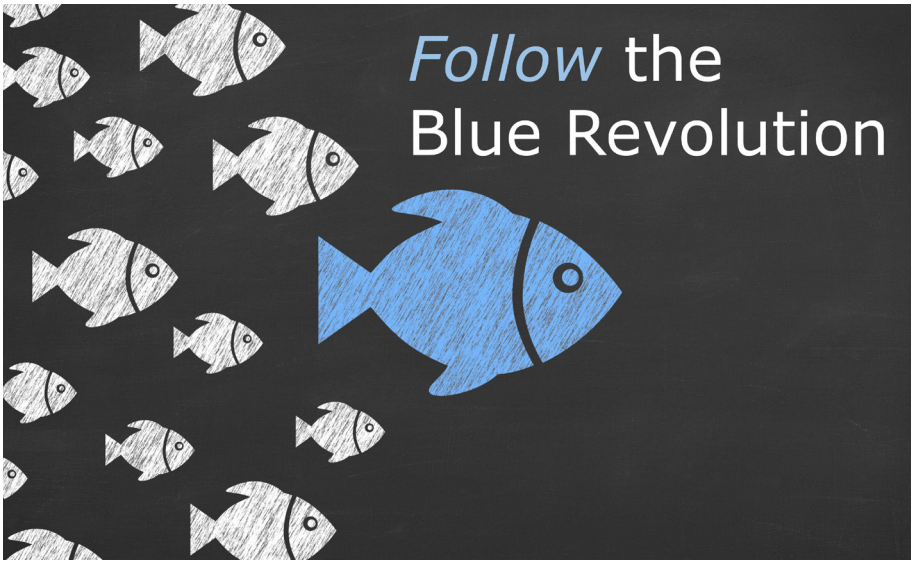

Figure 3. Follow the Blue Revolution.

So: what is Aquaculture? For that one there was no need to look it up. Aquaculture refers to all forms of culture of aquatic animals (for easy reference please think of fish, shrimp, mussels, oysters) and also plants (think of seaweed) in marine, brackish, or fresh waters. As with so many things to date, in China lies the origin of aquaculture, where it has been practiced with fish grown in freshwater ponds for thousands of years. But over the last 50 years or so aquaculture spread quickly around the world and many species of freshwater and marine organisms are now being cultivated. And these species are grown preferably in aquaculture systems where they can be harvested at high but sustainable rates without causing unacceptable environmental damage. Preferably taking circulized approaches. I said it before: to circulize should truly become a verb.

We at AFI we are true followers of the Blue Revolution because by research and development we remain at the forefront of technology such as on-land recirculation systems, systems that are massively transforming some of the current day aquaculture industry practices. So: let's ride the waves and make it clear to everyone; aquaculture is here to stay. To make it more easy for you to remember this, I would like to take a moment and refer to our University's logo. Not yet known to all of you, the growing importance of the Blue Revolution for our University has recently been adopted and displayed in our new logo (*Figure 4*). And by our improved gowns that now display a blue stripe next to a green one. Please join me for the next few minutes in exploring the potential of aquaculture to improve the quality of life.

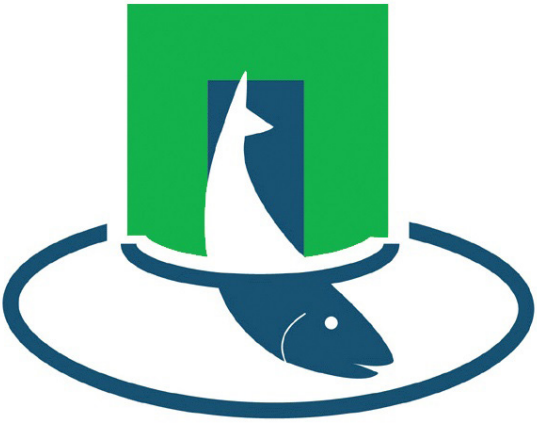

Figure 4. Provocative new logo of Wageningen University & Research displaying the importance of aquaculture and fisheries to the Wageningen research agenda.

We@AFI we fish the world

We are scientists at the Aquaculture and Fisheries group, and we study both aquaculture *and* fisheries, yet you may have noticed that so far I mainly emphasized aquaculture. I will take a moment to make up for this. We @AFI are world players. This is not megalomania but sometimes bare necessity when it comes to other parts of the world than our Western part. And this does influence our choice at AFI whether to study aquaculture or fisheries as the protein source.

As I just mentioned, right now it is capture fisheries that supplies most of the fish consumed in much of the developing world. At AFI we are aware that strategic investments in fisheries research will sustain the strength of local fishery systems. Paul van Zwieten of the AFI group is partner in an international project on small fish and food security. Eating whole small fish is presently under-valued, whereas whole fish supply vital nutrients for millions of people in Africa. This inter-disciplinary project aims to study the nutritional benefits of eating whole small fish in Lake Victoria and other places (*Figure 5*).

Figure 5. Whole fish can supply vital nutrients for millions of people in Africa. Fisheries on small fish are undervalued in the global food discourse. Their local use as fishmeal in animal feeds, including for aquaculture, is increasingly competing for these resources.

This approach aligns very well with the interests of WorldFish, an international research organization that harnesses fisheries and aquaculture to reduce hunger and poverty. For example, one of their Fish programmes addresses small-scale fisheries and the policy and management changes necessary to improve resilience and productivity. This touches on the discipline of my colleague Professor Simon Bush at the Environmental Policy (ENP) group, with whom we would like to sustain the present long and fruitful relationship.

Figure 6. In nutritious-system ponds the potential of the pond ecosystem to mineralise wastes and produce natural foods is exploited. This innovative feed-the-whole-system concept will make pond farming more sustainable and predictable.

We are even more heavily involved with a second programme at WorldFish, which embraces the 'nutritious pond' concept, a concept of stimulating microbial-mediated use of wastes in small ponds (*Figure 6*).

Nutritious pond feeds are formulated by considering not only the needs of the cultured fish species, but also the needs of the pond's ecosystem. In the feed, proteins are partially replaced by carbohydrates, reducing feed costs and minimizing pollution. Thereby, such well-functioning pond ecosystems integrate pond farming in a circular manner. It is a shame that pension is finally calling Roel Bosma but luckily Marc Verdegem of the AFI group is validating this feed-the-system concept to develop a technology package applicable for small-scale fish farmers. He is the Senior Expert associated with WorldFish in countries like Bangladesh, Indonesia, Egypt, Zambia and more.

Our home is The Netherlands

We may be world players, but we live in the Netherlands, where locally the aquaculture sector keeps on developing, where the culture of eel, turbot and yellowtail kingfish in recirculation systems is a success. During an early interview for the Dutch Society for Aquaculture as the new head of the Aquaculture and Fisheries group, I was asked what we at AFI could mean for the local fish farmer in the Netherlands. The local fish farmer who would be interested in high feed conversions and low operating costs of recirculating systems, and I said: "nothing". This was meant to be an overstatement and so was taken as such. Many of the people working in the Dutch aquaculture industry have been trained at AFI and we are rightfully proud of them. Yet, with so many alumni united in platforms such as the Dutch Aquaculture Experts we also like to emphasize that we are a university, and we do see it as our mission to also address scientific research and education beyond daily practice.

As I said: we are in the Netherlands and a sector traditionally most important here is fisheries, well-known for the herring fishery which, because of the apparent Flemish invention of gibbing or curing (haringkaken), experienced a tremendous growth by the late 16th century. Already in these early days the fisheries industry was actively supported by the Dutch government which, and you may be aware of a more recent example, is a practise that has remained active ever since.

Wageningen Marine Research is an applied research institute part of the Animal Sciences Group which provides advice on the sustainable management and practical knowledge on especially marine and coastal areas. For easy reference: think of the North Sea as a place where we meet with not only my colleague Professor Tinka Murk from Marine Animal Ecology (MAE) but where Tammo Bult, director of Wageningen Marine Research and myself swim together with the help of Jan Jaap Poos of the AFI group as recently added young connector.

But there are more fish in the sea. And in fresh water. Up to some 17% of the total surface of the Netherlands consists of fresh water and fish are a great indicator for the ecological state of our large river systems. For easy reference, imagine the presence of numerous shiny salmon or caviar-carrying sturgeons in the Rhine river. We at AFI are in the great position that we can offer a neutral platform to many different organisations dealing with inland fisheries, including fishermen and organisations for water management and recreational fisheries. Connecting with the latter organisation that has over half a million members allows for approaches based on citizen science, to register inland catches as ecological indicators and better connect the public with the management of fish in our inland water systems. This idea is supported by last

year's part-time appointment at AFI of Wageningen Marine Research freshwater expert Joep de Leeuw, and backboned by the expertise of Leo Nagelkerke at AFI, whose understanding of changes in natural and invasive fish communities is unparalleled. I strongly believe this platform has the possibility to create an ecological Blue Revolution of its own and deserves a seat at the scientific table.

Recirculating Aquaculture Systems (RAS) are here to stay

Now let's go back indoors for a second and return to aquaculture. Remember: we need to feed 9.5 billion people in the year 2050 and to do so aquaculture production will need to double, or even triple. How will the Blue Revolution achieve this? We are true believers in closed so-called recirculating aquaculture systems or RAS with Ep Eding at AFI as founding father and natural fertilizer of these systems. The technology allows for intensive culturing of fish while minimizing the use of natural resources, such as water and energy. The constant culture conditions create a technical but almost homeostatic solution for the production of fish protein in the midst of the Blue Revolution. In combination with good hygiene, these systems are rapidly becoming a first choice for much of the aquaculture sector and are being implemented globally for many fish species (*Figure 7*). I foresee AFI sustaining its leading position on understanding these aquaculture systems, ideally backed up by local living labs to also perform research at industry scale.

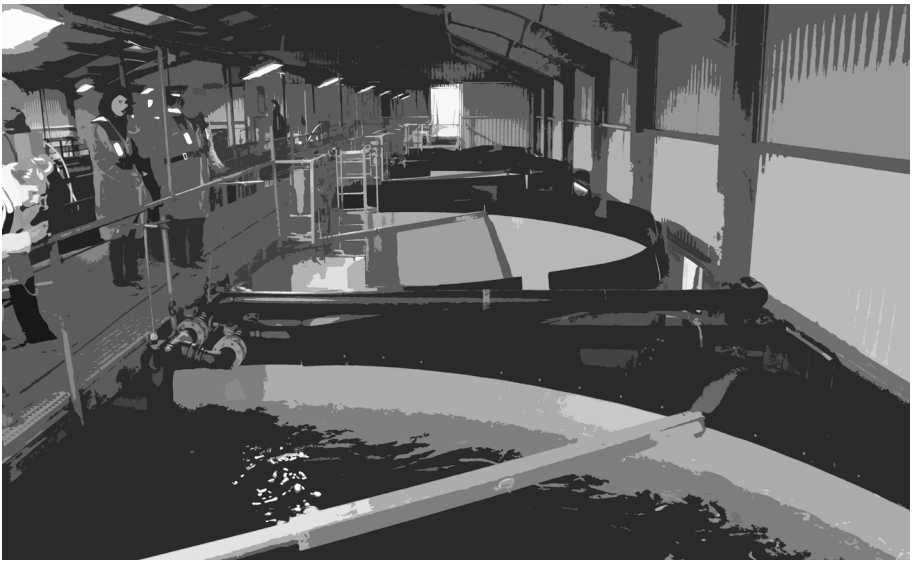

Figure 7. Recirculating Aquaculture Systems (RAS) allow for intensive culturing of fish while minimizing the use of natural resources, such as water and energy.

Figure 8. Diet composition, including protein and carbohydrate content, energy, but also physical properties of fish feed are crucial determinants of the fish' metabolism, whereas regulation of feed intake and waste production determine dissolved oxygen and thus critically influence growth performance and health.

With these words I would like to take this opportunity to advertise our open tenure track position on aquaculture production systems; to those listening, either in this room or via WUR-television: if you are a systems expert who understands the inter-relationships between water quality, ecosystem and fish biology, if you have a strong knowledge of aquatic production systems, if you are interested in the effects thereof on the fish host, if you have an open eye for the needs of the industry, if you have a PhD in Biology, Animal Sciences or alike, and if you have post-doctoral experience then please raise your hand or otherwise indicate your interest after this inaugural address. If you are triggered by my call please refer to vacancy number AFI-007a in English, the natural language of our International University. We are open to application by pro-active candidates, young or old, and would even accept present or former directors dying to return to research and education.

Fish Nutrition & Health in aquaculture production systems

We are convinced that fish in aquaculture are heavily dependent on nutrition, which plays a determining role in the success of the Blue Revolution. Diet composition, including protein and carbohydrate content, energy, but also physical properties of fish feed are crucial determinants of the fish' metabolism (*Figure 8*). Regulation of feed intake and waste production determine dissolved oxygen and thus critically influence growth performance and health. Johan Schrama at AFI is without doubt, one of World's leading fish experts in nutrition and when not at the phone with the feed industry, I am pleased to say he is my right hand at AFI.

We are also convinced that many aspects of fish nutrition provide key parameters when it comes to fish health. As I already explained to you five years ago: a physiological key to fish health is the ability of the immune system to distinguish between own body cells and foreign organisms, such as viruses, bacteria and parasites. I am sure all of you still remember, but I will repeat: innate immunity comes into play very quickly as a defence mechanism, whereas acquired immunity refers to a slower but highly specific defence mechanism which, once developed, retains a long-lasting memory component and provides the biological basis to vaccination.

To date, we may routinely vaccinate many of our most-cultured fish species. But we also require a panel of enhancers of immunity to be incorporated in fish feed. Because such enhancers will help battle the development of antimicrobial resistance. They require innate immunity only, are not restricted by specificity and thus can work for many different pathogens at the same time, semi-specifically boosting fish health for prolonged periods based on trained immunity (*Figure 9*).

Those of you particularly interested in the subject of trained immunity, and you should be, then do come back to the Aula on June 14 to listen to the PhD defence of Jules Petit, who studied the working mechanisms of beta glucans as enhancers of immunity in aquaculture. Interestingly, this approach may not only work for

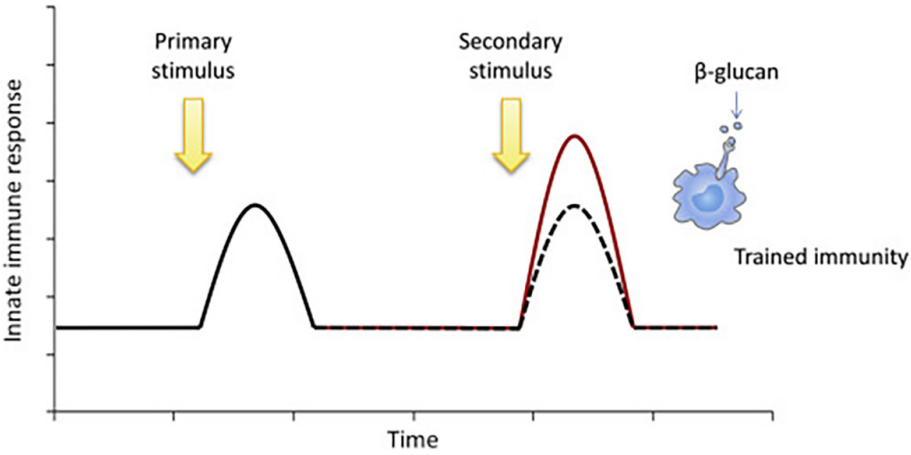

Figure 9. During certain infections or shortly after exposure to certain stimuli, innate immune responses can be primed to respond more strongly upon challenge with a second stimulus. Although this priming effect declines rapidly after the infection is resolved, the state of innate immune responses often does not return to basal levels after the infection, remaining enhanced through medium- and long-term reprogramming effects at the level of innate immune cells, defined as trained immunity. From: Petit and Wiegertjes, 2016.

intensive aquaculture systems such as those housing salmon, but also for less intensive pond systems housing tilapia or other fish species. Or for shrimp, which have no acquired immune system but are such an important species for aquaculture. For knowledge on fish health I myself can claim 25 years of expertise on fish immunology, built up during my time at the Cell Biology and Immunology group. At AFI, we are very much interested in building an applied immunology background supportive to preventive fish health. There are numerous exciting developments with an applied aspect such as those based on trained immunity, immuno-metabolism and also vaccination. Here, progress would be best achieved in collaboration with Sylvia Brugman, and with Maria Forlenza at the Cell Biology and Immunology group who is a leading figure in comparative immunology and fish vaccination and with whom I share a long-term and mutually beneficial working relationship that deserves a future.

Gills express it all

I started today by referring to my first inaugural address five years ago when I took you on a journey under water and let you experience life as a fish in aquaculture where your health would be threatened by dangerous pathogens. And continued my speech by promising that this time I would take you on a journey above water and let you experience life as a person dealing with fish, where your human health would be threatened by shortage of fish protein. The two, of course, are inter-connected.

We are humans, we are not fish. If this is not immediately clear to you, please do worry. We are scientists that work with fish which unlike us humans, use gills to breathe. At this moment I need to make a note for the purist biologists in this audience; all vertebrates including humans have a set of gills at some point in embryonic life, but obviously we humans do not develop gills later in life. Except maybe when you eat gillyweed. Just to be precise.

We are and always have been aware that fish gills are unique structures and well-known for gas exchange with the surrounding environment, extremely important for oxygen uptake and carbon dioxide transfer (*Figure 10*). This process is facilitated by the thin epithelial layers at gill filaments that form the basic functional units of the gill and create a typically large surface area. This has been well-known for many years. Yet, for a long time we ignored the obvious: it is this same large surface area so important for gas exchange that turns fish gills into a highly sensitive organ. Sensitive to water-borne infectious agents including bacteria, viruses but also larger gill parasites, many of which pose serious threats to fish health. But also sensitive to low water quality or high concentrations of suspended solids. Realize that fish swim

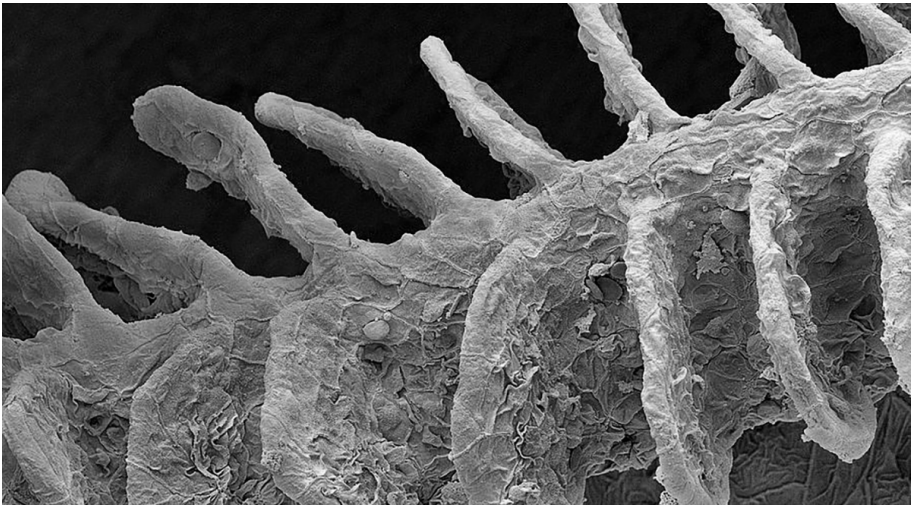

Figure 10. Fish gills are unique structures and well-known for gas exchange with the surrounding environment, extremely important for oxygen uptake and carbon dioxide transfer, a process facilitated by the thin epithelial layers at gill filaments that form the basic functional units of the gill and create a typically large surface area.

in their own poop. Or maybe you prefer not to realize this. No matter what, the large surface area of the gills is under influence of a large number of potentially pathogenic microbes. Now, coming back to ignoring the obvious: it is only since a few years that we recognize the presence of local gill-associated lymphoid tissue, which must be there to play a crucial role in the immune defence against micro-organisms in the water.

At AFI, we aim to study the interaction between nutrition and health in aquaculture production systems, be it recirculating or ponds. In a triangular approach to water quality, nutrition and health we consider the gills a central organ, crucially important for oxygen uptake and thus growth performance and feed efficiency and a focus point for fish health. Gill surfaces border mucosal and systemic communication, making gills probably the most interesting organ ever evolved apart maybe from the brain. Since fish have both gills and a brain this obviously makes fish the most interesting animal species that evolved on earth.

With this message I would like to advertise a second tenure track position on gill physiology and fish health: anyone listening and interested to become an expert in this area please indicate by raising your hand or sending an email naming vacancy number AFI-007b.

What follows *after* the Blue Revolution?

Right now, aquaculture-based losses due to infectious diseases can be enormous and cost the global aquaculture industry thousands of millions of euros each year. And have an impact on fish welfare that cannot be expressed in terms of financial losses. We are strong supporters of the idea that prevention is better than cure and we have been raised with the famous graph from the 1970's for Norwegian salmon farming, showing the decline in antibiotics coinciding with an increase in vaccination (*Figure 11*).

I myself have had leading positions in two major European projects aimed at developing preventive measures to mitigate fish diseases in European aquaculture and I myself have witnessed several great achievements on fish health that have helped the sector to further intensify. Yet, I was surprised to hear last year during my first meeting of the World Aquaculture Society that we should learn from lessons from the past, lessons from intensive agriculture of livestock, when it comes to handling the public's perception of intensification, infectious diseases, mortalities, animal welfare issues. Why was I surprised? Because having been scientifically born and raised in Wageningen, I grew up with ongoing debates on the merits and credits of intensive agriculture. I grew up with a debate that moved away from further intensification towards sustainability, robustness and most recently: circularity. Thus, I was surprised to hear the lessons from livestock had not already been learned and had not already come to the aquaculture sector.

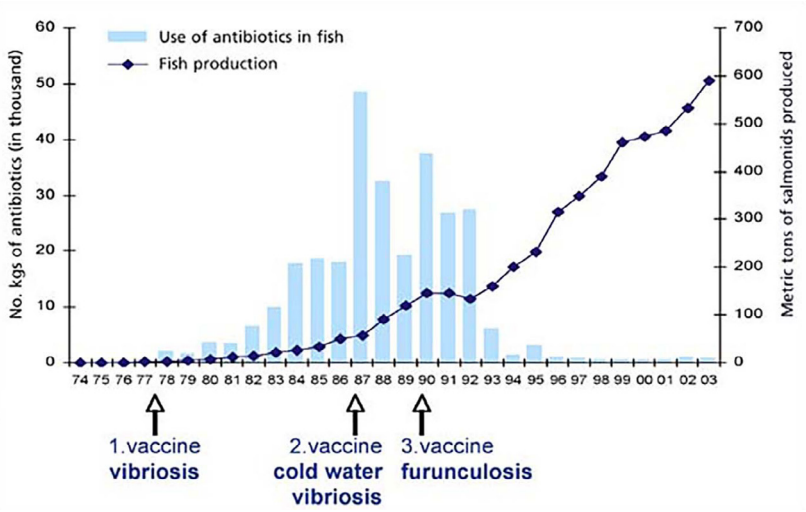

Figure 11. Effect of vaccination on the use of antibacterials in Norway 1974 – 2003. From: Håstein and Gudding, 2005.

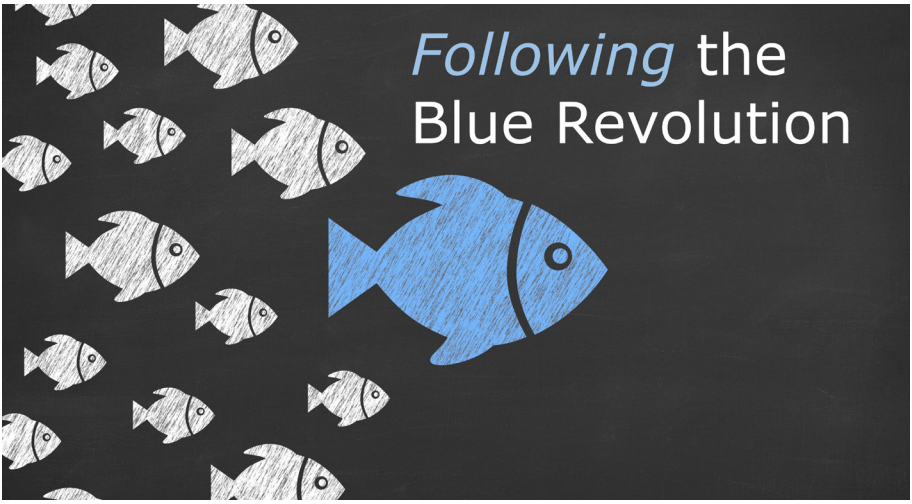

Figure 12. Following the Blue Revolution.

So far, I translated the title of my inaugural address as a straightforward "We follow the Blue Revolution". And I presented to you a fully one-sided view which some might like to address as the present. I also explained to you that we at AFI see it as our mission to address scientific research and education beyond daily practice. I therefore will now discuss with you what I think should be following the Blue Revolution (*Figure 12*), which could also be addressed as the future. It is here that I would like to support a circular approach to aquaculture, as presently being designed by my colleague professor Imke de Boer from Animal Production Systems (APS).

Together, we are taking the first small steps towards new concepts for the aquaculture systems of the future by trying to answer key questions such as: how much animal-source food, fish proteins, should we eat? It appears that livestock raised under the circular economy concept could raise a fair percentage of our daily protein needs. It is of great interest to see if we can take this concept further to also include aquaculture production systems. The key point for livestock is to no longer consume human-edible biomass such as grains, but mainly convert leftovers from arable land. Why should this be any different for aquaculture and for the consumption of fish proteins?

We are convinced that fish deserve their own circular approach, where the aquaculture industry needs to start feeding down the trophic levels and increasingly concentrate on biomass that is not directly eaten by humans. Because also

aquaculture should avoid feed-food competition. For easy reference: fish should not eat other fish but should feed on insects. Or fish leftovers. Or feed on omega-3 fatty acids from micro-algae, instead of feeding on oil from other fish. Or eat plants, or seaweed. This more balanced viewpoint than blindly following the Blue Revolution is one that I expressed on behalf of Wageningen when I attended the North Atlantic Seafood Forum in Bergen, Norway, two months ago, when I was asked to share my vision on sustainable aquaculture.

W-ARE can shape the Wageningen micro-climate

We at Wageningen University & Research, aim to contribute to global agendas such as the Sustainable Development Goals (SDGs) of the United Nations. Respecting earth's finite resources, we strive to fulfil the world's current and future needs for nutritious food by circular, healthy, resource-efficient agri-food systems, both on land and in the marine environment. I said this before, this is not megalomania but sometimes bare necessity when it comes to other parts of the world than our Western part. But how will we achieve this ambition here at Wageningen for the aquaculture and fisheries research area? We cannot do this alone. Our fisheries research may be well organized at Wageningen Marine Research but our aquaculture research is not equally well organised. Why not? Over the last 25 years, owing to its own success, the research area of aquaculture has matured and specialized. In other words, aquaculture has grown larger than the focus of single persons or single chair groups.

It is now time for me to explain why I started at least 25 sentences with "we are". And showed you many pictures of people. It is my opinion that at Wageningen we have vast opportunities for internal collaboration and international visibility, but only if we properly unite our people in a true 'One Wageningen' effort. This could easily be achieved via a platform named "Wageningen - Aquaculture Research & Education abbreviated as", and it may no longer come as a surprise, W-ARE (*Figure 13*).

Figure 13. Provocative new logo of Wageningen University & Research also displaying the abbreviation for 'Wageningen Aquaculture Research & Education, or W-ARE.

W-ARE should show the collective effort of many researchers at Wageningen and should accommodate the much-needed specialization. By doing so, W-ARE will prevent fragmentation of the aquatic domain within Wageningen. It should consolidate and improve our international visibility in the aquatic domain and with its large research potential, W-ARE should substantiate Wageningen as a major player in the aquaculture world. W-ARE should include natural partners, for example those that we already share research with, with excellent examples being professors Hans Komen and Martien Groenen from the Animal Breeding and Genomics (ABG) group with whom we share research on immuno-transcriptomics, but also Cell Biology and Immunology (CBI) on intestinal inflammation and vaccination, Farm Technology (FTE) on recirculating systems, Marine Animal Ecology (MAE) on fish migration in large river systems, and more. The European Community once chose not to set borders for Europe and I would like to follow this successful example of economic stability and peace, until we may be faced with our first exit hopefully many years from now.

So: how to realize the bonus of W-ARE? I like to picture W-ARE as an archipelago cluster that together is more than a collection of scattered islands but instead a well-known island group (*Figure 14*).

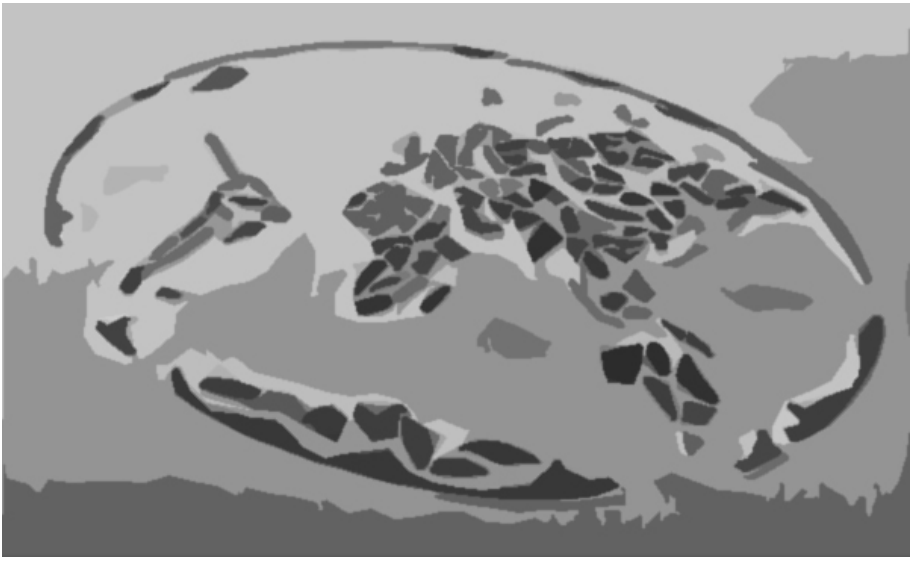

Figure 14: Visualization of Wageningen – Aquaculture Research and Education (W-ARE) as an archipelago cluster of islands.

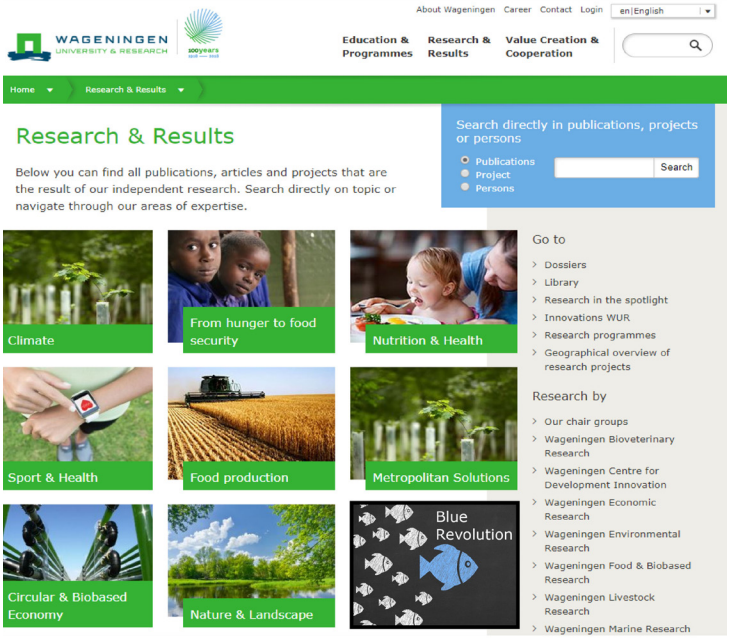

Figure 15. Provocative screenshot from the Wageningen 'Research & Results' website with all publications, articles and projects that are the result of our independent research. The website would allow for searches on aquaculture-related groups and topics and navigation through the areas of expertise of Wageningen University & Research.

I like to picture a professional website portal that highlights the research results of our own Blue Revolution at Wageningen. A portal that would become important to not only show our research highlights but also our education programme, joint initiatives, news, our unique Aquatic Research Facility so well directed by Menno ter Veld and much more. I have been promised full support by the Rector to take the lead in the formation of W-ARE and I am happy to say we are ready to fill the obvious gap on the website depicted here (*Figure 15*). I like to imagine W-ARE as an online platform where one wants to be seen and a portal which outsiders want to see, because it provides them access to Wageningen - Aquaculture Research & Education.

Explicit to the abbreviation of W-ARE is education. Within Wageningen University the organisation of education efforts on aquaculture and fisheries is largely embedded in the programme of the Master of Aquaculture and Marine Resource Management, or MAM. MAM aims to train academic professionals in the field of sustainable use, conservation and restoration of marine and aquatic ecosystems and

resources. After having heard most of my inaugural address it should be clear to you that MAM is at the heart of AFI. I like to think that a clear positioning of W-ARE, hand in hand with the present positioning of Wageningen Marine Research, would help to advertise even better the merits of MAM, stimulating a competitive growth in number of (inter)national students attracted to Wageningen for studies in aquaculture and fisheries.

In the Netherlands, professional education in these areas at bachelor level mainly occurs at the Universities of Applied Sciences and I am very pleased with new possibilities connected to the lectorships in Den Bosch of Olga Haenen on novel proteins and in Middelburg of Aad Smaal on multifunctional aquaculture. At the same time, several of us will argue that the Blue Revolution simply screams for an international Blue Bachelor programme here on our own beautiful campus.

Since 1998 I have organized an annual series of now 20 international fish immunology workshops, most of the time together with my colleague Maria Forlenza, for good reasons frequently nominated as teacher of the year. These workshops, supported by our Graduate School and the International Society of Fish and Shellfish Immunology, have probably become the best-known PhD training event in the research area. Its highly successful format is based on a combination of intensive science and hands-on labwork lubricated by social interaction and clearly has proven itself: some two weeks ago we said goodbye to the 700th workshop alumnus. It is my wish to continue on this successful path and adopt this format for more of such workshops, for example on recirculating aquaculture systems and on fish nutrition.

Five years ago, I referred to the Bachelor education of both of my daughters with reference to my own role as mentor in the Bachelor Programme here at Wageningen, a role that I still honour. Now, five years later, I am the proud father of a fully-grown Bachelor son and two daughters that became PhD students who now frequently confound with their own publications, PubMed searches for my family name. Several young scientists, including my own daughters, tell me they may not necessarily want to follow in the footsteps of their scientific parents, working more hours than generally considered healthy. My obvious answer that you can spend your time only twice is clearly not considered good enough and I would love to help develop a better answer that could also receive our University's support. Last but not least, I see it as a challenge to help further inter-nationalize our University not only at student but also at staff level. Five years ago I said: it cannot be a coincidence that Oxford, Cambridge and Wageningen are all situated near the sides of a large river. Now, more than ever, as head of the Aquaculture and Fisheries group, I appreciate the enormous potential of fishing for those that are swimming out there.

Allow me, mr Rector magnificus, to express a few words of gratitude

Words of Gratitude

I would like to thank the Board of Wageningen University & Research, the Rector Magnificus Arthur Mol, the Directors of the Animal Sciences Group Menno van Manen and Martin Scholten and above all the members of the Aquaculture and Fisheries group, for their confidence in me and my ability to further shape this great group of specialists. I will not end with thanking all individual group members but I do have to mention two specific sub-groups. To the ladies at our Office I would like to say: there will never be enough rose buds to express the daily pleasure of working with a well-functioning office! To the PhD students I would like to say: I very much look forward to our exchange trip to China only a few weeks from now, you have done a great job organising this!

The basis for my scientific career was formed as a master student of Aquaculture and Fisheries by Carel Richter who as acting head of the group, had a profound impact on my scientific thinking. Carel, it is a great pleasure to know you are present here today. Good fish books are rare! Guus Bongers, it is great to see that again we can combine friendship and work; I look forward to more of this. Bram Huisman, the first head of the AFI group: you sent me for my student internship period to visit dr Anne Powell close to Oxford: I still owe you for this experience, because the attitude and intense combination of private time and working life that I experienced during this internship period, forever changed my own working attitude. After my graduation I got offered a position at the Cell Biology and Immunology group. The continuous support of professor Willem van Muiswinkel makes me proud to wear his toga, now for a second time during my inaugural address. I also would like to thank professor Huub Savelkoul for supporting my route to personal professor and professor Johan Verreth for leaving me with such a great group of aquaculture and fisheries experts. I have returned home.

Last but not least, it is my greatest pleasure to share today's occasion with my family and friends, in particular my mother who may have turned 85 but with a new knee kicks harder than ever before, my beautiful and smart children Renske, Kim and Jidde, their partners, my own partner and best friend Maria, Imke and Paul and many others, including several who are present online. Last but not least, I would like to thank all of you in the audience and those at WUR-television who willingly listened to 45 minutes of Blue Revolution.

Ladies and gentlemen, thank you for your attention. Ik heb gezegd.

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Drir. G.F. Wiegertjes

'Capture fisheries supplies most of the fish protein, but the sustainable exploitation of natural stocks has been maximized and the production of more fish protein for a growing world population can best be realized by the continued intense growth of aquaculture, referred to as the Blue Revolution. Resource-efficient aquaculture, both in the marine environment and on land as ponds or recirculating systems can fulfil much of the world's current and future needs for nutritious proteins from fish. The concept of circularity as presently being developed for livestock, should also become an important guiding principle for the aquaculture systems of the future.'